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Declaration Sheet

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# Chapter 1: Introduction

## 1.1 Project Introduction

In the modern age, the way in which we access the internet is starting to become vastly different from what it used to be. According to statcounter (Global Stats, 2019), 50.38% of all web traffic globally was from a mobile device. 80% of the world’s population in 2023 own a smartphone, and in fact, the world’s population is more likely to solely use a smartphone than it is any other device (Markovic, 2023). Data also suggests that smartphone usage is only going to increase over time, showing an ever-increasing volume of web traffic from smartphones (Statista, 2023).

The aim of this project is to explore and understand web standards and the understanding of human-computer interaction has changed in response to increased smartphone usage, and if the implementation of this is indeed effective. Research will be conducted to explore these standards and current trends and then apply these to a new, dynamic web application.

A web application will be created especially to be accessed on browser within a smartphone device or similar. It is imperative that the design of the web app is accessible and has elevated levels of usability, as with all webapps, but there will be a more important focus on making a project that is easy to interact with and combats the difficulties that are typically faced with a smartphone device. The web application will be developed using a range of web development languages.

Testing of the web app will determine if the artefact created is in fact compliant with the standards research, but also importantly, to determine if indeed the standards applied have any effect on the usability, accessibility, and simplicity of interaction, which is indeed the main goal of this project.

## 1.2 Introduction to Human-Computer Interaction

Human-Computer Interaction is defined by Serengul Smith-Atakan (2008), as a focus on how to best design interactive systems, which are both productive and pleasurable to use. It is a theoretical, and practical implementation of design principles that help systems and designs be functional and overall, much more intuitive for its users. HCI is based on cognitive thinking, and how users of interactive systems, react to and occasionally, fail to use the systems in place.

There are two major design principles that are considered in HCI and web-design, the first of these being “Shneiderman’s Eight Golden Rules” (Ben Schneiderman, 1986). The “Eight Golden Rules” are seen as characteristics of excellent user-interface design and has been seen as a guideline to be used by many major companies since the ideas were first published in Schneiderman’s 1986 book. The aim of the rules is to provide responsive, clear, and concise user interactions, which allow users to receive feedback and have full control over. Euphemia Wong describes the set of rules as “productive and frustration-free.” The second major principle is “Nielsen’s 10 Usability Heuristics” (Jakob Neilsen, 1994). Unlike Scheniderman’s “Golden Rules,” Nielson’s ideas are more broad guides, not specific rules, but do pertain the usability of interactive designs. Also, like the 8 golden rules, the 10 heuristics strive to make applications responsive, giving users immediate feedback ensuring simple navigation, and “recognisable”, hoping to match digital products, to real-world applications.

## 1.3 Understanding Accessibility and Current Issues

Human-Computer Interaction should be constantly adapting, especially to new and emerging technologies and platforms, such as smart and mobile devices. Principles, rules, and guidelines need to be updated at the same time as these technologies evolve, and as the aim of pre-existing ideas strive to reach peak interactive design, these new principles should consider the current wants and needs of the technology. Faiola and Matei (2010), call for new scholarly approaches, equipping the latest academics with a new approach to HCI. Based on a case study, shows how new approaches and a new approach to the theory of HCI, can teach a new range of knowledge.

Understanding mobile HCI should be more than just focusing on the technology, the device, it should be focussing on the user, the person. This is according to Max Wheeler and Co. The idea of “mobile” web development should extend to more than just mobile devices, it is imperative to understand how people uses these devices. The idea of mobile HCI, is understanding these devices are small and portable, designed for on-the-go use. Web design should reflect the positives of the device as being an “anywhere and everywhere convenience.”

There is evidence to suggest that there is still work to be done to ensure usability and accessibility of websites and web applications. According to “A study on usage and usability of the mobile web” (2009), there are still issues with mobile variations of websites and applications in comparison to the computer/browser variations. Most of these issues stem from lack of a tailored version, hoping instead that the translating of the design from a large, peripheral-enabled device to a smaller, touch device is viable and accessible.

Web standards are not something that is enforceable. They are, typically, guidelines. Exact web standards are not forced, however, there are directives and laws demanding that any web or mobile application be accessible, in accordance with other accessibility laws also in effect. The UK and The EU laws are two examples of this. From the gov.uk website (2023), there is a mandated regulation titled the “Public Sector Bodies Mobile Applications Accessibility Regulations”, which states that web applications must be “perceivable, operable, understandable, and robust”. These regulations are based of the wider equality and discrimination act already in place.

## 1.4 Aims and Objectives

### 1.4.1 Academic Question

How have modern touch and mobile devices have affected usability, accessibility, and interaction in web applications?

### 1.4.2 Aims

- Research modern mobile HCI standards and trends to investigate how these have affect usability and accessibility in web apps.

- Understand how HCI is taught in current academia.

- Research current law and regulation to understand how, or if, usability standards are enforced.

- Investigate how the design of modern smart devices has limited interaction and use of web apps.

- Design and implement an interactive and dynamic web application.

### 1.4.3 Objectives

- Develop a functioning dynamic web application using various web development tools and languages.

- Test the prototype and produce user surveys to evaluate the accessibility of the web application.

- Understand if these modern mobile HCI standards have impacted the usability, accessibility, and interaction of webapps on modern devices.

## 1.5 Project Artefact

### 1.5.1 Proposed Artefact

The proposed artefact will be a prototype dynamic web app that will be developed using a variety of programming languages such as HTML, CSS, JavaScript, and PHP. The web application will be designed to fit modern mobile HCI standards and trends, and designed to be used on modern small, touch-based devices like smartphones. The aim is to test how the current trends and current devices have affected usage of webpages in the modern age.

Testing will be conducted to evaluate if these criteria have affected usability, accessibility, and interactivity in the application positively, or negatively. The testing will be completed using a variety of automated tools and well as responses to surveys.

### 1.5.2 Potential Issues and Limitations

There will be a few limitations with the project, in terms of the expansiveness of the artefact. The prototype will be limited in features and functions up to level one has been taught in my previous years at university. An attempt will be made to ensure the project is created at a level like the current level of the course, but it will not be able to compete with other examples available online done by professionals. However, it will be adequate to fully explore and demonstration the academic question and research produced for the project.

Access to the artefact will be reliant on the University’s resources. It will be hosted on the Universities MI-Linux web server, and any issues with access or hosting will be dependent on the connection provided. There is the possibility the service is down for any reason, which could provide delays in the development and implementation of the artefact, or access could be revoked. While this should not be the case, it is a possibility, and has happened in previous years.

## 1.6 Chapter Summary

The introduction to the project detailed the artefact for the project, including the academic question for the project, the aims, and objectives, as well as an initial look into the motivations that lead into the creation of the project.

This chapter have also insighted a look into the topic of human-computer interaction, what the topic covers, the goals, and ideas the subject strives for, and how it should be implemented. As well as details of some current issues and thoughts other have insighted about HCI, such as how it is taught, and what legal structure has been, or could be added, to support it.

# Chapter 2: Literature Review

## 2.1 Introduction

This chapter will be dissecting and reviewing various pieces of literature relating to the project discussion, which is mobile human-computer interaction. The chapter will be exploring discussions on what is human-computer interaction, how it is applied, what it means for usability and accessibility, how it is taught and applied in academia and if, and then how, it can be expanded.

## 2.2 Research

### 2.2.1 Theoretical Views Of Human-Computer Interaction

In the most basic principles, Human-Computer Interaction is the study of measuring interactions between a user (the human), and some form of interactable device (the computer). It concerns the physical, psychological, and theoretical aspects of the interaction [Alan Dix, 2004]. The aims of course, are to consider the means and the environments in which users can access and use information in an interactable space and consider how this can be presented fitting to constraints of not only the technology available, but in a means desirable by a user. Throughout the project, especially with the development of the artefact, one will aim to explore these principles and apply them.

Brain P. Bailey further discuss this notion [et al, 2001], exploring that interaction between a user and a device performs in a much smoother capacity when a user can feel a level of trust in the application. Examining further, the article presents the notion that interaction should always be designed with cultural experiences in mind, taking into consideration what the user is used to and how the interaction may play out in a non-computer-oriented environment. Examples of these non-computer orientated environments will need to be studied further in the project, these will then be applied and expanded on in the design of the artefact. Testing during the process of development will ensure if these ideas have been applied correctly.

Using the previous research, a study [Anacleto et al, 2008] has been conducted exploring and explaining that Human-Computer Interaction thrives when the interactable interface is built off common sense. There needs to be a lot of recognition and application to real-world scenarios in any virtual interface or environment. Building a database of these “common sense” knowledges to apply to Human-Computer Interaction has advanced understanding of how computer systems and interfaces can be developed to be more suited to the way of which users will want to interact and the typical and most frequent ways in which they do, ensuring more flexibility and evolution. In fact, many databases like these exists today – Cyc, Open Mind Common Sense (OMCS) - and include variations of the same model depending on geographical location, expanding on the ideas of basing HCI off cultural implications, which can include variables like language.

Human-Computer Interaction is very much a psychological study as it is a study of physical interaction between the human and the computer. As mentioned above, HCI studies and explores the methods and means in which a user will try to interact with an interface, but mostly this is applied in a case-by-case basis, using casual approaches. So sometimes, applications of Human-Computer Interaction are not consistent. Similarly, to the study above where common sense was looked at, a framework has since been suggested that to make HCI more consistent and to offer more control, theories need to be implemented to add generalisations to the applications of Human-Computer Interaction. The study [Lewis et al, 1989] comments on how most of the current theories regarding consistencies only look at application that are similar and are not applied in a broad spectrum across many different applications that require aspects of HCI. The issues that have been mentioned here start the basis of this project and the necessity of the artefact, there are current gaps in the application of Human-Computer Interaction, and the theory is not fully formed. The aims of the project at the end are to highlight and address these issues.

As mentioned, Human-Computer Interaction is just a study, a lot of what has been discussed is theoretical ideas within the study. The question remains how Human-Computer Interaction gets applied, and specifically, how does one ensure it is applied consistently. After all that is the consensus on what HCI needs, consistency. Standards and regulations are typically how these ideas are applied, by unfortunately a lot of what we have with Human-Computer Interaction now is more guidelines, two major examples of guidelines are the Golden Rules [Shneiderman, 1997] or the Heuristic Principles [Nielsen, 1994]. Any developer who creates an interface within an application will attempt to follow these principles, but there is nothing that binds these ideas to practice. Current lawmakers do not push these principles into current regulations, but there is a strive in accessibility especially regarding disability. Further in this review HCI approaches to disability accommodations will be discussed.

All the theories and practices explored in the research above detail that Human-Computer Interaction in a general form expand multiple routes of theoretical discussions and application. Many different approaches can be applied to achieve varying degrees of intractability and consistent design, some of which having different basis for its applications. HCI can be expanded, and made into a more concrete study, with the potential for regulations to come in to support the study.

### 2.2.2 Applying Human-Computer Interaction To Mobile Devices

As technology has advanced, and new devices and applications have also appeared and advanced, so has societies relationship and sometimes, reliance, with the technology. It has very much become a part of our society, and the type of technologies society employs reflect the type of society the world is. Lancaster University [John Urry, 2000] suggest that this current society, is a mobile one, reflecting technology usage. Virtual movements are like physical movements, an always moving society, which is mixing with other around the globe, need technologies like that. Human-Computer Interaction has thus adapted to mobile scenarios.

Mobile devices are exactly that, devices for a mobile society. The current requirements for a mobile device and its interfaces are to be used while in social environments and for a user who is currently on the move. Physical designs and other technologies have adapted, like reduced sizes and 5G technology, but the virtual interfaces need to reflect this as well. From of a study of on Human Computer Interaction [Oulasvirta and Brewster, 2008], it states that the core values of HCI has intertwined with these societal spheres, breaking new ground. However, the same paper details the shortcoming, and explains how Mobile HCI a doomed study for a long time after its conception was seemingly. The aim of the project is to put the idea that Mobile HCI has fully incorporated into society, by evaluating the current understanding of the study by creating a prototype web application and using human testers to give feedback.

Mobile devices today are a centre of vast amounts of information, they serve not only the social purposes they have always done, but are also a hub of news, or education, data of many kinds such a geographical, environmental, financial. These devices are multifunctional, all-in-one. Mobile devices of this time need to be contextually aware and respond appropriately to the current context using various inputs, not all of which should be provided by the user [Kjeldskov and Paay, 2010]. Using context clue to further interfaces in mobile application using data gathered from the mobile devices, can help strengthen interaction between the user and device, a theory called Indexicality, also described as being able to produce a meaning from social interaction through other means such as signs (Scollon, 2003). With the aims of producing a web application as part of this project, ideas of indexicality and context-based design will need to be taken on board. The idea of HCI is to provide as smooth and as in-depth interaction to users. The web application being produced will be assessed on these and look to address issues within HCI concerning any lapses in usable and accessible design, a context rich design in imperative.

### 2.2.3 Teaching Human-Computer Interaction In Academia

For advancements and new theories in Human-Computer Interaction to be put into practice, they need to be passed on, academia is an avenue for this. Universities and other educational departments will be key for passing new developments onto the next generation of designers and programmers. However, educational establishments need to be scrutinised check whether they are keeping pace with the advancements, and modules are effectively reflecting these innovative ideas. Students must be supplied with better equipped course, both in terms of the theoretical coursework, and the physical equipment to apply HCI methodology in their own builds [Faiola and Matei, 2009]. Pert of this project will be assessing whether current, or modern, mobile HCI theories are being taught and students could understand it and correctly apply these theories to their own work, using research one has conducted, and the own teachings one has received themselves.

Case studies have been conducted to determine such, to determine if academic staff are consistently keeping up with advancements in the subject of Human-Computer Interaction and are adequately applying teaching to the academic curriculum. Studies also look at how HCI can be taught across various environments and locations. To start, it must be known that Human-Computer Interaction is a very complex study, it is a subject that bridges a gap between typical computer science studies (information sciences, computing), social studies (psychology, sociology), and business (industry, ergonomics) [Gull, Saeed, Iqbal *et al,* 2018].

One study was conducted on students in Saudi Arabia [Gull, Saeed, Iqbal *et al,* 2018], across Computer Science and Computer Information Systems students, teaching these students Human-Computer Interaction and logging the results to determine how, or in a potential case, if teaching HCI was effective. The results showed there was two major areas that determine if HCI in academia is successful or not, these being background and orientation. The background of the students matters, not only in this context this study, being the exact course, but also on some other personal factors. One explanation is the global reach of knowledge and technology. Students and institutions fare better in environments that are technologically rich, environments where innovation is more likely to pass through or originate from. The takeaway from the study was that Human-Computer interaction is making a slow progress in academia, current approaches are positive but there are issues that need to be address. Current ideas are not being pushed at a rate at which advancing students’ knowledge, so better insights need to be approached to the HCI teaching spheres.

### 2.2.4 Usability And Accessibility Of The Web

The crux of any design, especially one in which interaction is the focal point, needs to be both usable and accessible. These terms do not necessarily mean the product works and users have access to it, the meaning in this context is the product is designed to be applicable in many scenarios, with ease, to any users regardless of any inflictions or potential disabilities. Human-Computer Interaction can be employed for addressing usability and accessibility, which in fact will be studied and applied to the artefact produced for this project. Another core focus will be on usability specifically within mobile devices, as that is the focused platform for the artefact.

Accessing the web through mobile devices is nothing new, since the turn of the millennia it is a practice that has exploded in popularity, but the infrastructure and design of the mobile web has taken much longer to be perfected. Usability has also been much harder to perfect on mobile devices versus desktop computer. First because of the devices being less powerful, but a problem of the past, and secondly with the smaller sizes and introduction of touch as interaction, both issues addressed. Consider mobile tailored versions of websites and web applications, a variation of standard web pages that have been specifically designed with the mobile platform, recreated to match the constrictions of the platform to improve usability. Studies [Schmiedl *et al,* 2009] have shown that indeed, the tailored sites do indeed improve usability, with tasks being conducted much faster and more efficient, however more complex tasks can be impossible, due to the versions being simpler and reducing commands. While it seems, these variations are preferable, the same study argues that an introduction of mobile specific protocols, and even creating entirely new languages just for web development on the mobile platform could improve usability and accessibility in web application. During the production of the artefact, languages and formats should be assessed. During the planning stage and early prototype, research into which of these should be applied will help create and application that is both more accessible hosted on mobile devices, and more usable to the user.

As we expand onto mobile devices, we need to consider the limitations and how to address them. One of the more obvious, and important limitations, is how accessible is the screen of these devices in terms of readability. Typically, with design comes scalability, so for example screen size and text size; the bigger the screen the bigger text becomes, and the same if you reduce the sizes. This is because not matter the size of the device, designers will ensure (and how programming languages address this) the content always occupies the same percentage of the screen across devices. When designing and thus creating the artefact, these will need to be taken in mind, and expanded on. Many of these issues can be cross evaluated with methodologies in HCI. A study [Cai *et al,* 2023] on readability has shown various way in which it can be improved, using the idea of “themes”. The study does conclude that typically, self-adjustable themes offer a better scale of readability, as not ever user is different and some need accommodations. Accommodations within HCI will be further discussed later in the review. Some obvious aspects of these themes which the study documents include aspects like font size, but also considers experimenting with the scale and spacing, especially negative – or “white – space. Colour is also another important aspect of usability and improving usability, which are an important part of considering a theme.

An aspect of accessibility is not necessarily accessibility of a specified devices, but social accessibility of technology, and advancements in technology. The world around is us varied, and not every society has the potential to access and accept these innovative technologies. Emerging technologies need to be first accepted by society if they are to prove to be useful. Using various social scenarios, social acceptability can be evaluated. Tests can be completed by implementing technology into various social settings or activities, measuring the effectiveness of use by users in the scenarios. These tests also consider the interfaces and inputs that are present, and how these along with the user’s involvement influence the outcome or have been influenced by the environments or the usability of the device. A study [Meyer *et al*, 2020] has been conducted simulating various scenarios, and in its finding found there is a potential for increase in efficiency and usability. Using the scenario generator, studying the various tests can see where issues in social acceptance and acceptability lie, thus countermeasures can be implemented, and technologies can be further expanded to reduce them.

### 2.2.5 Addressing Accommodations With Human-Computer Interaction

One of the core aims of this project is to address and acknowledge inaccessibility within modern web application and where design and methodologies such as Human-Computer Interaction fail to address them. Firstly, knowledge of what can cause inaccessibility is needed to conduct research, and secondly, knowledge of how to combat these accessibility issues to then adapt designs to be more accommodating. Inaccessibility often than not is due to disability, most of the users who face access challenges have some form of disability or impairment. The issue with Human-Computer Interaction research is that not enough of the research is done with people who face these disabilities first hand, a lot of the research is in fact, a generalisation of disability to appeal and work by general usability guidelines. Disability is diverse, and even a group of people who all have the same disability may be impacted by it in the same way. Within books detailing research into HCI [Lazar *et al*, 2017], research methods should be adapted to be more inclusive, as HCI is currently failing to accurately represent the disabled community within research, development, and even in studies and enquiries. The same book also takes into question how typically, designs centred around combating inaccessibility are quickly repurposed to be used by the public, often getting rid of, or changing the very features that made the designs accessible in favour of popularity and economic gain.

There are, fortunately, studies and implementations of using Human-Computer Interaction and general design principles to accommodate disabilities in interface design and interaction. A Polish study [Wrobel, 2018] looked at perception and motor issues in the elderly. The conclusion of the study showed that many motor disabilities can be alleviated with better ergonomic design, but specifically for web interfaces, callback and memory was an issue, contextual clues in the design of an interface made those with eyesight or memory issues struggle with using it. A study conducted in Sweden [Johansson *et al,* 2020] aimed to measure the scope of the range of disabilities in web users. The conclusion drew that common issues do not just stem from perception and motor issues but from cognitive issues as well, more social disabilities as well like those with ASD are underrepresented in HCI research. The common theme found in all these studies is that disability is often an ignored part of HCI research or internet perceptions in general. Studies [Scholz *et al,* 2017] have researched the season why for the neglection, often believing that researchers do not think come to conclusions that disability is even ignored when discussing digital exclusion, the issues is simply not addressed because sometimes it is not seen as an issue that need to be addressed.

## 2.3 Conclusion

From the research there is now a developed understanding of what Human-Computer Interaction is, how to apply it in context, how to methodise the study, and how various ideas and principles within the study can be applied to designs and implementations of web applications and interfaces.

There is also understanding of the history and future of the study of Human-Computer Interaction, in terms of research methodology and how it pertains to designing accessible and usable web applications. One now knows how flawed the study has been, where it has failed to accommodate disabilities in research, failing to acknowledge these communities in research and data gathering.

One also has insight into the teaching of the study of Human-Computer Interaction in academic settings, how the next generation of designers and programmers are being taught an ever evolving and expanding area. The conclusion is that there is need for improvements, resources are not evolving at the same rate, and academic material often fails to include the most recent developments, especially developments in accessible and usable design.

## 2.4 Chapter Summary

# Chapter 3: Investigation and Design

## 3.1 Aims and Objectives

The aim of the design of the artefact is to create a web application that is usable, accessible, and accommodating.

### 3.1.1 Usable Design

Usable design means creating an artefact that is easy to use. The interaction methods of the web application must be simple but effective, users must find them easy to operate, however they must perform often complex or important tasks. Essentially, masking the bulk of the operations behind a simpler face. Usability also falls under functional testing, the web application must first be working and operational, so part of the design must cover all aspects of traditional usability and functional testing. To ensure usable design, Schneiderman’s Golden Rules, or Nielsen’s Usability Heuristics.

#### 3.1.1.1 Schneiderman’s Golden Rules

* Consistency:
  + Consistent design and sequences of action.
  + Terminology should be the same in all prompts, menus, interfaces, etc.
  + Aesthetics design should remain consistent.
* Shortcuts
  + Allow for experiences users to by-pass interfaces (keyboard prompts, etc).
* Informative Feedback
  + Every action should offer feedback, could be visual (symbols, iconography) or text based.
* Dialogue
  + Like feedback, dialogue should be presented to signify the sequence of actions.
  + Beginning, tell the user what will happen.
  + Middle, remind the user what is happening.
  + End, inform the user of the outcome and when the sequence is over.
* Error Handling
  + Errors should first be prevented, telling the user, or blocking the user.
  + If an error occurs, notify the user.
* Permit Reversal of Actions
  + Allow the user to back out of or reverse actions (undo, delete, cancel).
* Support Internal Locus of Control
  + Allow, and encourage, user to be in control (with limits, see error handling).
  + Reduction of pointless actions or data-inputs, where automation can happen, it should.
* Reduce Short-Term Memory Load
  + Use terms, icons, symbols that are universally recognized.
  + Do not make the user repeat too many actions or inputs, remember what the user has done (cookies, auto-fill, etc).
  + Nothing too complex or unique, users should understand this application based on experience with other applications.

#### 3.1.1.2 Nielsen’s Usability Heuristics

* Visibility of System Status
  + User’s must know what the system (in context, the web application) is thinking.
  + Communicate the outcome of interactions and next steps.
* Match Between System and The Real World
  + Terms, icons, concepts, etc, should match real world counterparts.
  + Nothing should be unfamiliar, avoids confusion for the user.
* User Control and Freedom
  + Clear and straightforward way to exit, or cancel, interactions.
  + Clearly marked “exit doors,” so to speak.
* Consistency and Standards
  + Industry conventions must be followed.
  + Users must be able to understand the meaning behind the terminology.
* Error Prevention
  + Errors should be stopped, do not allow the user to fall into pitfalls.
  + Testing to eliminate common problems, error-prone sections.
  + Mistakes are often caused by a mismatch between the design and the users understanding on the design.
* Recognition Rather Than Recall
  + Have the information readily available, do not make the user remember meaning or intention.
* Flexibility and Efficiency of Use
  + Shortcuts for experts, but easy to use for novices.
* Aesthetic and Minimalist Design
  + No irrelevant information to avoid confusion.
  + Additional information must match context and be fully supplied.
* Help Users Recognize, Diagnose, and Recover From Errors
  + Layman’s terms for error messages.
  + Allow the user to self-diagnose and fix issues, rather than be told by the application.
* Help and Documentation
  + Supply additional sources to allow users to read.

### 3.1.2 Accessible Design

Accessible design can be seen in two different fronts, offering design that is accessible in features to a range of users, but also offering design that is flexible in terms of access and platform. While accessible design is usually thought of in the terms of providing design that is accommodating to those who are not as abled as others, or offering design that is easy to use and manageable by all users, but accessible design does not stop there.

One must remember in designing, that while the designs are for the mobile platform, that platform can still vary in size, functionality, and input methodology. Therefore, accessible design takes a priority in terms making a design that is ever functional, ever manageable, and maintains a consistence presence of ease of use over any mobile platform.

### 3.1.3 Accommodating Design

Whereas one focuses more on flexibility and manageable design for accessibility, addressing issues with usage that fall within realms of disability accommodations, is being addressed with accommodating design. A crucial aim with the design of the web application that will be creating alongside the project is research and implementing as many accommodations as possible and focusing on an approachable design philosophy. The initial web application interface that is presented to users, as in what they see once the application has been loaded up, needs to feature as many accommodations as possible. However, there needs to be some consideration, that while one feature may be accommodating to one person, it might prove repellent or discommoding to another. Therefore, additional options that are triggerable or externally applicable need to be implemented, meaning additional designs need to drafted alongside all other designs, one additional design for each accommodation.

Some accommodations that should be applied to the designs of the web application are as followed:

* Adjustable colour schemes/thematic/aesthetics: While the web application will have its initial colourway, which could already be one that is accommodating, additional optional variations that help with various forms of colour blindness.
* Adjustable font size/line spacing/image size: While most browser do have built in zoom functions; mobile applications can be more temperamental. Adding a built-in feature to the website itself allows as well for better formatting, one that can remain consistent.
* Brightness and contrast settings: Like colour schemes, to assist those with Colour-Visual Deficit.
* Reduced information mode: Implement a reduction in the amount of information being displayed or loaded at one time. This is to help deuce stimulation overload, occurring in those with neurodivergent disabilities.
* Plain text or alt text: Applies descriptive text to all images and icons.
* Easy buttons/functions: Allow better navigation and functional use of the web application, those with physical disabilities may find it harder to use a mobile device.

## 3.2 Development Applications

There are a few choices regarding resources that need to be made before design and development of the artefact can take place. A lot of resources are self-explanatory and do not need much consultation, but one specifical application does need some consideration.

As per the proposal, some of the applications and technology used in development, design and testing of the artefact have already been chosen. The artefact will be hosted on the University’s MI-Linux server, this allows the application to be hosted in one place and be accessed elsewhere, which will prove useful especially in testing, meaning tester will not need access to any files making the process much quicker and simpler. A browser is also key for my own personal testing, to access the application. Simple programs such as Excel will also be useful for creating test plans, testing materials, and documenting results of testing.

The one application choice that has needed some consultation, is the application that will create the artefact. An IDE or similar will be required, and the choice of which will vital, as IDE’s can offer great assistance in development. One aspect is price, a free application will be preferable, also easily available. Features and functionality will be an important deciding factor, offering resources and assistance is what makes a good IDE, and betters the developments. The choice came down to two offering by Microsoft, both free applications, Visual Studio Community and Visual Studio Code. Visual Studio Code is a fully developed IDE, while VS Community functions more as a text editor, but designed for code. Both has various levels of built in functionality for assistance. Ultimately, Visual Studio Code is the better option, as it is created more for the development of applications than its counterpart. While free, there is also paid options, allowing for more functionality, and a package manager to add or change additional support features. However, VS Community could still be useful, its design as an editorial application rather than a development one has advantages when testing and reviewing the artefact.

## 3.3 UML Diagrams

## 3.4 Wireframes

A screenshot of a website

Description automatically generatedA screenshot of a computer

Description automatically generatedA screenshot of a website

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Figure 1.C: A screenshot of a wireframe, displaying a proposed design for the web applications products page. The page features a dropdown menu displaying options for various filters, allowing users to change order or appearance of listed products.

Figure 1.B: Screenshot of a wireframe, displaying a proposed design for the web applications Settings page, featuring options for various accessibility settings.

Figure 1.A: Screenshot of a wireframe, displaying a proposed design for the web apps Homepage, including a popout navigation menu.

## 3.5 Test Plan

|  |  |  |
| --- | --- | --- |
| **Test** | **Details** | **Dates** |
| Testing Round 1: Functional Testing | Functional testing needs to conducted initially, but the results of this testing do not need to be recorded. The results of functional testing do not necessarily answer the question presented at the start of the project and does not present themselves towards the aims and objectives outlines at the start of the project either. However, functional testing is still required to ensure functionality of the artefact, and ensure the prototype is indeed in all working order. The results of the functional testing, however, can be used as a precursor to further levels of testing. | 15th March – 22nd March |
| Test 1: Automated Usability Testing | There are many software’s and applications available that offer automated usability testing. This enables a software to have access to the web application and score it based on many factors. Automated testing in beneficial for several reasons, mostly due to resource management. Automated testing can simulate massive amounts of users in such a brief time, making it a time effective process, a process which also requires little human interaction therefore needing a small number of resources. Automated testing is very much the first part of testing, but it is not a refined method, further testing methodologies should be applied to the artefact to ensure full coverage. While automated testing is a form of functional testing, the results from this specific testing could still be logged. As the automated software is testing for usability issues, the results can align with the aims of the project, and therefore the results could be used in any conclusions to back up any statements. | 15th March – 17th March |
| Test 2: Black-box Testing | Two types of black box testing will be employed, the first will be use-case, and the second will be error guessing. As the development of the artefact commences, notes and diagrams will be made on many different parts, highlighting what each function is for and the desired outcome. Once development is complete and testing will begin, these documents can be used to refer to, testing each entry and then logging the result. If the result matches the hypothetical outcome already written down, then the feature is deemed as operation. If not, further development could be required, or it could be deemed as something for future practice. After use-case testing is conducted, using the knowledge gathered from the process, more testing will be conducted to expand the realms of testing, Using the knowledge gathered and specialist knowledge, testing will be conducted on areas that can be deemed vulnerable or critical. | 18th March – 22nd March |
|  |  |  |
| Testing Round 2: User-Based Testing | The second round of testing is the section of the testing where the results are more of a direct response the projects aims and objectives, as well as the academic question. These tests require human responses, from a group of people who have had direct interaction with the project's artefact. Their responses will be part of the determination if the artefact is fully functional and answers the project's aims, and if the project is a success or not. | 23rd March – 29th March |
| Test 1: Surveys/Questionnaires | The automated responses carried out in the first round of testing will offer a great benchmark for where the artefact lies in usability, but automated testing can only take the feedback so far. For testing accommodations, inclusivity, interactability, a personal approach will be preferable. Especially when comparing the accommodating designs against the disabilities it is meant to accommodate, using a human reviewer will be more beneficial. This testing also gives much more detailed responses, automations can only give limited information based on its design and parameters, but personal usage of the web application by a real user can give more open and honest feedback. Each user will also be different in their experiences, in their time spent with the artefact and in how they choose to interact with the web application. A survey will be created to receive feedback from users about their experiences with the web application. Questions will be designed to test users about the usability and interactivity of the web application, and their experiences with the accommodations built into the artefact. There will be two different question types, offering different data types. Questions aimed at receiving a worded response will offer qualitative data. These questions will be more open ending, presenting the tester with offering honest feedback that is of their own choosing. These questions will often back up other questions in the survey and gather additional information. Other questions presented will be more of a scale-like question. Asking the user to rank features of the website on a scale, typically 1-10. This offers quantitative data. These questions allow a numerical representation of how well the features of the website are working, and the level of usability. The various results can then be compiled, and the average calculated. Features receiving a high average can be recorded as successful, and those with a medium to love score are areas that need to be worked on more. The worded questions act as additional information to the numerical type responses, especially if there is an anomalous result, using numbers help that to become more apparent than worded responses, but the worded responses help delve into the details of why a feature has received a low score. | 23rd March – 26th March |
| Test 2: Interviews | Interviews can be done secondary to the surveys and questionnaires. Interviews introduce a chance to be one-on-one with testers and users of the artefact, this will be especially useful if the testers have specialist knowledge. One’s colleagues and teachers would be useful for this and could be one demographic for the interviews. However, those without specialist knowledge can provide better and less biased feedback. Those without specialist knowledge have less of an understanding of how web applications are programmed, they see these objects on a more surface level, if a feature does not work, they cannot create a work around like most with specialist knowledge will. Allowing those without specialist knowledge to first test the artefact provides a much more appropriate baseline from which to then produce further testing. | 27th March – 29th March |

## 3.6 Chapter Summary

# Chapter 4: Implementation

## 4.1 Web App Implementation and Features

## 4.2 Accessibility Option – Colour

### 4.2.1 Outline

One accessibility considered is the option to change the colourway of the website in response to various types of colour-blindness. The though process behind this option was to research into the various types of Colour Vision Deficiency and implement an ability to adapt the various colours used within the web app using some form of checkbox. The research started off by concluding which colour palette would be best to initially use for the website, then the various types of Colour Vision Deficiencies there are to establish how many options there would need to be implemented, and then finally the best colour combinations to use for each variation of Colour Vision Deficiency. Through this research one found that a light blue and a medium orange were the best two colours to use, as these are the two colours that are least impacted by Colour Vision Deficiency. Also in this research, one found out there are three main types of colour deficiency, which are as follows: Deuteranomaly (deficiency in green pigments), Protanomaly (deficiency in red pigments), and Tritanomaly (deficiency in blue pigments). With this, one was able to better implement a changing colour design catered to these three types of colour vision deficiency.

### 4.2.2 Implementation

All implementations of all accessibility options are added in the same way. A new pop-out section has been incorporated to the website so that on each page, it can be opened, and all options are present. This also makes each accessibility option applicable to each individual page, rather than for all.

A yellow background with black text

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Figure 3.A: A screenshot of the web application, showcasing the ability to change colour via checkbox, each checkbox labelled for a different variation on colour-vision deficiency.

As evident from the figure above, for this accessibility option, four checkboxes have been included, each labelled for the various type of deficiency the option is aimed at, as well as an option to revert to the original selection (which is the default colourway of the web app). Once a new checkbox is marked, the colour scheme of the site is changed. The way in which this has been implemented is by using JavaScript, when a new checkbox is selected a function is alerted by having the code check which exact box is checked by receiving the ID name. Each ID refers to either the original, or one of the three deficiency types. Once a checkbox is selected, the JavaScript function then edits the CSS styling of all applicable elements that require the changes to be made, add changing the styling to reflect the different colours needed. This has been demonstrated bellow with various screenshots.



Figure 3.B: Evidence of the “Deuteranomaly”

checkbox being checked.

A blue background with orange text

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Figure 3.C: Evidence of the colour scheme changing in response to input.

These above screenshots demonstrate changing styles when the Deuteranomaly accessibility option is checked. Thus, the bellow screenshots demonstrate changing styles when the Protanomaly accessibility option is checked.



Figure 3.D: Evidence of the “Protanomaly”

checkbox being checked

A green background with orange text

Description automatically generated

Figure 3.E: Evidence of the colour scheme changing in response to input.

### 4.2.3 Issues

One major challenged faced with implementing an efficient colour assist was effectively designing and matching the various colours to each of their respective deficiency type. One wanted to keep the original colourway as intended, which meant when selecting new colours, they had to be carefully selected so that to even someone with a deficiency, it would look the same as to someone without the deficiency. While one did manage to find a tool to simulate how each colour would look with the varying types of deficiencies, a tool to effectively pinpoint what exact colour would be needed to match the original scheme was not available. So, creating this option involved a lot of trial and error by selecting a colour and running it through the simulator, then comparing the output to an original still image.

## 4.3 Accessibility Option – Text Size

### 4.3.1 Outline

### 4.3.2 Implementation

### 4.3.3 Issues

## 4.4 Accessibility Option – Image Size

### 4.4.1 Outline

### 4.4.2 Implementation

### 4.4.3 Issues

## 4.5 Accessibility Option – Changing Control Type

### 4.5.1 Outline

### 4.5.2 Implementation

### 4.5.3 Issues

## 4.6 Accessibility Option – Reduced Information

### 4.6.1 Outline

### 4.6.2 Implementation

### 4.6.3 Issues

## 4.7 Accessibility Inclusions – Alt Text

### 4.7.1 Outline

### 4.7.2 Implementation

### 4.7.3 Issues

## 4.8 Accessibility Inclusions – Keyboard Control

### 4.8.1 Outline

### 4.8.2 Implementation

### 4.8.3 Issues

## 4.9 Accessibility Inclusions – Language

### 4.9.1 Outline

### 4.9.2 Implementation

### 4.9.3 Issues

## 4.10 Conclusions

## 4.11 Chapter Summary

# Chapter 5: Testing and Verification

# Chapter 6: Evaluation

# Chapter 7: Conclusion

## 7.1 Summary

## 7.2 Critical Evaluation

### 7.2.1 Research

### 7.2.2 Design

### 7.2.3 Implementation

### 7.2.4 Testing

### 7.2.5 Project Management

## 7.3 Further Production

# References

Markovic, I. (2023) *Six Statistics That Highlight The Power Of Mobile Learning*. eduMe. Available at: https://www.edume.com/blog/mobile-learning-statistics (Accessed: 19 October 2023).

Bouchrika, I. (2023) *Mobile vs Desktop Usage Statistics for 2023*. Research.com. Available at: https://research.com/software/mobile-vs-desktop-usage (Accessed: 19 October 2023).

Taylor, P. (2023) *Average Monthly Smartphone Traffic Worldwide 2028*. Statista. Available at: https://www.statista.com/statistics/739002/worldwide-smartphones-monthly-data-traffic/ (Accessed: 19 October 2023).

Smith-Atakan, S. (2006). *Chapter 1: Introduction*. In: Human-Computer Interaction. Australia: Thomson.

Wong, E. (2023). *Shneiderman’s Eight Golden Rules Will Help You Design Better Interfaces*. The Interaction Design Foundation. Available at: https://www.interaction-design.org/literature/article/shneiderman-s-eight-golden-rules-will-help-you-design-better-interfaces (Accessed: 23 October 2023).

Nielson, J. (2020). *10 Usability Heuristics For User Interface Design*. Nielsen Norman Group. Available at: https://www.nngroup.com/articles/ten-usability-heuristics/ (Accessed: 23 October 2023).

Faiola, A. and Matei, S.A. (2009). *Enhancing Human–Computer Interaction Design Education: Teaching Affordance Design For Emerging Mobile Devices*. In: International Journal of Technology and Design Education. Volume 20, Issue 3. Pp. 239–254. DOI: 10.1007/s10798-008-9082-4.

Castledine, E., Eftos, M. and Wheeler, M. (2011). *Build Mobile Websites and Apps for Smart Devices*. Collingwood, Australia: Sitepoint Pty.

Schmiedl, G., Seidl, M. and Temper, K. (2009). *Mobile Phone Web Browsing*. In: Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services [Preprint]. DOI: 10.1145/1613858.1613942.

(2023). *Understanding Accessibility Requirements For Public Sector Bodies*. GOV.UK. Available at: https://www.gov.uk/guidance/accessibility-requirements-for-public-sector-websites-and-apps (Accessed: 24 October 2023).

Dix, A. et al. (2004). *Human-Computer Interaction*. Edition 3. Pearson Educational.

Bailey, B. P., Gurak, L. J., Konstan, J. A. (2001). *An Examination of Trust in Computer-Mediated Exchange.* In: Proceedings of the 7th Human Factors and the Web Conference. Pp, 1-8. DOI: 10.1.1.202.4085.

Anacleto, J. C., de Carvalho, A. F. P (2008). *Improving Human-Computer Interaction by Developing Culture-Sensitive Applications Based on Common Sense Knowledge*. In: Asai, K (eds.) Human Computer Interaction: New Developments. Pp, 1-30. DOI: 10.5772/85.

Lewis, C., Hair, D. C., Schoenberg, V. (1989). *Generalization, Consistency, and Control*. In: Bice, K., C, Lewis. (eds.) Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, Volume 20, Issue SI. Pp, 1-5. DOI: 10.1145/67450.67451.

Shneiderman, B. (1997). *Designing the User Interface: Strategies for Effective Human-Computer Interaction*. Addison-Wesley Longman Publishing.

Nielsen, J. (1994). *Enhancing The Explanatory Power of Usability Heuristics*. In: Adelson, B., Dumais, S., Olson, J. (eds.) Proceedings of the SIGCHI Conference on Human Factors In Computing Systems. Pp, 152-158. DOI: 10.1145/191666.191729.

Urry, J. (2000). *Sociology Beyond Societies: Mobilities For The Twenty-First Century*. Routledge.

Oulasvirta, A., Brewster, S. (2008). *Mobile Human–Computer Interaction*. In: Brumby, D. (eds) International Journal of Human-Computer Studies, Vol 66, Issue 12. Pp, 833-873. DOI: 10.1016/j.ijhcs.2008.10.001.

Kjeldskov, J., Paay, J. (2010). *Indexicality: Understanding Mobile Human-Computer Interaction in Context*. In: ACM Transaction on Computer-Human Interaction. Volume 17, Issue 4. Article 14, Pp, 1-28. DOI: 10.1145/1879831.1879832.

Scollon, R., Scollon, S.W. (2003). *Discourses In Place: Language In The Material World*. Routledge.

Gull, H., et al. (2018). *Reflection on Teaching Human Computer Interaction Course to Undergraduate Students.* In: 2018 International Conference on Computational Sciences and Computational Intelligence. Pp, 659-662, DOI: 10.1109/CSCI46756.2018.00132.

Shcmiedl, G., Seidl, M., Temper, K. (2009). *Mobile Phone Web Browsing: A Study On Usage and Usability of The Mobile Web.* In: Oppermann, R (chairman) Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services, Article 70. Pp. 1-2. DOI: 10.1145/1613858.1613942.

Cai, T., et al. (2023). *Preferred Reading Formats for Mobile Devices: Results from Readability Studies*. In: Komninos, A., et al. (eds.) Proceedings of the 25th International Conference on Mobile Human-Computer Interaction. Article 19. Pp, 1-9. DOI: 10.1145/3565066.3608706.

Meyer, H., Keolle, M., Boll, S. (2020). *A Scenario Generator for Evaluating the Social Acceptability of Emerging Technologies.* In: Loizides, F. et al. (eds.) Human Computer Interaction and Emerging Technologies: Adjunct Proceedings from the INTERACT 2019 Workshops. Pp. 101–110. Cardiff: Cardiff University Press. DOI: https://doi.org/10.18573/book3.

Lazar, J., Feng, J. H., Hochheiser, H. (2017). *Research Methods in Human-Computer Interaction*. San Francisco: Elsevier Science & Technology.

Wrobel, K. (2018). *Identification of the Perceptive and Motor Skills in Elderly People when Designing a Human-Computer Interaction*. In: Polak-Sponinska, A., Krolikowski, J. (eds.) Ergonomics For People With Disabilities. Volume 1. Pp, 163-174. DOI: 10.2478/9783119617832-014.

Johansson, S., Gulliksen, J., Gustavsson, C. (2020). *Disability Digital Divide: The Use of The Internet, Smartphones, Computer and Tablets Among People With Disabilities in Sweden*. Univ Access Inf Soc 20. Pp, 105–120. DOI: 10.1007/s10209-020-00714-x.

Scholz, F., Yalcin, B., Priestley, M. (2017). *Internet Access for Disabled People: Understanding Socio-Relational Factors in Europe*. In: Cyberpsychology: Journal of Psychosocial Research on Cyberspace. Volume 11, Article 4. DOI: 10.5817/CP2017-1-4.

(2022). *Visual Studio vs Visual Studio Code - What’s Best In 2024?* Available at: https://www.turing.com/kb/ultimate-guide-visual-studio-vs-visual-studio-code (Accessed: 12 December 2023).

Dudharejia, M. (2020). *9 Ways You Can Make Your Website More Accessible*. Search Engine Journal. Available at: https://www.searchenginejournal.com/make-website-more-accessible/347450/ (Accessed: 23 December 2023).

Wong, K. (2022). *What Is Automated User Testing and is IT THE FUTURE OF UX Testing*. Marvel Blog. Available at: https://marvelapp.com/blog/automate-user-testing-process/#:~:text=Automated%20tests%20can%20simulate%20hundreds,and%20shortening%20your%20development%20cycles. (Accessed: 27 December 2023).

Homès, B. (2012). *Fundamentals Of Software Testing*. iSTE.

*Color Blind Vision Simulator: Color Blind Glasses Simulator.* (no date). Pilestone Inc. Available at: https://pilestone.com/pages/color-blindness-simulator-1.

# Bibliography

*Desktop vs Mobile vs Tablet Market Share Worldwide - September 2023.* (2023). Available at: https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet

Laricchia, F. (2023). *Smartphone Shipments By Quarter 2023*. Statista. Available at: https://www.statista.com/statistics/728644/quarterly-global-smartphone-shipments-by-quarter/ (Accessed: 19 October 2023).

Love, S. (2005). *Understanding Mobile Human-Computer Interaction (Elsevier Butterworth-Heinemann information systems series)*. Butterworth-Heinemann.

York, J. and Pendharkar, P.C. (2004). *Human–Computer Interaction Issues For Mobile Computing in a Variable Work Context*. In: International Journal of Human-Computer Studies. Volume 60, Issue 5–6. Pp. 771–797. DOI: 10.1016/j.ijhcs.2003.07.004.

(2020). *Web Accessibility Directive: Frequently Asked Questions*. Web Accessibility Directive: Frequently Asked Questions. Available at: https://www.web-directive.eu/#toc1 (Accessed: 24 October 2023).

Mantere, E. (2020). *What Smartphones, Ethnomethodology, and Bystander Inaccessibility Can Teach Us About Better Design?* In: Loizides, F. et al. (eds.) Human Computer Interaction and Emerging Technologies: Adjunct Proceedings from the INTERACT 2019 Workshops. Pp. 91–100. Cardiff: Cardiff University Press. DOI: https://doi.org/10.18573/book3.

Repenning, A., Sumner, T. (1994). *Programming as Problem Solving: A Participatory Theater Approach.* In: Costabile, M. F, et al (eds.) Proceedings of the Workshop on Advanced Visual Interfaces - AVI ’94 [Preprint]. Pp. 182-191. DOI:10.1145/192309.192346.

Urquhart, L., Rodden, T. (2017). *New Directions In Information Technology Law: Learning From Human-Computer Interaction.* In: International Review of Law, Computers & Technology. Volume 31 (2). Pp, 150-169. DOI: 10.1080/13600869.2017.1298501.

Brewer, J., Dourish, P. (2008). *Storied Spaces: Cultural Accounts of Mobility, Technology, and Environmental Knowing*. In: Internation Journal of Human-Computer Studies. Volume 66, Issue 12. Pp, 963-976. DOI: 10.1016/j.ijhcs.2008.03.003.

Lazem, S., Dray, S. (2018). *Baraza!: Human-Computer Interaction Education In Africa*. In: Barbosa, S., Cockton, G. (eds.) Interactions: The Business of UX Strategy. Volume 25, Issue 2. Pp, 74-77. DOI: 10.1145/3178562.

Baker, S.C. (2014). *Making It Work For Everyone: HTML5 and CSS level 3 for Responsive, Accessible Design on Your Library’s Web Site*. In: Journal of Library And Information Services in Distance Learning, 8(3–4), pp. 118–136. DOI: 10.1080/1533290x.2014.945825.

Prosvetova, A., Bartlett, S. and McCall, S. (2023) *5 Tips On Designing Colour-Blind-Friendly Visualizations*, *Tableau*. Available at: https://www.tableau.com/en-gb/blog/examining-data-viz-rules-dont-use-red-green-together#:~:text=For%20example%2C%20blue%2Forange%20is,palette%20designed%20by%20Maureen%20Stone. (Accessed: 19 December 2023).

# Appendices

## Appendix 1: Gantt Chart

A screenshot of a project

Description automatically generatedThe Gantt chart above details estimated key milestones within the project, as well estimated periods to complete various tasks that are relevant to the development of the project. The milestones were based off guidance from the module leader and are not exact time measures or enforceable submission dates, the actual dates for milestones are estimated to be delivered up to a week either before or after the date on the Gantt chart.

## Appendix 2A: Initial Timetable

An additional timetable was created to assist in planning and an insurance for timekeeping. Additional information can be added to each task that was not available to be added on the Gantt chart. A positive of this timetable is the ability to record not only an expected start/end date, but an actual start/end date. This allows a comparison to be made at the end of the project and see which aspect of the project I spent too long on, or therefore did not spend enough time working on, to highlight where shortcomings within the project came from.

A screenshot of a computer

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A screenshot of a computer

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## Appendix 2B: Final Timetable