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Exploring Different Ways to Present Pedagogical Material in Digital Formats

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Abstract

English

With more and more schools today introducing computerized literature and digital consumption tools such as the Apple iPad, there is a need to identify what efforts have gone into making them both usable and pleasant to utilize. While the availability of digital text is abundant, the availability of digital syllabi specifically tailored for digital consumption is still limited. This study will research the differences between reading digitally and reading from physical books. A secondary part of this study is to assess the viability of using modern web technologies to create a usable reading application while providing the reader with a pleasant reading experience.

To collect the data for this study, three semi-structured interviews with two different groups of university students have been conducted. These interviews include a simple user testing of a purposely built prototype web application. This prototype is used by thee of the interviewees to explore the various typographical techniques implemented, and evaluate the importance of an assortment of usability-enhancing features.

Through these interviews, this study identifies a set of typographical features and techniques that helps create a pleasant reading experience, and identifies a set of features that needs to be present to create a usable digital reading experience.

The features requested unanimously across the interviews seem to suggest that there is a set of features that a usable text-reading-centric application should include to be considered useful. These features mostly seem to consist of ways to make up for the features that go missing when translating a text to a digital format, but also ways to assists in utilizing the relative advantages of being digital.

Norwegian

Stadig flere skoler innfører i disse dager digitale læreverk og digitale leseverkøy som for eksempel Apple iPad. Det er derfor behov for å identifisere hvilke grep som har blitt gjort for å gjøre disse tekstene både anvendelig og behagelige å lese. Selv om der er rikelig tilgang på digital tekst i dag, er tilgjengeligheten av skreddersydde digitale læreverk fortsatt begrenset. Denne studien vil se på forskjellene mellom lesing digitalt og lesing fra fysiske bøker. En sekundær del av denne oppgaven ligger i å vurdere brukbarheten til moderne web-teknologi for å lage en brukervennlig leseapplication som bidrar til en god leseopplevelse.

Datainnsamling for denne studien er primært tre semi-strukturerte intervjuer med to ulike grupper studenter. Deler av disse intervjuene bestod av en enkel brukertest hvor en enkel prototype skal benyttes av intervjuobjektene til å utforske ulike typografiske teknikker og vurdere betydningen av et knippe funksjoner implementert for øke applikasjonens brukervennlighet.

Gjennom disse intervjuene, identifiserer denne studien et sett typografiske funksjoner og teknikker som bidrar til å skape en behagelig leseopplevelse, og identifiserer et sett med funksjoner som må og bør være tilstede for å lage en brukervennlig digital leseopplevelse.

Funksjonene som ble etterspurt i intervjuene synes å antyde at det eksisterer et sett med funksjoner som en brukervennlig leseapplikasjon bør inneholde for å oppfattes som brukervennlig. Disse funksjonene består stort sett av måter å gjøre opp for funksjoner som mangler når en oversetter en tekst til et digitalt format, men også bistår i å utnytte de relative fordelene en bok har ved å være digital.

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1 | Introduction

This thesis will explore the possibilities of using modern web based digital typographic techniques to enhance the experience of reading of digital texts, using a university compendium of texts and digital typography best-practices gathered from available literature. An emphasis has been put on using a paginated interface for navigating, as opposed to the scrollable text that one most often encounter on the Internet.

This thesis will through the development of a prototype book, using a set of emerging web technologies, try to create the "perfect book", by alleviating the pitfalls that the studies points out and by implementing all the features deemed necessary to create a pleasant reading experience of digital text. With maturing web standards and web technologies, new modern typographic techniques are made possible, creating a possibility to create web based digital long-form texts. The thesis will explore these possibilities to establish the viability to use the web platform to create a readable digital book.

1.1 Motivation and background

Ever since the introduction of the home computer, more and more information is being consumed digitally. Music and photographs have been digitized for years already, with videos slowly joining its cousins. One type of medium has however, even though the format is easy to store and reproduce eluded digital consumption: the *long form text book*. The idea of reading books digitally is however not at all that new, with the availability of digital books on the Internet predating the world wide web by decades. The world's largest digital library, *Project Gutenberg* has for instance been around since 1971 [Gutenberg, 2011]. Yet, studies show that most people prefer to read texts in a physical format, citing various reasons to why this is the case.

> What is different now, some literacy experts say, is that spending time on the Web, whether it is looking up something on Google or even britneyspears.org, entails some engagement with text. [Rich, 2008]

The issue is clearly not a lack of availability of text, but rather something else entirely. Yet, there is some evidence that the perception of digital text is changing. The Amazon Kindle and the Apple iPad has with their impressive sales figures proved that people are starting to purchase books in digital form, which can suggest that people do in fact read digital texts. The conclusion of a selection of relevant studies are discussed in chapter 2.

1.2 Research questions

The main idea is to explore the possibilities of using new web technologies to create a digital book that is actually readable. This has lead to the following research questions.

1.2.1 Primary research questions

The core topic that this thesis will explore is the idea of the digital book. As one can see from the literature review in chapter 2, it seems that literature in general supports the notion that people prefer to read physical versions of text compared to digital counterparts. This thesis will attempt to find reasons for why this might be, as well as suggesting how to alleviate the shortcomings of digital books. To do this, two primary research questions has been formulated to research this.

RQ1 How can you create digital expository books that are readable?

RQ2 Which features of a digital book are important for creating a pleasant user experience?

1.2.2 Secondary research questions

The primary research question above can be divided into secondary research questions focusing more granular on usability and user experience, as the concept of a readable digital text is very dependent on providing a usable, pleasant experience. The questions defined below are mainly concerned about assessing the viability of available HTML technologies[1] to adhere to a defined set of criteria regarding usability and user experience. To best test this, a working prototype implementation is to be created as an aid in answering the following questions.

RQ3 How does a text created using web technologies compare to a text using traditional typography techniques?

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[1]HTML, CSS and EcmaScript/JavaScript.

The prototype

To assess the utility of web typography, part of this thesis is the design and implementation of a working prototype application – *Clementine* –, using a defined set of the typographical innovations afforded by modern web standards. This is to get an indication of how hard it is to create a text using the new standards, either from scratch or converting an existing text and help assess difficulties and the feasibility of the conversion in future projects. Furthermore, this thesis will discuss the advantages and disadvantages of using HTML as a publishing platform for long form textual content, both from the respondents' perspectives gathered through the user testing and perspectives gathered from available literature. A discussion on the design and implementation of the prototype can be found in chapter 5.

1.2.3   Tertiary research questions

Related to the secondary question, thoughts and experiences gathered by the developer during the creation of the working prototype will be documented as this will answer some interesting tertiary questions. These questions are more related to work flow, and how the technologies chosen for the implementation stack up against their alternatives.

RQ4 How hard is it to create a digital text using HTML technologies?

1.3   Goals of this study

1.3.1   Primary goal

The primary goal of this study is to research how a digital text produced using modern typographical techniques is perceived by a group of students, compared to an equivalent text produced through traditional means.

There seems to be a need to paginate text, but most of the formats available today are bad, usability-wise. Dyson and Haselgrove [2000] points to how digital text is traditionally laid out as a long continuous scrolling page might affect how readers comprehend the text. In physical books, a reader is able to keep a mental map of where important information is located, in relation to the physical book and page itself [2]. This is lost in long, scrolling pages, where text is continually moving, transforming and shifting as the reader navigates through the document.

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[2]Including approximations to where in the book a chapter is, where on a page an important chunk of information is.

Paginated texts are not only readily available, it is for academic text by far the most prevalent – most academic texts available on the Internet today are available in PDF format. There are however large usability problems associated with the PDF format. Jacob Nielsen provides us with the following analogy on his professional web log.

> PDF is great for one thing and one thing only: **printing documents**. Paper is superior to computer screens in many ways, and users often prefer to print documents that are too long to easily read online.
>
> For online reading, however, PDF is the **monster from the Black Lagoon**. It puts its clammy hands all over people with a cruel grip that doesn't let go. [Nielsen, 2003]

While studies continue to show that people prefer to print to read long form texts [Liu, 2005], the success of devices such as the Kindle show us that text can in fact be presented in a format that users would like to use. In other words: can be consumed digitally *if the text presented fits the format*. With increasingly sophisticated web browsers and web standards, and better screens, is it possible to create texts that are pleasing and usable for digital consumption? What effects on the user, in terms of retention and recollection has texts created using new technologies compared to the "old" way of presenting digitally? What effects do such texts have in comparison to the "traditional" printed page?

Another hurdle to digital consumption is that digital texts are missing an easy way to do markup, compared to physical texts [Thayer et al., 2011]. On printed pages a reader is able to take notes in margins of the text and highlight text if deemed important. There are tools available for digital texts, but compared to pen and paper they are cumbersome.

How does a text laid out with new web typography technologies and techniques compare with equivalent texts with traditional web typographical means?

1.4   Research Method

The main method of data collection in this study is group interviews with students – people who are expected to have read academic texts as part of their education. These interviews will consist of a discussion on the interviewees' experiences with reading, both from screens and physical books, and a user test of a prototype version of a digital book specifically designed for the purpose of this study. A detailed explanation on how and why this prototype was created can be found in chapter 5. After the conclusion of the user test, there is set aside time for a discussion on the prototype book, the metaphors employed and the overall user experience. Chapter 3 contains a more thorough description of the research methods used.

1.5 Results

Resulting from this study will be a set of conclusions and hypotheses gathered from the interviews, topics that is felt that provides some insight into what features and techniques are relevant when designing a readable digital text. Special interest has been given to the technique of pagination, but the results are not limited to pagination.

Due to part of the study including the creation and testing of a prototype application that incorporates a battery of typographical techniques with the intention to create a pleasant reading experience for consuming digital text, this prototype, presented in a functional manner[3], is an additional result of this study.

1.6 Outline of the report

This report starts with a literature study in chapter 2. Here the background data for the proceeding interviews are summarized. A short process plan, detailing the project and how it was performed can be found in chapter 4. The design document in chapter 5 gives insight into how the prototype application implemented for the purpose of this study was designed. Chapter 3 is concerned with detailing the research method in place for gathering the data from the interviews that are conducted for this study. To prepare for these interviews a pilot study was conducted, the results of which is presented in chapter 6. Based on the experiences from this pilot, two group interviews has been conducted with university students at the *Norwegian University of Science and Technology*, one group consisting of informatics students, the other group were teacher students. The results from these interviews can be found in chapters 7 and 8 respectively. Chapter 9 details the lessons learned from the interviews and the conclusions derived from the studies are discussed.

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[3]Due to the web standards used for the implementation of *Clementine* at the time not being available in all browsers, this prototype will only work in select versions of the Opera browser for desktop and Android devices.

2 | Literature Review

To initiate the study, a collection of relevant literature has been reviewed. The studies sheds some light on how people read digitally and their affinity towards reading digitally. These studies also further clarifies the motivations behind this project – identifying the reasons to why people dislike to read digitally and find solutions to what can be done to best alleviate the problems regarding digital consumption of text.

The amount of textual data available and continuously being produced digitally today is *"absolutely stunning"*, we still haven't discovered the most optimal way of reading digitally [Coyle, 2008]. Whenever faced with articles superseding three or four pages, most would much rather print the article than read it from a digital screen [Buzzetto-More et al., 2007], and it seems that as many as 80% of people *always* or *frequently* print electronic documents for reading, and that most seem to prefer printed books to ebooks [Liu, 2005]. Printers are asserted as being *modern photocopiers* in that people – in the same vein as people previously would photocopy books and articles in libraries – people will today use modern digital tools to locate the texts, but will print them for the actual reading [Mercieca, 2004]. With so much apparent reluctance to read even shorter texts digitally, it would seem that reading a book-length text is out of the question.

Students are more likely to read digital text if they are cheaper, and comparatively provides better or easer access to the content itself [Mercieca, 2004].

2.1 Designing the digital book

Books available digitally today are often either *digital books* or *digitized books* [Coyle, 2008]. Digital books are books designed for the screen, adapted to the user experience afforded by the technology and viewing device. Digitized book on the other hand are books designed for print, but viewed on screen, with perhaps the PDF as the most common format available today. Unfortunately, PDFs are cumbersome, and not satisfactorily adapted to the screen, as they need to be panned and scrolled through, with awkward zooming – they do not fit the interaction

model one would else use on a computer [Nielsen, 2003]. There is a need format documents better, in way that suits the experience better [Valstad, 2011].

Some take this notion even further, and wants to completely rework out model on how to educate children. Children growing today are "wired differently" by growing up accustomed to digital screens, and compared to previous generations are "digital natives"[1]. They are *wired for distraction*, accustomed to the use of the Internet and hypertext, and value instant gratification above anything else, something that should be taken into account when addressing them in education [Prensky, 2001]. The notion of today's children being inherently different is however disputed, and that this so-called group of digital natives is too heterogeneous to even be considered a "group", and suggest exercising caution when considering changing to accommodate this [Jones et al., 2010].

It is possible to utilize the interactivity of the medium to create experiences that help motivate and activate students in a unique way, something that has had promising results when it comes to motivating reluctant readers [Edwards, 2008].

2.2   Responsive reading and expository writing

There are some core differences in how one reads expository texts – educational texts read for learning – versus how one reads narrative works read for pleasure. *Responsive reading* – "using a text to develop or modify existing knowledge" [Thayer et al., 2011, p. 2918] – is described as a strategy for reading expository texts [Pugh, 1978]. Unfortunately, digital consumption of *expository writing* (as well as narrative texts) leads to poorer reading comprehension compared to reading a physical version [Mangen et al., 2013]. People also seem to read physical texts faster than they would on an iPad, although not by much [Nielsen, 2010]. The predominant strategy for reading on the web is *skimming* and *scanning* [Krug, 2009; Liu, 2005]. While this is not inherently bad – skimming and scanning is a great way to get to know the essence, but not the details, of the subject matter – to be able to properly learn the material one should strive for responsive reading. A defining aspect of responsive reading is *production of markup*, including highlighting, margin notes and scribbles [Thayer et al., 2011]. This is something that traditionally has been hard to accomplish digitally [O'Hara and Sellen, 1997], and still often is [Mangen et al., 2013; Thayer et al., 2011; Liu, 2005] and is noted as being one of the main reasons to why people prefer to read paper based books over their digital counterparts.

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[1]Their antithesis being *digital immigrants*.

2.3 Use of metaphors

Conceptual models are described as being a "high level description of how a system is organized and operates" [Johnson and Henderson, 2002, p. 26] and provides a "working strategy and a framework of general concepts and their interrelations" [Rogers et al., 2011, p. 40]. In other words, by using *metaphors* and *analogies* to create conceptual models that assists the user in figuring out both why and how to use an application interface. Such a match between the system and the real world is very beneficial to an application's usability [Nielsen, 1995].

Providing the reader with cues on their reading progress is important [Coyle, 2008], and use of various metaphors to convey this information about the document has been proposed, including the rather interesting use of audio [O'Hara and Sellen, 1997].

There is no intrinsic value in just being "book-like" [Coyle, 2008], and one should use great care in creating a book emulating user experience. Uncritical use of metaphors and affordances known from reading physical documents – such as the *fanning and flipping pages* – is potentially more confusing than it is helpful to the reader [Thayer et al., 2011; Agarwal-Hollands and Andrews, 2001]. Furthermore, the utility of using skeuomorphisms – use of visual metaphors to create an interface that mimics a physical analogue – is often deteriorated over time. While they might be useful for learning how to use the interface, strict adherence to the metaphor might obstruct the potential to surpass the physical version [Arment, 2010]. People are generally quite aware that they are not reading a physical book, and can more often than not do without anachronisms that are present just to evoke a sentimental feeling of using a book.

2.4 Text layout

Differences in how a text is laid out leads to a performance differences in reading [Lonsdale et al., 2006]. Studies suggest that the spatial representation of a text is related its comprehension, as the readers create and maintain mental maps of the text they are reading [Kerr and Symons, 2006], something that needs to be accounted for when designing a digital document. One device for achieving a text that reinforces these mental maps is pagination. A paginated layout, by having a temporal stability, aids the reader in creating and maintaining mental maps. Scrolling on the other hand might interfere with these models [Mangen et al., 2013], as having the text move while scrolling forces the reader to continuously refocus on the correct part of the text, something which makes for poor user experience [Melchior, 2001]. To make up for this nuisance, fixed and paginated PDFs are sometimes mentioned as being a solution. People do in general find

paginated text preferable to scrolling text [Lonsdale et al., 2006; Nielsen, 2010]. Alas, as mentioned above, PDFs are unsuited to digital screens, as interaction with PDF documents are unnatural as they do not fit the screen, nor the interaction model, that one else would use on a computer.

2.5 Form factor

Form factor is also an important factor to consider when designing a pleasant reading experience. It is much easier to read a book held in ones hand than a text lying on a table [Liu, 2005], and when reading for a prolonged period of time, one wants to be "comfortably seated, feet up, and uninterrupted" [Coyle, 2008, p. 161]. Modern tablet computers, popularized with the introduction of the Apple iPad in 2010, is used in the same manner as one would use a book: comfortably seated with the tablet in hand, without any distracting wires[2]. While providing a reading experience regarded worse than a printed book, the tablet form factor is perceived as much better than a computer [Nielsen, 2010].

Computers today are often used to read short emails and status messages and not longer coherent texts. This perception of how computers are "supposed to be used" influences how they are actually used, and might make it harder to read longer texts [Mangen et al., 2013]. Computers also reminds people of "work", something that is considered a detriment to the user experience [Nielsen, 2010].

2.6 Criticism of the studies

While effort has been put into finding contemporary studies, most of the studies cited above are starting to show their age – especially display technology has improved immensely since the conception of the cited studies. Introduced with the iPhone 4 in 2010, Apple popularized high density displays with their *Retina* brand displays with the intention to make individual pixels invisible to an unaided eye. Apple has since expanded the line of products with these high resolution displays with the third generation iPad in the beginning of 2012 and the 15 inch MacBook Pro in the middle of 2012. Extrapolating this evolvement one can expect that the availability of high resolution displays will be even wider in the future. Other manufacturers are expected to follow suit – Google released its Chromebook Pixel with a similarly high resolution display with "invisible" pixels (239 pixels per inch) in the beginning of 2013 [Google, 2013] and Samsung is expected to release a 276 PPI display in the near future [The Verge, 2013]. While still problematic

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[2]Compare this to how one reads in front of a traditional computer – sitting upright with the text propped vertically in front of you.

in the way the screens are lit up, the high pixel density of modern screens makes them more pleasant to use, alleviating parts of the eye strain issue.

Many of the papers are performed using desktop or laptop computer screens, which has usability issues other studies asserts are alleviated using tablet computers. The new form factor afforded by tablet computers makes digital texts almost as available as physical texts, and are better suited for reading due to form factor, battery life and portability.

Most of the more modern studies does conclude that more research is needed.

3 | Research method

The research will be a qualitative study, where the data will be primarily gathered from conducting group interviews with students – people that do a lot of responsive reading of expository texts. The research methods used for this study is largely based on the research of Professor Oates [2006].

3.1 Design

The main data for this study is mainly to be gathered through performing qualitative research. Qualitative research is well suited to gathering information about the *why* and the *how* of a particular phenomenon.

The "antithesis" to qualitative research is quantitative research, where one uses quantifiable methods to generate its conclusions. For this thesis, the *System Usability Scale* (SUS) has been considered to be utilized to be able to asses the prototype's usability in a quantifiable manner [Brooke, 1996]. It has however been omitted due to the general usability of the system not being the core design principle for this thesis. There is also the problem of the prototype application not being sophisticated[1] enough to warrant a "proper" user test, creating some issues in creating proper tasks for the respondents to perform, mooting the applicability of such a test. Other quantifiable data such as reading speed and retention rate has been considered for inclusion in the study, but has been omitted both due to time constraints and due to frankly not knowing what to do with the resulting data.

3.1.1 Case study

A case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. [Yin, 1994]

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[1] There is much more emphasis on creating a pleasant *user experience* for reading than creating a feature rich, yet usable, application.

A core aspect of this study is to research how to best create a pleasant digital reading experience. Reading is however a complex task, and the variables of how to best create a good reading experience is hard to break down to the individual constituents and it is little use to try to look at the aspects that makes a digital text readable separately. Because reading and studying a personal affair a natural setting for the study is preferred. It is however hard to observe academic reading in its most natural setting – usually done in solitude at a desk either at home or in a study hall. This study has this been decided to be performed as a case study.

3.1.2 Type

When it comes to designing a case study, there are several approaches one can take. For the purpose of this study, an *exploratory* approach has been taken, where one instead of performing a rich and detailed analysis on a particular phenomenon, one gathers a more broad and holistic onlook on the phenomenon as a whole. This is in part because of the difficulties of dissecting the constituents of a pleasant reading experience, and because of the limited availability of contemporary studies relevant enough for this study. Using an exploratory approach one should derive conclusions with great care, and the results are generally not generalizable to the general public. What is possible to do, however, is to generate hypothesises to be used for further research [Yin, 2003].

3.1.3 Time

In regards to time, this study is a *short-term*, *contemporary* study, where the participating students are asked to donate a few hours of their time at given moments during the semester to talk and discuss the topic at hand with an interviewer. The other types of studies considered for this study – *historical* and *longitudinal* – are not particularly fitting for this study. A historical study is not applicable because as it is primarily the effects of use of modern technologies that is to be tested. The respondents' previous experience is however to be regarded, as is historical literature whenever applicable to substantiate the hypothesises derived in this study. While a longitudinal study on the topic would be highly interesting to conduct, due to reading is typically an activity that both takes time and is something that is formed by habits. It is unfortunately far beyond the scope of this thesis.

3.1.4 Selection

The selection of participants for the study is a so-called *convenience* selection, where the participants are chosen more or less only because of their availability. While such a selection method is usually frowned upon and should be avoided as

much as possible – the results are generally not generalizable – , it has been deemed satisfactory for this particular study due to three factors: (1) students are a prime target for inclusion in this study because they are expected to read numerous expository texts in the course of their studies; (2) the text that has been prepared for the study is mandatory reading for the students selected to participate in this study, something that provides the students an incentive to participate; and (3) the course subject is about the use of digital technology in education, making it plausible that there are students that are interested in the thesis' topic present in the course.

Because the interviewees, in virtue of being students, are likely to have done extensive reading of academic papers and books, they should have developed habits and preferences in how to consume such texts, something that creates an opportunity to discuss a variety of topics regarding digital reading.

3.1.5   Interview

To gather the data, group interviews with students is to be conducted. A group interview is a particular kind of interview, where instead of talking to interviewees on a one-to-one basis, one talks with a group of interviews at the same time. This creates the opportunity for the interviewees to discuss the topics between themselves. According to Oates [2006] the optimal number of participants to be between three and six people.

The interviews are to be *semi structured* in nature, where the interviewer is equipped with a set of topics and questions that are to be discussed with the interviewees. This makes the interview more conversation-like, where inter interviewer is able to direct the flow of this conversation as interesting topics and themes arises – one can explore issues that one had not initially prepared questions for. Semi structured interviews are well suited for this study because of how it is to explore the perceptions of its interviewees regarding the topic subject [Barriball et al., 1994].

To be better able to recollect what has been discussed, the interviews are to be recorded.

3.1.6   User testing

As the user test of the application is to be very simple, no particular method or standardized procedures has been implemented. The interviewees are to perform a number of tasks given by the interviewer, the interviewer's task is to merely observe the participants, and try not to interfere. While performing the tasks, the participants are encouraged to express their though processes in words, enabling the interviewer to better understand how the tested application is perceived.

The idea is to have the participants explore and use the application on their own, to assess the intuitiveness and general usability of the application.

3.1.7   Limitations

The methods used for designing this study has a few limitations that limits the general applicability of the study. One of these limitations is that one should not derive any definitive conclusions from exploratory studies. The number of interviewees in the test makes the test less generalizable, one needs a larger sample size to be able to conclude for the wider public.

The study is still a good way to be able to generate new hypotheses and topics for future research.

3.2   Execution

3.2.1   Pilot interview

To help in the creation of the themes, topics and questions for the main interviews a pilot interview was conducted. This interview was designed to be a model for the proceeding main interviews, but compared to them only a handful of questions and themes was prepared in advance. These questions were based on the themes and issues raised in the reviewed literature.

During the interview, the participants of the pilot interview got a chance to use the prototype version of *Clementine*, both on a tablet computer and on their own laptop computers. This created the opportunity not only to ask questions about the prototype and have a new discussion about the prototype itself, the user test also acted as a catalyst that spurred more discussions about digital consumption of text in general.

Based on the feedback gathered from the participants in the pilot interview using the prototype application, the most glaring omissions and errors found in the prototype are to be implemented and corrected.

3.2.2   Main interview

The first part of the interview is a general group interview where a number of topics are to be discussed. These topics are presented below.

There has been set aside time for a short introductory discussion to introduce the project itself, instruct the interviewees on how the interview is to commence, and to map various demographic variables.

Themes, topics and questions

Reading experience Their experience in reading both physical and digital text is relevant.

Affinity to read digitally compared to reading physical documents Academic papers are often distributed as PDF documents, and most students will have been subjected to the choice of reading the paper on screen or print it. This topic will shed some light on how often they print compared to simply reading the paper digitally. A part of this topic will revolve around what kind of texts they prefer to read in the different formats.

Relative advantages and disadvantages of digital reading The interviewees are to compare reading digitally to reading physical text by describing where the two reading experiences excel based on their experiences.

Note taking Note taking is a very personal activity, and everyone seems to take notes in a different manner. As note taking and the creation of markup is apparently a defining aspect of responsive reading, this is something that is decided as an important topic for the interview. The interviewees are to talk about how and for what reasons they take notes, as well as how they make use of these notes when reviewing them.

Feature set of an utopian digital book Here the interviewees are tasked with designing the perfect digital book. Here they'll have the opportunity to suggest features and improvements based on things they feel are missing from digital books today.

User testing

As a part of the initial interview the interviewees are expected to use and explore the prototype application created for the purpose of this study – *Clementine.* Even though this study is not a creation study, there is still two reasons to why *Clementine* is to be user tested. First, the overall usability is to be tested for glaring errors and unintentional omissions that should be fixed in the course of the study, and create ideas and requests for the future development of the application. The second reason that the prototype is to be tested is to provide the interviewees of the study an implementation of the discussed topics be better able to discuss the metaphors and user experience that the prototype encompasses.

The participants is encouraged to describe their actions and thought processes aloud so that the interviewer is better able to understand how it is actually used.

The application is to be made available on a tablet computer and on a laptop computer, both provided for the test by the interviewer. The interviewees are not

expected to bring their own devices. The reasoning behind separately testing the tablet and desktop versions of the application stems from feedback gathered from the pilot interview where it was made apparent that the different form factors provided by the different devices made for a notably different user experiences. Both versions of the application will be tested by all interviewees to ensure that all has experienced both versions and form factors for the ensuing discussion. Depending on the number of interviewees available in the test, the interviewees are to divided into two groups that will explore the application and perform the tasks together, exploring the application on different devices.

User testing tasks

Task 1 Read through a complete chapter

Task 2 From a chapter, navigate to the following chapter

Task 3 Use the sidebar menu to jump to a specific chapter

Task 4 Use the sidebar menu to jump to a specific sub-chapter

Task 5 Highlight text

Task 6 Reload the application and go to the previous reading position

The prototype has been considered not advanced enough to warrant a "proper" user test, and a simple variant has been put in its place. The purpose of these tasks is to make sure that the participants used every part of the prototype, and were were given after the participants had had their chance of discovering the capabilities themselves.

Concluding discussion

As the first interview, the concluding discussion is too a *semi structured* interview. This interview is to be freer in form than the first interview with only a few questions prepared in advance.

Of special interest here are the interviewees thoughts on pagination metaphor used for the realization of *Clementine*, and how they felt about using a paginated book compared to a longer scrolling text. Observations done during the user test will also be used to seed the discussion with topics if deemed applicable.

4 | Process evaluation

This chapter describes the procedure of how the study was performed. It was planned to use a class of students enrolled in the course *IT1301 – Datastøttet læring* at NTNU, a course held by the supervisor for this thesis.

4.1 Literature review

After defining the problem of which this study was to research, a literature review was commenced. The goal of the literature review was to explore mainly three areas of interest.

- Typography, both general and digital

- Digital readability

- Learning with the assistance of digital tools

Newer books and articles were preferred to older ones due to the rapid development of digital tools. The literature review can be found in chapter 2.

4.2 Designing and building the prototype

Part of this study involved assessing the viability of using modern web technologies to render a usable and readable digital book. To implement this, comparable applications were used as inspiration.

The prototype was initially designed to be as simple as possible, but due to issues raised by reviewed literature and a pilot interview performed, it was decided to implement a selection of extra features to enhance the user experience of the application.

This resulted in the prototype application *Clementine*, the design and rationale of which is described in chapter 5.

4.3   Designing the interviews

The design was for the most part based on the research of Oates [2006]. It was found to be suitable to perform the research as a exploratory research, using group interviews as the main data source. The research design can be read in detail in chapter 3.

4.4   Pilot study

In the beginning of the spring semester 2013, there was an an opportunity to talk to the student class to discuss the project, the prototype with the intention of recruiting participants for the study. Attending the class at this time was however four students. While the specifics of the interviews were not yet finalized, the general theme and topic had been ready for some time, and the opportunity was used to perform a simple ad hoc pilot study to be better prepared for the proceeding main interviews.

Some feedback on the prototype and missing features were discussed as part of this pilot, and there were opportunity to improve on it.

The interview is described in chapter 6.

4.5   Improving the prototype

The time in between the pilot interview and the main interviews was used to improve the prototype, based on the feedback gathered in the course of the pilot interview. The largest improvement was the implementation of a highlight functionality which persistently lets users highlight and store highlighted text for later, complete with a function that lets readers get an overview of all the highlights gathered throughout the book. Other smaller bugs and annoyances were also corrected to better prepare the prototype for the later interviews..

4.6   First interview

The final interview was planned to be had with a selection of students from the same course as before. There was given an opportunity to once again talk to the class, but once again the number of students attending were abysmally low. The interview was however still planned and executed with these students.

During the interview there were discovered some areas where the habits of the students seemed to suggest that their take on responsive reading were not

generalizable. The interviewees were all male, studying the same field which made the group rather homogeneous. The students were all also in their first year of their studies, which could suggest that their studying habits had yet to mature. A new interview with other, more experienced students was thus planned and executed.

The interview is described in chapter 7.

4.7   Second interview

The second interview was held with a small group of female teacher students studying in their third and forth year. As expected, the results did diverged a bit from the first interview. The teacher students were a whole lot more talkative, and also noticeably more experienced in being students. The general themes of the resulting discussion was however comparable to the one in the first interview, but some insight was gathered by comparing the two different groups.

The interview is described in chapter 8.

5 | Designing *Clementine*

As described in chapter 1.2.2, part of this thesis focuses on exploring the possibilities and viabilities of using web technologies to create a user experience for reading that rivals, or even excels the one found in physical books. To accomplish this, a prototype application is to be created to virtually bind an example text, the design of which is described in this chapter. This prototype will then be the focal point of the proceeding interviews. The textual content of the prototype is to be a compendium of articles to be read as part of the course *IT1301 – Datastøttet læring* at the IDI faculty of NTNU.

It has been decided to implement the prototype as a *web application* – an application created with HTML5, CSS3 and JavaScript for use in a web browser. McKesson [2012] presents an informal study of how to use modern web technologies to create web based books, with techniques mostly based on the CSS Generated Content for Paged Media Module [Lie, 2013]. These techniques makes it possible to create web based, paginated experiences much akin to what one find in other contemporary ebook formats (see chapter 5.2.1 for a description on available ebook formats considered as inspiration). By being web based the books will be accessible from all applications able to render web pages, and not only in the proprietary applications developed by book creators, which is the situation for comparable formats. An additional advantage of being web based is that compared to other formats that has emerged and perished – every format mentioned in the relatively recent article by Rao [2005] has since expired – the continued existence of the web is comparatively more reasonable, at least for the foreseeable future. It was because of this found to be interesting to explore the viability of modern web based technologies to create a pleasant digital reading user experience.

This chapter details the design of the prototype from a *usability* and *user experience* perspective. Technical details concerning the creation of the prototype, including details on the technologies and frameworks utilized, can be found in appendix A.
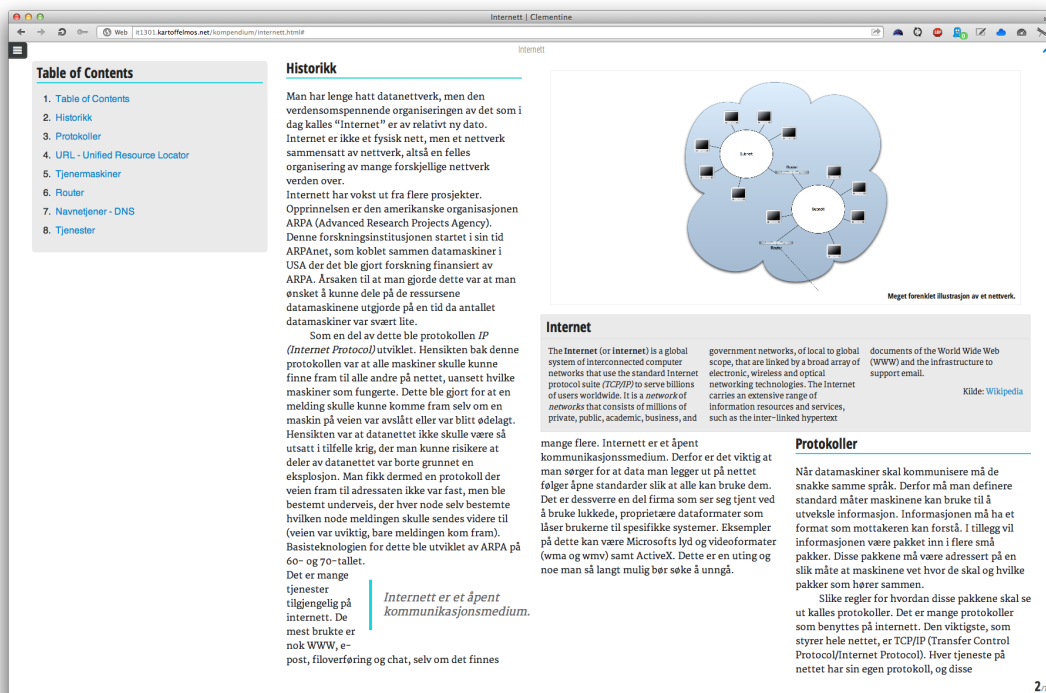
23

Figure 5.1: Screenshot of the final prototype, rendered in Opera 12 on Mac OS X.

5.1 *Clementine*

To act as a test bed for the web technologies and be the focal point for the interviews in this study *Clementine* has been created. *Clementine* is a web application styled with cutting edge web based typographic technologies and given interactivity with simple JavaScript to create a reading experience very different from what you find in traditional web pages. The typographical techniques allowed by these new technologies are to be applied in a manner dictated as best-practice by available literature, in addition to a pilot interview (see chapter 6) where students are asked about what the perfect digital reading application should incorporate.

5.1.1 Design goals

The primary design goal of *Clementine* is to create a pleasant user experience for reading digital expository texts. This is to be achieved through the application of the design guidelines and best-practices available for creating readable texts and

usable web applications, with good typography being one of the cornerstones. To further support various responsive reading strategies, some additional features has been added.

Primary goals

Underpin the creation of mental maps
This does first and foremost mean that the text should be properly chunked into sections the reader is able to form these mental maps. Use of typographical "landmarks" such as visible headlines and figures also aids the reader in the creation of such maps.

Good typography
The text shall be readable, and make use of the available best practices to create a text that is both pleasant to read and beautiful.

Design for touch
The application shall be designed with touch enabled devices, especially tablet computers, first in mind. This is both due to the continued growth of such devices and that the form factor afforded by the devices is noted as being very natural for reading.

Responsiveness
The application shall not be tailored to any one device, but rather scale according to the device's screen size. The application shall also scale functionally up to a desktop version.

Secondary goals

In addition to the aforementioned primary design goals, a set of secondary goals has been formulated with the intention of helping establish the perception of the application as a "proper" reading application. These goals are for the most part derived from how students interact with a document when responsively reading expository texts, as well as other similar applications which should make the application feel familiar to those who have used such applications in the past.

Navigational aid
The application shall implement features that aids the user to navigate fast and easy in the application.

Creation of markup
The application shall implements features that allow for the user to create markup in the text as a mean to support responsive reading.

Accessibility
The application shall be built around applicable accessibility standards.

Non-goals

In addition to the aforementioned goals, there are several goals that has been considered useful, but in the end has had to be omitted from the final design due to to time constraints, the goals not being close enough to the core concept of *Clementine* and due to reducing the number of variables for the user testing.

Framework
The prototype has however been created in a way where the content is separated from both the logic (including markup) and the presentation – similar to the popular MVC software architecture pattern [Fowler, 2006] – making it fairly easy to replace the content, in effect being a basis for a framework.

Strict platform convention adherence
The application will not adhere to design conventions for any the operating systems it is to be used on. *Clementine* does break with some of the conversions in place for web pages, most notably that one do not scroll the page.

5.2   Inspirations

The main inspiration for *Clementine* is contemporary ebook and document readers, both software based and hardware. Below are the most important ones detailed.

5.2.1   Ebooks

As *Clementine*'s main task is to render digital long-form texts in a pleasing manner, the most important inspirations for its look and feel are devices and pieces of software that renders ebooks. The most popular applications and devices easily available has been evaluated, and the finds are described below. How to use and navigate in the application has been of largest importance when evaluating the applications.

In the ebook format space there are several formats available today. At the time of writing, Project Gutenberg provides their books in six formats, four of which are "proper" ebook formats[1]. The most popular formats today are: the open source EPUB format by the *International Digital Publishing Forum*, in use

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[1] Single downloadable file for opening in a specialized ebook reader application.

by most Norwegian book stores as well as by Apple Inc. for their iBooks platform; and the KF8 format by *Amazon.com*, in use for their popular *Amazon Kindle* platform. It is however the rendering applications for these formats that have been the largest influence for the design of *Clementine*.

Amazon Kindle

Amazon Kindle is a series of hardware devices and software applications created by *Amazon.com Inc.* to render ebooks, and is perhaps the most popular platform available on the market today. The software applications are available on all major platforms, including iOS and Android. By being one of the most popular ebook-reader hardware device, and with applications being near universally available, the *Amazon Kindle* can be considered the de facto standard when it comes to ebooks. As many of the different software versions has been tried evaluated, but the desktop application has been tried the most. A non-touch screen version of the (forth-generation) hardware device has also been evaluated.

In the desktop application, navigation is performed by clicking on the edges of the application window. Of special note is the context menu. The application is a very visual pleasing application, with few buttons visible. Some features are hidden until needed, such as the ability to highlight text. This feature is activated by marking text which will bring up a small context menu. You are then presented with the ability to highlight the marked text, add a note to the text or search the web for the text. If a single word is selected a definition is displayed.

Cloud Reader is a web based version of the desktop application available as an extension for the Google Chrome web browser with largely the same capabilities as the "ordinary" desktop application, including offline capabilities. Interaction with the Kindle hardware devices are slightly different from the software applications. On the non-touch screen versions of the device[2], there are two large hardware buttons on the edges on the device, which when pressed will navigate through the book – similar to how the left and right edges in the desktop application are clicked to navigate between pages. The iOS and Android versions of the applications are interacted with using a touch interface, and to navigate through ebooks one swipes ones finger horizontally across the device as if one were to slide the page physically sideways. One is also able to navigate through the book by touching the left and right edges – the margins – which will navigate to the previous and next page, respectively.

It is evident that much effort has gone into creating a unified interface, interfaces that looks similar and familiar while at the same time adhering to the different interaction paradigms of the different platforms. For instance, buttons

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[2]The touch screen version of the device has not been tested in this study.
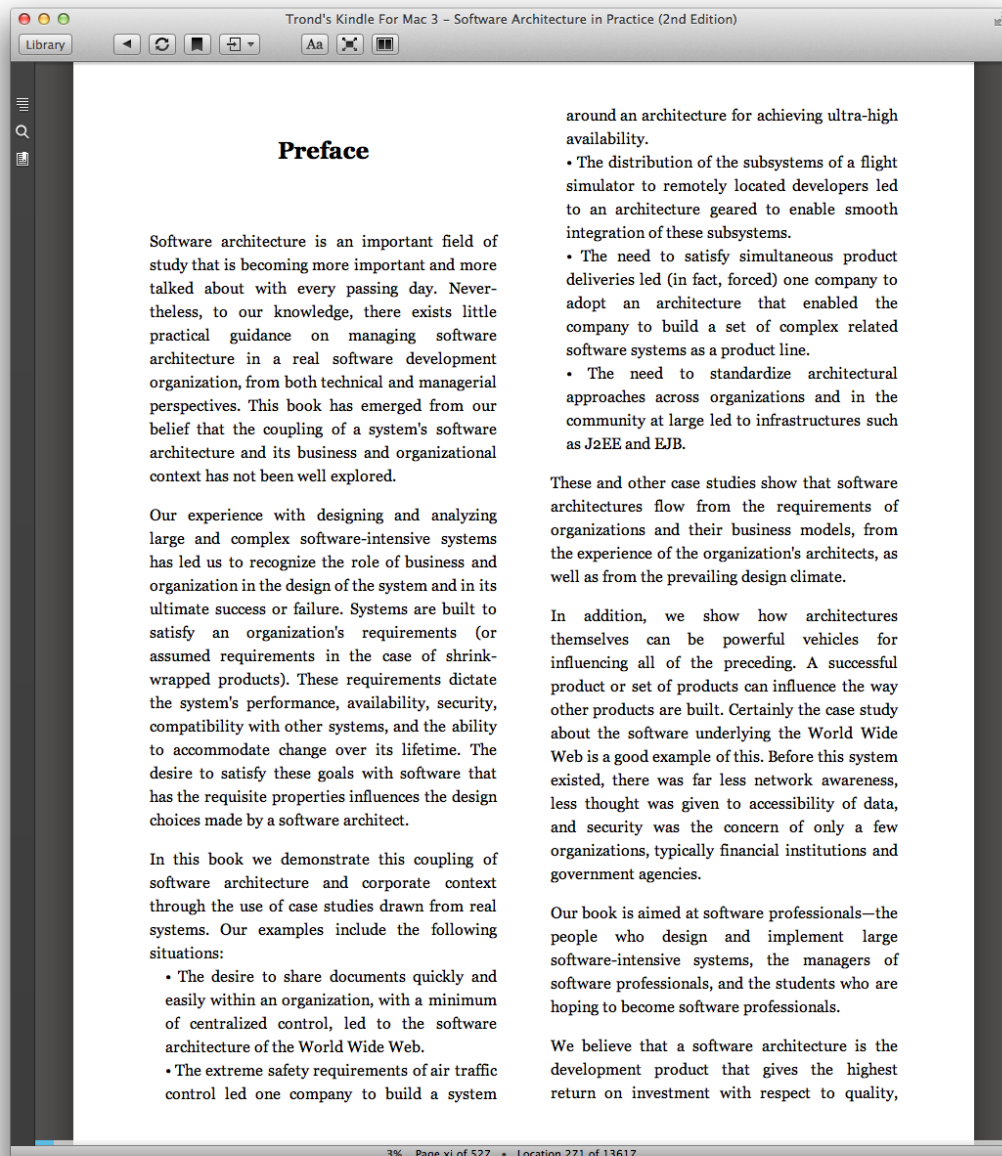
Figure 5.2: *Kindle for Mac* displaying the book *Responsive Web Design* by *Ethan Marcotte*

are bigger on a touch device than they are are on the desktop version, to make it easier for the user to press the correct button with the less precise input method that is the finger touch.

Users are able to customize the reading experience by changing various aspects

of the text. On the desktop for instance, it is easy to change the font size, words per line, brightness (independent from the device screen brightness) and colour mode[3]. One can also change whether to display the text in single (full width) column or in multi-column mode. The hardware device is capable of changing the font of the text[4].

Calibre

Calibre is one of the most popular free, open source project available that renders ebooks and is available on all major desktop platforms and supports most ebook formats available today. The application is not only used for reading ebooks, but is also used to keep a collection of books. Figure 5.3 shows the user interface of *Calibre*.

Unfortunately, Calibre is a lesson in how *not* to design a user interface. Calibre lets the user do every action available with a press of a button, most of which are visible in the application tool bar at all times. The result of this is a tool bar severely cluttered with buttons, something that can be confusing to the user – do notice that are no less than three sets of nearly identical arrows present on the screen at all times. The end result is an application that is confusing and borderline unusable. Additionally, Calibre is very slow to load – yet another user experience hazard.

5.2.2   Portable Document Format

Portable Document Format (PDF) is today the most popular document format for distributing static text not meant for editing, and is the *de facto* standard for static document distribution – academic articles included. It is also an official standard for distributing official documents in many countries, including Norway [Direktoratet for forvaltning og IKT, 2012]. There are several applications capable of rendering PDF files, but only the reading experience of the *Adobe Reader* available for Windows, Mac, Android and iOS has been evaluated, as has *Preview*, an application pre-installed on Apple computers. These readers by default present the document as a vertical list of virtual pages which are scrolled through.

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[3]Limited to black text on a white background, white text on a black background and black text on a sepia background.

[4]Limited to switching between a serif and sans-serif font.

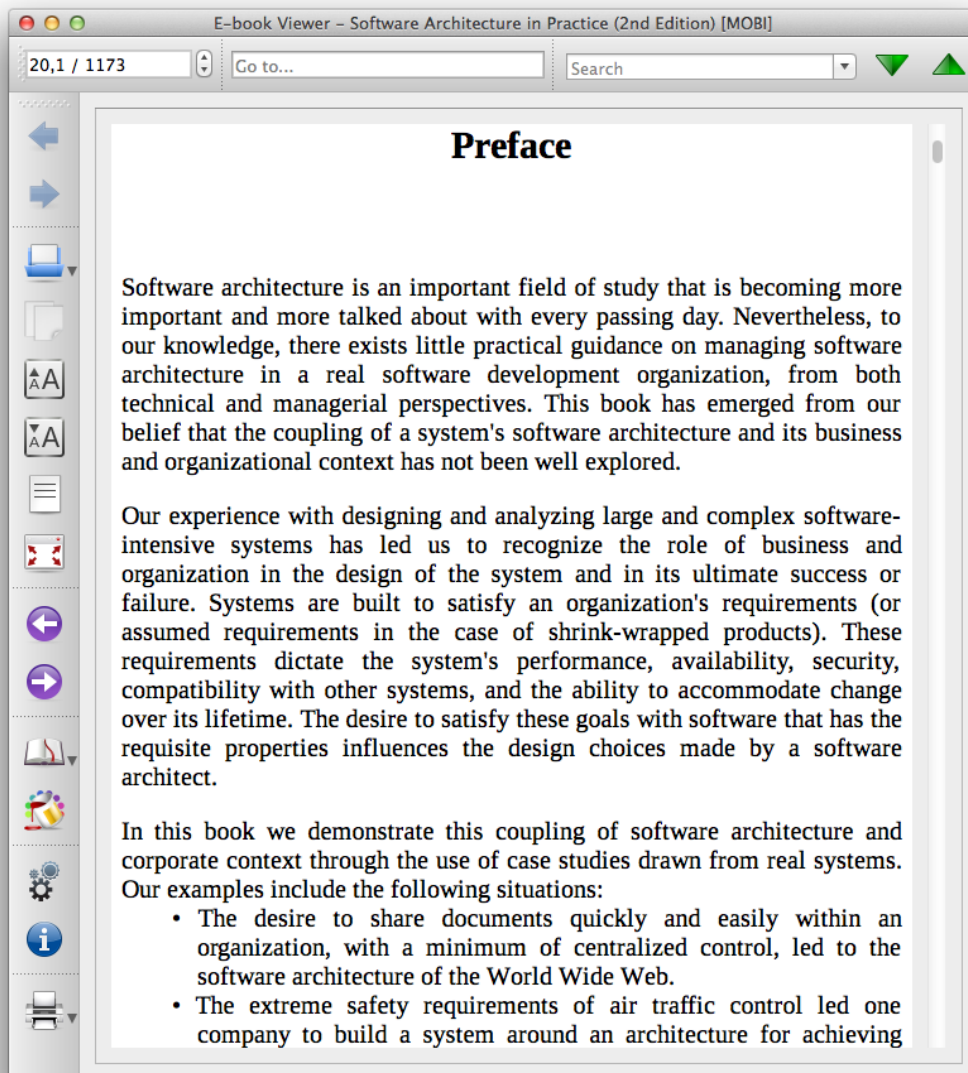Figure 5.3: *Calibre* displaying the book *Responsive Web Design* by *Ethan Marcotte*

5.2.3   Word processors

While word processors such as Microsoft Word, Apple Pages and LibreOffice Writer are not designed the activity of *reading* in mind, but the activity of *writing*[5], there

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[5]According to Piolati et al. there seems to evidence that a paginated interface provides a benefit in text editing [Piolat et al., 1997].

is still a lot of text distributed in these formats. The experience of using such software for reading has therefore also been evaluated for this project. The ability to comment and highlight text is present in all the most popular editors, and is probably the features that a reader is most likely to use when reading the text responsively. These features are however in all applications reviewed hidden inside a cluttered tool bar. It is very clear that word processors designed around the activity of producing words. User interface wise, the pages are represented in the same manner as in the aforementioned PDF documents, as a vertical list of virtual pages which are scrolled through.

Microsoft does provide a product called *Word Viewer*[6], an application capable of rendering Word documents to be able to read, print and copy Word documents without Word installed – in other words, Word Viewer is a lightweight document reader. A quick look at the user interface, however, reveal a user interface that is nothing more than the traditional Word interface sans the tool bar – a paginated, scrollable interface not unlike what you find in PDF documents, but lacking any kind of note taking functionalities.

5.2.4   Treesaver.js

Lastly, there are several JavaScript based applications on the Internet that lets designers paginate text. The library evaluated when designing *Clementine* is *Treesaver.js* [Treesaver, 2011] which seems to be one of the better ones available and provides the same functionality that *Clementine* is to embody.

Treesaver.js is an open source JavaScript library that is able to reflow text into a paginated interface, complete with controls, a table of contents and menus. While it does not work consistently across all web browsers, it is still an example of how one can implement a paginated structure with standard web technologies such as JavaScript and CSS. The business model of Treesaver, the company behind Treesaver.js, is for them to act as consultants for companies, implementing the library for their content.

There are several other libraries, each with their own set of capabilities. Common for them all is that they are able to paginated text, they have either dedicated buttons or hotspots on the page for changing the page, and more often than not support swiping gestures on touch enabled devices. They are also very similar to Treesaver.js, and are not detailed here.

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[6]Available from `http://www.microsoft.com/nb-no/download/details.aspx?id=4`

With the help of renowned pastry guru Sébastien Godard, Deseine selected cacao beans from Tanzania and Venezuela to use in her Chocolates By Trish products.

Figure 5.4: *Treesaver.js* displaying an example text from *Nomad Editions' Real Eats*, available from the Treesaver.js website.

5.3 Visual design

> [Design is] not just what it looks like and feels like. Design is how it works. [Walker, 2003]
>
> (Steve Jobs)

The goal of the visual design of *Clementine* is to produce a book that is professional, aesthetically pleasing and a pleasure to use. It is important to note that this not a study in neither visual design nor in typography, but as the user experience is considered paramount one must pay a great deal of attention to the visual design. Below are the choices taken and contemplated upon when developing the visual design of Clementine.

At face value, it is easy to see that design matters – a cluttered page is harder to read than a clean page, too many distracting elements makes a page hard to navigate. Additionally, there are a number of typographical studies identifying different techniques for maximizing legibility and readability. In short identifying what is good design and what is not. A literature review done by Geraci [2002] identifies a set of typographical recommendations collected from a large set of different studies in typographic design. While there are some minor disagreements in what is best practice the studies does by and large correlate with each other. These recommendations are used as much as possible when designing *Clementine*.

Related to this discussion is the topic of being able to customize the visual appearance and typographic features of the application, something that is discussed in chapter 5.7.6.

5.3.1   Typography

To create a reading experience that is both legible and pleasant to use utilizing good *typography* is paramount. As this is not a study in typography, *Clementine* shall only employ the typographic elements deemed most necessary, based on best practices and recommendations found in reviewed literature. There are numerous studies on typography and on how to create good *digital* typography to try to alleviate the disadvantages of reading from digital screens, which has been used as the foundation for the typography used in *Clementine*. The typographic choices made for *Clementine* are documented below.

Fonts

When considering the fonts to use for *Clementine*, the first typographical decision was how to use the two major font variants *serif* and *sans-serif*. There are some disagreement in what kind of font should be used where, and whether there even is a difference at all. What seems to be the agreed upon conclusion based on both research [Geraci, 2002] and what is used in practice is to use serif fonts for body text. This conclusion is often attributed to to the use of serifs making the letters more discernible and as a result making the text more legible, especially in body text where there are a lot of letters in close proximity to each other. A serif font *might* thus be the best font to use to render body text, but the worst case scenario seems to be that there is no discerning difference in legibility either way. Additionally, using a serif font emulates the source material as few, if any, academic texts are using sans-serif fonts for their body text. This might help evoke the feeling of reading a "proper" academic text in the reader more than the use of a sans-serif font would.

Some research interestingly suggest that using a hard-to-read font (such as italicized *Comic Sans*), creating *disfluency*, can be beneficial to learning as this forces the students to focus more on the task of reading, having the side effect of the student retaining more of the text read [Diemand-Yauman et al., 2011]. Furthermore, there are fonts created to alleviate various handicaps, for instance dyslexia. OpenDyslexic is one such font, and is a free and open source typeface designed to be easy to be easier to read by being a typeface consisting of letters that are highly discernible [OpenDyslexic, 2013]. Incidentally, the oft-criticised font *Comic Sans* has been claimed to be very legible for people with dyslexia [Penney, 2012; Garfield, 2010].

The default fonts chosen for *Clementine* are *Merriweather* for body text, and *Open Sans Condensed* for header texts. Both fonts are available to use for free from *Google Web Fonts* [Google Web Fonts, 2013]. Again, as this is not a study of typography, this particular pairing is done simply because Merriweather is regarded as a very readable font, both in print and digitally, and is often found together with Open Sans on the web[7].

Type size

The effect of the type size is simply that a larger typeface is easer to see, and easy to read. The larger the type, the less characters you will be able to fit on a line. The impact of this is discussed below. The default type size in *Clementine* is 16 pixels (equivalent to a 12 point or 1 em printed font.).

By using the built in zoom feature available in all modern browsers, users can natively adjust the type size. This kind of zooming will however affect all the elements on the screen. It is trivial to add the functionality to increase or decrease the font size without the rest of the application being influenced.

Line length

The number of characters per line has an impact on the readability of the text, and has to limited to create an optimal experience. There is a fine balance between having to many or too few characters per line: if there is too many characters per line it will be harder to focus on the text due to it being harder to "get an idea of where the line starts and ends" ; having too few per line will cause the readers to have move their eyes between the lines too often, "breaking the reader's rythm" [Holst, 2010]. Depending on the source, the optimal number of characters per line is considered to be between 45 and 75, though up to 66 can be considered ideal.

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[7]*Google Web Fonts* has a section on their font page for suggesting good font pairings based on real world usage of the font. According to pages indexed by Google, Merriweather is most often found paired with Open Sans.

For multi-column layouts, such as the one used in *Clementine*, an average of 40 to 50 characters per line is recommended [Bringhurst, 2004]. For web pages, shorter line lengths are in general better than longer [Ling and Van Schaik, 2006].

Columns

To limit the number of characters per line while still exploiting the entire width of the viewing screen, the text in *Clementine* is columned. The columns are implemented responsively, the number of columns are dependent on the width of the screen[8]. Smart phones displays one column, iPad size tablets in portrait mode displays two columns, laptops three and larger desktop screens four columns or more.

Paragraph indentation

Contrary to what is the norm on "regular" web pages, *Clementine* uses paragraph indentation instead of spacing, as this is more prevalent in print.

Other minor features

In addition to the aforementioned typographical features, *annotated figures*, *pull quotes* and *info-boxes* are implemented in *Clementine*. Hyphenation was attempted implemented, but had to be omitted due to technical concerns[9].

5.3.2 Colours

The colour palette used for *Clementine* is intentionally limited, mostly using the colours that web browsers use for non-styled web pages. Non-styled HTML pages use black text on a white background, with blue hyperlinks. This is the same colour scheme that *Clementine* is using, with slight adjustments to the colours' hues. Black text on white background is also the most commonly found scheme both on the web and in print, and has been kept due to the excellent contrast it provides. The choice of keeping the colour blue for hyperlinks is done due to readers likely having been conditioned to associate the colour with hyperlinks, due to its prevalence on the web. The same blue colour can be seen used as a decorative border in the text. An inverted colour scheme has been used in the sidebar to contrast it from the body text.

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[8]In the case of laptops and larger desktop screens the number of columns are dependent on the width of the browser window.

[9]Due to a rendering bug, the Opera browser – the browser used for the – will not display a hyphen when using dynamic hyphenation (soft-hyphens), rendering the page nigh unreadable.

It is very possible to implement functionality to make it possible for readers to change the colour scheme to their linking. Popular colour schemes available in similar applications include off-black text on off-white background, and a *night-mode* where instead of black text on a white background, one would have white text on a black background. This makes it so that the amount of bright light emitted by the screen is reduced, making the text easier to read in a dark room. Similarly, white text on a blue background[10] has been considered as being made available as a choice. Colour themes was omitted due to limited applicability for this study.

5.3.3 Iconography

Icons can be used to convey information alongside or – if the icon's affordance is good enough – in place of describing words. To render the icons used in *Clementine*, the popular open source *Font Awesome* has been incorporated [Gandy, 2013] – a so-called *icon font* which will render scalable icons in place of letter characters. Font Awesome contains a staggering 302 free icons, but only a handful was used for *Clementine*, including a menu button for the hamburger menu, some experimental pencils for illustrating the highlighter function and arrow buttons for navigational aids.

5.4 Interaction design

5.4.1 Usability

Application usability is concerned with optimizing the interaction users have with an application. The goal of achieving this usability is often broken down to six sub-goals: *effectiveness*, *efficiency*, *safety*, *utility*, *learnability* and *memorability* [Rogers et al., 2011; Nielsen, 2012]. The concept of usability is very important in the creation of *Clementine* as an application with poor usability will doubtless lead to a book with poor readability.

Among the core principles used when designing *Clementine* is Jakob Nielsen's ten usability heuristics, ten rules of thumb that one should consider when designing usable interfaces [Nielsen, 1995]. Below are the list of the ten heuristics, and how they are related to the design of *Clementine*.

Visibility of system status
The application shows a loading screen whenever the page is loading.

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[10]White text on a blue background was in the computer's early days a popular choice for lower the light intensity on from the screen.

Match between system and the real world
> The use of metaphors, including pagination, page numbers and tables of contents had been implemented to give the users a sense of familiarity.

User control and freedom
> The browser supports a myriad of undo-functions, such as the ability to go backward and forward in the browsing history and navigating backward and forward in the book.

Consistency and standards
> The application will adhere to web standards, as well as adhere to platform conventions[11].

Error prevention
> Not considered in the prototype.

Recognition rather than recall
> The menu button is always visible in the top-right corner of the screen, helping the user recognise the location of the menu. The discussion on whether or not to have the highlight feature announced with a visible button can be found in chapter 5.7.7

Flexibility and efficiency of use
> Not considered in the prototype.

Aesthetic and minimalist design
> The screen has intentionally been designed as clean and distraction free as possible, and attempts to hide functionality until they are actually needed.

Help users recognize, diagnose, and recover from errors
> Not considered in the prototype.

Help and documentation
> The need for tutorials and help dialogues has been attempted kept at a minimum, and nothing of the sorts has been added to the prototype. Due to that the application is to be tested under supervision, this has been deemed fair.

5.4.2 User experience

Where usability is concerned with the goal of making a user able to actually accomplish a given goal, *user experience* is concerned with making the use a pleasant

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[11]The platform in this case is the web, not the individual operating system.

experience – in other words, "the overall experience a user has with a product." [DIS, 2009]. Great care has been done to create an experience that a user will find pleasant to use.

5.4.3   Accessibility

Accessibility is concerned about making web application or web page accessible to people suffering from disabilities. There are two main standards in use today: *Accessible Rich Internet Applications*(WAI-ARIA) and *Web Content Accessibility Guidelines*(WCAG). WAI-ARIA is concerned concerned with defining a standard way of providing semantic information in order to allow assistive technology – such as screen readers – to convey appropriate information to persons with disabilities [Pappas et al., 2011]. This is done by supplying the elements that constitutes the web page with extra semanticity through the use of a defined set of *roles* added as attributes to the element An example of this is providing a navigational section of the page an attribute that conveys its role to a screen reader[12]. WCAG is a broader standard, concerned with creating a set of guidelines one should adhere to if one is to create a web site (or web application) that is more accessible by having the site and its elements *perceivable*, *operable*, *understandable* and *robust* [Caldwell et al., 2008].

   Clementine will unfortunately not adhere to these standards, due to both the lack of time to properly implement and test the feature, and because the prototype is to be tested by non-disabled people under supervision. To add support for these standards is considered trivial, if time consuming.

5.4.4   Design patterns

First proposed by the architect Christopher Alexander in 1977, a *pattern* is a tried and tested solution we know works to a common problem in a defined context [Rogers et al., 2011]. An *interaction pattern* is consequently a known solution to an interaction problem. There are several advantages to the use of patterns. Not only are the patterns tried and tested in the sense that we know that users are often able to deduce how to interact with the application based on the pattern, but by the power of the pattern being used many designers across various applications and web sites, the user will often have been exposed to use the pattern. The user is then likely to have been accustomed to their use, and thus able to use the application – the experience gained from use of other applications can be transferred to the new application due to similar use of the same interaction pattern.

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[12]In the case of this navigational element, one would use the attribute `role=navigation`.

!ht]

Figure 5.5: "Hamburger" icon

Listed below are a selection of the most prominent patterns used for the implementation of *Clementine*.

Hamburger Menu Drawer

To hide information and functions that are *occasionally* needed, the popular *hamburger menu drawer* pattern has been implemented. This is a modern take on the old *left navigation* pattern [Yahoo! Design Pattern Library, 2009]. The difference between the two is that with the left navigation pattern, the left sidebar is always available and visible – the hamburger menu slides in when needed. The hamburger menu drawer pattern can be seen in many modern web sites and applications, such as in the iOS Facebook application seen in figure 5.6, something that might help in defining the affordance of the icon and concept.

The origin of the name is uncertain, but seems to be first used by Mark Kawano in a message posted on Twitter [Kawano, 2012]. Probable reasons for the name the icon used to open the drawer somewhat resembling a hamburger, and that the content of the menu is arranged in layers.

5.5 Responsive web design

Responsive web design is a modern way of designing web pages, where one uses techniques and technologies present in modern web browsers to create designs that adapt themselves to the size and capabilities of the devices that views them. The term responsive web design was coined by *Ethan Marcotte* in his article *Responsive Web Design* [Marcotte, 2010] and elaborated further in his book with the same name.

> Rather than creating disconnected designs, each tailored to a particular device or browser, we should instead treat them as facets of the same experience. In other words, we can craft sites that are not only more flexible, but that can adapt to the media that renders them. [Marcotte, 2011]

(a) Menu closed   (b) Menu open
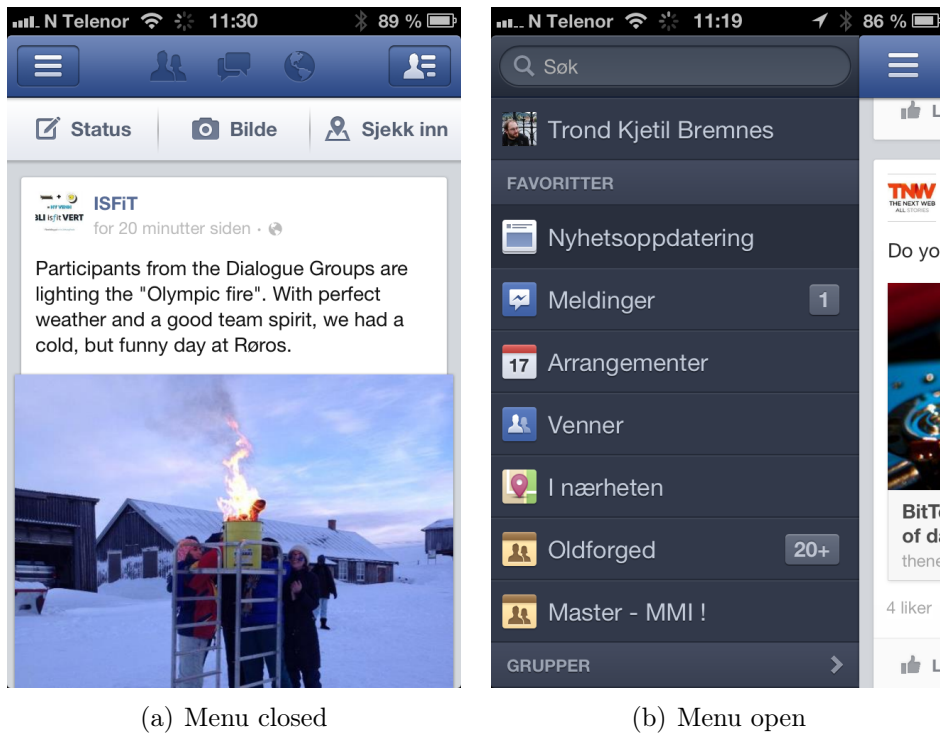
Figure 5.6: Facebook's implementation of the hamburger menu drawer.

In practice you design *responsively* by defining rules and conditions in the web site code, through the use of so-called *media queries* in the page's CSS rules[13], that resizes and rearranges the layout to better suit the size and input method of the device. An example of a popular way of making a site more responsive is in the instance of a small screen size being detected one can increase the size of all buttons on the page to account for the less precise pointer (your finger). In their *iOS Human Interface Guidelines* Apple recommends a minimum of 44 times 44 points for a touchable target [Apple Inc., 2010].

The variety of digital devices capable of using the internet is steadily increasing, creating a diversity of screen sizes and form factors. For instance for television sets, which are viewed from a distance one would need larger elements and text fonts to be able to be viewed from across the room, compared to a laptop that is much closer to the viewer's eyes. There are also a few concerns when considering input methods. Feature phones can connect to the Internet through Opera Mobile, which must be used with only a directional joystick. The Nintendo Wii uses a motion based controller, making it possible to navigate the Internet by pointing a remote at the screen. The Xbox 360 and the PlayStation 3 uses game pad controllers with

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[13]One can also use *feature detection* in JavaScript,

analogue sticks. Nintendo 3DS uses a stylus. Steam uses a method which they call *first-person browsing*, where instead of using the controller to move a pointer cursor, you instead move the entire screen, leaving the pointer in the middle of the screen at all times. All this means that while the device might be capable of accessing the Internet, and capable of rendering web pages, there is still a big issue of having to create a user experience that is pleasant to use on the device. For instance, finger based touch input is very imprecise compared to mouse pointers, due to the large are that is touched. To create an experience that is pleasant on such a device, one will have to design the page with this in mind, for instance by enlarging buttons when a touch screen is detected. *Clementine* will be designed for primarily touch interfaces.

5.5.1   Relation to *Clementine*

The ideas and principles of responsive web design has been applied when creating *Clementine*. As mentioned above, one of the core principles behind the creation is to make a book that is as usable as an analogue book, which means that the book should be as available, if not more. By creating a book that is as usable on a handheld device, something most students own and use today, as it is on their laptop computers, the book will be available to read wherever the user wants to read, as regular books are. To illustrate this, a simple user story has been created, and is presented below.

Consider a student of informatics on NTNU. She has not been reading as much as she should have during the course of the semester, and as the exams are coming up rapidly, she needs to read as much as humanly possible in the course of time that she has left. With *Clementine*, she is able to read at the table as she eats breakfast on her tablet computer. Finished with her meal, she runs to catch her bus going to campus. Here she is able to read the same book on her phone, cramming as best she can while ignoring the noise around her. Finally arriving at campus, she exits the bus and runs towards her study hall. Happy that no one had taken her favourite spot, she sits down and continues reading her book, now on her laptop computer. While this is arguably possible with all web pages, the reading experience is often nowhere near optimized for all platform as a responsive web page is, especially so on mobile phone platforms. With new web technologies, a designer is able to construct a web page that reflows properly, adjusting font sizes and omitting content depending on the size of the screen that is used to view the content, making for the best viewing experience independent on the device. The content adapts to the device, not the other way around.

5.6 On pagination

Central to the design of *Clementine* is the concept of pagination – the division of content into discrete *pages*. Research suggests that pagination has a quite a few benefits when it comes to structuring content, such as content chunking[14] which makes a text easier to read [Agarwal-Hollands and Andrews, 2001; Sutherland-Smith, 2002]. Pagination is one such way of content chunking. Research also suggests that people do prefer paginated interfaces compared to scrollable interfaces Lonsdale et al. [2006]; Nielsen [2010].

There also seems that reading from a page results in readers retaining the main ideas and details of a text better than when reading the same text from a scrolling interface [Piolat et al., 1997]. This effect is however disputed [Mangen et al., 2013].

The creating of so-called mental maps is easier when reading from paper due to its fixed nature [Mangen et al., 2013]. This might be applicable to the semi-fixed[15] implementation present in *Clementine*.

5.6.1 The evolution of record keeping texts

The way we collect written words together in works has evolved throughout the ages. Scrolls are one of the first forms of record keeping texts, used in Ancient Egyptian civilizations from the end of the thirtieth century BC [Store norske leksikon, 2013a]. With the spread of Christianity, the scroll was later replaced by the *codex* – a collection of etched boards of wood or ivory (and later papyrus) bound together in one of the edges [Store norske leksikon, 2013b]. Compared to the scroll, a book has several advantages, one of main ones being how referencing in a tome – a codex is random access, the scroll is sequential access. It is easy to open a book at any part you wish, a scroll needs to be searched through. Lookups are done with the use of folios – page numbers – is a tool afforded by pagination, and is something that greatly aids in referencing [Agarwal-Hollands and Andrews, 2001].

To relate this to how information is consumed on the web today, the vast majority of textual web pages are scrolled sequentially vertically – using a navigation metaphor based on the scroll. While the scroll metaphor is not entirely without its advantages, thousands of years of typographical development and evolution is lost. After all, there is a reason to why we have left the old scroll behind, and use books instead.

As the web developed and evolved, several print based techniques has been

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[14]Logical division of content into more palatable segments.

[15]The text is not completely fixed due to how it adjust itself to different screens. Different screens renders the same text differently.

introduced. Where the first web pages were simply long blocks text which one has to scroll vertically to read, one is now slowly getting able to create interfaces using columns [Lie, 2011], alter the flow of content [Hardy et al., 2013b] and even wrap text around custom shapes [Hardy et al., 2013a]. In a similar vein, introduced with the *CSS Generated Content for Paged Media Module* standard proposal [Lie, 2013], one now can use comparatively simple CSS techniques to create paginated interfaces for use on the web. While it has been possible to create such interfaces for the web using JavaScript (see chapter 5.2.4) for a while, the CSS solution is comparatively much simpler – a single line of CSS (`overflow: paged-x;`) can replace several hundreds of lines of JavaScript. Using this, it is finally easy to create paginated interfaces, complete with the beautiful typography one finds in print magazines, drawing from thousands of years of typographical experience and advancements, with the added advantages of being digital.

5.6.2 Implementations

There are, broadly speaking, two distinct ways of implementing pagination. The first method is perhaps the one most often encountered on the Internet: simply splitting the content into discrete HTML documents based on length and then linking between the pages with hyperlinks. An implementation of how this can be achieved can be found in the major news outlet *The New York Times* (see figure 5.7), where its longest articles are split into pages. The second pagination implementation is to have the pages generated dynamically based on the size of the device. This way of segmenting articles is rarely found on the web, but one can find examples of implementations in ebook reader applications such as Amazon Kindle and Apple iBooks. For convenience, the monikers *static* and *dynamic* pagination respectively is used, to differentiate between the two implementations.

Static pagination

Static pagination is the commonly found on the web today, where to read a longer article one has to continuously click to the "next page" to read it its entirety. The reasons for paginating pages like this is done for a few different reasons. Among the reasons is to limit the page size, both for the sake of the client's memory and the server's bandwidth. This is however practically a non-issue in today's multi-gigabyte memory, multi-gigabit bandwidth world[16], but the tradition still lingers. Another reason is the tradition of keeping content *above the fold*, to always keep important content displayed on the top of the page and limit the amount of

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[16]This is still however still a problem in less developed countries where Internet access is predominantly provided through comparatively expensive cell phones.

Figure 5.7: Example of static pagination. (New York Times)

scrolling the user has to do[17]. This is related to the early assertion that users do not scroll beyond the visible portion of the page – that scrolling is too foreign a concept – a notion that has since been adjusted [Nielsen, 2005]. People do in fact scroll, yet the myth survives. Yet another reason for paginating content is that this will load more adverts, which in turn generates revenue for the page. The last one that is to mentioned here is the aforementioned psychological benefits of chunking content.

PDF documents is another example of a paginated format commonly found, especially common in academic literature.

Dynamic pagination

Dynamic pagination is the idea is that the content adapts itself to the screen size dynamically – the screen always contains exactly *one* page and there is no need to scroll to read a page as one would do in PDF documents. Dynamic pagination is thus related to *responsive web design* (see chapter 5.5), as the amount of content of one page dynamically changes with the size of the browser or screen that views the page. *Clementine* is implemented using dynamic pagination, and is readable on every device with a browser that supports the pagination feature.

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[17]The concept of *above the fold* dates back to the way that newspapers' front pages are created. When displayed at a vendor, the newspapers are folded in half, in effect only displaying the upper half of their front page. To catch the consumers' eyes, the content on this part of the front page must be eye-catching enough to make them consider buying the paper.

Scrolling

The anti-theses to pagination is scrolling, the traditional way of navigating content on the web today. Scrolling is to simply display the text in a long vertical block of text that the reader will have to scroll downwards to read. Arguably, pagination of content is obtained with a scrolling user interface. By pressing the *page down* button, browsers will scroll the web page approximately a page down (also achieved by pressing the space bar). The amount of text that is scrolled down is however not consistent across browsers and the amount can be hard to predict. That the action is not sufficiently predictable might lead to sub-par usability as you often have to search for the line you are to supposed to read next.

5.6.3   The web standard

To create the paginated interface in *Clementine*, the web standard *CSS Generated Content for Paged Media Module* has been implemented. This standard lets web authors create paginated interfaces for the web with relative ease[18]. The support for the standard is not yet widely available, but available in the Opera 12 desktop version, as well as in the (pre-Blink) Android versions of Opera. In addition to making it possible to paginate interfaces, the standard promises methods to easily create other features related to pagination such as page numbers and footnotes [Lie, 2013].

5.7   Features

In addition to the actual typographical rendering of the text, *Clementine* needed to incorporate a few extra features deemed necessary for establishing the user experience of the prototype.

5.7.1   Text highlighting

As discussed in chapter 2, being able to produce markup can be considered a "defining aspect of responsive reading" [Thayer et al., 2011, p. 2921]. Thus, to improve on the user experience of *Clementine*, such functionality has been implemented.

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[18]It has been possible to create paginated interfaces on the web using JavaScript or embeddable technologies such as Adobe Flash. This is however comparatively harder to accomplish, especially without programming experience.

Figure 5.8: Text with a highlighted section.

Responsive reading

Responsive reading is a way of reading text – usually instructional, academic in nature – while "developing new knowledge or modifying existing knowledge by engaging with the ideas presented in a text." [Thayer et al., 2011]. This is different to *scanning*, *search reading* and *skimming* – different reading techniques related to finding information in a text – and *receptive reading* – holistically reading a text, often for pleasure – in how the reader engages with the text. The production of *markup* – taking notes, annotating, highlighting and drawing figures – is especially a defining aspect for responsive reading. The study had found by studying students reading on an Amazon Kindle DX that the reading experience was poor for responsive reading, pointing out that the cumbersomeness of marking up text in particular as being a detriment to academic reading and processing of the text. As 75% of the students interviewed in his study marks up the text while reading, the ability to do so is a very important feature of a digital expository text. This is why highlighting has been implemented in *Clementine*, and a note taking feature has been considered.

Text highlighting

The act of highlighting text – e.g. marking text regarded as important with different colour – is among the most practices methods of creating markup in physical books. This notion was confirmed by the respondents in the pilot interview, and a virtual highlighting feature has thus been added to the prototype. There are however some usability issues that has to be considered when designing such a feature. User experience wise, the largest issue at hand is how one should visibly and intuitively present the functionality to the user. Two solutions has been created and tested in order to find the best possible one: a clickable button that toggles a

"highlight mode"; and a context sensitive menu that appear when the user selects text.

The toggle button approach functions by having a the user press a button to activate "highlight mode". When the highlight mode is active, indicated by the icon changing colour, selected text is highlighted with a yellow colour and subsequently saved. The use of a buttons to toggle a highlight mode is used by Apple Preview and Adobe Reader.

The second approach to solving the issue of making the highlight function visible is to create a context sensitive tool bar. This was implemented by having a small selection of relevant button appear when the user selects text. The rationale behind using a context sensitive menu that appears automatically is that when a user wants to highlight text, the user has to select the text. By "hiding" the button like this, the user interface is less cluttered, and adheres to the utopian objective of only showing relevant buttons at any given time (see chapter 5.7.7). The tool bar is also a prime location for other features that require the user to select text, such as looking up word definitions and searching the web for the selected phrase. The Amazon Kindle desktop applications uses the context sensitive approach, and has been adopted for *Clementine*. A screenshot showcasing the menu can be seen in figure 5.9.

> (datastøttet læring). Det er også et utbredt
> samarbeidsverktøy i næringslivet (CSC **Highlight**
> Computer Supported Cooperative Work), og bør
> også være det i skolen (CSCL – Computer
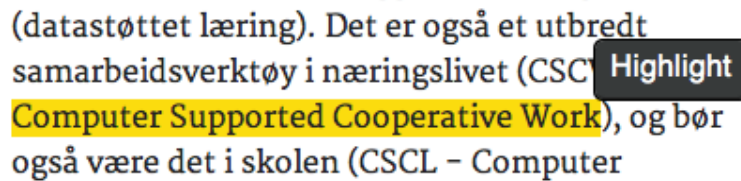
Figure 5.9: Screenshot showcasing the context sensitive menu for now only containing a single highlight button.

Notes and drawings

The next candidate for inclusion in *Clementine* is the ability to store notes. These notes would be connected to (a selection of) text in the book, similarly to how one might do notes in the margins of a book. Similar applications, such as Amazon Kindle and even word processors such as Microsoft Word lets users make notes in the text. The notes function would have been implemented in a manner similar to the aforementioned highlighting function, where after selecting text one would have a choice to create a new note to the text selection. A note function has not been implemented in *Clementine* due to time constraints.

Similarly, free-hand drawing would have been useful in a reading application, but the technical challenges involved in creating such a drawing function that would work with the dynamically flowing text is deemed insurmountable in the time allotted for this project.

Notes overview

To collect the notes taken in the application[19] a special page has been designed. The notes are sorted by chapter. A screenshot of this page can be found in 5.10.
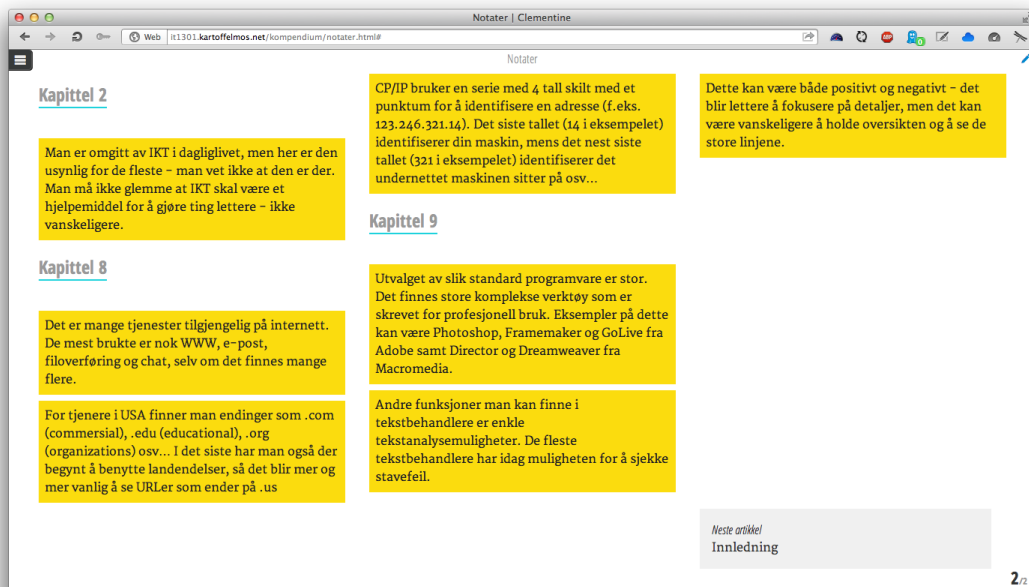
Figure 5.10: Collection of highlights collected throughout the book.

5.7.2   Progress indicators

Unlike traditional web pages, a paginated interface by default lacks a visible scroll bar. This means that there is no way for user of knowing how long a text is, and no way of knowing how far into the text they have read unless special cues are implemented. Physical books uses the thickness of the book and page numbering providing respectively approximate and specific data about reading progress. To provide users the same information in *Clementine*, several Inspiration for the design

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[19]In the prototype limited to highlighted passages of text.

is mainly gathered from the Mac version of the Amazon Kindle reading application which can be seen in figure 5.11.

Figure 5.11: Screenshot of the progress indicator used for Kindle (version 1.10.3 for Mac OS X). The leftmost number is the percentage of read text (across the entire book), the middle number indicates progress using the corresponding page number from the physical version of the book. The rightmost number indicates progress using absolute positioning from the digital book. Not shown in the picture is a visual progress meter.

Page numbers

As the pages are dynamically adapted to the viewport size of the device the book is viewed on, page numbering strictly speaking does not mean all that much – the ability to use page numbers to navigate to a specific position in a text is severely limited. Usability wise is the actual need for page numbering thus a point that needs special consideration. Two alternatives for a numerical progress indicator were considered: *page numbers*, analogous to the ones found in physical books; and *percentage* of read pages.

There is one issue with using page numbers. Because of how the application responsively scales to different screen sizes a section of text located at page 4 (of 16) can be located at page 8 (of 32) on a different device with a lower screen resolution. Using a percentage approach would on the other hand be comparatively more fixed, and would translate well across devices and window sizes. A section located at "page" 45% will always be located at "page" 45%. Page numbering does say something about how many times you have to turn the page to read the entire article – something that a percentage is unable to convey by itself[20]. People were asked what solution they preferred in the pilot study, and the respondents unanimously preferred the page number method. The reason given for this was that the metaphor can still be considered useful, and that the use of a percentage could be considered a difficult abstraction to fully grasp. Additionally, the progress meter located at the bottom of the page conveyed the same information that a percentage based counter would. Thus *Clementine* implements the page numbering approach, where the current page is displayed together with the total number of the pages in the document. The page number updates when the window is resized.

After deciding upon using page numbers, two distinct ways of using the page

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[20]That is to say without the users having to calculate this themselves.

numbers were considered: having the page numbers indicate reading progress for the current chapter; or having the page numbers indicate reading progress across the book in its entirety. Due to technical limitations, the page numbers denotes progress in the current chapter.

Progress meter

In addition to having page numbering, there has been placed a simple progress meter at the bottom of the page. This meter fills itself up gradually as the user changes the page, indicating progress. As the case is with the page numbers, the progress meter is an indication of how far the reader has read into the current chapter, not the book in its entirety.

The ability to click and scroll to the pages of *Clementine* through interaction with the progress bar was requested in the pilot study, making the progress meter function more like a scroll bar does on a scrolling web page. This is a novel idea, but it has not been implemented to to time concerns. Another similar feature requested was a thumbnail-view of the pages in the document, as the one you often encounter in PDF readers such as Adobe Reader and Apple Preview. These features would let readers quickly scan through the text and retrieve text easier. The feature has not been implemented in *Clementine* due to them being difficult to implement in the time allotted for this project.

5.7.3   The sidebar

The primary goal of *Clementine* is to make text as readable as possible, but there was however still a need to supplement the text with extra information and functionality for the sake of usability. Of the more important functions to have is is a readily available table of contents where the user can easily navigate through the sections of the book. To keep the user interface as clean as possible work has gone into keeping the screen as free from superfluous information and buttons whenever the user does not explicitly need it. To accomplish this, functionality and content not explicitly related to the act of reading has been hidden away in a sidebar "drawer" – a so-called *Hamburger Menu Drawer* (see chapter 5.4.4 for the user experience patterns employed) –, which can be slid in from the left side of the page by the press of a button. To annunciate its existence, a small animation has been implemented (see chapter 5.7.7).

In the final prototype version, only a table of contents has been implemented due to time constraints. The finalized version the sidebar would contain the features to customize the text (see chapter 5.7.6) and note taking related features (see chapter 5.7.1).
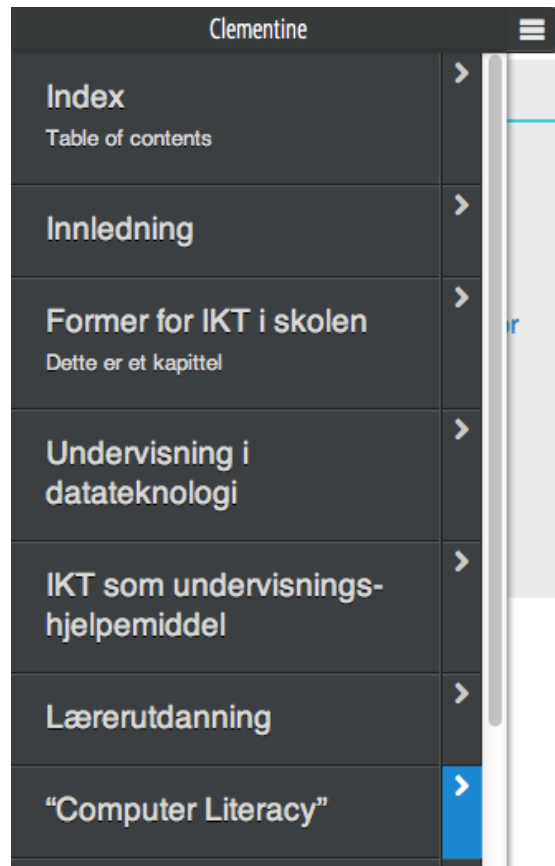
Figure 5.12: The Hamburger Menu Drawer. Initially hidden, made visible when pressing the hamburger icon visible at the top right corner. Pressing the chevrons (here highlighted in blue by hovering the mouse cursor) will load an index of the sub-chapters contained in the chapter.

Table of contents

The main content of the sidebar is the table of contents which is a feature that lets users rapidly jump between the chapters of the book, as well as skim through the topics of the books. Navigation to a chapter is done simply by pressing the chapter name. To navigate directly to a specific sub-chapter contained in the chapter, one can press a small button on the right side of the chapter button, indicated by a chevron pointing to the right (see figure 5.12). By pressing the button the sidebar content slides left – revealing the content of the chapter with links to each of the sub-chapters contained, similar to the *Master-detail interface pattern* (see chapter 5.4.4). Navigation to a sub-chapter is then done simply by pressing the sub-chapter

name[21]. It is possible to nest the chapters even further, but only two levels are present in the prototype text. Also not used in the prototype text, it is possible to supplement the chapter entries with a descriptive text.

User testing has shown that the sub-chapter button is not visible enough on tablets. On the desktop version, the button to reveal sub-chapters lights up (see figure 5.12) to indicate interactivity.

Additional content

Another prime candidates for functionality to be hid in the sidebar would be the ability to customize the text. This is a feature that would most likely seldom be adjusted (and perhaps only just once: when opening the book for the first time), and there would be not much need to have this function present on the screen at all times. Other features suggested for inclusion in the menu is meta data about the book, the repository of notes collected for the book and the ability to customize the text. No other feature than the table of contents has been implemented in the sidebar due to time constraints, and that these extra features were not found important enough to be prioritized.

5.7.4   Using stored user data

When considering storing user data there is one small usability issue to consider: how to use the data in a way that will not disrupt the user. In the case of storing highlights and notes, the solution is easy: just keep the book persistent – when the user has highlighted text, the same text should be highlighted the next time the user reads the same text. Using the previous reading position is however not as easy, as there arises some usability issues in how to best make use of this data.

The first solution is simply to redirect the user to the last position whenever the user reopens a book that is previously read. This could potentially be problematic as this entails making a choice on behalf of the user. That *Clementine* is a web application further accentuates this problem, as the choice made – to automatically redirect a user from the main page to the last read article – is something that web pages normally does not do.

The method implemented for *Clementine* is whenever the front page is loaded to display a subtle box in the top right corner of the page that asks readers if they would like to continue reading from the last saved position. Readers can then either ignore the box, reading from whatever position they themselves want, or they can click the box and continue the previous reading session.

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[21]The chapter structure data is gathered from an external file. The sub-chapter data is dynamically gathered by querying the chapter for all headlines contained in the document.
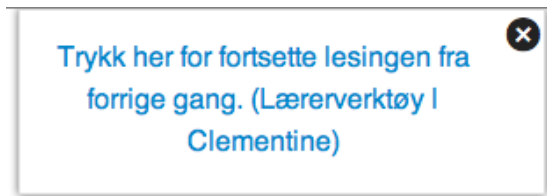
Figure 5.13: Dialogue box present in the upper right corner of the application whenever it is detected that the user has read previously. If clicked, the application loads the previous reading position.

Synchronization

Ideally, data stored in the client should be synchronized across all devices used by the reader. While the server-less solution created to implement *Clementine* does not permit for this at the time of writing, there are motions for creating standardized solutions for synchronizing local data across browsers and devices. Refer to appendix A.2.1 for more details on this.

5.7.5   Search

Searching is reported to be one of the major benefits of having a book available digitally, as this is an immense help when attempting to locate and relocate snippets of text without having to skim the book in its entirety. Unfortunately, due to technical limitations imposed by how it is implemented, it is not possible to search the book in its entirety, only on a per-chapter basis using the built in search function present in all modern browsers. This is something that needs to rectified in later versions.

5.7.6   Customization

Most reading applications available today implements the ability for the reader to be able to adjust the user interface to better suit their needs and preferences. For *Clementine*, the ability to change the font, line width and colour scheme, has been planned. Fonts are considered to be an especially important aspect to be able to customize. This not only for aesthetic reasons, but also because one can implement a way to activate a font that for instance is better suited to people suffering from dyslexia. Customization is however not implemented in the prototype version of *Clementine* due to time constraints.

5.7.7 Minor usability elements

Zooming

On tablets and other touch screen devices it is in many applications – web browsers included – possible to "zoom" the picture by pinching your fingers on the screen. Zooming has been deactivated in *Clementine* due unresolved usability issues in regards in how to properly implement it. Two ways to use zooming has been considered. The first solution considered was to simply do nothing, that is to *not* deactivate the gesture. This way, the interface would be zoomable in the same manner that ordinary web pages are. This manner of zooming is usually deactivated in "single page web application" to improve its "nativeness". The second solution, and was the most likely candidate for inclusion, is to adjust the font size based on the pinch motion. If the user gestures to zoom out the font would be set to a smaller size, if the user gestures to zoom in the font would be set to a larger size. This would however be a duplicate of the font adjustment feature found elsewhere in the application. The decision on how to implement it, or even if to implement it at all has been postponed.

Animations

Many of the elements that constitutes *Clementine* is animated to make the application both prettier and more pleasing to use, as well be a way to indicate interactivity on the page. There is a fine line between animations that are pleasing to the eye and provides a richer user experience and animations that are distracting, and great care has been taken to not distract the user.

The respondents in the initial pilot study pointed to the animated progress bar as being distracting. One of the interviewees mentioned that he felt as his eyes was lead to the movement on the screen. This animation was removed in the later version of *Clementine*, but the idea to use animation to attract attention was used for other elements on the screen. The pilot study revealed that the button that slides out the side bar containing the table of contents was not visible enough. To aid the readers in locating the table of contents, the sidebar has a slight "bounce" to indicate its presence.

The page turning is animated on Microsoft Windows and in the experimental version for the Android platform, but not in the Mac OS X version. This is a limitation of the implementation of the layout engine, not the CSS produced for the prototype. The standard proposes the ability for designers to choose between several page flip animations.

Hiding functionality

The only thing of actual importance to a reader when reading is the nothing but the actual text and words – everything else is secondary. In fact, everything that is not needed by the user is a potential distraction – if the feature is not needed, it is potentially in the way. So instead of cluttering the user interface with buttons, exposing every function of the application at all times, there has been put in some work in hiding unneeded functionality from the page. Somewhat humorously, Twitter employee Tom Wuttke exclaimed that "If web designers made doors, the knob would be invisible until you reach for it." [Wuttke, 2013].

The most obvious example of unneeded data hidden from view is the table of contents, only made visible whenever the user explicitly wants it. Other features that a user is interested in using very seldom – such as customizing the user interface (whenever you have found your preferred font and font size, you are unlikely to need the ability to change it again for a while) – are also prime candidate for features to hide away in the sidebar drawer. Another example of this is the highlight feature. Instead of having the feature exposed as a button in a tool bar, the button is revealed when the user selects text.

There are some usability issues that has to be considered with hiding information. The most obvious one is that if the feature is hidden, it might not be too obvious that it even exists in the application, or hard to find if one does not know where to look. Jakob Nielsen suggests that one should use recognition rather than recall [Nielsen, 1995]. To use recognition is most often done by having buttons visible in a tool bar (which the user recognises). Recall is most often found by hiding the function in a menu (which the user has to recall the location of). By hiding the highlight function one goes against this recommendation. Furthermore, by hiding the feature one introduces an extra click for executing the action.

Main table of contents

As part of the first "chapter" in the book one can find a table of contents, replicating some of the features found in the sidebar. A screenshot of the table of contents can be seen in 5.14.

5.7.8   Indicating interactivity

When hovering clickable elements in the text, interactivity is indicated by using changing colours. This is either by inverting the colour scheme (inline links in the text) or slightly increasing the colour brightness (sidebar links). Additionally, the mouse cursor changes to the operating system default pointer to indicate that the element is clickable.
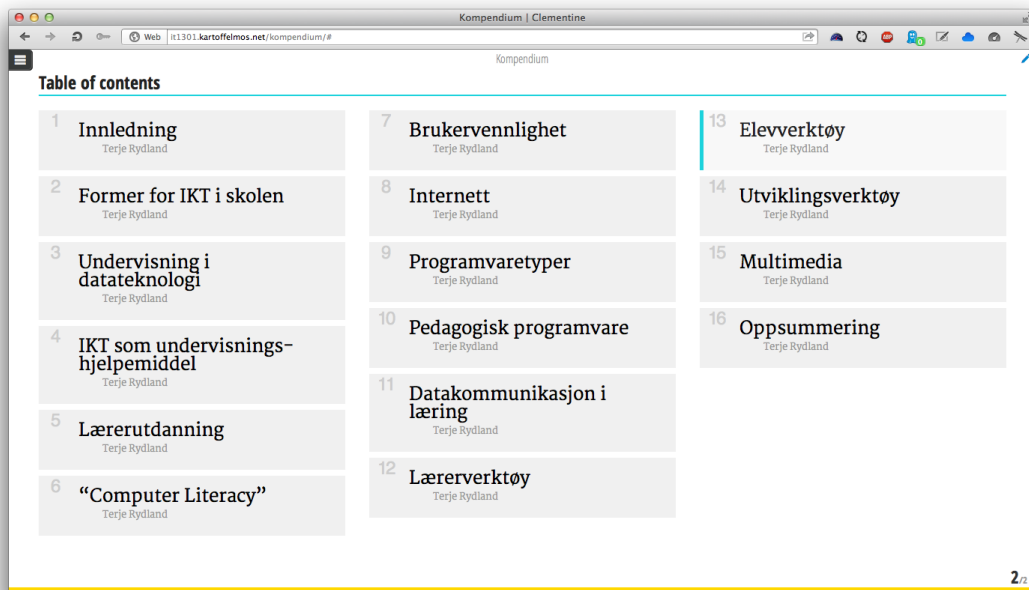
Figure 5.14: Main table of contents.

Figure 5.15: Default pointer cursor for Apple Mac OS X.

5.7.9 Replacing default behaviour

The main issue with replacing or otherwise overriding default behaviour is that this could potentially be confusing for a user in that the otherwise common behaviour that one is used to utilizing does not work as expected. *Clementine* being a web application which might involve navigating to and from external web pages accentuates the problem, as these external pages most likely will adhere to the default method of doing things.

That being said, *Clementine* does replace some core navigational features with its own – namely replacing the common scrolling interface with a potentially very foreign paginated interface – making it plausible that users expect that other facets of the application does not work as one would expect.

5.7.10 Browser versus application

When designing the extended feature set of *Clementine* – the features not concerned with the actual (typographical) rendering of the text –, the feature set of the web browser itself had to be evaluated, as there are reasons for omitting features if the browser provides the same or similar features. There are several advantages to having the browser do as much as possible and create a text that is as "dumb" and featureless as possible, as this will guarantee a form of uniformity across the books. One of the main advantage of having such functionality supplied by the web browser is that one is then able to have a minimum feature set present across all books.

An example of this is how Amazon handles this with their Kindle platform. Here, the books are simple text documents, which is supplemented with a simple manifest – a file that, among various other meta data, contains information about the chapter structure. This manifest file is then used by rendering applications which uses this information to create a table of contents which links to the different chapters and sub-chapters of the text. Features such as highlighting and notes are also handled by the rendering application, not by the individual book. Again, one is not dependent on the individual author or publisher implementing such functionality in their books. Here, another advantage of the separation rears its head: the data can be stored in the rendering application and will not be hermetically contained in the individual books. One is thus able to create a searchable collection of notes across books.

No modern browser is delivered with the advanced ebook related functionalities that has been considered for *Clementine*, and the ones deemed the most important has been implemented in the application.

6 | Pilot study

To be better able to create the topics and questions for the proceeding interviews, a pilot study was executed, with the purpose to gain a better understanding of how students feel about existing digital books and curriculum, their expectations on what a digital book should be and feel like, and how much text they read digitally versus the amount they read in a physical format. Additionally, as the interview in part consist of testing the prototype version of *Clementine*, response gathered can be used to further develop the prototype to correct errors and omissions in preparation to the main interviews.

The pilot study took place 30 January 2013, where instead of a normal lecture in the course IT1301 the attending students were asked to participate in the study. To introduce the study, there was held a short presentation of the project and the motivations behind it. The presentation included a short demonstration of the early prototype, its purpose as well as a brief introduction in how to properly operate it. The session as a whole lasted approximately 90 minutes.

6.1 Design

The pilot study was performed as model version of the main study, which is described in chapter 3, though the more exploratory nature of the pilot, and that the more specific questions had not been finalized at this moment, made it more appropriate to conduct it in a even more unstructured manner. For the interview, only the most basic topics and questions were prepared.

- The respondents' digital reading habits

- The respondents' printing habits

- Note taking techniques and requirements

- Advantages and disadvantages with digital books compared to physical books

Additionally, the prepared prototype version of *Clementine* was to be tested by the interviewees. Due to the rather simple nature of the prototype at this stage, the respondents were not given tasks to accomplish as one would normally do, but should rather navigate through the prototype by themselves. The interviewees were asked to discuss the metaphors and navigational features implemented in *Clementine*, and compare them to both physical documents and traditional (scrolling) web pages.

Three participants were attending the study, all male, studying informatics. Two of the people were using Windows laptops, one used a Mac. Two of the people owned a tablet computer, one owned an iPad, the other a 10" Android based tablet.

6.2   Results

6.2.1   Advantages and disadvantages of digital books

Among the advantages of digital books were *search* perhaps the most important one. Instead of having to skim through texts and indexes, one can simply search for what one need, saving minutes every time. The availability afforded by being digital was another strong point. Digital books are possible to carry with you at all times, unlike physical books that are both heavy and easy to misplace.

The biggest disadvantage of reading texts digitally were that prolonged use leads to eye fatigue. The respondents did however talk about how today's high resolution, low latency, high refresh rate screens such as found on the later Apple iPad models, reducing this problem to a point to the strain on the eyes from reading from a screen not being that much greater than the one produced from reading from paper. The continuous development of screen technology is likely to alleviate this problem even further. Back lit screens prevents the text from being read in bed as the blue tinted light produced by digital screens are tricking the brain to stay alert and awake and are potentially disrupting our natural sleep patterns [Viola et al., 2008].

The way PDFs are created, many of them are lacking proper search and copy-functionality. When questioned about what defines a good PDF document, the ability to search and highlight text were the examples specifically pointed out.

6.2.2 User testing

Reactions to Clementine

The initial reaction was that Clementine was clean and visually pleasing, and something that the students said they "could get used to using". It was in some areas seen as a bit too too clean in some areas where the pages was perceived as being "empty", and the lack of instructions created some initial confusion. While not strictly relevant to the study, the lack of advertisements cluttering the page was mentioned to be a positive element[1].

There were some differences in how *Clementine* was perceived in a desktop web browser compared to on a tablet device regarding the paginated interface and its navigation. The desktop version was perceived to be a bit disorienting at first, as text normally scroll vertically on the desktop[2]. On a tablet device the motion and navigation methods were on the other hand perceived as being very natural, and the user experience was quoted as being "seemingly made for tablets". Note that none of the students had tried similar reading software on desktop computers.

Parts of the interview were conducted with the participants using the Clementine prototype on both their own laptop computers and Android tablets. While not the intention of the interview, some feedback were gathered on the prototype itself. This feedback included feature requests, bugs and annoyances, and suggestions on further improvements.

The sidebar
> The button meant to show the menu drawer (see figure 5.5) was not as apparent as intended, and the existence of the menu had to be revealed to the interviewees. Apart from this the interviewees were able to navigate this menu just fine.

Paginated navigation
> The interviewees were quickly able to figure out how to navigate without any input from the interviewer.

> With a paginated interface, the interface supports the reversing of – *undoing* – navigation actions. If the user unintentionally scrolls the page, there is a bit of confusion on where the reader was reading, resulting in the user having to spend time relocating the passage. When using pagination, the

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[1]This is interesting to note, as this could suggest that the book, even though it is far from being a traditionally laid out web page, is still perceived as a web page where one might be conditioned to expect adverts to be present.

[2]*Clementine*'s pages are laid out horizontally.

user is able to easily reverse the action, reverting the state of the document to the state it was in the moment before the action was performed. The fixed nature of paginated text makes it easier for a reader to locate their previous reading position, which in turn makes it easier to take breaks away from the document. If you take a break after turning the page, you know that you are supposed to start reading at the top of the page. One is also better able to plan the reading session, as one can divide the session into "numbers of pages", something that the interviewees apparently often did.

The pagination metaphor was noted to be better suited to tablets than on the desktop. On tablets, the swiping motion used to navigate between pages is natural, and thus something – many applications uses this, including "regular" web pages. On the desktop, navigation on web pages is usually not done using the methods implemented in *Clementine*[3], making the user experience feel unnatural.

Progress indicators

Two methods are implemented in *Clementine*: *page numbers* and a *progress bar*.

The way the page numbers indicate the number of pages in the current chapter was noted as being positive, as the lower page number this results in did make it easier to plan the reading sessions according to the participants. When queried about what need the page numbers fulfilled, the interviewees replied that these are used for both remembering and locating the position of important sections in the text. After being informed about the difficulties with use the page number to locate information (see chapter 5.7.2), the interviewees found he sidebar with the proper tree structure like the one implemented in *Clementine* was noted to be sufficient for locating information in most cases. The proposed use of a percentage counter in place of the absolute numbers was then discussed, and the interviewees found the absolute number the better choice. According to the interviewees, people *"like to have something old"* – it is valuable to keep some metaphors people know from physical equivalents to make it easier to learn, and less "frightening" to people not used to the technology.

The progress bar at the bottom of the page serves the same purpose as the page numbers: letting the users have a sense of how far they have read into the document. The progress bar has a slight animation, which the interviewees found to be a bit distracting, citing that their eyes were drawn

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[3]At the time of the pilot study one can use the left and right arrow buttons, the space bar, and clicking the margins of the page.

to the moving object on the screen. The animation has since been removed from the application.

6.2.3   Important elements of a digital book

After the interviewees had tested the prototype, the topic of what features and functionality a digital book needs to have in addition to be able to represent text in a clear and readable manner. Note that some of these are already present in the prototype shown to the interviewees.

Chapter overview
> There has to be an easy way to navigate between the different sections of the book to make up for the fact that random access is harder to achieve in digital books[4].

Search
> Search is one of the most important advantages found in a digital book – one is able to quickly locate and navigate to desired information without the use of clunky indexes and content tables. This search has to function across the book in its entirety, and not only in the current chapter as is the case in the prototype version of *Clementine*.
>
> When questioned how the interviewees search on the different devices, the Android tablet owner said that he seldom actually searched on his tablet, at least compared to how he reads on a desktop. While he was aware that it is possible, he noted that it is not as natural an action as it is on a desktop computer. One possible hypothesis on why this is the case is that the search feature itself is harder to locate on a tablet than on a desktop – experienced computer users often uses *keyboard shortcuts*[5] to activate the search functions, something that does not exist on tablet computers.

Copy and paste
> The book needs to be available in a format the user is able to directly copy text from, something that was noted as being absent in many of the documents that the interviewees were familiar with. This would be used to copy entire sentences and paragraphs into separate documents for the purpose of taking notes during reading.

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[4]In physical books one is able to open the book at any page – if you know that some piece of information is located at page 45 you can jump straight to page 45. Scrolling pages are sequential access, meaning that one has to scan through the text sequentially to find the sought after information.

[5]In the case of search, one uses Ctrl+F (Windows) or Cmd+F (OS X).

Ability to take notes
> An ability to take notes in the text, somehow anchored to the text should be present to assist in responsive reading of the text. By anchoring them to the text, one can easier contextualize the notes when reading them later. The notes are best collected in a central repository to be able to find these notes at a later stage.

Progress indicator

> The ability to be made aware of reading progress as one reads is important for both motivation, and later information retrieval. In a physical book, one can usually get a feel of where a section of important information is located by using the thickness of the book. A digital version of a book does not have thickness, and the information thus needs to be given to the reader in another manner.

Bookmarking In addition to imprecise progress indicators, a more precise indicator of where important information is located is needed. In physical books, this need is fulfilled by using bookmarks and dog-earing, something that needs to be implemented. The bookmarking feature already present in the browser is not adequate enough, as this only bookmarks single pages – users needs the ability to bookmark passages and paragraphs.

Feature requests

To conclude the interview the interviewees were asked to create a top three list of features that should be present in a digital ebook reader. As a result, there seemed to be consensus around the following three items: *advanced bookmarking*, *text highlighting*[6] and *note taking*. This list is very much consistent with the preceding discussion as well as has been noted as important in the literature studied surrounding responsive reading (see chapter 2).

Other feature requests gathered throughout the interview are listed below.

- The ability to customize font types and size, among other typographical adjustments to be able to tailor the experience to ones own needs and preferences would be a highly valued addition to the prototype.

- A visual overview of the pages in the document, similar to the ones found in traditional PDF reading applications were suggested as a future improvement. Reasons for this was to have a greater overview of the book

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[6]This was not present in the prototype used here.

- Using the progress meter to quickly navigate between pages, akin to how one might use a traditional scroll bar.

- A simple tutorial explaining the application and how to use it.

- Retention of all data entered into it.

6.3   Conclusions

As previously mentioned, the main purpose of this study is to be better equipped to prepare questions and topics for the main study, as well as having an opportunity to gather feedback on the prototype version of *Clementine* for the purpose of correcting omissions and errors. While being a model interview, the discussions did generate some data on the topics of the study, which are detailed in chapter 9.

While the number of participants available for the study was unexpectedly low, the topics and themes were still able to yield a good discussion. Of special note in this particular study is that the students showed an unusually high threshold for printing, that the participants actually preferred to read academic texts digitally and had a rather high threshold for printing texts. This is somewhat uncharacteristic [Buzzetto-More et al., 2007; McNeish et al., 2012], and might be indicative that the group interviewed was too homogeneous. That they were all informatics students might also have slanted their views in this direction. The interviewees gave several reasons to why they preferred to print. Among the reasons cited where *environmental concerns*, that the texts are *easier to transport* and is made *more available* digitally. The possibility to *search inside the texts* as some texts have was a major advantage for having the text available digitally.

When questioned about their reading habits, none had read complete books digitally, though had been reading academic texts digitally. The tablet owners had read these on their tablets. Both of the tablet owners were aware of the availability of books tailored for their devices, and both had intentions to start using the devices to read books. When questioned why they felt they needed tablet computers (and why they did not think of doing so on their laptops) they described the the form factor of the devices creating a more natural reading experience.

The number of participants in the study was a bit too low, and the group was a bit too homogeneous to be able to construct anything more than simple hypotheses. Yet the students raised several valid points which has been used to create the proceeding interviews.

7 | Interviewing the informatics students

A group interview was designed and conducted to get insight into the reading habits of students, both digitally and print. The student's note taking habits was also of special interest due to the literature often describing note taking as one of the defining aspects of responsive reading. The (non-) ability to create markup in digital texts has been noted as being one of the largest detriments to the usability of digital books [Mangen et al., 2013; Thayer et al., 2011; Liu, 2005].

The interview was divided into three parts. The first part was a traditional group interview where the interviewees thoughts and experiences with both digital and non-digital reading was to be mapped. The second part was a short and simple user test, where the *Clementine* prototype was shown to the interviewees, with a few simple tasks to perform to make sure that the complete application was used. The final part of the interview was a recap of the interview as a whole, where the different features and presentation techniques employed in *Clementine* was discussed.

The interview took place at NTNU Gløshaugen, Thursday 07 March 2013, and had a total duration of approximately 90 minutes. The interview was recorded, but not transcribed.

7.1 The interviewees

Four interviewees had agreed to participate in the study, selected from a pool of students in attending the course *IT1301 – Datastøttet læring* at NTNU. This is both because of the convenience of getting students that are in the target audience of an application such as *Clementine* and because of the content that is rendered in *Clementine* is part of the curriculum in the course, giving the students an extra incentive to participate. The interviewees were all male first year students of informatics at NTNU.

7.2 Part Zero – The Introduction

Before initiating the interview, a few questions were asked to map the general personal details of the students, as well as their experiences and preferences in *responsive* reading of expository texts.

7.2.1 Devices

The interviewees owns the following equipment.

- All participants has smartphones

- All participants has laptop computers

- Three participants has desktop computers

- One participant has a (Android based) tablet computer

- None owned e-ink based ebook readers.

7.2.2 Previous experience

Two of the interviewees had participated in the pilot interview, and had thus some previous experience with *Clementine*. One of them had read the text between the pilot interview and this interview.

One of the participants had participated in a similar study earlier, where he had to review a digital book application, a project not too dissimilar to this one. He described the book as being little more than a glorified PDF with added features, including some animations and interactive features not found in physical books. This book was paginated, and would be navigated in by pressing buttons. He did not particularly like to read this book, and said he would much rather read from a physical medium.

Another of the participants had also participated in a digital book trial in his previous studies, where he as part of an English course got a digital version of the curriculum handed out. He did not have much to say about the project, other than that he e did not mind reading it digitally.

7.3 Part One – The interview

As described in chapter 3.1 the study is to be conducted as a semi-structured interview. The questions and topics for the interview can be found in chapter 3.2.2.

7.3.1 Advantages of using digital books

The main advantages of using a digital curriculum are according to the informatics students the topics listed below.

Availability

A digital book is always available wherever you have your device with you. Contained inside your smartphone, tablet or laptop you could carry your entire curriculum, not having to worry about having to either carry heavy books nor about having sufficient space to store them. You can have all your books on your body at all time, something that is mentioned as being very convenient.

Search

Search is noted as being one of the main advantages of digital texts, as it lets one be able to quickly locate relevant information, as well as being better equipped to cross-reference and locate related topics across books.

7.3.2 Advantages of using physical books

The discussion then went on to revolve around the the relative advantages of a paper based curriculum, the main points of which are detailed below.

Availability

Physical books are also noted as being available, though in a different manner. When presented in a physical book, the text is always available – just open and the text is available. That a book is not dependent on electricity further improves its availability.

Eye strain

While modern monitors has evolved immensely compared to the monitors that previous studies has tested with, the issue of eye strain is still very much an issue. They have higher resolution, updates quicker (reducing screen flickering) and are generally easier for the eyes. What has not changed, however, is that displays are still constituted of millions of tiny bright light sources something that is tiring for the eyes to look at for prolonged periods of time. Screen flickering – the result of the screen updating at a rapid, but noticeable, speed – is still being a problem, and still is a contributor to eye strain.

There exist special types of digital screens that aims to alleviate this issue from a different angle. Instead of increasing the refresh rate there are e-ink screens using actual ink pixels, and are purportedly easier on the eye due to not being back-lit. While none of the participants owned a Kindle or similar e-ink based device, and thus had not experienced reading on such a screen for prolonged periods of time, they still were all positive to reading texts on such a device as they believed that the eye strain problem was less an issue here due to the screen.

Distraction free reading

According to the students they are more prone to distractions in front of computer screens – on a computer, the Internet and all of its distractions are never too far away. Further, the mental model that the participants had of the computer as a device accentuates the problem. Where the very image of the book in their minds is that it is meant for serious work. On the other hand they associate computers as being a device for fun and enjoyment, vessels of videos, social interaction, games and leisure. These models of the objects were mentioned as accentuating the problem of keeping focused on the task at hand while using computers.

Tangibility

The respondents thought of reading from a screen as being *sterile* and *impersonal*, something that they felt was related to the lack of tactility when interacting with the device compared to what you would get when interacting with a physical book. The tangibility of the book is intrinsically positive. None were able to convey exactly *why* they felt this, but hypothesized that part of the reason was that where physical books are individually crafted, digital books are often presented in a standardized format where every book is identical.

7.3.3 The perfect digital book

To shed light on which features are important when reading digitally, the interviewees were designated with the task of designing the "perfect digital book" by describing features and attributes that must be present in such a book.

First and foremost the book needs to be both easy (usability wise) and comfortable to read – after all the consumption of textual content is the primary reason for using the digital book. Secondly, the book needs an advanced bookmarking feature more granular than the one supplied by the web browser – one should be able to bookmark pages (presupposing a paginated interface) and even paragraphs, sentences and words. One should also be able to use more than one bookmark per page, something that some browsers today disallow. This compared to the more

limited one found in most web browsers today, where a bookmark will (in most cases[1]) point to the top of a page. Lastly, the digital book should take cues from its physical counterpart, and try to emulate it as best possible, with the intention of creating a user experience that rivals reading physical texts.

The conclusions one can draw from this is that usability – the book should be easy to read – and user experience – the text should provide a pleasant reading experience, and that it should emulate a book – is the most valued features of a digital book. An advanced bookmarking feature is a very important according to the students. Do note the note taking technique of the students, where they admit to recording the page number of important information in a separate document. The advanced bookmarking function described would largely provide the same functionality as these notes. (see 9.1.9).

7.3.4   Note taking technique

Seeing that taking notes and making markup is such an important aspect of responsive reading (see chapter 2), how and why the students do this was decided to be an important aspect when discussing how to create a pleasant user experience when reading.

Among the note taking techniques used by the students were writing down important snippets of information, often accompanied with the page number where the text can be retrieved at a later stage, in a separate document (as opposed to making the note in the margins of the text). Only one of the interviewees admitted to using a highlighter, but had since quitted as he had found that he seldom actually used the highlights for anything and thus questioned its usefulness.

The way students read responsively differs so much from the "standard way" to take notes when doing responsive reading, the validity of the interview is questioned. Two hypothesis for why this is has been formulated, the first being the *inexperience of the students* interviewed – the students were all in their second semester of their studies. This lack of experience might translate into that their study and note taking techniques simply have yet to mature. The second hypothesis for why the note taking technique differs is the field of study, and a possible difference in how one would read different kinds of curricula responsively. Informatics is not a field of study where students are expected to read too many papers, especially not during their first year where most of the education is focused on giving the students a practical introduction to programming. The nature of technical books might not lend itself to be used in this way, but this is not something that has been researched in this study.

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[1]One is able to create bookmarks that points to specific sections of a page, but to do so is hard (one needs edit the bookmark manually), and presupposes that the page authors to add the required markup to the page.

It is mostly due to this that a second interview with teacher students has been planned and subsequently executed.

7.4 Part Two – The user test

The second part of the interview consisted of an informal user test of the prototype application *Clementine*and consisted of entrusting the interviewees with a simple task: use and explore the application. The participants was divided into two groups, one testing the prototype on a MacBook Pro, the other on an Android tablet. As two of the people interviewed had tried an earlier version of *Clementine* in the pilot interview, these two were divided evenly across the groups, so that both of the groups consisted of one participant that had tried the application and one who had not.

7.4.1 Procedure

The interviewees were divided into two groups, one group testing the application on a Asus Nexus 7 Android tablet, the other using a 13 inch MacBook Pro. The two interviewees that previously had tested *Clementine* was divided among the teams. Refer to chapter 3.2.2 for the tasks used in the test.

7.4.2 Results

The first impression of *Clementine* was that it is a clean application that looks and feels like a "normal book".

The inclusion of a navigatable table of contents in a hamburger menu and a repository that collects the notes created[2] was mentioned as being especially useful. No grave issues were had in performing the tasks, but some insights were gathered as the respondents explored the application. In addition to the issues described below, there were some small inconsequential usability flaws.

The omitted zoom feature was noticed by the interviewees, and was noted as being needed in a final version. The choice of icon used for the toggle button for the highlight functionality was noted as being poor. Some thought it was a button for an edit function. The context menu on the other hand worked well, the interviewees were able to use it correctly.

There were some confusion when clicking inline links, as the application would then send the user to an external site. The interviewee seemed to be confused about what had happened, and wondered how to get back to the book. Related to

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[2]Note that only highlighted text is stored in the prototype.

this, the application directs the reader to the first page of the document whenever the page is reloaded (as it is after coming back from an external link). This was a grave annoyance, and needs to be corrected in future versions – the reader needs to be directed back to wherever they were reading. The sidebar was usable, and the interviewees had no issues in using its basic functionality. That the sidebar contained links to the individual sub-chapters were however not noticed, due to the button not being clear enough. One of the interviewees also noted that he did not expect that the sidebar would contain such links, and thus never really looked for them.

Feature requests

Some additional features not present in the prototype was requested during the test. The two most prominent requests were the inclusion of interactive elements and animations, the ability to print pages and more advanced bookmarking.

By including animations and interactivity, the interviewees felt that one is more able to better utilize the advantages and possibilities made present by being a digital application, and as a result creating a more involving experience. Even though one of the potential goals of the application is to be able to pleasantly read documents digitally, the application needs to support printing, as one is not able to use a digital application at all times.

7.5 Part Three – The closing discussion

7.5.1 Perceptions of *Clementine* as a web application

How the prototype application is perceived can be an issue because of how In short, by being regarded as a web site, the user will have certain expectancies in how it should behave based on their previous experiences with other web pages as web pages are used in more or less the same manner. One comes to expect a certain feature set being available. Regarded as an application, the expectancies can be comparatively lax – each application behaves according to its own rules[3]. As *Clementine* is used in quite a different way than a "regular" web page it is important that it is regarded as a "web" application. The issue was detected during the pilot study, and for the testing the browser chrome had been hidden to mask its web based nature as much as possible.

In some cases, the participants viewed *Clementine* as a web page, often made apparent in how the participants trying to use features that is available natively

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[3]Note that there are however best practices, user experience patterns and interface guidelines that should be adhered to whenever deemed appropriate.

in the web browser. One such feature is the pinch-to-zoom gesture that one can use to zoom in on a section of a web page. This feature has been purposely deactivated due to usability concerns, detailed in chapter 5.7.7. In other cases, the interviewees viewed *Clementine* as an application, made apparent in how the interviewees requested features that is already available in the browser[4].

7.6 Issues

While the interview went rather well, and most of the results correlates to what is found in other studies, there are some issues with the study as it was performed. The main issues found are discussed below.

7.6.1 Lack of participation

It proved to be harder than initially to recruit students to participate in the study. This was both due to the number of students participating in the course were much lower this year than previous years, in addition to a seemingly general lack of interest among the attending students. Several attempts on recruiting students were had, and in the end only four people were able to attend a scheduled interview.

7.6.2 Number of students in the group interview

Oates[Oates, 2006] recommends having between three and six people attending a group interview. This means that four students is within acceptable limits, but due to the homogeneity in the group, and that Pairing this with the fact that two of the interviewees were a lot more active than the other two, accentuated the problem. Being only four participants might pose a problem when determining the validity of the study, and the results here are not expected to be too generalizable to the main public.

7.6.3 Lack of reading experience

The students that participated in the study were all first year students. This result of this problem can be seen in how the students interviewed, when asked about their note taking habits, *none* of the students highlighted text as they read. While not a truly universal thing to do, based on the literature reviewed there is reason to believe that one should find that at least *some* of the respondents highlighted text as they read. That all of the students interviewed were only in

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[4]One such feature requested has been bookmarking, a feature present in all modern web browsers.

their second semester at the university, there is reason to expect that they have not been subjected to too many papers yet, and their study and note taking habits are yet to mature.

7.6.4   Homogeneity

The largest issue with the study is that the participants was a very homogeneous group of people – they were all males in the same age span, all studying informatics in the same grade, and they all happened to enroll in the same course. The answers they gave was largely correlated with the available literature, but differed in some key areas, such as note taking habits. They all were very technologically interested, and all are likely to have had more experience than most people in the use of digital tools.

These issues were however to be expected due to the way the interviewees were a convenience sample. It would probably be beneficial to the group dynamic and the data generated to have seeded the group with interviewees from different disciplines.

The problem of homogeneity was made more apparent by discussing the project and the study with students from other disciplines. Where the interviewees often had a preference for reading academic articles on their computer, it was easy to find several students preferring to print the articles and read them from physical format. When probed about the reasons for reading from paper, there could be found several factors, one of the students talked to preferred the tactility of the text and studies by sliding her fingers across the text as she read it. This is something that is better achieved on paper than on screens.

7.6.5   What I have to do to alleviate this

To alleviate these problems, it seems necessary to design a second study. This interview will be conducted with students in a different field entirely, but with the same set of questions and themes as the first study.

It is important to note that even thought the study was flawed, there were had a lot of good discussions. Additionally, the students seemed eager to try to use the

8 | Interviewing the teacher students

Due to some issues considering the homogeneity and lack of reading experience in the first group interview, it was decided to have a second group interview with people that is very different from the first group studied. This way, one can perhaps see what difference a different field of study, as well as more reading experience makes when considering people's habits and preferences in relation to reading digitally.

The study is laid out in the same way as the previous studies with three distinct parts: a group interview; an intermission with user testing of the prototype application; and a closing discussion around *Clementine* and the ideas and metaphors employed in its creation.

The interview took place at NTNU Dragvoll, Monday 08 April 2013, and had a total duration of approximately 90 minutes. The interview was recorded, but not transcribed.

8.1 The interviewees

There were three participants in the study, all women in the same age group and approximately at the same level. All of the women studies pedagogy, which is the main reason for including them in the study. It was thought that due to their experience with not only themselves reading academia, but also their experience with teaching using both physical and digital curriculum[1] would give them a unique insight into digital consumption of text and domain knowledge. As it was found to be interesting to be able to keep track the participants throughout the study, the respondents are referred to as *Participant 1*, *Participant 2* and *Participant 3*.

The interviewer was acquainted with the interviewees, though not a close friendship, though participation in the same student organization.

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[1]All participants had through their studies been deployed at schools.

8.2 Part Zero – The introduction

The very first part of the interview consisted of a short introduction to the project and the interview itself. The interviewees were introduced to the concept of semi-structured interviews, and were encouraged to talk in between themselves. They all permitted that the interview was to be recorded. As they had all had interviews which they have had to transcribe, they agreed upon discussion rules between themselves – they would try not to talk at the same time, and agreed upon using common finger signals to indicate comments and new posts to be discussed.

To initiate the discussion, the interviewees were to talk about their experiences with digital reading, including the digital devices they use on a daily basis.

8.2.1 Devices

The first part of the interview was to find what digital devices the interviewees owned. This was done to have more data when mapping their previous experience with digital devices, and provide an extra variable to consider when evaluating their preferences in how to consume digital content.

It was found that:

- All participants has smartphones

- All participants has laptop computers.

- Participant 2 participant has an iPad Mini.

- Participant 1 participant has an iPad.

- Participant 2 participant has a desktop Mac computer.

- None owned e-ink based ebook readers.

Summarized, all the respondents owned several devices capable of rendering web pages, as well as ebooks. The variety and number of devices handled by the respondents suggests that they are fairly experienced in using digital platforms – at least they are not unfamiliar with it. The women were all good friends and shared a flat, making the available devices communal. This was made evident in how Participant 2 unlocked Participant 1's iPad during the interview, indicating that she knew the PIN by heart.

8.2.2   "Used to it"

Often when asked about their habits and experiences, the interviewees – especially Participant 1 – would often mention that she felt that she was not "used to" using digital texts in the same way that she is used to using physical books. Through having used physical books for studying all her reading life, she had domesticated the book in a manner that she had been unable to do with digital reading. She felt that people growing up with the technology available today will have an opportunity to domesticate the technology in a manner that she had not – that by having the technologies introduced to them so early on, it will be as natural to them as physical books are to her.

8.2.3   On reading digitally

Participant 1 expressed an intention to completely digitize her academic life and keep all her study material – articles as well as notes – digitally. She had found that whenever she was to print a paper, or take notes on a physical paper sheet, these would eventually wind up getting lost – with digital notes, she felt that this is no longer a problem. She did however occasionally print material[2], but now that they were available digitally, when she inevitably would lose them she could easily produce a new copy of the material. This person was also the only one to take digital notes during classes – she did this to keep concentrated during classes, and to be sure that she does not miss anything critical during the lecture. Participant 3 was Participant 1's exact opposite – preferring to print whenever she could, as she felt this better fit her personal study technique. Do note that Participant 3 was also the only one not owning an iPad. Compared to her fellow interviewees, Participant 2 placed herself somewhere in between, without any real preference either way and printed as often as she read papers digitally.

Form factor

Participant 2 mentioned that the form factor of the iPad, being comfortable to interact with in the same manner as one can a physical book, is important when reading longer texts. According to her, it simply feels more natural than reading from an upright computer screen. A book can be read while lying in a couch or bed, as can a tablet device. Desktop and laptop computers with their fixed screens is best used when sitting upright in a chair in front of a desk, something which is comparatively more uncomfortable.

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[2]It is unclear why she did this, it could be because of an actual need, or it might be for convenience.

8.3   Part One – The interview

As in the interview with the informatics students, the first part of the interview was a general semi-structured. interview Chapter 3.2.2 lists the questions and topics used for the interview. The themes and topics below are not in the order as discussed by the interviewees, but rather sorted based on how they relate to each other.

8.3.1   Readable digital books

Readability

Good screens, with good contrast is key to create a pleasant reading experience, to be as readable as possible, the screen of the device has to be pleasant to use – if prolonged reading results in eye strain and discomfort, it will be difficult to use properly. After this, the text must be as legible as possible. Good use of good fonts was mentioned as being a great driver in achieving this, with *serifs fonts* (see chapter 5.3.1) specifically mentioned by Participant 1. To further improve the readability, the ability to customize the fonts creates the possibility to tailor the experience to ones own needs and preferences.

Usability, user experience and accessibility

A good way to navigate through the pages of the book is crucial for creating a good user experience. It should be intuitive, and most importantly, it should be fast. It should be possible to flip through all the pages of the book in a fast manner, to be able to quickly locate important information. A slow application breaks the flow, and makes it hard to use. Page numbering – a way for the book to convey information on which page on reads further improves the reading experience. The interviewees mentions two reasons how this improves the usability of the book: one is able to get a sense of both how far one has read into a chapter and how much is left; and page numbering provides information on the relative location of a chunk of interesting information – such as a snippet of text or a picture – is located. Similarly, a way to emulate a book's *thickness* improves the user experience by providing yet another cue to convey progress and location in the text. To make the book more accessible to a wider public, the ability to be read aloud by screen readers is important. Do note that the interviewees took it for granted that the readable digital book is paginated – these discussions were had *before* the prototype book was shown to the interviewees.

While not strictly tied to the concept of *readability*, the price of the book has to be fair, and the availability of the book and book store must be constant.

It is very interesting to see that much of the discussion, without being shown the prototype book, or by being prompted by the interviewer, revolved around the matter of making *pagination* work as good as possible, examples being that the interviewees demands both page numbering (something that is inapplicable on a vertically scrolling page), and mentions that navigation *between pages* should be smooth and easy to perform.

Collection

A university course often has a number of curriculum books to be read as part of the syllabus. By having all these books somehow collected in a central repository would bring with it several advantages, one of which is the ability to collect notes across books.

The participants expressed a dismay in how things often are done today, where different functionalities are available in different applications. A good reading application will function as a collection of books, complete with all the necessary functionalities contained, negating the need to navigate back and forth between different application with differing feature sets. The use of a common interface with a common layout for the books make it so that the users will not have to repeatedly have to learn how to use a new interface for each book.

Functionality

Part of providing a good user experience necessitates supplementing the text with certain functionalities. Participant 1 had noticed that she, after having worked with computers with word processors and reading applications for a number of years, she tended to expect a certain level of functionality being present in a reading application. A great reading application needs to have this minimum feature set. Below are the ones specifically mentioned by the interviewees. Most of the functions discussed are functions one can find in other reading applications.

Search The ability to search in the text is noted as being very important for a digital text – maybe even contributing the largest advantage a digital text has over physical text. A readable book has a good search function that is able to find anything in the text that the user needs at any given time.

Bookmarking A bookmarking function, where the user can bookmark pages or segments of the text for later.

Copy and paste The common copy and paste function to be able to store snippets of text in other applications is a great convenience during note taking when studying.

Highlighting All of the interviewees used highlighters to mark text as they read. An improvement on the idea is to make it possible to use different colours to differentiate between topics, something that they did when reading physical papers.

Overview A novel idea presented in the interview by Participant 3 was to include a "zoom-out" feature, with the function of getting an overview of the book in its entirety. This is a feature for instance found in Microsoft Word and Adobe Reader, and can make it easier to locate information among a lot of pages.

8.3.2 Advantages of using physical books

Distractions

Physical books are not as distracting as digital devices, as the content of a physical books is just the words and sentences that the author decided to put in it. Digital devices on the other hand are nearly always connected to the Internet with all of its distractions. The interviewees said that they were able to lose themselves more into a physical book.

The interviewees suggested a feature that blocked distractions by disabling the Internet connection to be able to better escape this. There are browser extensions[3] that accomplishes this by blocking access to web pages by black- or white-listing[4], which could potentially be used in tandem with *Clementine*.

The way people are distracted easier when reading from digital devices might have a lot to do with how they Participant 2 most often used her iPad for playing games, Participant 1 is an avid user of email, activities that are notoriously known for being used for procrastination. By repeatedly using the devices for such activities, the norm slowly becomes that these devices are made for such activities.

Backups

It seems that there is still an anxiety for losing digital content – computers still occasionally suffers from crashes that physical books does not. You do not need to worry about the content of the book suddenly disappearing. It was noted that it is still possible to misplace and lose books. *Corruption* – that the content of the book in some way gets distorted or destroyed within the file – can be an issue.

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[3]Small applets that extend the browsers functionality beyond what is provided by default.

[4]**White-listing** is blocking access to *all* web pages, except the white-listed ones, **black-listing** is blocking a specified selection of web pages.

Tangibility

By existing in three dimensional space and being possible to hold and feel in ones hands gives one a feeling of physicality that is impossible to convey using digital tools. The tangibility of a physical book is something intrinsically positive.

Additionally, there are some discernible features provided by a physical book's tangibility. One of them is that progression can be felt with your fingers – the thickness of the remainder of the book is a conveyor of information on your reading progress. This is something that is very hard to replicate digitally using contemporary technology – the closest thing available is the scroll bar located on the right side of the screen in most applications with scrolling content. The interviewees noted that this might be something that this might be a problem because of them not being sufficiently used to the technology.

Using physical books one can interact directly with the text, highlight directly, write free form note in the margins, make drawings. Tools are often very limited in digital reading applications, imposing large restrictions on how notes are to be taken. Physical books does not have this problem. The respondents continuously added that they felt restricted by the tools, and, that they might have been more comfortable in using digital tools if they were more unconfined. The tactility of writing notes using a pen was also noted as being better than using buttons.

They also felt that they were inexperienced with using digital reading tools compared to physical reading tools. Participant 1 noted that the way she had 24 years of experience with physical tools could have something to do with her feeling that the digital tools she used were inadequate.

Simplicity

Physical books are presented with "no fuss", a book is simple – it only needs to be opened to be used *instantly*. A digital book on the other hand needs to be powered on, something that might take time[5]. Digital devices are dependent on electricity to function, needing either a charged battery or an available power outlet. Physical books on the other hand can be accessed wherever and whenever you have sufficient lighting to be able to read.

Most reading appliances are multi-purpose devices, capable of doing much more than just read books. This is accomplished by dividing the tasks the device can do into single-purpose applications. This means that you often need to navigate between applications to be able to find the book you want to read. In some cases you even need to navigate between different applications to be able to do different things – the feature sets of different reading application might differ in what you are allowed and able to do with a book.

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[5]Booting even the latest versions of the Apple iPad takes around 30 seconds.

Participant 3 mentioned that she felt that she was more engrossed in the text, and read physical books in a more *holistic* manner. This compared to digital sources, where she felt that one would be able to continually immerse oneself in the material by having near effortless availability of different sources to consult. In a physical book, she would just learn the data that the book provided, if she read about the same theme digitally (such as on Wikipedia), she would be able to navigate and read more about subtopics (continuing the Wikipedia comparison, where articles are littered with links to related themes and topics) as she was reading.

8.3.3 Advantages of using digital books

Continuing the discussion, the interviewees were asked to discuss what they find advantageous with digital books compared to physical ones.

Search

Search is a major advantage of digital books. Unlike physical book that needs users to use table of contents, indexes and skimming to be able to locate wanted information, with a digital book you can simply just do a keyword search for the text.

Availability

All of the interviewees were owners of both smartphones and laptop computer, some even had tablet computers. Because of this, digital books are always available wherever they are. Given that their entire curriculum is digitized they always have *all* their books at their disposal at any given moment. Books that are needed, but currently do not own are still available, due to new books being purchasable over the Internet.

Evolution

Compared to physical books, digital devices are ever evolving and receives constant updates. The two most digitally savvy of the group – Participant 1 and Participant 2 – expressed an excitement in the applications on their phones being updated, anticipating new and exciting features. They were thrilled whenever their smartphone indicated that one of the applications they use regularly had been updated. Whether or not this is generalizable to the population at large was however noted as being less than certain – the way Facebook often comes under fire after each new design direction came to mind. Participant 3, the less digital of the trio, was indifferent to this.

Revisions

Digital textbooks are able to be revised and updated in manner that physical books are not – once a physical book has been printed and sold, this is the product that the end user will have to use and put up with. A digital book can receive updates when it is revised , that being because of typographical errors or because of obsolescence.

Being teacher students with a syllabus in constant flux due to reforms they have often had to buy entirely new books with only parts of the books changing. Related, the environmental impact of constantly having to print new editions of nearly unchanged works was also mentioned as being a concern.

8.3.4 Utopian book

Now that the interviewees have been discussing the concept of the digital book and compared it a physical counterpart, the interviewees were tasked with designing the feature set of the utopian digital book. This book should not merely be on par with its analogue counterpart, but if at all possible provides an experience that makes it *preferable* to read the text digitally. When discussing this, Participant 2 mentioned Prensky's idea of digital natives and digital immigrants Prensky [2001], again pointing out that children growing up today might have different views by having digital texts introduced to them in a very young age compared to themselves. Where they themselves preferred that a digital book in many ways should emulate the look and feel of their analogue counterparts, this might not be applicable to those who are growing up surrounded with technology. Humans are incredible adaptive which makes it plausible that children growing up today are accustomed to using digital devices in a different manner than themselves – to them using a computer is no different than using a toothbrush. This makes it plausible that children growing up today are not as aware of the perceived shortcomings of digital books as digital immigrants.

When describing this utopian book, the interviewees specifically demanded that the utopian digital book should be first and foremost focus on *usability* and *user experience*. It should be easy to use by anyone – in essence, create a "book-like" experience, create a digital book that incorporates the relative advantages of being digital, while alleviating its relative disadvantages. In addition to this, the utopian book of course need to incorporate the features that gives digital books its relative advantage.

To reinforce the usability , the interviewees suggested using some sort of tutorial such as an introductory video to make sure that the features are accessible and the user knows how to use them. As for user experience, the interviewees said that a good digital book needs to be as simple as possible – the reading application needs

to focus at its core functionality: create a pleasant reading experience. Often the bells and whistles added to reading application are more of a distraction than it is useful to the end user. While a reading application might have many features (they mentioned several important features themselves just a moment ago), it is very important not to pollute the experience with buttons, menus and other distracting elements – a good digital book needs to be simple to use.

8.3.5   Note taking techniques

According to Thayer et al. [2011], one of the defining aspects of responsive reading is the creation of markup as one reads. The interviewees were therefore asked to detail how they take note while reading.

It was found that all all of them took notes during reading academic texts, with some variation in how and for what reasons they take notes. Both Participant 2 and Participant 3 highlighted text as a part of their note taking technique. Participant 2 highlighted text as a mean to achieve mental focus when reading, Participant 3 read the text in its entirety first and then highlighted important parts of the text when reading it for a second time. To signify the theme and importance of highlighted text, different colours were used.

Participant 1 wrote summaries of the syllabus digitally in a separate document and then iteratively shortening and distilling this summary, but seldom used a highlighter. This due to she, in her continued intention to digitize her academic life, interestingly had adapted her markup habits to better suit her reading habits. When discovering the poorness of the tools available for highlighting text digitally, instead of printing the documents to be able to highlight text better, she had instead nearly stopped highlighting text altogether.

8.4   Part Two – The user test

As the case was in the previous test, the second part of the interview was concerned about having the interviewees testing the prototype application. The interviewees were all familiar with digital devices and reading digitally, so no further instructions were deemed necessary. Both the desktop and tablet versions of *Clementine* was tested on devices provided by the interviewer. The testing was done by having all three participants grouping around the devices. The interviewees were asked to simply explore the application by pretending to use it as they would have done if they were to actually read it. However, to make sure that every major feature of the application was tested some simple were devised and given to the interviewees if they did not do the tasks themselves. Refer to chapter 3.2.2 for the tasks given to the interviewees.

8.4.1 Procedure

The interviewees were divided into two groups, one group testing the application on a Asus Nexus 7 Android tablet, the other using a 13 inch MacBook Pro. The two interviewees that previously had tested *Clementine* was divided among the teams. Refer to chapter 3.2.2 for the tasks used in the test.

8.4.2 Gestures

When trying *Clementine* on the MacBook Pro[6] that was brought along, the respondents repeatedly tried to change the pages using a two fingers swipe motion[7]. In Mac OS X, this action is reserved for **back** and **forward** browser history navigation, which means that there might be some issues if it were to be implemented in the application. The action was repeated intuitively enough times to be noteworthy. Note that in the Amazon Kindle desktop application on Mac OS X this motion triggers a page change.

There are however some implication of replacing default behaviour with custom routines (discussed at length in 5.7.9), something that was noted by Participant 1. A potential scenario illustrating the issue is detailed below.

1. A user reads an article in *Clementine*, changing pages with the two finger swipe gesture.

2. She clicks a link.

3. She read the content.

4. She navigates back to the application with a two-finger swipe to the right.

5. She regrets her choice of going back to the article and wants to "go forward" to the linked content

6. The two finger swipe no longer navigates the browser history, the gesture will now navigate to the next page in the article.

Here you can see how switching between interaction methods potentially can cause some confusion. There is also the issue of replacing the gesture action with a non-standard action, as users will be used to the back and forward gestures used

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[6]The device being a MacBook might be relevant, as there are several gestures available as shortcuts to common tasks.

[7]This gesture is performed by touching the touchpad with two fingers and swiping them horizontally across the touchpad.

in a conform way in all other web pages making interacting with the web page feel unnatural.

The issue can be solved by opening the content inside a frame inside the application. This is something that the respondents earlier on described as being a good thing – one should keep all content inside the application.

Pinch zooming

The absence of pinch zooming, a feature that has been deactivated due to not knowing what to do with it (see chapter 5.7.7), was noted. The interviewees were told about the potential issues, and when asked about what they would prefer to happen when pinching there seemed to be a slight preference in changing the font size, not doing a page zoom.

8.4.3 Navigation

Navigation on the tablet version was likewise intuitive, and the respondents immediately figured out how to read this version as well. Navigation in the desktop version is different due to a lack of a touch screen. To navigate between pages on the desktop version one can use the arrow buttons and the space bar[8]. The participants immediately tried using these buttons, and quickly understood how to navigate through the application. Gesture based navigation was, as described in chapter 8.4.2, attempted in the desktop version.

8.4.4 The sidebar

The version of *Clementine* used for the user testing had a slight "bump" animation – the moment the page is finished loading the sidebar pops into view for a short moment to let the users know of its existence. This was adequate, as they were able to find it with no help from the interviewee.

The only issue the participants had with the implementation found in *Clementine* was that the method of revealing the menu while using the tablet version. Participant 2 repeatedly tried to "drag" the sidebar in from the left by the button by touching the button and dragging it to the right. A plausible reason for this behaviour is that everything else in the application is interacted with by using gestures (not counting the elements located inside the sidebar) – this is the only visible button in the application. The problem is accentuated by the sidebar using a slide animation when revealed, something that could have influenced how it is

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[8]One can also use the page up and page down buttons on keyboards that have these buttons, something that the supplied laptop did not have.

expected to be interacted with. The desktop version does not have this problem, as the application is on this platform interacted with using clicks.

Sidebar sub-menus

In addition to containing the book's table of contents, one can navigate through the chapter sub-chapters using this table. These sub-chapters are accessed by pressing a small arrow button on the right side of the chapter button. The presence of this button was not apparent enough and the participants were not aware of this function before being told of its existence.

   The problems of using buttons for the sidebar was again made apparent, as Participant 2 once again tried to use swiping gestures to navigate through the sub-menus. An improvement on how to improve the sidebar was thus suggested by Participant 2. Instead of pressing a button – something that is rather seldom done elsewhere in the application – one should be able to use a swiping gesture to navigate between the sub-menus.

8.4.5   Text highlighting

After much deliberation (see chapter 5.7.1), the use of a context menu was decided upon as being the preferred method to implement the highlighting function in *Clementine*, yet the toggle button was deliberately left inside the menu. This was to be able to see how the interviewees would react to the task of having to highlight text, to see whether they tried to use button first, or if they would try to mark the text. The button was pressed multiple times during the test, but no one knew figured out what the button was supposed to do, though noticed that *something* was activated. This might indicate that the icon was unable to convey its associated action well enough, something that could have been improved upon by using either an illustrative icon with a stronger affordance than the one used or replace the icon with a descriptive text.

   On the desktop version one is able to use the mouse cursor to mark text, which in turn will pop open a context menu containing various actions one can take on the marked text – including highlighting of text[9]. After having tried the application and asked about which way to highlight text was perceived as the best one, there was an inclination to prefer the context sensitive menu over the toggle button.

Improvements

To improve the context menu the interviewees suggested the following features to be added: a way to add notes to the selected text; the ability to copy text to

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[9]In the prototype version only the highlight function in implemented.

the system clipboard; and a dictionary lookup for the selected text. To be able to categorize their notes when reading, the interviewees had mentioned that they would use highlighters of different colours – the ability to do this in *Clementine* was suggested. To further make use of the highlights, these coloured highlights could then be categorized together across chapters and books.

8.4.6   Colours

Some feedback were given on the use of colours in the application. Links were noted as being a bit too invisible, blending in a bit too much with the surrounding text. Otherwise, the use of colour in the application was noted as being good – the sparing use of a subtle blue colour was specifically noted as being a good choice for the application.

8.4.7   The notes section

After the application was deemed to be fully experienced and explored and the small tasks given to the interviewees were carried out, the interviewees were shown the "notes section" of *Clementine* – the location where all the notes taken in the application are stored for posterity. This was only shown in the desktop version of *Clementine* due to the highlight function not being implemented in the tablet version.

The interviewees quickly found that the elements were clickable, and thus found that the notes links back to the sections where the text was highlighted. The reason why they tried to click the elements was because of the elements "lighting up" as they hovered the mouse cursor over them.

8.5   Part Three – The closing discussion

The last part of the interview was a closing discussion, where the interviewees were to discuss the prototype application, and new ideas on digital reading that might have been conceived in using a digital book. The initial reactions to the prototype is that they found it to be "nice and clean" with "no distracting elements", and that the choice of fonts were good. One of the main goals with *Clementine* was to emulate the source material – the academic book – as close as possible. This is thought to have been achieved, as one of the participants said that the prototype evoked a "book feeling".

To steer the conversations away from the *visual* parts of the application, specific topics deemed interesting had been prepared for the interviewees to discuss.

8.5.1 Pagination

One of the most important features implemented for improving the readability of *Clementine* was *pagination*, where the content is dynamically split into pages. How this was perceived by the interviewees was therefore explicitly questioned for discussion.

Participant 3 experienced the text as being more "fixed" because of the use of pagination. The text does not move, and Participant 2 added that interacting with the prototype felt like interacting with a PDF. This was noted as being advantageous compared to a "standard" web page. It is worth mentioning that when the idea of the "perfect" digital book was discussed prior to the user test, it is evident that the interviewees considered a paginated interface standard for digital books.

8.5.2 Page numbering

The use of page numbering was noted by the participants as being important, even when told of the problems in the page number's information bearing capabilities in a responsive web application. It was felt that the progress meter located at the bottom of the page supplemented the information in such a way that they should be able to relocate information based on relative location in the text. The page numbers was used by the participants as a tool to gauge how long the text is, and how far they have read in the text.

The group, experienced in reading and citing academic sources, did find a potentially severe issue with dynamic pagination and associated page numbers. When one is do a direct citation or a quote from a text, one is supposed to use the page number the quote is located on, something that is impossible when using dynamic pagination where page 3 on one device is not page 3 on a different device. This is an issue that has been discussed in chapter 5.7.2, but the potential issues when properly citing direct quotes is new insight.

8.5.3 On scrolling

To better compare the experience of reading *Clementine* and "ordinary" articles, the experience of reading *longer* articles on the Internet was discussed. (Unlike the informatics students) The interviewees did manage to read even long articles, if the material was deemed interesting enough.

Participant 2, the one of the trio most likely to print articles, said that even she had read a book length text, and even though she agreed that the reading experience was poorer (than it would have been if she read it in a physical format), she managed to read the complete thing due to her being completely engrossed

in the text. When the respondents were asked to discuss the user experience of reading longer articles on the web (using scrolling pages), they all preferred that the articles were short in length.

8.5.4   Printing

Even though all the participants said that they thought that they would absolutely be able to read longer texts in the paginated interface created, they still insisted on the pages being printable.

A small feature in *Clementine* is the ability to collect ones notes in a central repository for later viewing[10]. This was curiously something that the interviewees wanted to be able to print. This might have something to do with how they admit to using their notes – highlighting for reading later, summarizing and distilling content.

8.5.5   Additional feature requests

While the ability to take textual notes was a feature that has been requested at every interview and testing that has been had during the development of the prototype, this interview introduced the idea of having the ability to create audio notes. This idea spurred from the interviewees describing the peculiar study technique of one of their friends. She studied by taping her notes and listening to them while travelling between her home and the university. There are standards in development that should make this possible, but it it has yet to mature and be commonly found in web browsers.

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[10]As only the highlight feature is properly implemented, only highlights are available in this feature.

9 | Conclusions

This chapter will conclude the study by providing further discussion on the topics from the interviews, and propose answers to the research questions from chapter 1.2 based on these discussions together with issues and limitations of the study as a whole. Lastly, suggestions and recommendations on future work, both in regards to the prototype application and future research based on the data gathered in the study, is presented.

9.1 Topics discussed

A variety of topics were discussed as part of the interviews in chapter 6, 7, and 8. Below are a selection of the ones found most interesting.

9.1.1 Pagination

While pagination of the text – the act of chunking content dynamically into pages instead of scrolling – is a large part of the visual representation of *Clementine* it has proven to be somewhat difficult to entice discussion around the topic. Some observations were however made.

When interviewing the teacher students, as made apparent that it was taken for granted that digital books are paginated. This was before the interviewees were subjected to the prototype and its metaphors and navigation interface.

In the pilot interview the issue of inadvertently scrolling the text while reading was discussed, and that having a paginated interface alleviates this quite nicely. If users accidentally scrolls the text, something that according to interviewees happens occasionally, there is no way to easily return to the same spot – resulting that users will have to manually search for their position. Using a paginated interface enables an undo functionality in that the use can more easily return to the same position if the page is accidentally turned as the text is always positioned in the same place. Undo and redo[1] is the act of reverting the state of the document

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[1]Redo is arguably just a special case of undo: one undoes an undo.

or application to the state it was in before an action was performed. This is very useful in the events of unintended actions, and is among Jacob Nielsen's term usability heuristics [Nielsen, 1995]. Undo an action is easily performed by simply turning the page in the opposite direction. The action of turning a page is reversible, the action of scrolling is not.

9.1.2 Navigation

The interviewees had generally few issues with navigating through the site, even though the act of flipping through pages is very different from a scrolling text. There can be many reasons to this. After being asked about it, the interviewees said that they regarded the prototype as more of an "application" than they regarded it as a web page. This way the affordances and metaphors they are used to dealing with on "regular" web pages are not applicable any more.

The user testing of the prototype was first done on a tablet device, where the interviewees were able to instantly figure out that the swiping motion navigated the pages. The desktop computer version was introduced later in the test, after the participants had familiarized themselves in how the application behaved and was expected to be used. They then instantly used the arrow keys to navigate through the pages, and seemed to have no issues in how to read the book.

The sidebar worked adequately with only some minor usability issues considering – the existence of sub-chapters inside the sidebar sub-menus were not evident enough. Yet, after having been shown how to use the menu, the possibility to easily jump to sub-chapters was well received.

9.1.3 Typography

Unlike what is most often encountered on web pages, *Clementine* uses indented paragraphs instead of paragraph spacing[2]. This choice was noted by Participant 1 in the teacher interview, which said that while she generally disliked indentation, she found it to work rather meritoriously for this text.

Columns

It was however noted as not only being a visually pleasing element of the page, it was noted by Participant 2 that especially the division of the content into *columns* is something that for her was something that helped the readability. She much preferred columns to reading long lines.

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[2]The default non-styled behaviour of the paragraph HTML element is to use top and bottom margins to create spacing between paragraphs.

9.1.4 Progression indicators

Two progression indicators are put to use in *Clementine*: *page numbering*; and a *progression meter*. As discussed in chapter 5.7.2, there are some information conveyance issues in using page number, but their inclusion has been regarded as positive and useful. Among the reasons to why the page numbers were perceived as being useful, was that this helps enforce the book metaphor. All this is done to emulate the source material in the best way possible, to evoke the positive aspects of reading from a physical book. Proper use of good metaphors can assist the user learn how to use the application [Nielsen, 1995].

The alternative to page numbers considered for *Clementine* was to use a percentage instead. All of the interviewees preferred to use the page numbers, citing the familiarity of the page numbers being positive. Also, the progress meter was said to be an adequate indicator for illustrating the relativity of the progress, rendering the use of a percentage based page counter moot.

While the decision that the the progress indicators in *Clementine* should work on a per-chapter basis was initially done due to technical limitations, this quasi-decision lead to several usability and user experience discussions about the use and need for page numbering in both interviews. The general perception seems to be that the small number of pages resulting from this is actually positive, as one would then easier – in their – "feel the progress", as well as being able to better plan their reading sessions. It was however noted in both interviews that this way of handling page numbers might be better suited to the kind of academic papers, educational texts and compendiums that *Clementine* contains due to chapters being more separate in topic – and possible to read in isolation – than for instance a fictional book would.

Issues

The main information missing from using a dynamic page counter is that is hard to know the relative position of an element – such as an important text section or an interesting image – in the text. To alleviate this, there is a progress meter located at the bottom, which according to the people interviewed provided adequate spatial information.

According to many academic citation standards, including the APA style used in this thesis, when doing direct quotations, one is supposed to provide the page number to assist in locating the quote [American Psychological Association, 2013]. As pointed out by the teacher students, this is problematic using dynamic page numbering. There are however solutions defined by the American Psychological Association [Lee, 2009].

9.1.5   Keeping everything inside the application

During the interview with the informatics students, one of the respondents got confused after clicking one one of the inline links scattered in the text. This link brought him to an external site, which caused some confusion. The interviewees in the interview with the teacher students explicitly requested that as much of the book is contained in the application, that external links should be used with caution. Thus it seems to be appropriate to limit how the application links to external services.

There are two types of links in *Clementine*: *internal links* that links to either chapters or sections contained in the application itself; and *external links* that links to external web sites on the Internet. In *Clementine* nothing has been done to distinguish between the two types, both are represented as light blue text. Disregarding disallowing linking to external pages, there are at least two ways of making hyperlinks more usable. The first solution is to make the difference between the types of link apparent by somehow marking the external links. This is for instance how Wikipedia solves this problem – as seen in figure 9.1.5, links leading to external sites are marked by a small icon. The second solution is to open the link inside the application in a contained window. What one can do is embed the content of the external link into the application using so-called *iframes*. This is how it is done in many applications on the iOS platform – instead of being sent to the web browser, the application embeds a web browser of its own which it uses to render the content of the linked page. There are however some technical restrictions imposed when implementing embedding iframes as web authors can (and often do) prohibits embedding their content on third party web sites. Thus, the solution most feasible at the moment is to mark external links.

4. ^ Usability 101: Introduction to Usability ⧉, Jakob Nielsen's Alertbox. Retrieved 2010-06-01

5. ^ Intuitive equals familiar ⧉, Communications of the ACM. 37:9, September 1994, pg. 17.

Figure 9.1: Example page from Wikipedia, showing icon denoting external link.

9.1.6   Growing up surrounded by digital instruments

Frequently the issue of them not "being used to" technology in the same way that a child growing up today is was mentioned by the teacher students. Participant 2 in this study even specifically mentioned the concept of *digital natives* and *digital immigrants*, that children growing up today are uniquely used to digital technology, and because of learn by different means that older people [Prensky, 2001]. She

noted that she herself found herself somewhere in between these two definitions, that by having been introduced to computers at a relatively early age and had become comfortable around them, yet computers are still external utilities to them.

While computers are a relatively old technology, digital text is something that has been gaining popularity only in the most recent years. It remains to see if the concept is translatable, and how children "used to" reading digitally feels about it. Such a study would need to be conducted more longitudinal and together with a lot younger people than this study. Note that the concept of digital nativity is heavily disputed [Jones et al., 2010].

9.1.7   Preconceptions and form factor

It was found in a study by Nielsen [Nielsen, 2010], computers makes people uncomfortable as they reminded them of work. The same study found tablets computers being better liked by its respondents, especially for the task of reading text. Similarly, the informatics students thought of computers as toys, and attributed their preference of the physical book to this. The informatics students mentioned having intentions of starting to use the devices to do serious reading, describing the form factor of the device as being "more natural". It seems that the form factor of the tablet computer is an important driver for creating a positive reading experience.

9.1.8   Trust and authority

The discussion afterwards revealed that the interface was noted as being very "book-like" and resembled a PDF document, something that they found to be a positive merit of the prototype. *Clementine* was mentioned by the teacher students as being similar to PDF documents, something that the interviewees indicated was beneficial to the readability of the text. Earlier studies have found that physical books is an embodiment of authority [Sutherland-Smith, 2002], and it is possible that academic articles being distributed in the PDF-esque format of *Clementine* might evoke the same feeling of authority.

9.1.9   New features

Dictionary

The teacher students spent some time in elaborating the need for a way to look up meanings for words. Dictionaries are readily available on the Internet[3], but to use

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[3]`http://www.thesaurus.com`,   `http://www.thefreedictionary.com/`   and   `www.merriam-webster.com/` are often found on the top of search results when searching the web for a definition

such tools is however problematic according to the teacher students – this requires the reader to remove oneself from the text and venture into the distraction filled Internet. The dictionary should be as integrated into the reading environment as possible.

There are tools available that can be used to define words, both as traditional application (such as *Clue*), as features integrated in the operating system (this is the case for Mac OS X 10.8 and above). Other applications – such as Amazon Kindle (which uses the Oxford Dictionary of English) – uses a dictionary bundled with the reader application. The solution to the dictionary problem is thus to simply rely on the platform (the OS, the browser or a separate tool) to provide the dictionary. A problem regarding the use of such a dictionary is that it is not given that a words always exist in all dictionaries on all platforms, or if the word's meaning in the dictionary is the same one as the author intends. This problem is especially prominent in academic articles which often uses common words differently, or defining new words. For instance, this thesis alone uses two different non-colloquial meanings of the word *responsive*[4]. A second solution is thus to bundle the web application with a dictionary of its own, with words defined by the author.

Bookmarking

When asked about what is important when designing the perfect digital book (see chapter 7.3.3 and 8.3.4) one can see that the different groups of students have different views on what features must be present. The informatics students were more reliant on using page numbers to retrieve important snippets of text. These notes would in effect achieve the same function that the bookmarking feature that they request from the perfect book. The teacher students did on the other hand did take thorough notes, and consequently establishing the importance of advanced note taking features such as highlighting.

9.2 Research questions

This section will summarize the research questions submitted in chapter 1.2 and attempt to answer them in light of the literature reviewed (see chapter 2) and the interviews performed (see chapter 6, 7 and 8). The questions proposed are given below. The research methods used for gathering data for this study has some issues in defining an explicit conclusion as described in 3.1.7.

RQ1 How can you create digital expository books that are readable?

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[4]Responsive web design and responsive reading

RQ2 Which features of a digital book are important for creating a pleasant user experience?

RQ3 How does a text created using web technologies compare to a text using traditional typography techniques?

RQ4 How hard is it to create a digital text using HTML technologies?

9.2.1 Primary research questions

[RQ1] How can you create digital expository books that are readable?

Good and readable typography is the cornerstone of a readable book and there is a great number of best practices and advice in how to make readable texts.

Through the interviews there were discussed some of the more common font related myths, such as serif fonts being more suited to body text. While research is heavily slanted towards suggesting that there is no discernible difference in *performance* [Bernard et al., 2001; Tullis et al., 1995; Zachrisson, 1965], there still seems to be a *preference* for the use of serif fonts in body text noted by both the interviewees and reviewed literature [Zachrisson, 1965].

While starting to show its age, Geraci [2002] has collected the results of 30 such studies with the intention of creating general guidelines to how to create readable digital text. It might be reasonable to suggest that, when disregarding the relative disadvantages of screens[5], that the general advice given in the paper is applicable to digital text – especially when considering today's modern digital screens with a pixel density that rivals paper[6]. The complete list of typographical and visual features of *Clementine* and associated rationale can be found in chapter 5.3.1.

The interviewees all responded favourably to the user interface of *Clementine*, it was noted as being both visually pleasing and easy to use. The fonts chosen were specifically mentioned as being suitable, and the use of columns was noted as making the text easy to read. There did not seem to be any issues in directly translating print based typography techniques to the screen.

[RQ2] Which features of a digital book are important for creating a pleasant user experience?

The concept of user experience is closely related to the concept of readability: a readable digital book is a book that provides a good reading experience. Simply

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[5]Including resolution, flickering and lighting – areas where modern screens are getting ever better each year.

[6]The Apple iPad has a pixel density of 264 pixels per inch (PPI), whereas good commercial printers operates in the 300 PPI range.

scanning and otherwise converting physical documents to a digital format, creating what Coyle [2008] calls *digitized books*, is apparently not a sufficient approach. Nielsen [2003] pans the usability of digitized books with gusto, observing that the strict paper-based metaphor do not fit the user interaction model of computers – they should only be used for printing, and works suboptimally on computer screens. Digitized books are also unable to utilize the relative advantages of being digital. In other words, one can't uncritically translate ones existing knowledge from physical typography to the digital screen, it is essential to identify what variables aids the user experience, and what variables are usability hazards.

Furthermore, research suggests that we read text on screens differently than we do on paper – instead of immersing ourselves in the content we simply skim the text [Krug, 2009; Liu, 2005]. It is thus important to find the optimal way to represent digital text in a format that people read in a responsive manner. This is especially the case for expository writing, as there is little that indicates that schools and universities will replace their textual tomes with any other forms of teaching material in the foreseeable future.

This study has through its interviews identified some important elements as being important variables when designing a digital book which are described below.

Simplicity

To create a pleasant experience, a digital book must first and foremost focus on the task of displaying digital text. It needs to be minimalistic and fast. There seems to be an understanding that to emulate the physical book makes for a pleasant experience, as long as one is careful about which metaphors to use. Some metaphors – such as pagination – can be helpful, others – such as needless flipping animation – can be harmful [Thayer et al., 2011; Agarwal-Hollands and Andrews, 2001].

Digital books should be careful not to be too complex, and a simple book is preferred to a book that filled to the brim with distracting bells and whistles. The interviewees praised how physical books are free from distracting elements – a physical book contains nothing but the text that the author has chosen to enter into it. A digital book should introduce other elements with extreme care. The minimalistic, uncluttered user interface of *Clementine* was noted by all interviewees as contributing to a pleasant experience.

Navigation

No real issues arose when the interviewees were to navigate through the application, they immediately defaulted to use the arrow keys on the desktop version and using swiping gestures on the tablet. It was however noted that the experience felt

more natural on a tablet computer, that using the arrow keys might be straying a bit too far from the norm of using gesture based scrolling[7] on a touchpad. The interviewees did try to scroll the text by using the two finger swipe gesture in the desktop version.

There is reason to experiment with the inclusion of gesture based navigation in the desktop version, even if it might carry some usability issues as described in chapter 8.4.2. The application that *Clementine* was modelled after, Amazon Kindle for Mac, allows for navigating using two-finger swipes.

The teacher students interviewed seemed to take the use of pagination in digital books for granted, demonstrated that they requested that flipping through the pages of the application should be fast and simple to create a good reading experience.

Form factor

In creating a pleasant reading experience, the form factor of the device apparently plays a pivotal role according to both the reviewed research and the people interviewed for this study. While none of the of the tablet owning interviewees in this study had done extensive reading of longer texts using their devices, they all expressed an *intention of starting to read* using their device. They did prefer to use their tablets to read academic articles, as according to the interviewees, the form factor afforded by tablet computers makes for a better reading experience than reading from a upright computer screen.

The prototype was also noted by the computer students as being more natural to use on a tablet device – the swiping gesture used to navigate between pages felt intuitive. That tablets are more pleasant to read from has also been established by Nielsen [2010].

In some of the interviews it could seem that one expected the pages to flow vertically in the desktop version. This is how most PDF readers operate, something that all interviewees have had experience with. Other, non-paginated text is almost always laid out vertically, horizontal scrolling is something that is highly advised against [Nielsen, 2005]. One should experiment with paginating the text horizontally to see if this makes the pagination feel more natural on desktops.

Something that was discovered was that when creating a gesture centric application, one should use similar gestures in all the application's features. The sidebar was made observably more difficult to use on in the tablet version than on in the desktop version due to an unexpected change in input method – for navigating the book one uses swipe gestures, for navigating the sidebar menus one uses button presses.

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[7]On most operating systems one can scroll by swiping two fingers vertically or a similar gesture.

Features

While simplicity is a major goal when designing a digital book, a set of features that still needs to be present has been identified. The purpose of these features is to both account for the capabilities that goes missing when translating a book to a digital format, and to utilize the advantages of being digital. The identified features found most important are presented below, a more extensive list can be found in chapter 5.7.

Highlighting and notes The ability to take and keep digital notes has traditionally a hard problem to solve, usability wise. Highlighting is something that is often explained as one of the reasons for people in general preferring physical documents to reading digitally as described in chapter 2. One of the interviewees had stopped highlighting due to it being inconvenient to perform digitally. None of the computer students highlighted text as they read, which *could* be related to this, as they all, similarly to the teacher student, seemed to have a propensity to read digitally.

Bookmarking Bookmarking is used to be able to retrieve the location of important information at a later stage. The computer students used such bookmarks to be able to reread important texts, as this was how they preferred to read responsively and seemingly replaced their need for "traditional" note taking.

Search Search, often described as the largest advantage digital books has compared to their physical equivalents. While search was seemingly used less on tablets due to the action not being "natural", it was mentioned as being something that needs to be present in a digital book. *Clementine* uses the browser standard search – something that has certain limitations, including that it is only possible to search inside the current chapter. The search function might need to be more apparent to the user than the browser search function is.

There are likely to be several other features that help improve the usability and user experience of a digital book. The features listed above are the ones that has been found to resonate well with both the reviewed literature and through the discussions in the interviews. Through the interviews conducted, it has been found likely that these features are required for a well functioning digital book.

9.2.2 Secondary research questions

[RQ3] How does a text created using pagination compare to a text using traditional digital typography techniques?

Research suggests that using a paginated interface for text makes it more preferable compared to a scrolling text, a notion that seemed to resonate with the ones interviewed in the study [Lonsdale et al., 2006; Nielsen, 2010]. The discussion with the teacher students even seemed to suggest that using a paginated interface for digital books is a given. Several hypotheses has been proposed as an explanation for this phenomenon, one of which is that scrolling interfaces are harder to use for longer text due to moving text being harder to focus on. Utilizing the fixed nature of paginated text one is more able to create mental maps of the text, something that assists in reading.

The informatics students interviewed noted that use of pagination makes it easier to keep track of ones reading position – possibly due to the fixed nature of the paginated text. The potentially lets readers focus more on the task of reading instead of having their attention diverted to the task of navigation. The interviewees also suggested that the paginated interface makes it easier to take short breaks from reading, as it is easier to retrieve ones reading position. When removing ones focus from the text for a period of time, be it short or long, it is comparatively easy to find ones reading location.

The paginated interface introduces the concept of undo to navigation, as the informatics students noted – in the case of unintentional scrolling it is comparatively easy to navigate to the previous position.

9.2.3 Tertiary research questions

In addition to the primary and secondary research questions described above a few questions related to the technicalities surrounding the implementation of the prototype application has been answered based on the experiences gained when designing and implementing the prototype.

[RQ4] How hard is it to create a digital text using HTML technologies?

Clementine is realized using a new CSS standard that lets authors use a single line of CSS to implement pagination as shown in figure 9.2. Compare this to the hundreds, if not thousands of lines of JavaScript code one has to write to accomplish the same. That being said, pagination in *Clementine* is implemented somewhat in a slightly more complicated manner to accommodate the header, footer and sidebar.

```
body {
  overflow: paged-x;
}
```

Figure 9.2: This snippet of code will paginate the body element in the HTML document horizontally. To paginate the page vertically, one must use `overflow: paged-y` instead.

While it is completely possible to create a great reading experience using web technologies the process to do so is harder than it is to create the corresponding ebook formats due to the lack of specialized tools for creating HTML based books. *Clementine* is implemented by writing HTML, CSS and JavaScript by hand, something that might be feasible for a web professionals, but might not be viable for the casual author. This especially when considering that the tools for creating books for iBooks and other format are both comparatively easy to use. No web site creation tools available today are able to create paginated interfaces due to the web standard being relatively new, with few browsers fully supporting it.

There is also the issue of browser compatibility. The CSS web standard is fairly new, and unanimous browser support is not likely to arrive until some time in the future. One can however use JavaScript libraries, and because of the rather poor support today, use of these libraries is the one recommended at the moment if one wants to create a paginated interface on the web.

9.3   Limitations & Issues

9.3.1   Method

Based on the data gathered in this study, the method of using group interviews seems to be adequate. Oates [2006] does recommend using between three and six participants in a group interview. The interviews conducted for this study had a number in the lower end of this spectrum: four interviewees in the pilot and first main interview; three in the second main interview. The reason for having such a low number of interviews are that the number of participating students in the course from which the interviewees were to be marshalled in the case of the pilot and the first main interview, and lack of time to properly plan and conduct the second interview. There is also the case of how the selection of participants were sampled – the interviewees were selected based on convenience. While in most cases a very criticized sampling method, that the students interviewed[8] have some

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[8] Informatics students taking a course about digital learning tools, and teacher students.

interest in pedagogy might have been a catalyst for the discussions that was had.

The user testing of the prototype application was very brief and simple, and did not adhere to any recognized procedures. This was mainly because it was not the usability of the application that was to be tested – the purpose of the prototype was to act as a catalyst for discussing the user experience afforded by the metaphors and digital typographical techniques employed in the application. Additionally, the prototype was not considered advanced enough to warrant such a thorough user test. The user test thus cannot say anything about the general usability of *Clementine*.

Studying academically is a personal activity, and the interview setting used here is comparatively unnatural to how one would normally read. To better able to study the effects and preferences of digital reading, the respondents would have to use the application for a longer period of time while reading in a more natural setting. A longitudinal study would thus have yielded better results than this short-term study.

9.3.2 The participants

Regarding the participants, some issues were encountered, the largest being that there were simply not enough of them. The students for this study was to be recruited from a group of students in a relevant course, but the number of students enrolled were much lower than initially expected, as were the number of students actually attending the classes.

The first group of interviewees, the informatics students, were all first year students, which translates into being less experienced than one would have hoped. Many studying habits form over the course of several years, and the way that how the students read responsively diverges from the "norm" dictated by the literature (see chapter 2) might be the embodiment of this experience.

The group dynamics was not as good as it could have been. Out of the four participants, two of the interviewees were a lot more talkative than the others. The two most vocal of the students did try to include the others, but might have done so in a manner that made the quieter ones even more uncomfortable.

To alleviate the issues with the first interview a second interview was conducted with a different group of students – this time a group consisting of nothing but female teacher students. The second group of interviewees, the teacher students, were friends of the interviewer, something that might have affected the discussion.

Both interviews were fairly homogeneous in that the interviewees in both interviews were very similar to each other in terms of sex and studying background. The second group did however attest to using different studying techniques, where the first group studied very similar to each other. There might very well have been

a different kind of discussion if the two main interviews were done as one larger one with all participants.

9.3.3   The prototype

The prototype created for this project – *Clementine* – was initially conceived to explore and showcase only certain typographical techniques made possible with new web technologies. The feature set and purpose of the prototype evolved over the course of its development, adding parts and features initially thought to be extraneous for the study. The prototype can thus be regarded as too complex for what the study initially set out to explore, and because the interviews quickly resulted in yielding more data on digital books in general than on the specific techniques employed in its realization.

One of the reasons for this is because of the aforementioned problems in recruiting students for the study. An alternate direction for the thesis was to put more emphasis on the actual design and implementation of this prototype in case the interviews did not pan out as expected, and instead focus on a more product design approach with a different kind of interview. The prototype and its features were developed with this in mind alongside the planning and design of the interviews. The second main reason for the prototype growing in complexity is due to how the interviewees of the pilot study, other informal user tests, as well as the literature reviewed, regarded the lack of proper markup tools as being one of the main limitations of digital reading. To alleviate this, some basic markup tools were designed and implemented – again in case that the study should in the end up have a product design approach. Additionally, most of the inspirations for *Clementine* has such markup features implemented, and as the interviewees were to evaluate *Clementine* the omission of such tools could potentially

9.4   Future development of *Clementine*

In addition to correcting bugs and errors, adding the features omitted due to time constraints or technical difficulties should be implemented. This includes solving the zoom issue (chapter 5.7.7), implement the ability to customize the user interface (chapter 5.7.6), synchronize data across devices and clients (chapter 5.7.4) and adhere to accessibility standards (chapter 5.4.3).

Some typographical techniques often found in other expository media are already present in the prototype – such as pull quotes and info-boxes. This feature set could be improved upon, granting authors and designers more tools to create beautiful, readable texts. Some navigational issues and feature requests was requested during the interviews, including that the page should turn when using

a two-finger swipe gesture on trackpads (similar to how the Kindle application works), and that at the end of a chapter the "next page"-action should make the book go to the next chapter[9]. A proper, book-wide search must be implemented, and done so in a manner that is more visible to the user than the search function available in most tablet computer browsers.

The idea of using multimodal features by including elements that activates the reader in more ways. The prototype application, by being web based, is already capable of including such elements with trivial work. This feature was also requested by the IT students interviewed[10]. Video and audio is prime candidates for inclusion, as are interactive elements. Another good way to introduce interaction to documents is to create quizzes, something that can be very appropriate in pedagogical texts. Such quizzes can be designed to correct themselves, giving the student the opportunity to cram on their own, and even to dynamically adjust its questions according to what the students is able to answer correctly. Such an approach is for instance taken by the language learning site *DuoLingo*, where vocabulary questions answered wrongly are asked again repeatedly later in the quiz to make sure that the student is able to remember the word. Gamification, to introduce elements commonly found in video games, such as achievements and numerical scores, can be used to motivate students even further. These achievements could potentially be given based on results on quizzes and reading progress – One can even use such achievements as an incentive to learn how to use the application interface itself by rewarding achievements based on exploring the possibilities and features. available. Proper design of such a feature is a field of study in its own [Blair, 2011].

Creating text for use in *Clementine* is not nearly as easy as it could have been, and a proper authoring tool for authoring texts would be very useful.

Tutorial

Both the teacher and informatics students mentioned having a tutorial to teach users in the use of the application[11]. This is something that one usually wish to avoid, one usually wants to create an interface that by the use of known metaphors with good affordances that invites to be touched and used by the user – rendering the utility of instructions and tutorials moot. A system is better if a user does not need help to use it [Nielsen, 1995]. It could however be an idea to have some sort of instructional material available for those instances where the user is completely

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[9]In the prototype there one navigates to the next chapter by pressing a large button.

[10]The teacher students on the other hand preferred the text being simple and readable beyond anything else

[11]Note that the informatics students indicated the need for this *after* the user testing, the teacher students *before* the user testing.

unable to use the application.

Supporting rapidly flipping though pages

A suggested feature for *Clementine* was to have the progress bar function more like a traditional scroll bar would – by clicking on the progress bar you could jump directly to any given page. The suggestion also involved having pages be visible when the user hovers the progress bar, and provide a scan-feature as the one often found in video software – by clicking and dragging the progress meter you can visually see the pages flowing assisting in rapidly finding the page you were looking for.

9.5   Future research

Studying is a personal activity, and the interview setting used for this study is comparatively unnatural to how one would usually read. As mentioned in chapter 9.3, a longitudinal study should yield more data on the effects of using the experience of reading digitally using a tool such as *Clementine*. A later study should use the data and conclusion from this study and design a study lasting for a longer time, where the respondents have had more time to read on their own.

A tangential research route is to improve *Clementine* as described in chapter 9.4, and then use the improved prototype as a basis for a proper user test.

A | Technical implementation

This chapter will discuss the actual implementation on *Clementine* and the way that the prototype has come to be based on the inspirations and designs formulated in chapter 5.

A.1 URLs

While largely ignored when designing web sites, Microsoft has demonstrated that the URL is in fact a user experience issue [Cutrell and Guan, 2007]. That being said, there are anecdotal evidence that the importance of a well formatted URL is diminishing. Examples of this can be found in the most popular web sites today – Facebook and Twitter – where the importance of the URL is downplayed by the sites fetching the actual page title and some text from the page, and replaces the URL with this instead. As static URLs that do not change over time are imperative to bookmarking functioning properly, the URLs should not be edited. It is thus of high importance that the URL scheme is sufficiently thought through.

The following URL schemes were considered:

1. `http://domain.com/world-wide-web`

2. `http://domain.com/chapter3/world-wide-web`

3. `http://domain.com/the-internet/world-wide-web`

Due to the simple nature of the prototype, the first scheme is the one that was implemented. Number 2 and number 3 are schemes that are more appropriate for larger publications.

A.2 Storing user data

There are three types of data that is to be stored between reading sessions: storing the reader's reading progress; storing notes and highlights; and storing typographical adjustments done by the user.

If *Clementine* was implemented as a "normal" client-server based web application, the data can be synchronized to the server for centralized storage. The client would then log in to the application, and the client would download and apply the stored data to the book. This is the classical approach, and one can find this approach in most popular web based services today[1].

The other approach is client side storage, storing the data inside the client browser. There has for a very long time been possible to store data in the client, in the form of so-called *cookies*. Cookies are however very limited when it comes to the volume of storage that is made available, and is thus not used for much more than storing textual strings that makes it possible for a server to identify the client across page requests and browser sessions. With the introduction of HTML5, several more sophisticated solutions have been made available. Now it is possible to store not only simple strings, but large amounts of data, both in string and binary form.

Additionally it is possible to leverage the advantages of both approaches by implementing a hybrid solution where one could store the data in the client, but synchronize the data in a central place. This is an approach that is increasingly found in the wild. A web application can this way be able to function offline, as the data can be cached – temporarily stored – in the client until the connection has been reestablished. Google's popular Gmail service is able to function offline by caching the application in the client browser. When a user writes an email without a working Internet connection, the email is stored in the browser to be retrieved later. When a working Internet connection is detected, the stored data is sent to the server.

The solution that was chosen and other alternatives considered are detailed below.

A.2.1   LocalStorage

Clementine stores the data in the client through a web API called *LocalStorage*. This is an API that is able to store data as text strings to a repository, a *local storage*, which can be queried to store and retrieve data locally in the browser itself.

Data types

While the data stored by *Clementine* is a JavaScript object, something that in fact is not possible to store using the LocalStorage API – one can only store strings,

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[1]Google Docs, for instance, stores all data on Google's servers which then can be retrieved by logging on the service.

modern JavaScript engines has the ability to parse and "stringify" between these two data types with ease.

There are a few disadvantages to using this compared to its alternatives, including speed of retrieval, size restrictions and the data types that can be stored, but due to the simple nature of the data that is to be stored[2] and the relative ease that the data can be stored (one simple line of JavaScript compared to a complex SQL query), the LocalStorage API was chosen as the technology to be used to store user data.

Browser differences

There are, as is the case with most of what the web is capable of doing, differences in what the different browsers can do. LocalStorage, is by far the solution that is implemented best by all modern browsers. There are however slight differences, but these differences are by and large limited to the amount of data that the web page is allowed to store. Considering the minuscule amount of data that *Clementine* is storing, this is a non-issue.

Alternatives

There are a couple of storage alternatives available, namely: the (extended) *File API* [Uhrhane, 2012], where the client can store and retrieve data to and from the client file system; and the *Indexed database API* [Mehta et al., 2012], where the browser can store and retrieve data that can be accessed through a query language such as SQL. If considering a library application, the Indexed database API could for instance be leveraged to provide a way to do complex queries such as ordering all the books available based on author and publish date. A possible scenario for utilizing the File API is to store the content of *Clementine* to the client file system, as a text file (rather than a series of text strings) caching it for the foreseeable future.

Both approaches solves the problem of storing user data, but are much more complex compared to the LocalStorage solution. The LocalStorage solution is also more compatible across browsers. A future version of *Clementine*, with broader browser support could possibly benefit from using the more complex solutions with the promise of more useful features implemented.

Synchronization

One of the major features of *Clementine* is that being a responsive web based application is that is available wherever a (compatible) web browser is installed.

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[2]Reading position, font sizes, bookmarks, highlights, etc.

While this is brilliant in the way that makes it possible for those of us fortunate enough to own more than one device to read the book in different form factors, there is now a need to synchronize user data between the different clients. As *Clementine* is implemented as a static web page, this is problematic, as there is no server that can store the data, no server that the clients can connect to to retrieve the data.

Modern web technologies does however intend to solve this by providing a way for web browsers to synchronize offline data between clients. The Chromium Projects team has proposed the SynchFileSystem API [The Chromium Projects, 2013], and the Mozilla Foundation proposes the SyncStorage API [Mozilla Foundation, 2010]. These proposals this moment not interoperable, and are both experimental and not properly standardized, but the intention and goal of both proposals are the same: to provide a standard, interoperable way of synchronize offline data between clients. This can in effect solve the synchronization problem, making it possible to have all the data that the user leaves in the client, including reading progression and notes, available in all browsers and devices that she uses. As the proposals are at a very experimental stage at this moment in time, this is not to be implemented in *Clementine*.

A.3   Search

Being able to search through the content is one of the major advantages of digital books. The search feature in *Clementine* is unfortunately limited to using the search function present in the browser[3]. A "proper" implementation of search would entail more advanced features. The ability to search through the entire book for a word is perhaps the most important feature of a more advanced search. Other advanced features would be the ability to search for phrases in a selection of chapters.

The limitations of how search is handled by Clementine is first and foremost a result of decisions of how to implement the application – *Clementine* displays only one chapter at a time, which means that the browser is only able to search one chapter at a time. If one were to download the web pages to ones local file system, one can use the operating system's search function to search through all chapters. This is however a sub-par solution to the problem, usability wise.

Potential ways of solving the search issue is described below.

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[3]All modern browsers are capable of searching through the displayed text for letters, words and sentences.

A.3.1 Server side search

By creating the book in a more traditional manner, with a proper client-server model, a search feature capable of traversing all the files that constitutes the book is very possible. Here, the search box in the application will send the query to the server application, which then traverses all documents for matches and returns a results page back to the client. This is how most web pages that incorporates search works.

A.3.2 Client side search

The second solution to the problem is to create a JavaScript based search engine able to traverse all the documents that constitutes the application. This would entail having the web application be aware of all (traversable) documents, fetch the documents asynchronously and store them in the client's memory, traverse all of the documents and present the results. This is a hard problem to solve, and is perhaps suitable for a master's thesis of its own.

A.4 KeyListeners

The KeyListeners implemented in *Clementine* works by interrupting the keyboard presses, substituting the standard routine with a custom one.

An example of how this can be implemented is extending the search function. If one were to implement the custom search engine as described above (chapter A.3), one could make it easier to use by replacing the browser search keyboard shortcut. All desktop browsers tested uses the same keyboard shortcut[4], as do numerous other applications. Users are used to this key combination, so it is likely that it would increase the usability of the application if one were to utilize the same key combination. What one should then do is to intercept the keyboard event, prevent the default behaviours and then executing the function that displays the custom search field.

This is implemented in the case of page turning. While the browsers have the functionality implemented from the get-go, using the arrow keys, as well as the space bar button and page-up and -down buttons to change pages, the implementation was found to be a bit lacking in the prototype and had to be extended by implementing a custom function.

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[4]Cmd+F for Macs, Ctrl+F for Windows.

A.5   Fonts

Previously web browser used what is commonly known as *Core fonts for the Web*, a collection of fonts distributed by Microsoft. The font package inludes the fonts *Andale Mono*, *Arial*, *Arial Black*, *Comic Sans MS*, *Courier New*, *Georgia*, *Impact*, Times New Roman, *Trebuchet MS*, *Verdana* and *Webdings*. While a functional arrangement, this is naturally severely limiting for designers. With the introduction of HTML5, so-called *Web fonts* have been There are some inconstancies in what formats the different browsers support, but this is a trivial concern due to conversion tools being readily available.

Clementine uses custom fonts hosted by *Google Web Fonts* [Google Web Fonts, 2013] to render the text used for the body text. There are some technical issues in using a third party service for font hosting, including that the fonts can potentially be made unavailable without notice, and that the solution used by Google requires a couple of extra requests – something that makes the site slower to load, and that one needs a working web connection to load the fonts. All of these issues are however considered trivial. If a font fails to load, the browser will use another font – the text is still available.

In addition to using fonts to render text, it is possible to use fonts to render icons. To render the different icons used in *Clementine*, the icon font *FontAwesome* has been implemented [Gandy, 2013], a popular open source font project by Dave Gandy. Icons loaded as fonts are nigh infinitely scalable, and can be coloured with CSS.

A.6   Hyphenation

Hyphenation, the act of splitting a word into segments when a word is too long to be displayed on a line, is a typographical technique that adheres to strict grammatical rules. Support for hyphenation in web browsers has been around for quite a while, but only when an author statically types the hyphen. Support for dynamic hyphenation, where the text automatically reflows according to grammatical is forthcoming [Etemad and Ishii, 2012], but not available across all browsers yet. It is however possible to use third party libraries that supplements the browser's ability to hyphenate text. The most popular being *Hyphenator.js*, support for which has been implemented in *Clementine*.

A.6.1   Hyphenator.js

Hyphenator.js functions by crawling through the text from start to finish, creating so-called *soft-hyphens* in every position a word can be hyphenated with the end

result of creating a text reflows dynamically according to available space. Hyphenator.js is based on the Liang-Knuth algorithm, an algorithm also found in LaTeX.

Support for Hyphenator.js has been added to *Clementine*, but has been deactivated due to issues in how different browsers renders the soft hyphens. Opera does not render any character in its place, creating line breaks that looks strange and makes the document harder to read.

A.7 DocPad

To assist the creation of *Clementine*, the framework *Docpad*by the Australian company Bevry has been employed [Bevry, 2013]. This is a tool that generate static web pages from a collection of markdown-formatted text files. This lets the user separate the content from the formatting.

A.8 Sidebar

Inside the sidebar The content for each of the chapter entry is dynamically generated from the HTML files, and works as follows:

1. The user presses the reveal-sidebar button

2. The user presses the arrow button to reveal the subchapters contained in a chosen chapter

3. The application fetches the HTML asynchronously in the background

4. The application sifts through the document to collect all H2 elements

5. The application builds the index and presents it to the user

An alternative solution to this would be to define the chapter structure separately, either statically typed out by the author, or constructed when the web page is built. The latter of these solutions would probably be the best solution for a non-prototype version of the book, but is not used due to the framework used to produce it not supporting such behaviour out of the box.

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