

# Future of Digital Reading through the Lens of Horizon Scanning

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**Abstract** –The purpose of this paper is to investigate the future of digital reading and present possible scenarios for designing digital reading experience. Author uses a foresight method called Horizon scanning which consists of desk research focusing on published experimental research studies within the field of reading on screen and on paper. Psychological and cognitive aspects of reading are presented here. Second part of the Horizon scanning method is a review of up-to-day emerging technological trends. Possible future scenarios for digital reading are discussed.

**Keywords:** Design, Horizon scanning, Reading, Digital reading, Foresight, Trends, Psychology, Cognition.

## 1. Introduction

New mobile devices have become widespread and people use it for everyday tasks such as communication, entertainment or work. Reading electronic text is one of the most common activities people do when they communicate through SMS, browse emails, while googling new information, when they follow Facebook or Twitter streams or check news using personalized magazines and RSS readers. Academics, researchers and students read journal articles in PDF format and use annotations. There is a large e-book market, which supplies people with novels. Purpose of this paper is to propose possible future scenarios for digital reading.

We know reading electronic text is not equal to reading on paper. Printed book, as it had been designed for centuries, is the most usable reading medium of its kind. There is not much to improve. Reader can usually hold it in one hand, navigate through pages easily and have a sense of how many pages there are still left to read. On the other side, tablets and smartphones with interactive screens have been here only for few years. There are plenty of devices and reading applications for various operation systems. The quality and usability of those applications differ significantly. Research studies say electronic texts influence speed of reading, remembering and cognition. Well-designed applications could bridge the gap between reading on paper and reading electronic text. That could be achieved if designers of electronic text or e-readers applications were familiar with recent scientific research findings, which are often based on experimental methods such as eye-tracking, EEG or fMRI techniques. Designers should also follow new technological trends within the field such as Spritz application (Web-1) etc.

Major science fields which define and examine reading are presented in the following paragraph. Recent research findings serve as a framework for this paper. Reading is defined differently by many researchers. Dillon (2004) presents various approaches to reading in his book. New thoughts on reading process originated as a secondary product of psychology or cognitive research studies on memory or learning. At first reading was understood as a linear model (from visual input to comprehension). More complex and contemporary cognitive theory of reading was proposed by McClelland and Rumelhart (1981). Multi-level reading process was defined by Beaugrande (1981) for instance. Underwood and Batt (1996) introduced reading as a problem solving and information processing task. Kline (1988) points out that prior psychological and cognitive research studies missed practical insights. According to him people

“read for pleasure or to gain information. Furthermore, reading has serious emotional connotation on occasion.” Reading is not only about information processing or dealing with lack of knowledge. Reading influences human emotions and feelings. Psychology and cognitive sciences are not the only research fields with a theoretical interest in reading. Hatt (1976) for example encourages information scientists and librarians to take part in the research due to their natural interest in the reading process and designing electronic text for reading. Lately Berns et al. (2013) proved that reading novels causes measurable changes in resting-state connectivity of the brain. This is one of contributions of neuroscience to the reading research field. Digital reading, by definition, is also examined by the human-computer interaction field which contains interaction design and user experience.

To summarize this chapter, psychology, cognitive science, neuroscience, information and library science and human-computer interaction are the fields researching digital reading.

## **2. Methodology**

The paper applies Horizon scanning (Brown, 2007) as a foresight research method to find useful insights in the area of designing usable electronic text and applications for digital reading. The goal of the method is to analyse past and present evolution within a specific area and to predict possible future scenarios.

For analysing past evolution of psychological and cognitive aspects of reading, desk research had been done. Relevant databases and journals on Masaryk University and Google scholar were searched using following keywords: digital reading, screen-based reading, psychology, cognition, reading. Desk research was conducted in February and March 2014.

Secondarily analysis of social media with the aim of identifying cutting-edge technologies and approaches to digital reading had been done. Following Twitter hashtags (Web-2) and saved searches (Web-3) were used for filtering posted information: (#neurology AND #reading) OR (#psychology AND #reading) OR (#cognition AND #reading); (#ux AND #reading) OR (#cognition AND #reading) OR (#usability AND #reading).

Qualitative analysis of records had been done afterwards. Relevant recent research studies and their findings on digital and paper reading are presented in Chapter 3. Based on Twitter saved searches, up-to-date technologies and approaches to digital reading were chosen. The filtering was done through perceived potential and frequency of occurrence within the Twitter stream. Findings from this part of research can be found in Chapter 4.

Building on the aforementioned analysis future possible trends and scenarios are presented and discussed in Chapter 5.

## **3. Reading Digital and Print**

To understand reading features, differences between reading digital and print are presented. Experimental research on reading and reading habits has a long history. How do people perceive text? How should text be structured in order to be more readable or how do demographic factors influence reading preferences? These questions and many others have been objects of research for last fifty years. Let us describe what main research has been done in this area and present its key outcomes.

Dillon (1992) published a critical review of literature describing differences, pros and cons of digital and printed documents. Similar study published by Noyes and Garland (2008) agrees that digital reading and reading of printed documents will never become equal. We present concrete cognitive aspects of reading in following paragraphs.

### **3. 1. Accuracy**

Both of those studies conclude respondents reading paper documents are better in terms of accuracy and speed. On a contrary research by Mayes et al. (2001) presents reading on screen as faster.

### 3. 2. Comprehension

Text comprehension is another cognitive aspect of reading which was analysed. Both (Dillon, 1992; Noyes and Garland, 2008) presented studies conclude that comprehension is better in case of reading on paper. The problem is studies applied different methodologies. Another weakness of the studies is that research was done using older display technologies. But also recent research confirms paper as a medium is better for comprehension, as Mangen et al. (2013) proposed.

### 3. 3. Remembering and Learning

Process of remembering has become object of research as well. Ackerman's and Goldsmith's (2011) results say people learn better from a paper-based medium. Moreover, the ability of remembering was again better when using paper. These findings are supported by research done by Wu and Chen (2011). They observed students reading and browsing couple paragraphs of digital text. When they found it valuable, they printed it for further and deeper reading.

### 3. 4. Stress

There are other cognitive aspects of reading. Wästlund et al. (2005) presented a study, where respondents were more stressed and exhausted by using digital media compared to those who used print media.

Recently published research by Kratzchmar et al. (2013) suggests that we must disassociate people's subjective evaluation of digital reading and their actual cognitive effort. People usually choose paper as more readable compared to e-readers and tablets. But EEG and eye-tracking measures show reading using tablet is better (less cognitive effort) than paper, especially for older people.

### 3. 4. Digital Reading Behaviour

If we take a closer look at reading in digital environment, we recognize specific reading habits. For instance Liu (2005) concludes that people spend more time scanning, browsing, keyword spotting, one-time reading or non-linear reading. See table 1 showing an increased frequency of selected digital reading habits. According to Liu (2005) people read more selectively and do not read in depth. Cull (2011) agrees and describes phenomenon of Tunnel vision and Marginal destruction.

Table 1. an increased frequency of selected digital reading habits.

Percentage of time spent on	Increasing	Decreasing	No change	Don't know
Browsing and scanning	80.5	11.5	8.0	0
Keyword spotting	72.6	2.7	16.0	8.8
One-time reading	56.6	8.0	29.2	6.2
Reading selectively	77.9	2.7	16.8	2.7
Non-linear reading	82.3	0	15.9	1.8
Sustained attention	15.9	49.6	29.2	5.3
In-depth reading	26.6	45.1	23.0	5.3
Concentrated reading	21.2	44.2	26.5	8.0

### 3. 5. Tactile Experience

Payne and Reader (2006) proposed the idea of mental models, which are developed in reader's mind during reading. Li et al. (2013) call it cognitive maps. (1) Knowing where we are, (2) what we have already read and (3) how many pages are left till the end of the text seem to be crucial for navigation and orientation. In case of printed books tactile experience enables users to construct their mental or cognitive models more easily.

Mangen at al. (2013) presume digital readers miss the tactile experience of printed medium. They lose sense of control over text and they have difficulties with navigating through pages and locating concrete information.

## **4. Emerging Technologies and Approaches**

There are several interesting emerging technologies and approaches to digital reading. Some of them are broad concepts which affect how people filter and choose information to read. There are also couple specific technologies with a great potential of becoming widespread.

### **4. 1. Digital Curation**

Still more and more information becomes digitally curated. If we use Facebook, Twitter or so called personal magazines, we consume information, which was personalized based on our prior interest and reading history. Such systems, which use this type of curation, decide what information is displayed, what is hidden and in what form the content appears. This curation is mainly based on analysis of big amount of data we produce. Technology of algorithmic curation (Web-4) seems to have a certain degree of influence on our world view and therefore impacts our social behaviour. Using Human-computer interaction terminology we can classify it as social computing. Such approach has been implemented by Facebook, Amazon or Zite for instance.

### **4. 2. Personalized Magazines**

Self-curated content has become popular recently. Readers not only follow curated news, they like to curate and share their own topical collections of articles within the community as well. There are online services such as Flipboard, Zite or Paper.li, which allow users to distribute their curated content in a form of beautifully designed personal magazines or newspapers.

Effects of these applications on reading have not been objects of research yet. But design of magazine-like information sources is discussed in a context of learning for instance (Web-5). The more people read on tablets and smartphones, the more such applications will spread among people. In 2014 Flipboard aims to pass 150 Million users (Web-6).

### **4. 3. Fast Reading Technologies**

As we have mentioned above, reading behaviour changes to skimming, spotting keywords and nonlinear reading in digital environment. Tendency seems to be that people do not want to spend much of their time by reading. They want to read as fast as possible.

From a technical perspective, wearables such as smart watches or glasses provide users short and quick chunks of information. The reason is to avoid taking too much of user's attention and to allow them to focus on their physical surroundings and real world situations. One such innovative technology, which has been introduced recently, is called Spritz. It enables users to read 80% faster due to reduction of eye movement. It displays just one word at a time. The word displayed is aligned to the center of the screen based on its Optimal recognition point (Web-7). Nowadays Spritz is available for developers of mobile applications. It can be implemented into web pages too.

There is a strong interest in implementing Spritz technology into wearables. On the other hand there are cautious opinions on psychological and cognitive aspects of reading using Spritz. It is very often criticized for problematic information processing and significantly less control (Web-8). Readers can have difficulties with the text flow. What happens when reader wants to re-read the last paragraph because something was not understood correctly? Spritz also requires high level of attention not to miss any word. It is question how much mental effort user must spend on concentration (Web-8).

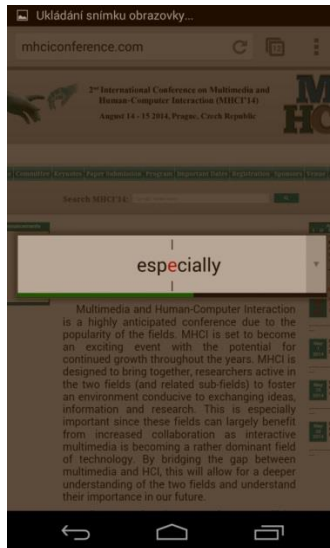


Fig. 1. Screenshot of A Fast reader (Web-9) based on Spritz technology.

#### 4. 4. Blue Violet Light

According to a BBC article opticians claim blue violet light can cause serious eye damage to frequent mobile or tablet user (Web-10). The very article generated a lot of discussion on social media which means people care about the possible dangers of prolonged use of mobile technologies. Looking at a mobile device screen can cause macular degeneration, insomnia and headache. There are special applications or screen films for filtering blue light, which reduce screen brightness and blue light itself to some extent. But simultaneously content can be a bit harder to read. We presume this might influence reading or interaction with the device. Serious research study has not yet been carried out to discover its true impact.

### 5. Discussion of Future Possible Trends

In this section we analyse prior findings and brainstorm possible emerging trends and scenarios within the field of digital reading.

#### 5. 1. General Outcomes

Naturally there are differences between various devices which impact the design of electronic text itself.

Smart watches, glasses, smartphones, tablets or computer monitors were created for specific purpose of use. Wearables are designed to inform users about currently needed contextual information in a concentrated form. For instance tablets are mostly used for leisure reading in the evenings (Web-11).

*Takeaway message: Every piece of content has to be customised for specific device.*

Design of electronic text and text-rich applications also depends on the length and nature of the text. Reading a long electronic academic paper or a scholarly book compared to reading a blog post or a Facebook status requires different level of mental effort. When reading longer serious texts, reader's tactile experience, we assume, is very important for modelling and adjusting his mental models.

*Takeaway message: Tactile experience can help understanding and comprehension of longer serious text.*

## 5. 2. Emerging Trends

We identified following possible trends which have significant potential to be implemented into digital reading applications. Therefore digital reading experience and usability might be improved.

Great potential for innovation is in the lack of tactile experience. Users want to know their position in a text, they want to flip several pages at once and move to a desired part of the text easily as printed books allow. Nowadays, reading applications incorporate progress bars, bookmarking and annotation features, which help readers form their mental models. Despite of these functions, navigating a document can distract user's attention from the current section being read. Students of KAIST Institute for IT Convergence challenged these issues of digital reading in a prototype they developed. So called Smart eBook Interface uses Apple API for page flipping (Web-12). Readers are able to find information in different parts of the book without leaving the actual page using multi-touch gestures to flip and hold pages.

*Takeaway message: We predict such technology will be implemented into reading applications such as iBooks (Web-13) or GoodReader (Web-14).*

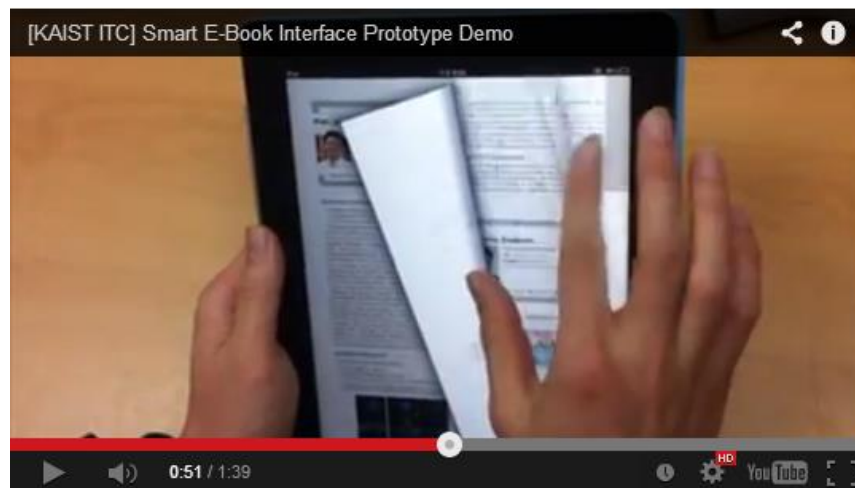


Fig. 2. Multi-touch interface of Smart eBook prototype (Web-12).

We think graphic user interface of Flipboard or Zite is a suitable form for pleasant consumption of digital content such as blogs, news and Twitter, Facebook or LinkedIn streams. Similar content blocks, or cards if you will, as Flipboard implemented within its application are used by Facebook (See Fig. 3). Facebook also introduced a new Facebook mobile application called Paper (See Fig. 3), which focuses more on the reading experience and content curation. Undoubtedly, Facebook got inspired by usability and interaction flow achieved by Flipboard (See Fig. 3).

*Takeaway message: Flipboard-based interface might be used as a reading interface for blogs and other social media.*

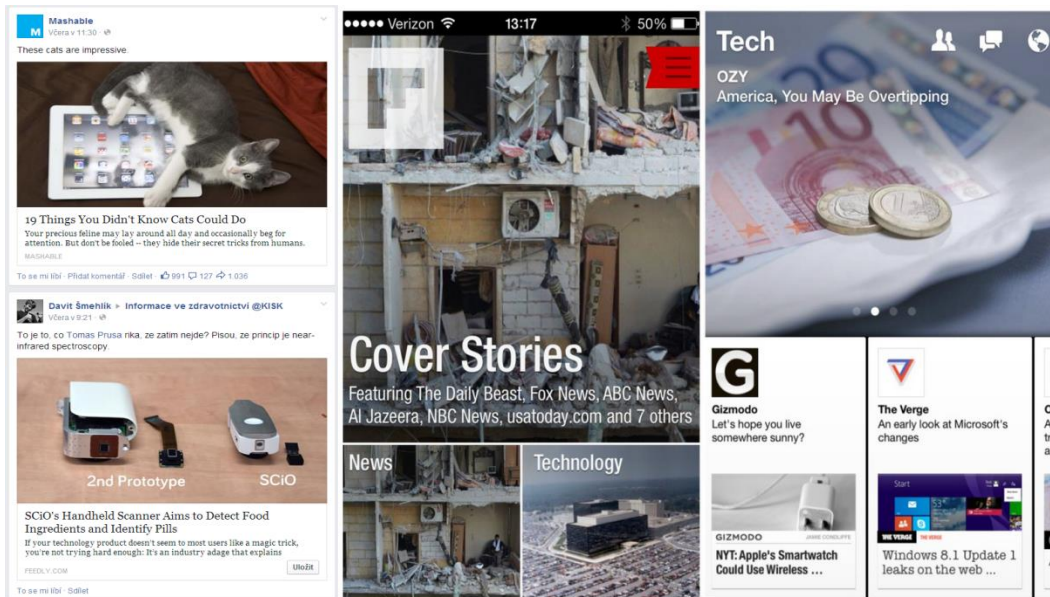


Fig. 3. Left: Facebook stream with external links; Center: Flipboard; Right: Facebook paper (Web-15).

Wearables such as Google glass or various smart watches are on the rise. We predict more technology similar to Spritz is going to be implemented, but on a more sophisticated level. As we have mentioned above, users have difficulties controlling the flow of a text stream. They have to be highly concentrated on the screen not to miss any word. One elegant solution could be monitoring reader's eye movement with a device front camera, which would pause the text stream when she looks away.

With improvements in computer-generated simulation of speech (speech synthesis) we could assume that reading while using wearables will be transformed to audio stream. Information would be consumed in combined form of an audio and a text stream (See Fig. 4).

*Takeaway message: Reading from wearables will be realized using text flow and speech synthesis.*



Fig. 4. Operation system called Her communicates with Theodore (Joaquin Phoenix) using speech synthesis (Web-16).

## 6. Conclusion

To summarize our findings: there is no innovative breakthrough technology to bring completely new experience of reading yet. We have discussed couple of interesting trends and scenarios which might become widespread. There are also few directions where further research needs to be done. For instance, we actually do not know how digital reading affects our thinking in the long term. How does reading of short messages, multitasking or googling influence our ability to think critically and independently?

Related health issues are important to cover in the research as well. These questions should be addressed in order to bring digital reading closer to the experience we expect from printed books.

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