E-newspaper Navigation – Designing navigational aids for a new electronic medium

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Abstract. In this paper we examine the need of navigational aids when designing interfaces for e-newspapers – newspapers presented on a digital paper built on E-Ink technology. By reviewing literature on navigation, and by handling input from both newspaper designers and potential e-newspaper adopters, we have suggested a number of navigational aids for the future e-newspaper. Our suggestions have been tested through a prototype using a modification of the Cooperative Usability Testing model (CUT) on a total of fifteen potential users. The results show that most users prefer a linear organization of the e-newspaper. To render a sense of depth in this flat medium, page-numbering is essential. Several different interaction possibilities will also be needed to ease the navigation and our suggestions include a blend of page-turning and hyper linking, combined with an index to give the user a better overview of the content.

1. Introduction

One of the great benefits of traditional printed newspapers is the simple user interface where the navigation mainly consists of page turning. In many ways, reading the newspaper is a more pleasant experience than sorting through newsgroups, online forums, web sites, and other Internet information sources (Treese, 2003).

The newspaper interface has been tuned in form and function into a user-friendly, universally accepted product (Gurtler, 1984).

Today, news is not communicated through a single medium. Instead, newspaper companies communicate news to its readers through several different channels, such as on the web, wap and PDF-versions etc. Of course, the printed newspaper still plays an important role and will probably do so for many years to come. But since the commercial breakthrough of the Internet in the early nineties, the newspaper industry has gone through radical changes. A modern newspaper company of today's highly information technology-influenced society utilizes the benefits of modern technology to satisfy and give its customers an added-valueexperience.

E-paper technology [1] makes it possible to combine the portability and readability of the printed newspaper, with the interactivity of electronic mediums into a brand new channel to communicate news -the e-newspaper. In the same way as the Internet introduced a new era of usability design for news sites a decade ago (Boczkowski, 2002), the e-newspaper will require new design solutions for the graphical user interface once again (Ihlström, Åkesson & Nordqvist 2004).

In this paper we will examine the need of navigational aids when reading news on an e-newspaper artifact. The challenge is to create an interface that supports both the sequential structure of printed newspaper, with a beginning and an end, and the hierarchical structure with hyperlink navigation of the web. By starting out from the core of navigation through Lynch's (1960) urban design elements and how these can facilitate the construction of mental representations, and by identifying the key concepts in the navigation design of both print and web, we will in this paper present and evaluate a proposed solution for e-newspaper navigational aid.

This work is done in the context of the DigiNews project concerning digital distribution and consumption of the future newspaper. Our contribution is a further development of an earlier study on interface design for e-newspapers (Henriksson, Lindqvist & Söderblom, 2004). In that study, a prototype was developed and it was taken in favour by the collaborators of the DigiNews consortium.

2. E-paper

The electronic paper holds several advantages compared to traditional computer screens. Firstly, it provides a level of readability fully comparable to printed paper with twice the contrast of an LCD display. Because of no backlight, it can be read in bright sunlight and other lit environments. This, in addition to that e-paper products does not require any power to maintain an image on the screen, lead to a very low level of power consumption. Another powerful feature of the

electronic paper is its flexible nature which offers a lot of opportunities, not least when used as a simile to traditional print implements [2].

3. Navigation

Navigation, the process by which people control their movement, using environmental cues and aid to achieve their goals without getting lost (Darken & Sibert, 1993). Most of us have little difficulty navigating in the real world due to the reason that we mainly navigate in environments which are quite familiar. Even when the environment is not fully familiar, we can still keep to familiar routes,
e.g. by taking the same roads or buses. Difficulties arise when navigating unfamiliar environments, where we have to rely on navigational aids such as maps or written directions (Vinson, 1999).

Navigation becomes necessary in "large-scale environments" where the navigator's viewpoint cannot cover the totality of the environment. In hypermedia environments this is often referred to as "lost in hyperspace" (e.g. Conklin, 1987). To navigate such "large-scale environments" generally requires the navigator to be able to conceptualize the space as a whole (Darken, 1995; Darken & Sibert, 1996). The navigator creates a mental representation of the encountered environment, often termed "cognitive map", on which she then relies to navigate the environment (Lynch, 1960; Rovine & Weisman, 1989). Many scientists believe that cognitive maps have picture-like qualities, and like pictures, cognitive maps can be described in terms of three components: identity, structure and meaning (Elvins, 1997).

In *"The image of the city"* Lynch (1960) identifies legibility, the ease with which people can understand the layout of a place, as fundamental for urban design. According to the author, legibility can facilitate people in their creation of cognitive maps. Legibility is acquired by five types of elements; (i) *paths* – familiar routes by which people can move around to different locations, (ii) *districts* – two-dimensional areas which are recognizable as having a common identifying character, (iii) *edges* – lines which separates the districts, (iv) *landmarks* – point-referential objects which, due to their characteristics, can be distinguished from other objects, and (v) *nodes* – similar to landmarks but can be distinguished from a landmark by its active functions. While a landmark is a visual object, a node is rather a hub of activity.

Passini (1984) develops Lynch's (1960) ideas of categorizing the elements of an environment by identifying that a space should have a basic organizational principle behind it. According to Passini (1984) the organizational principle is used directly to structure spatial knowledge.

3.1 Spatial knowledge

When navigators first encounter a new environment, they heavily rely on landmarks as points of reference (Vinson, 1999). As the experience of the environment increases, the navigator gains route knowledge; which is described by Dillon, McKnight and Richardson (1993, p. 173) as *"the ability to navigate from point A to point B, using whatever landmark knowledge we have acquired to make decisions about when to turn left or right"*. Route knowledge (also referred to as procedural knowledge; e.g. Darken & Sibert, 1996) make use of landmarks *"which is static information about the visual details of a specific location"* (Darken & Sibert, 1996, p. 2). Despite gaining route knowledge, the navigator has not necessarily gained knowledge about the environment as a whole.

As the navigator experiences the environment even more, she may transform the route knowledge into survey knowledge (Thorndyke & Hayes-Roth, 1982). While route knowledge is static information about the visual details of a specific location, survey knowledge is map-like in structure (Darken, 1995; Darken & Sibert, 1996). Hence, it can be directly acquired by map use (ibid.) and allows the navigator to approve the most convenient perspective on the environment for a specific task (Thorndyke & Hayes-Roth, 1982). Survey knowledge is the key to successful wayfinding in any environment (Darken & Sibert, 1993; 1996).

Search 3.2 strategies

When navigating, so be in the real world, in a 3D virtual world or in a hypertext media environment, the task objective can diverse from finding a specific target to simply explore the encountered environment. Darken (1995) and Darken and Sibert (1993; 1996) classify three primary categories of search strategies; *naive search*, where the navigator has no prior knowledge of the whereabouts of the target in question, *primed search*, where the navigator knows the location of the target, and *exploration*, where the navigator does not search for a particular target but rather explores the environment as a whole.

Carmel, Crawford and Chen (1992) identified three browsing strategies for hypertext navigation: *search-oriented browsing* when scanning and reviewing information relevant to a fixed task; *review browsing* when scanning and reviewing interesting information in the presence of transient browse goals that represent changing tasks, and *scan-browsing* when scanning for interesting information without reviewing.

3.3 Consistency

Consistency is important in the placement and appearance of navigational support (Fleming, 1998). The ability to predict where to find the navigational support is an important first step in making choices. Consistency is probably the most widely

mentioned design principle. Users rely on consistent interfaces (Dix et al., 2004). Still, consistency is described as the most violated of design principles (e.g. Shneiderman, 1998; Dix et al., 2004). This is probably because consistency is not a single property of a system. Consistency must be applied relatively to something (Dix, 2004) and can be applied in many different forms, i.e. through terminology, layout, color and fonts (Shneiderman, 1998).

3.4 Feedback

Lynch (1960) points out the importance of frequent directional cues to maintain orientation. For every user interaction, the system should provide some response. For minor actions, the response can be modest while more major actions should imply more substantial response (Shneiderman, 1998). Dix et al. (2004) points out that feedback from past actions is essential for the users' determination of effects in present actions.

3.5 Metaphors

Metaphors are a way to facilitate the construction of mental models. New users of a system bring knowledge across a wide range of application domains, obtained from earlier experience in both real and virtual worlds (Dix et al., 2004). These earlier experiences can facilitate the learnability and ease of use of a system (Carroll & Mack, 1985). Since the invention of the first operating system with graphical user interface, the desktop metaphor have played a central role by imitating organizational principles of traditional desktops with folders, trash cans etc. These traditional metaphors have later been extended by spatial metaphors such as the room (e.g. Savidis & Stephanidis, 1995) and city metaphor (e.g. Darken, 1995; Darken & Sibert, 1993; 1996). Newspaper layout and usage are familiar, and can serve as a metaphor through which features of the printed medium may be mapped onto computer user interfaces (Golovchinsky & Chignell, 1997). The front page of a newspaper can serves as a landmark around which semantically related articles are organized (Golovchinsky, 1997).

4. Research approach

This work takes its starting point in an earlier study on interface design for e-newspapers (Henriksson, et al., 2004). That study included the development of a proposed interface design solution, which was tested in two different sessions. The solution was presented to the DigiNews consortium and several newspaper designers, and we were encouraged to continue the research. In this continued research, our research approach can be divided into three phases; *specification*, *development* and *testing*. The different phases are described in more detail below.

4.1 Specification

In the specification phase, the features of the e-newspaper were defined. The specification phase consisted of four stages; (i) hardware specification, where hardware requirements for the e-newspaper reader were identified, (ii) organization specification, where we defined how to organize the e-newspaper, (iii) functionality specification, where the functional requirements were specified, and (iv) navigational aids specification, where required aids to maintain orientation were identified. The specification was achieved through three different input sources; earlier study on interface design for e-newspapers (Henriksson et al., 2004), design workshops with newspaper designers and reviewed videos from mockup-building workshops conducted within the DigiNews project.

4.2 Development

In the design phase, the prototype was built based on the outcome of the specification phase. It was a result of newspaper designers' and potential users' views on the e-newspaper artifact, composed with theoretical aspects on navigation. Our prototype was developed in a Macromedia Flash MX environment and was used as a tool to validate our theories in the testing phase. For the prototype, we have used authentic material from the Swedish newspaper Norrköpings Tidningar (NT).

4.3 Testing

For the last 20 years, think-aloud testing has been used as a technique for detecting interface usability issues by documenting respondents' thoughts and verbal comments (Dumas, 2003). The think-aloud technique is powerful and simple in its way to identify instant experiences that the test subject encounters (Nielsen, Christiansen, Clemmensen & Yssing 2003). We have conducted our tests in two sessions, using the Cooperative Usability Testing model (CUT); a technique which uses ground theory of think-aloud but takes it one step further by adding one more interaction with the respondent. "*The chief idea of CUT is to bring together users and evaluators in a constructive dialogue aimed at uncovering usability problems*" (Frøkjær & Hornbæk, 2005, p.1383).

In the first session of CUT, the interaction session, the evaluators have two different roles; guide and logger. The guide plays an active role during the test and gives the respondents instructions and contributes with answers and directions if the respondent finds any problems. The logger, on the other hand, takes notes of the respondents' behavior and comments, which will be further used in the coming session. In the second session, the interpretation session, the roles of the evaluators are inversed and the logger establishes a discussion with the respondent based on the notes from the previous session. In the CUT model,

video recordings from the first session are used as a foundation for the discussion. In our modified version of CUT we used the prototype once again. By implementing the prototype in the second session instead of a jointly walkthrough of the video recordings, our aim is to reach another level of discussion where the respondent is given a second chance to explain her thoughts during the interaction.

We conducted our tests on fifteen people, ten males and five females. One part of the selection consisted of a focus group which had earlier been involved in the DigiNews project and had, due to that, some understanding of e-newspaper. This group consisted of three male and two female participators and had a range of age from 28 to 82 years. From the start, the focus group was established in the DigiNews project by answering an Internet newspaper questionnaire. The remaining ten respondents were handpicked by us and had no prior knowledge of the e-newspaper and what it concerns. The sex ratio was seven male and three female participators with an age span from 22 to 33 years.

Each test was divided into the two sessions of our modified CUT model described above. The test duration was approximately 30 minutes each for both sessions. The interaction session was structured so that the respondents initially explored our prototype and when we considered them to have gained a fairly good knowledge of how to navigate it, we addressed a few task-based questions concerning navigating to a specified location.

After these tests we decided to conduct another test on the same prototype altered by removing landmarks and navigational aids. The aim of this test, which was performed on four handpicked participators, was to see how the respondents approached the prototype when having a reduced number of navigational aids to rely on. The age span of the second test was 23-26 years and the sex ratio three males and one female. As a last complementing test we asked eight people to navigate to a specific page to see which navigational method they used. Two of them were not involved in any previous tests.

5. Results

5.1 Specification

The specification resulted in several sub results. Below, the outcome of the hardware specification, the organization specification, the functionality specification and the navigational aids specification is described in more detail.

5.1.1 Hardware specification

During several meetings and workshops together with associates in the DigiNews project, we agreed upon two aspects of the e-newspaper reader which we found

essential to carry out: (i) the format of the e-newspaper artifact, and (ii) the way to interact with the artifact.

There are currently two discussed formats of the e-newspaper artifact. The first e-newspaper artifact to enter the market will probably hold the size of ISO standard A5 which measures 148 x 210 millimeters. This format though, is rather a result of the specification made by the hardware developers than a requirement from newspaper designers and readers. The second discussed format holds the size of ISO standard A4 which measures 210 x 297 millimeters. This format is, according to previous study (Henriksson et al., 2004) and the common opinion of newspaper designers, more likely to be accepted by e-newspaper adopters. In this work, we have decided to focus on the latter format because of the reasons mentioned above.

There are also two different interaction methods discussed for the e-newspaper; (i) by software buttons on a touch-sensitive display, (ii) by hardware buttons placed in the frame of the artifact. As touch screen technology is considered viable to implement, we have decided to develop our prototype for a touch-sensitive display because of three major reasons; (i) touch screen makes it easier for us to simulate our prototype in the test sessions. (ii) touch screen technology enables the interaction elements to be integrated in a layer above the information presented on the screen. Due to that, the screen surface can be more efficiently used and the total size of the artifact can be reduced. (iii) maybe the most important, is that software buttons are not definite in the sense that they can easily be modified through software updates in case different newspapers require different navigation.

5.1.2 Organization specification

In our prototype, the linear organization of traditional printed newspapers is maintained. This approach to organization was found preferable already in earlier conducted study (Henriksson et al., 2004) and the outcome of that study was confirmed by newspaper designers' opinion, where all of the participating actors in the workshops preferred to organize articles in a sequential manner. In the mock-ups built in future workshops with potential e-newspaper adopters, we identified differing opinions considering the approach to organization. Nine out of twenty mock-up-builders designed their mock-up as to rely on a linear organization. Simultaneously, nine other seemed to prefer the more web-like, hierarchical organization. In the remaining two cases we were not able to identify the underlying organizational principle.

5.1.3 Functionality specification

Based on the statement from previous sections, we identified a number of required interaction functionalities. Concerning the design workshops, the newspaper designers advocated a minimization of interaction possibilities due to

the hypothesis that some of the interaction possibilities would make the e-newspaper more adoptable to potential users. This was not reflected in the mockups though, where several potential users seemed eager to implement as much functionality into the e-newspaper artifact as possible. Several of these suggested functionalities had to be disregarded due to the reason that they did not concern the navigational aspects or did not meet the requirements of our hardware specification stated in section 5.1.1. Examples include functionalities concerning; (i) Internet services such as e-mail and browsing, (ii) advertisement and print to paper, (iii) media such as playing movie and sound, and (iv) alternative interaction styles such as voice control. Our concluding functionality compilation includes five interaction functionalities; (i) page turning, (ii) indexing, (iii) hyperlinks to different topics, and (iv) clickable items on main pages. Due to the characteristic division of NT, we also presumed to implement (v) hyperlinks to the different sections (NT, in fact, consists of four sections).

5.1.4 Navigational aids specification

The current newspaper of NT is divided into four sections (A, B, C and D), where each section consists of sub sections (i.e. section A consists of the sub sections "Ledare", "Norrköping", "Börsen" and so on). To support the current division in this flat medium, we identified two indicators as required to maintain orientation; one indicating the current section and the other indicating the current sub section. We also identified an indicator showing the current page as required. In an attempt to give the user a sense of depth in the newspaper, a bar, conceptualizing the current page out of all pages, was identified as required.

5.2 Development

In this section, our prototype is further described. As the prototype is a product of our specification, it relies on the outcome from previous section.

5.2.1 Prototype

Our prototype is developed upon the outcome of the specification phase and can be described by the terminology of Lynch's (1960) five urban elements (figure 5.3). Its core component is "the Thumb" (see figure 5.1, A) which is equipped with functionalities assumed to be frequently used. The Thumb is a remainder of the prototype developed in an earlier study (Henriksson et al., 2004) and was one of the features that received the most positive feedback from both respondents and collaborators of the DigiNews project. The Thumb has also been used in a further study Svensson, J., Hakeröd, J. (2006)
The Thumb can be moved freely on the right hand side of the screen and appears wherever the user puts her thumb. The Thumb is equipped with five buttons; turn to next page, turn to previous page, menu, index and hide. The menu button is

currently not working but is implemented by commands of the DigiNews collaborators.

The intention is that the menu button should bring the user to a kiosk-like service where she can buy subscriptions or single editions of different newspapers, magazines or books. This service was not further developed in our prototype due to the reason that it does not concern the navigation. The Index-button can be used to enter a table-of-contents-like service where the user, by a single press, can be hyperlinked to the selected part of the newspaper. The hide button puts the Thumb invisible for the user. It is restored by a single press in the right hand side of the screen.

The prototype consists of four sections (districts) and each section consists of several sub-sections (sub-districts). Each section is edged by that the current section is highlighted in top right corner (B) and each sub-section is edged by that the current sub-section is shown in the header (D). The navigator can choose to navigate through several different paths; by page-turning mechanism (A), by Index (A), by hyperlinks to the different sections (B) or by hyperlinks to the different sub-sections (C). To navigate to the first page, the user can either press the A-button in top right hand corner or use the hyperlinked NT-logotype in top left (E). As pointed out in the specification, landmarks in form of page numbers (F) and a bar to conceptualize this (G), was implemented. The first page has clickable items and serves as a node to underlying pages. Also the Index serves as node. The prototype is attuned to any device compatible to run Macromedia Flash 6.0 applications or higher and consists of authentic material from the Swedish newspaper NT in tabloid format. The prototype is optimized to be presented on any touch sensitive display with at least the size of A4 and is fully functional to navigate the stated edition of NT. Figure 5.2 shows the prototype used for the second test, where several navigational aids were removed.

5.3 Navigation testing

The tests were conducted using two different prototypes. One with fully functional navigational aids used in test 1 (figure 5.1), and one where some navigational aids was removed which was used in test 2 (figure 5.2). When the users started to use the first prototype, the navigation was in most cases easy for them to understand. They identified the key elements; page numbers, page to page navigation through the thumb, the four different sections (A, B, C, D) and the Index very quickly. The users were able to solve most of the tasks we gave them. Minor problems were identified with the thumb for the sequential navigation of page turning. The main problem was to take the initiative to actually try to navigate from page to page. When the user started to use the thumb the reaction was very positive and they could easily navigate with it. When doing the test on the second prototype, the users had more problems navigating the prototype. The lack of navigational aids caused confusion and disorientation.

Figure 5.1 Prototype with navigational aids.

Figure 5.2: Prototype without navigational aids.

		Path	District	Edge	Landmark	Node
A	**Page turning mechanism**	x				
A	**Index**	x				x
B	**Sections**	x	x	x	x	
C	**Sub sections**	x	x			
D	**Heading**			x	x	
E	**Logotype**	x			x	
F	**Page numbers**				x	
G	**Bar**				x	

Figure 5.3: Objects of the prototype described in the terminology of Lynch's urban elements

5.3.1 Organization

Overall, the users expressed that the e-newspaper felt like a printed newspaper. This mainly because of the layout, that differs radically from the web, and because the page turning function. All the users commented that they preferred this way of reading instead of scroll functions and they rather used the page turning arrows on the Thumb instead. Page numbers and the newspaper-like appearance of our prototype, increased the feeling of page turning and linear organization.

5.3.2 Interaction functionalities

Index was in most cases used when a user searched for a specific subject. There were no problems among any of the users finding the Index-button. When we asked a user to navigate to a specific place in the newspaper, the Index was used by almost everyone. Situations where Index was not used occurred when they already were in the right section for the topic we asked for. In those cases, they used the sub section links at the bottom of the page instead.

The thumb was used to navigate page to page i.e. page turning. When users were given a task to navigate to a specific page, they navigated through different sub-section links to get as close as possible to the page, and then used the thumb to navigate to the demanded page. The section buttons, A, B, C and D, was not fully understood. Some of the users did understand them directly when they started to use them, others had to ask or be instructed to understand the full potential. When we asked a question of a specific topic, and the user remembered where it was located, the section buttons were used instantly as hyperlinks to the different sections. They worked as a complement to Index.

The sub section links were used when the user had used either Index or section buttons to navigate to the right section. The user then used the sub section links to navigate to the specific sub section. Exceptions were cases when the users already found themselves in the right section. Then they navigated directly with the sub section links. Some users expressed a need for some kind of navigational aid on these links e.g. highlights in the current sub section, i.e. intensifying the current sub section link. Those who identified themselves as frequent Internet-users used the NT-logotype directly without questioning or thinking when they wanted to navigate to the first page or on our request to do so. The other users navigated to the front page with section button A or through Index and then the link to the first page. When we in the second session of the first test, asked those who did not use or find the NT-logotype if they could find any other way from the one they previous had used, they all found the link of the NT-logotype and related it to the Internet. One person queried the need of navigating back to the first page/ front page.

The users in our second prototype paid more attention to the Thumb and page turning. At first they thought it was used for "jump" to different sub sections, which was displayed in the bottom of the newspaper, "In similarity to hyperlinks on the internet" they said. After a while the users, in all cases, figured out that it was a page turning function and thereby realized that they navigated as in a real paper newspaper. The logotype link in the upper left corner was discovered by all users during the second test. They all associated it with the Internet and gave positive feedback about the function. When they discovered that the front page articles were hyperlinks, they liked the function, and by discovering this they looked for more such functions.

When the users from the second test retried the tasks on the first prototype, which had all the navigational aids, they used subsection links or section buttons if they remembered the location of the specific issue, if they did not, they used Index and sub section links instead. One user wanted more choices implemented in the Thumb, such as a button for favorites and also a list of the sub-sections as an extra feature. One of the users queried better indication of the newspaper content on the first page in form of a small Index or similar.

5.3.3 Navigational aids

When the users navigated around on the prototype, they relied on page numbers, the highlighted section buttons and the subsection heading as aids for orientation. The highlighted section buttons were used by some of the users to identify their location in the different sections. The subsection heading was used frequently as a navigation aid by all of the users. When we asked for a specific page number to navigate to, half of the users (four of eight who did this specific task) used Index as an overview to navigate to the page which was closest and then used the thumb to navigate page to page until they entered the right page number. The page number indicator gave different comments and thoughts. Some of the users wanted them to present the whole newspaper, while others wanted them to present the different sections e.g. page 4 of 12 in section B instead of page 4 of 72 for the total amounts of page numbers. Although most reactions were that page numbers in any form was essential for the navigation (or as a navigation aid). On our question, "can you tell us where you are in the newspaper?" all but one answered a page number instead of an idea of their location with help from the bar. The only one who answered different looked only on the bar to get an idea of his/her location. In the first test, the users did not take notice of the bar's existence, though with further questions of its needs, the users' response was that it gave them a sense of depth in the newspaper. Most comments of the bar were that it probably was needed for a more unconscious matter for supporting the deep.

On our second test we removed vital element in the prototype, e.g. important landmarks, which decreased the orientation tremendously. The users had no idea of the newspaper's size because both page numbers and the bar were removed. Almost instantly they felt lost and confused. The main navigational aid they could localize them self with was the Index. Index was used frequently to navigate through the newspapers different pages, articles and sections, compared to test one where the users used the Index in search situations. We had also removed page numbers on the Index page, which made it harder for the user to determine the size and different subsections. They could not know if the newspaper contained fifty pages or two hundred pages.

Due to the lack of orientation objects, the user observed the pages more meticulously and two of them discovered that the first page had an "A" marked

after the newspapers heading. When they later used the Index, they realized that the newspaper consisted of four sub sections named A, B, C and D. The thing they questioned was that only the "A" section was marked on the first page and the other three "first pages" (section head pages) had no such indication.

Due to the lack of page numbers, four users asked for highlights on the current subsection that they entered. They thought that it would be helpful if the location was highlighted as a clear indicator in the bottom of each page. Two users wanted to place the subsections on the top instead, and continued with explaining that maybe they thought so because of their frequent use of the Internet. All users navigated by using the hyperlinks at the bottom more or less throughout the entire test, especially during the last questions when they had become more familiar with the prototype. When trying the first prototype, they pointed out the bar and page numbers as very important orientation aids, and by using them they could give exact specifications of their current position in the newspaper. Especially by using the page numbers, and in second hand the bar as an enhancement. Two of them wanted additional orientation aid in form of the current subsections total pages, for example; sport 1 of 5 with the total page number as well. When we mentioned that a real newspaper could consist of up to 500 pages the all preferred sub section page numbers instead of total.

6. Discussion

We have examined the need for navigational aids when reading news on an e-newspaper artifact. The challenge has been to develop a navigation solution that supports both the sequential organization of printed newspaper, with a beginning and an end, and hyperlinks of the web. By combining these two approaches we enable to give an added-value experience to future e-newspaper adopters.

Legibility can facilitate people in their creation of cognitive maps (Lynch, 1960). We developed our prototype upon Lynch's (1960) five elements of paths, districts, edges, landmarks and nodes. In our tests, most of the test subjects seemed to identify our division of districts and sub-districts. Probably, this depended on our prototypes' similarities with the printed newspaper, concerning page layout as well as organization. Golovchinsky and Chignell (1997) discuss that newspaper layout and usage are familiar, and can therefore serve as metaphor through which similarities of the printed medium may be mapped onto a computer user interface, or in this case, we applied the newspaper metaphor onto our prototype.

Some test subjects had problems to identify which sub-section they were currently in. In our prototype the edges of the sub-districts was defined only by the topic shown in the header. If we had highlighted the current sub-section, the location might have been clearer for the navigator. It is possible that the relationship between the different sections and sub-sections was a bit unclear.

This is because the hyperlinks to the sections were placed at the top of the page, while the hyperlinks to sub-section were placed at the bottom of the page.

With Lynch's (1960) elements we wanted our navigators to experience a sense of place or resemblance to similar environments at their first contact with the prototypes. In our case, none of the users had prior experience of NTwhich did overthrow their legibility a bit. They had to rebuild their conceptual map with small scale changes in identity and structure of this particular newspaper but as a whole the structure was very similar to an everyday newspaper. Earlier experiences (Carroll & Mack, 1985) and prior obtained knowledge (Dix et al 2004) can ease the learnability and facilitate the construction of cognitive maps (Lynch, 1960; Rovine & Weisman, 1989). Important to note is that the navigators only got about a minute to get familiar with the prototype after which we begun to ask questions while also giving them tasks to perform.

The different sections are accessible through the section-buttons (A, B, C and D). These paths were not obvious to all the users. The users that did not try the section-buttons in the beginning minute later realized their functions when looking through Index. We believe that this occasion occurred because of the unfamiliar structure of NT. There might have been easier to comprehend the structure if it was the local newspaper. Lynch (1960) describes path as familiar routes by which people can move around to different locations, and in this case the lack of familiar routes made the users uncertain of which path to choose. One interesting point occurred when we tested the flawed prototype. One of the navigators discovered a consistency failure that we had not thought of.

On top of the first page directly after the newspapers heading the section was marked with a big "A". With no other references they spotted this, and when they later on realized (through Index) that the newspaper consisted of four sections they lacked such indications on every sections first page. This is a sign of spatial knowledge (Vinson, 1999) and illustrates an example that users heavily rely on landmarks in new environments.

When using the flawed prototype the elements that were missing became obviously visual for us but clearly missed by the navigators. They became confused and lost all sense of legibility, which Lynch (1960) points out as essential for the creation of cognitive maps. The thing they requested most during the flawed test was the page numbers, which together with the bar in the header conceptualize the implemented landmarks. Also objects like the highlighted current section and the sub section topic shown in the header served as landmarks. These landmarks were not missed in the same sense as previous mentioned landmarks in the flawed test, but with prototype one, they served their purpose and gave the navigators more control of their environment.
The navigator's initial contact with our first prototype was positive and they comprehended its purpose while they clearly did not react likewise when encountering the second flawed prototype. We wanted the navigators to get some

sense of control of the environment by them self without our interaction or help in the beginning of the test phase. When they recognized the resemblance with a traditional printed newspaper, considering layout, articles, sections and structure, their conception increased. They started to search for information they were interested in e.g. sports, culture and local news, i.e. they took the same "roads" and "buses" as they normally do, they started to gain, what Dillon et al. (1993) call route knowledge. One thing we were interested in was which search strategy phases the navigator went through during the test. At first they explored the new environment as a whole, relying to prior knowledge of navigating other artefacts and newspapers, then transformed the new input of landmarks to different point of references. After that, they seemed to go through naive and primed search (Darken, 1995; Darken & Sibert 1993; 1996) depending on which task was laid ahead of them. Further we got request in form of some kind of change in the pages/sections that they had already been in. This could be implemented and used as a feedback for the presumptive users.

The method we used came out well and we were pleased with the results, but added some elements and changed it in a way to fit our research better. With our questions, we insured that the navigator used all the elements of the prototypes. When they had tested the flawed prototype we let them try the first prototype to observe and discuss their reactions.

7. Conclusion

The creation of a new medium with navigational aids from the world of newspapers and the world of Internet, have proven to be both a challenge and a learning process. The way a user creates his/her cognitive map for the ability to navigate unfamiliar environments have proven to be very important even if the e-newspaper continues to have the look and structure of a regular paper based newspaper. The navigational aids that we have tested for supporting a user's navigation, in both a linear way and through hyperlinks, have been well used. We have identified, as we think, some essential aspects; (i) the importance to indicate the edges on districts i.e. subsection links. (ii) There should be some type of landmark that shows in more detail where, in a section or subsection, the user is located e.g. page numbers for the specific section or a highlighted mark which indicates how far the user are in a specific section. (iii) Index or a table of contents should be implemented, so that the user easily can get a good overview for the news presented, as we noticed, the user used the index function frequently for different search strategies and for navigating fast to different locations. As we point out, for keeping the linear structure and easy give the user a chance for localization, page numbers are vital, no matter if they display the total amounts of page numbers or for the different sections only. The bar, as we call it, may not be what the user needs most for the ability to navigate, but for an unconscious

matter, as we have seen, it does create a depth in the newspaper.

Finally, we have achieved the challenge to create a prototype which supports the sequential organization and the opportunity to navigate via hyperlinks, where the users not only have expressed the feeling of reading from the beginning to the end, and in fact a sense of page turning, but also the similarity of navigating the web.

References

Beishuizen, J., Stoutjesdijk, E., Zanting, A. (1996). Using Hypertext for Studying and Information Search. *Journal of Educational Computing Research*, 15, 289-316.

Boczkowski, P. J. (2002). The Development and Use of Online Newspapers: What research Tells Us And What We Might Want to Know, in L. Lievrouw and S. Livingstone (eds.)," *The Handbook of New Media*, Sage publications, London, 270-286.

Carmel, E., Crawford, S., Chen, H. (1992). Browsing Hypertext: A Cognitive Study. *IEEE transactions on Systems, Man, and Cybernetics*, *22*, 865-884.

Carroll, J., Mack, R. (1985). Metaphors, computing systems and active learning. *International Journal of Man-Machine Studies, 22*, 39-57.

Conklin, J. (1987) Hypertext: An Introduction and Survey. *Computer*, 17-41.

Darken , R. P. (1995). Wayfinding in Large-Scale Virtual Worlds. *CHI'95 Proceedings.*

Darken, R. P., Sibert, J., L. (1993). A toolset fornavigation in virtual environments, *Proceedings of the 6th annual ACM symposium on User interface software and technology*, 157-165.

Darken, R. P., Sibert, J., L. (1996). Way finding Strategies and Behaviors in Large Virtual Worlds. *CHI'96 Proceedings,* 142-149.

Dillon, A., McKnight, C., Richardson, J. (1993). *Hypertext: A Psychological Perspective.* Chi Chester: Ellis Horwood

Dix, A., Finlay, J., Abowd, G. D., Beale, R. (2004). Human Computer Interaction, London: Prentice Hall

Dumas J. S. (2003). User-Based Evaluations, in Jacko, J. A. & Sears, A. *The Human-Computer Interaction Handbook*, Lawrence Erlbaum Associates, 1093-1117.

Elvins, T. (1997). 10 VisFiles: presentation techniques for time-series data. *ACM SIGGRAPH Computer Graphics*, *31*, 14-16.

Eveland, W. P., Dunwoody, S. (1998). Users and Navigational Patterns of a Science World Wide Web Site for the Public. *Public Understanding of Science*. 7, 285-311.

Fleming, J. (1998) *Web Navigation: Designing the User Experience*. O'Reilly & Associates, Sebastopol.

Frøkjær, E., Hornbæk, K. (2005). Cooperative usability testing: complementing usability tests with user-supported interpretation sessions. *ACM Press*, 1383–1386.

Golovchinsky, G. (1997). What the Query Told the Link: The integration of Hypertext and Information Retrieval. *Conference on Hypertext and Hypermedia, Proceedings of the eighth ACM conference on Hypertext*, 67-74.

Golovchinsky, G., Chignell, M. H. (1997). The Newspaper as an Information Exploration Metaphor. *Information Processing & Management*, *33*, 663-683.

Gurtler, A. (1984). *The history of newspaper design*, Swiss Typographic Journal.

Henriksson. S., Lindqvist. M., Söderblom. M. (2004). *Design av navigeringssystem för E-pappers tidningar*. Kandidatuppsats, Halmstad University; Halmstad

Ihlström, C., Åkesson, M. & Nordqvist, S. (2004). From Print to Web to e-paper -the challenge of designing the e-newspaper. In *Proceedings of ICCC 8th International Conference on Electronic Publishing, ELPUB 2004*, Brasilia, 249-260.

Lynch, K. (1960) *The Image of the City*, Cambridge: MIT Press.

Nielsen, J., Christiansen, N. (2003). Clemmensen, T., & Yssing, C. Mindtape -a Technique in Verbal Protocol Analysis, *HCI International, Lawrence Earlbaum Associates*, 188-192.

Rovine, M. J., Weisman, G. D. (1989). Sketch-map variables as predictors of way-finding performance. *Journal of Environmental Psychology*, *9*, 217-232.

Passini, R. (1984) *Wayfinding in Architecture*, New York: Van Nostrand Reinhold Company Inc.

Savidis, A., Stephanidis, C. (1995). Building nonvisual interaction through the development of the Rooms metaphor. *CHI'95 Mosaic of Creativity.* 244-245.

Shneiderman, B. (1998) *Designing the User Interface: strategies for effective Human-Computer Interaction*, Addison-Wesley

Svensson, J., Hakeröd, J. (2006). Design of navigational support for task oriented reading in e-newspapers. To be published in Proceedings of the 29th IRIS, Denmark.

Thorndyke, P. W., Hayes-Roth, B. (I982). Differences in spatial knowledge acquired from maps and navigation. *Cognitive Psychology*, *14*, 560-589.

Treese, W. (2003). Why the newspaper has a great user interface. *Attack of the killer virus COLUMN: Putting it together,7,* 13-15. Vinson, N. G. (1999). Design Guidelines for Landmarks to Support Navigation in Virtual Environments. *CHI'99 Proceedings*, 278-285.

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http://www.eink.com/technology/index.ht
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