Clicking and Linking: A Life-cycle Model

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ABSTRACT

In some sense, links are the writer's clicks, while clicks are the reader's links. Clicks on links build a reading structure and force the reading contexts to change. This contextual change affects the reader's prediction. As a result, it modifies the reading plan. Despite this key role of clicks on links in this chain of reactions, they are not well investigated. We propose a short life-cycle model to provide a comprehensive framework for the chain of reactions around clicks and links in the reader's view. This model consists of the six stages corresponding to the critical contextual changes on the screen. To see the effectiveness of our life-cycle approach, we looked at the two popular Web browsing systems, Netscape and Internet Explorer. In both systems, the reader's prediction is not well supported.

Keywords: Click, Link, Life-cycle, WWW, Browsing.

1. INTRODUCTION

In this paper, we explain a life-cycle model that explains the chained reactions around clicks and links. Clicks force the reader to face some critical contextual changes on the screen and in his/her cognition. Prediction is a major factor for the cognitive transition resulting from the clicks on links. We have looked at the two popular Web browsers from the viewpoint of our life-cycle model.

Links and clicks

"Links are the writer's clicks, while clicks are the reader's links."

Links make Web documents different from the paper documents. Reading Web documents can be characterised as clicking on links. This action as a reader's decision seems a clear source of a high cognitive load for browsing tasks [7, 8, 24]. The importance of clicks is also found in Shneiderman's Object/Action Interface (OAI) Model [19]. However, clicks and links are not well investigated from the viewpoint of the reader.

Prediction

The user interface is the closed space in which possible states are fixed regardless of time. The user's selection definitely results in one of these states, but the reader predicts something different. This deviation in the reader's prediction induces the high cognitive loads as the reader has to compare the difference and make a decision to stay or go back. To diminish the level of prediction deviation, the user interface requires sound structure and procedure on navigation. A good prediction promotes the reader's navigation similar to one's information structure. We see 3 factors affecting the prediction: vision, time, and meaning. Shannon's uncertainty $H = - \Sigma Pi \log_2 Pi$ [18] is useful to understand the properties of choice uncertainty. The reader's choice depends on the probability distribution of links at that time.

Interface structure

The right information reduces the uncertainty level. Then, the information is carried by the user interface components. According to the Attributistic Information Theory, the structure of the interface affects the information itself [5]. The reading methods also affect the reading [3]. The Web reading style accompanies lots of clicks on links. Therefore, clicking/clicks and linking/links, in the reader's view, should be well defined in the interface. The Web interface structure has to support the reader's prediction for this reading style.

2. READERS' VIEWS TO LINKS

Links and clicks as reading relators

Readers have their own reading models [2, 3, 4, 10] and like to read the documents in an inverted pyramid structure within single topic [2, 11, 13]. Therefore, the Web pages are required to be condensed, small, concise, scannable, objective, and related. Links are the mechanism to satisfy those requirements and clicks are the method to realise the links. Then, the links act as reading cues and decision points. Baron et al [1] reported that labelled, typed links were helpful in a query task. Nielsen [13] argued that the documents having the outbound links are more credible. Morkes and Nielsen [11] found that their subjects favoured links as the opportunities to get more information. Therefore, it is natural that the reader reads the Web documents through links with the clicks on them.

Links as prediction aids

The purposes of connections vary [23, 16, 1, 22] and the purposes of documents also vary [19]. These purposes are usually represented at the links, so the reader's prediction is motivated by the presence of links whether they are helpful or harmful. To be helpful, link interfaces should be well defined like those of module interfaces.

Sound coupling

Sound coupling is necessary for a sound document structure and smooth browsing through links. It is implemented by sound semantic and syntactic links. To be semantically sound, a link should have a message that is semantically the same as the topic of its destination. If a page has a semantically unsound link, the reader meets the semantic gap by the prediction deviation. To be syntactically sound, a link should reach an encapsulated unit. Web pages are frequently updated, so any link to somewhere within a page is unstable in keeping the semantic soundness. Meanwhile, the links to the page capsules is resistant to the update of the page contents. Syntactically unstable links are easy to transform to semantically unsound links. They cause useless or information-less navigation so that

the semantically unsound links induce a high potential uncertainty by impairing the reader's prediction.

3. A LINK LIFE-CYCLE ON THE SCREEN

Links always exist inherently and become alive on the screen. During the time on the screen, the links travel through some stages till they fade out of the screen. Once fading out, the links are not in the reader's direct concern any more. The time length of staying on the screen is usually short but iterative. Fig. 1 shows the link life-cycle on the screen.

The reader evaluates the links on the screen through the fading-in, attracting, and focusing stages, and then executes and realises one's decision through the clicking, linking, and fading-out stages. The reader predicts things to come and has gone through the life-cycle stages. This general concept of evaluation and execution cycle is based on Norman's cognitive engineering model [15], which successfully explained the direct manipulation proposed by Shneiderman [6, 20, and 21].

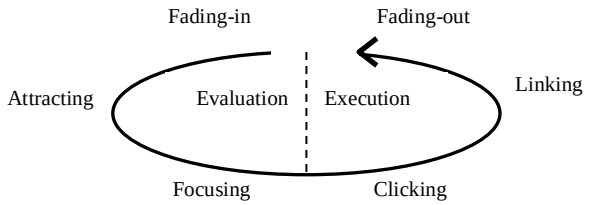

Fig1: A link life-cycle model on the screen

Fading-in
Some of the built-in links fade in on the screen by scrolling or linking. A screen state transits to another state either at once or over time. In the case of transition at once, its promptness is important to the reader. If it is too slow, the reader gets bored and is interfered by other information so that the uncertainty increases. Meanwhile, if too fast, the reader can not perceive the change [17, 14]. This also increases the cognitive load. Transition over time is not usual but should be counted on if the network or processing speed is slow. In this case, the order of fading-in critically affects the reader's attention. Browsing Web documents over a slow network falls in this case. For example, advertisements use the top area of a page and early time frame in order to get the reader's attention.

Attracting
The links faded-in are seen as reading cues because of their differences from the others on the screen. For the reader, links are opportunities for more information [13], clues for the credibility of the document [11] and chances to improve task performance [1]. They compete to get focused. This competition is extremely crucial between the links for commercial advertisements. The sources of the competition are the writer's intention and the reader's intention to contrast each other over time and appearance. At this stage, the reader tests the links whether to focus or not. In the quantitative view, the more links mean the higher uncertainty level and the uniform distribution of the links on the screen will result in the highest uncertainty level, according to the Shannon's uncertainty $H = -\Sigma Pi \log_2 Pi$ [18]. This clearly explains why the newspaper front page is composed like that and seems to suit Web documents.

Focusing
This is the last stage of the logical evaluation. The most attractive link is focused on with the reader's indicator at this stage. The indicator changes to show the changed stage or the link type like the Guide system does. Besides these visual indicators, some other prediction aids are required to decrease the uncertainty level. Those can be the author's intention to the link and/or the abstract of the connecting page. This change may strengthen or weaken the attraction. If the attraction is successful through the focusing stage, a soft-selection is made. In other words, the reader will select and follow the link if there is no physical problem like slow network speed. At this stage, the reader's logical evaluation completes. The physical evaluation based on the physical environment like the network speed at that time will be performed at the next stage.

Clicking
This is the 1st stage of execution/implementation of the linking process. A link is hard-selected after being soft-selected at the focusing stage. The indicator changes again to show the stage change. This stage usually quickly moves to the linking stage if the reader doesn't care about any physical aspects of the linking process such as the page profile, the network speed, and the expected transmission time at that time. The information, however, is usually useful for the reader to decide go or no-go. Therefore, the support for cancellation as a result of the physical evaluation is also required to minimise the useless navigation that has neither any navigational benefit nor any informational benefit. However, the whole process for the reader's prediction in this stage can be supported at the focusing stage by providing the physical information at the focusing stage. In that case, the decision to select a link is made at the focusing stage and then implemented at this clicking stage by a simple click on the link.

Linking
This is the stage of physical connection process for the selected link. There can not be expected to be any information gain from the physical connection because it is not a process for providing information. So no waiting time for the connection is ideal for the reader. However, the waiting time is actually unavoidable. During the waiting time, the roles of the links on the screen are suspended at this stage. The reading task is also suspended because the new page has not been up yet. In browsing Web documents, the waiting time usually depends on the network and processing performance at that time. Time management is required to avoid the readers getting bored or losing information so that the reader keeps at least the current uncertainty level. Time delay accelerates forgetting the information in the reader's short-term memory [12]. Some lubricant information showing the linking progress, as the popular browsers do, can be helpful to avoid any totally unpredictable situation. In addition, the structural overview of the navigation the reader made can be a useful information to minimise the time delay effects by strengthening the topical connection.

Fading-out
All the links on the screen fade out after completing their roles to switch the reader to a new document, or by simple manipulation like scrolling. After this stage, the reading contexts such as interface, information, and the reader's cognitive state change. This transition can happen either at once or over time like that at the fading-in stage. The reader's

working/short-term memory also fades out of the previous contexts.

4. CASE STUDY: Life-cycle management in two browsers

We looked at two popular Web browsing systems, Netscape 4.04 and Internet Explorer 4.0 on the Windows 95. Both systems seem to be modelled with three stages such as the before-selection, selection, and after-selection stages emphasising the focusing, clicking stages. In time management, they have not well considered the time as a critical design factor. Time delays at the fading-in and linking stages happen, which are not utilised. These wasteful time delays may accelerate the reader's forgetting [12] or get the reader bored. So, the prediction is critically damaged. In vision management, they seem to manage well the vision with the cursor shape, the link colour, and the pop-ups. However, the pop-up methods are not well utilised for the prediction as they have the pop-ups for only image links, but no for text links. Fixing the pop-up duration regardless of the pop-up length seems not to be a good idea.

Table 1: the life-cycle management in two popular systems

Stages	Netscape 4.04			IE 4.0		
	Link	Pointer	Others	Link	Pointer	Others
Fading-in	-	Arrow	Unmanaged fading-in over time	-	Arrow	Unmanaged fading-in over time If arrived in 5 secs, the pop-up overlaps for the rest time duration.
Attracting	Blue for the not-visited Magenta for the visited	-	-	Blue for the not visited(Always) Blue for the not visited(Hover) Magenta for the visited (Always) Magenta for the visited (Hover)	-	-
Focusing	-	Hand indicator for links I-shape cursor for normal text	One long-line pop-up for image links: ~0.5 sec wait and ~2 secs stay No pop-up for text links	Blue(Hover) Magenta (Hover)	Hand indicator for links I-shape cursor for normal text	One multi-line pop-up for image links: ~0.5 sec wait and ~5 secs stay No pop-up for text links
Clicking	Red after btn-down No change for image links Reversed blue when cancelled	No change Back-slash-in-a-circle cursor for cancellation	Pop-up disappears if btn-down within ~2 secs	Blue for the not visited in a box after btn-down Magenta for the visited in a box after btn-down Image in a box after btn-down	No change Back-slash-in-a-circle cursor for cancellation	The pop-up disappears if btn-down within ~5 secs.
Linking	Blue for the not visited Magenta for the visited	Sand clock	Unmanaged waiting till the 1st screen presentation ready	Red in a box	Sand clock with an arrow	The same pop-up re-appears & stays ~5 secs Unmanaged waiting till the 1st screen presentation ready
Fading-out	-	-	Fading-out at once	-	-	Fading-out at once

5. CONCLUSIONS

We proposed a life-cycle model for the clicks on links, which consists of the six stages. With this model, we have looked at two popular Web browsing systems, Netscape 4.04 and IE 4.0. We see that they are a little different in details but are the same in their basic concepts. Time management for prediction is not so good, but vision management is good in both systems. The pop-ups for image links at the focusing stage are the only advanced prediction aids in both browsers. This case study shows the effectiveness of our link life-cycle model

We see the proposed model has a possibility of extending to a general interaction model based on clicks on the screen. Further work will be focused on this, as well as the application of the current model to a Web browser.

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