Int. J. Human-Computer Studies 86 (2016) 121–137

Contents lists available at ScienceDirect

Int. J. Human-Computer Studies

journal homepage: www.elsevier.com/locate/ijhcs

Towards user–intuitive web interface sign design and evaluation: A semiotic framework ☆

Muhammad Nazrul Islam [a,*], Harry Bouwman [a,b]

[a] Information Systems, Institute of Advanced Management Systems Research (IAMSR), Åbo Akademi University, Turku, Finland
[b] Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands

ARTICLE INFO

Article history:
Received 21 July 2014
Received in revised form
6 October 2015
Accepted 19 October 2015
Communicated by P. Mulholland
Available online 26 October 2015

Keywords:
Human–computer interaction
Semiotics
Ontology
Web user interface
Web usability
Interface sign

ABSTRACT

Although signs like navigation links, small images, buttons and thumbnails are important elements of web user interfaces, they are often poorly understood. Based on data gathered over a 3-year period (2011–2013) making use of observations in a usability testing lab, by expert review and by structured and semi-structured interviewing users, we developed a Semiotic Interface sign Design and Evaluation (SIDE) framework, consisting of five semiotic layers: syntactic, pragmatic, social, environment and semantic. The framework includes an extended set of determinants and heuristics, based on four empirical studies that help practitioners design and evaluate intuitive interface signs that can be accurately interpreted by users with less effort.

1. Introduction

Web interface signs are particular elements of web interfaces, which usually take on the form of "words, images, sounds, odours, flavours, acts or objects and even gestures" (Chandler, 2002). Their key features are that they (i) should have some meaning and (ii) should be interpreted by someone. It is the designer's task to encode meaning in interface signs in such a way that end-users can decode that meaning accurately and access the desired information or perform specific tasks. Web interface signs are the object of study in this paper.

There are some important properties of interface signs that can be identified. For example, users may interpret a sign in a number of ways, mainly because the meaning depends on the socio-cultural context. As a result, there is no direct link between object and sign. Some signs may have multiple meanings, while other signs may refer to a single meaning, despite being different in appearance. As a result, some signs may be easy to interpret by some users, while others are not. End-users may perform a specific task appropriately when their decoding matches the referential object as encoded by the designer. As such, semiotics research is relevant within the context of HCI and so frameworks and models are developed, design guidelines or principles defined and analytical methods developed.

The smallest elements of web user interface (UI), such as navigational links, small images, thumbnails, short text, command buttons, etc., are called *interface signs* (see Fig. 1). According to Peirce (1931, p. 58), each sign has its own triadic relation, which consists of (a) the *representamen,* corresponding to the representation or form of a sign, (b) the *object,* corresponding to the referential meaning or underlying functionality, and (c) the *interpretant,* corresponding to the meaning (or a sign) generated in the mind of the interpreter or user. Consequently, when looking at the features of a sign, one would focus on (i) the sign as having some meaning, and (ii) the sign being interpreted by someone. Based on this definition, an entire website (e. g. an e-commerce website) can be viewed as a sign, since the website can convey meaning to its users as whole, while particular webpages (e. g., the product list on a website) can also be a sign, since they can provide messages to users. In a similar vein, small elements of a webpage (e. g., a navigational link or label of a product item on a product list of an e-commerce website) can be viewed as a sign, since these elements convey meaning or functionality to the users. In this paper, we focus on the small elements of user interfaces that we define as interface signs.

For example (see Fig. 1), the element 'Calender»' on the homepage of Åbo Akademi's website refers to a unique meaning or functional message (i. e., it shows the events of ÅA according to the calendar dates) to users. 'Calender»' can be seen as an interface

☆This paper has been recommended for acceptance by Henrik Iskov Christensen.
* Corresponding author.
E-mail addresses: nislam@abo.fi, nazrulturku@gmail.com (M.N. Islam).

http://dx.doi.org/10.1016/j.ijhcs.2015.10.003
1071-5819/

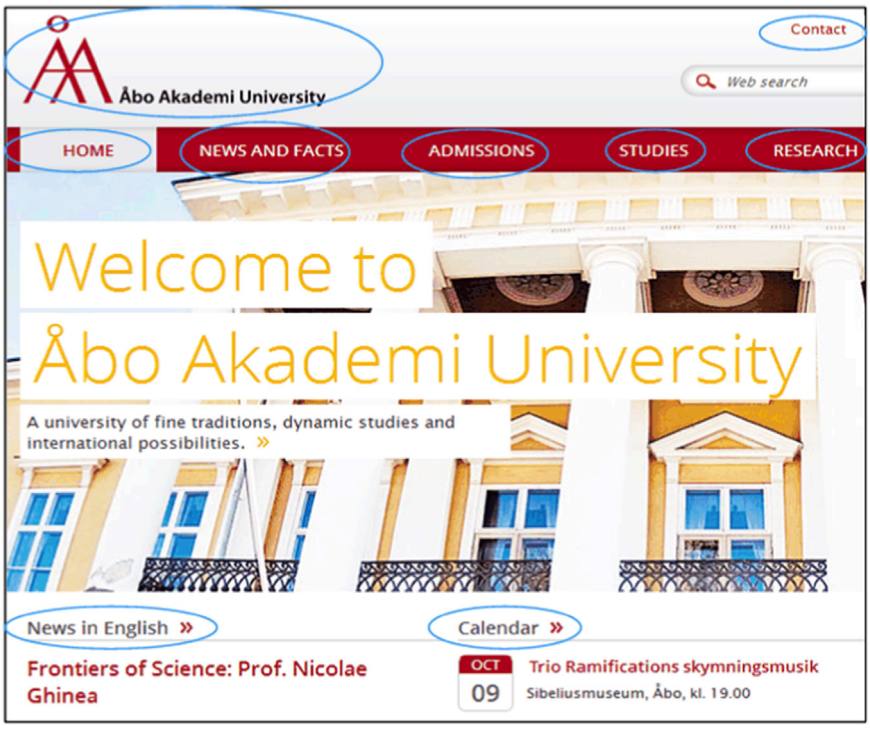

Fig. 1. Snapshot of Åbo Akademi homepage shows some interface signs marked by ovals (retrieved from www.abo.fi in October, 2013).

sign. In this paper, an interface sign can be a single sign like 'contact', 'home', 'admissions'. The sign can be appended with an icon, symbol or additional short text, that are interrelated and as such convey a unique meaningful and functional message like 'News in English»', 'web search with the search icon', 'logo of Åbo Akademi with the text Åbo Akademi University'. Because these signs act as communication artefacts in web User Interfaces (UI) and communicate web content and system functionalities, they should be designed in such a way that their referential meaning can be correctly interpreted by end-users.

To summarize, the term *user-intuitive interface sign* refers to an interface sign that is easy and intuitive to interpret and that allows users to understand the referential meaning accurately. The referential meaning of an interface sign refers to the meaning (information, content and/or functions) as assigned by interface designers in a web UI. A user–intuitive interface sign should reflect the meaning of the sign, to allow users to access content directly or to obtain the desired information. Interfaces with user–intuitive interface signs are supposed to be easy to use and designed to improve end-user experience.

In this context, usability is defined as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998). Usability research in human–computer interaction focuses mainly on the lay-out, navigation, information architecture and content of a web application, while little attention has been paid to interface signs in user interfaces (Speroni, 2006). Some studies (e. g., de Souza, 2005a, 2005b; Bolchini et al., 2009; Speroni, 2006; Islam, 2012; Islam and Tétard, 2014) indicate that designing intuitive interface signs is essential in keeping the user satisfied, improving a system's learnability, ensuring understanding as well as task completion, and providing a means for effective communication. The design principles for interface signs focus on sense production and interpretation, by making use of semiotics (Nadin, 1988, 2001), i. e. the science of signs (Peirce, 1931, p. 58). Very few methods emphasize the importance of semiotic design as such or the use of semiotics in evaluation tools. The reasons for not including the semiotics perspective are a lack of knowledge of semiotics, a limited view on semiotics theories as a background for interface design and evaluation, and a poor understanding of how semiotic aspects can affect user interface design and play a role in usability evaluation (Islam, 2011). In this paper, we argue that using semiotics can help improve the design of websites and help designers evaluate their designs.

We are not the first to address semiotics in design. Some researchers and practitioners have addressed semiotic principals in human–computer interaction (HCI) research (Islam, 2013). Examples are (i) the semiotic inspection method (SIM) for interface evaluation, as developed by de Souza et al. (2006); (ii) a usability inspection method called MiLE+ for web application development, as proposed by Bolchini and Garzotto (2007); (iii) the web–semiotic interface design and evaluation(W–SIDE) framework to evaluate information intensive web user interfaces (Speroni, 2006); (iv) the use of semiotics in usability evaluation to improve the quality of the systems' usability evaluation (Islam and Tétard, 2013); and (v) semiotics-based heuristics used to evaluate web interfaces (Bolchini et al., 2009; Islam et al., 2010).

In this paper, the objective is to identify determinants of user–intuitive interface signs, with the aim of improving web usability and end-user experience. The overall research question is: *Can a framework be developed and heuristic proposed, based on empirical studies that can support the design and evaluation of user–intuitive web interface signs in order to improve web usability?* To answer this question, we look at why some signs are intuitive to end-users, while others are not; what factors make it easier for users to interpret the meaning of a given sign and help them interpret the referential meaning of the interface signs accurately. To achieve the research objective, four empirical studies were conducted, with a total of 37 test participants. Based on the results of these studies, we propose a semiotic framework for the design and evaluation of web interface signs. Although this paper contributes to the improvement of web usability, the research does not examine all issues related to web usability, such as content, navigational architectures and page layout. The main focus is on