Metacommunication and Semiotic Engineering: Insights from a Study with Mediated HCI

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Abstract. Semiotic perspectives on HCI take human-computer interaction as a special case of computer-mediated human communication. Through the interface, systems designers communicate to users their design vision as well as how the system can or should be used for a variety of purposes. To date, there hasn't been enough empirical research in HCI exploring this complex phenomenon. This paper reports an empirical research about metacommunication in HCI and discusses how and why semiotically-inspired research can contribute to advance knowledge in this field. The aim of the discussion is to motivate and justify more research projects in this interdisciplinary territory and to present semiotic engineering concepts and tools that can be used to carry them out.

Keywords: Semiotic engineering, computer-mediated human communication, end-user development, mediated web navigation.

1 Introduction

Human-Computer Interaction is an interdisciplinary field *par excellence*. Semiotics, however, in spite of its indisputable contribution to all investigations involving representations, interpretation and communication, is hardly listed among the disciplines that have influenced HCI to this date [1]. Although the straightforward explanation for this is that semiotic theories look plainly esoteric to most non-semioticians, a justification to perpetuate HCI's impermeability to semiotic influence cannot be easily sustained. To be sure, the effectiveness of this discipline's contribution depends on the semioticians' willingness to revisit and revise the foundations of their discipline in order to produce *usable* concepts, models and methods for the benefit of non-semiotician [2]. However, successful cross-disciplinary initiatives in this context also depend on compelling *cases*, which demonstrate the distinctive contribution of a semiotic perspective while responding to relevant HCI challenges and opportunities. This paper takes the latter course and discusses one such case against the backdrop of new kinds of social participation brought about by the Web 2.0.

De Souza [3] argues that semiotics can provide solid conceptual foundations for the design of technology that *mediates* one's participation in contemporary society and shapes the signs that can be used to express one's intent, beliefs, values, capacities, social engagement, etc. This, in and of itself, is a strong reason to stimulate more

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research projects at the intersection between semiotics and HCI. What must not be forgotten is that interested researchers must have concrete examples of what they should be looking at and looking for.

In response to this need, our paper concisely presents how semiotics has been used in a qualitative empirical study that explored new kinds of technology-enabled social interaction. The study is described in detail in Monteiro's dissertation [4] and a subsequent technical report [5]. Here we only describe how it was conducted and highlight its main findings with selected pieces of evidence collected in various experiments with users. Our goal is to discuss how this kind of research can be conducted and how it opens the door to promising investigations about *metacommunication* and *mediated HCI*. We strongly believe that such investigations are particularly relevant to improve the design of technologies that support end-user development and wider social participation in the Web 2.0.

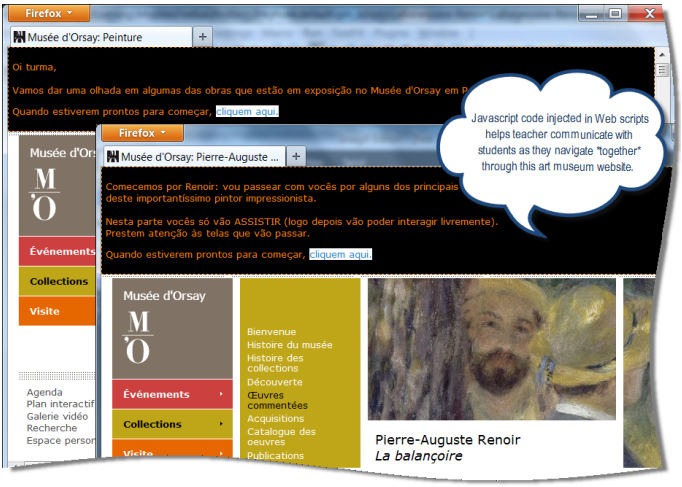

Fig. 1. Scripted Web navigation creates new kinds of social experience

For a quick illustration of applications that can benefit from semiotically-informed research, let us think of software that enables users to customize their experience with Web applications. In Fig. 1 above we show how a Portuguese-speaking art teacher might combine two Firefox Add-ons, Greasemonkey [6] and iMacros [7], to create new learning experiences for her students. Greasemonkey injects JavaScript code into existing Web pages as they are loaded in the browser while iMacros records sequences of interaction steps. With both, the teacher produces a scripted tour across the Musée d'Orsay's website. By sharing her scripts with students, who cannot speak French, the teacher achieves among other things two important effects. She creates new software upon existing software and thus communicates new things about what the original software communicates to her. And she mediates her students' learning experience by means of a digital representation of herself, which virtually encounters and guides each student in a technologically amplified educational environment.

Using a semiotic theory of human-computer interaction to analyze and design for experiences like the one above has at least one major advantage. The hallmark of semiotic perspectives on HCI is to expand the scope of the phenomenon under study and say that, in fact, we should not be speaking strictly of user-system interaction (or its recent reconceptualization referred to as *user experience*). Rather, what goes on as people interact with computer technologies is that they (knowingly or not) engage in a very specific kind of computer-mediated human communication. Through the interface, software designers and developers communicate with software users. They tell them things like how the software product could or should be used, when, where, why and what for. It is only when users, through interaction itself, *get the message* (*i. e.* achieve a satisfying interpretation of what the software product *means*) that technology begins to be used successfully.

Once we accept that software producers and software consumers communicate through systems interfaces, we not only include 'more humans' (*i. e.* users *and* designers) in our scope of investigation, but also gain a unified theoretical framework that can account for semiotic processes taking place on the designers' side, on the users' side and also in their the digital mediator's side, the system's. In short, semiotic theories and methods can support the investigation of a very large and relevant span of computer-mediated communication, unlike any other breed of theory currently used in HCI.

In the following sections we will show how this can be done. Section 2 briefly characterizes semiotic engineering [8], the specific HCI theory that we work with, and presents the Web Navigation Helper (WNH), a user agent that supports mediated interaction with Web applications. Section 3 concisely reports how we collected metacommunication evidence in a lengthy case study carried out by Monteiro [4, 5]. Section 4 highlights the main findings of the reported study and discusses the relevance of this sort of investigation, making the case for more semiotically-inspired research in HCI. Finally, section 5 concludes the paper with suggested items for future research.

2 Semiotic Engineering and End-User Metacommunication with the Web Navigation Helper

Semiotic engineering is a comprehensive theory of HCI dedicated to the study of how designers (one person or a team) and users communicate through systems interfaces. A system's interface acts as the designer's deputy, telling the user what the designer knows about users, what the designed system does, how and why, the designer's vision of how his product benefits the users, how it attends to their needs and meets their expectations [8]. The communication of the designers' vision is received by the user as he or she interacts with the system and discovers the meanings designed into it. This is called metacommunication (communication about communication) and constitutes the prime object of investigation for semiotic engineering. The most striking distinction proposed by this theory compared to other theories in HCI is, as already mentioned, to postulate that designers of interactive software are active participants in the process of interaction.

In order to be of any scientific value, semiotic engineering must provide appropriate tools for researchers to investigate metacomunication and draw valid conclusions that can be subsequently evaluated and used in theory and practice. In response to this requirement we have developed specialized methods to analyze how the designers' communication is emitted through the interface and how it is received by users [9]. Additionally, in recent years, we have started to use technology to help us collect empirical data of metacommunication, namely the Web Navigation Helper (WNH).

WNH is a script-based user agent originally developed to help users with special needs navigate the Web [10, 4]. It is built on top of CoScripter [11] and implemented as an extension of Firefox. While CoScripter is a macro recorder for the Web, WNH is a tool to create and deploy user-defined dialogs that shown on screen as the recorded macro executes. Such dialogs explicitly address the targeted user and, by means of typical interface elements like dropdown lists, text boxes and buttons, among others, they keep parallel interaction *about* the web page in reference. This is done in such a way that all information required to interact with this web page is collected in the parallel conversation between WNH and its user before it is passed on as a macro parameter to the web page. Consequently, WNH *mediates* interaction between users and web applications.

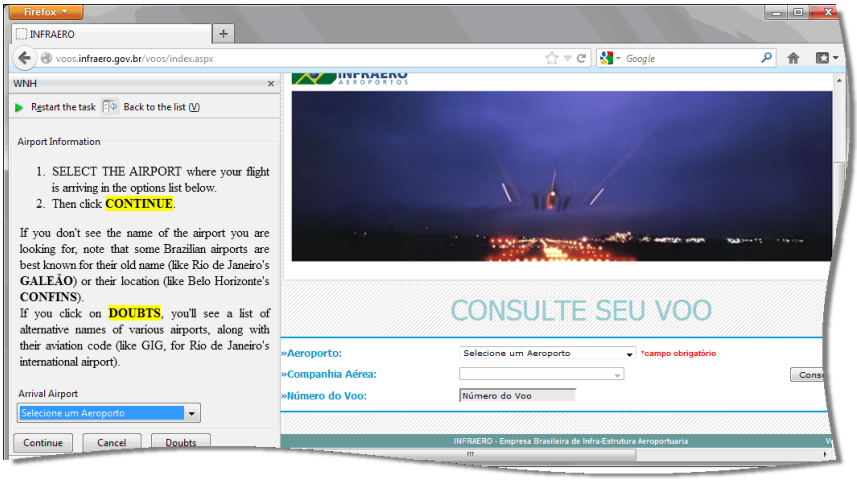

Fig. 2. WNH dialogs help foreign visitors use a local website

For illustration, take the snapshot shown in Fig. 2. The sidebar on the left of the browser window shows a WNH dialog in English. It has been specifically designed to help English-speaking users interested in checking flight information in a Brazilian website (Infraero's) whose interface is only available in Portuguese. The dialog creator included not only the necessary instructions for the addressed user (instructions in 1 and 2 at the top of the sidebar) and a dropdown list at the bottom to collect the user's input and execute the macro, but also useful tips about the official names of some major airports that differ from the name by which they are known to the locals.

The style and content of the dialog on the sidebar signify important things to researchers interested in metacommunication. For example, they provide powerful evidence of how the dialog creator *interprets* and *receives* metacommunication originally encoded in the web page to which the dialog refers (see part of the original web page on the main area of the browser window in Fig. 2). The comment about famous airports' local names, for example, indicates that the dialog creator finds that this is important information missing in the original web page design (where it is not included). Likewise, WNH dialogs reveal their creators' ability to *rephrase* (and in some cases to *repurpose*) metacommunication by means of *interactive computer vocabulary*.

To create mediation, dialog authors can use the WNH dialog editor. It works in combination with CoScripter and allows them: to record scripts for specific tasks; to create mediation dialogs that can be inserted before or after selected script steps; to create mediation dialogs to introduce, capture and explain information that must be passed on to the running script; and to create "online help" pages associated with mediation dialogs, which can include all the range of elements that HTML can handle (text, images, video, audio, etc.). An important feature of the WNH dialog editor is that authors can choose to import into their own dialogs the same interactive elements as are used in the original web page design (see this in Fig. 2, where a dropdown list with exactly the same elements as are shown on Infraero's web page appears at the bottom of the mediation dialog in the sidebar). Alternatively, authors can choose different widgets and even constrain parameters or change properties to improve the quality of mediation (*e. g.* use option buttons rather than a dropdown list, with only the sub-set of choices that make sense to a particular user audience that the dialog author is about to address).

Given this general characterization, the next sections show how semiotic engineering research can be carried out with WNH and the kinds of results it can achieve.

3 Collecting Evidence of End-User Semiotic Engineering

Starting in 2008, we have carried out a number of empirical studies with WNH. Initially, we were mainly interested in building the user agent [10] and exploring its potential as an accessibility tool [12, 13]. Later, however, research carried out by Monteiro [4, 5] showed that accessibility was in fact only one of many possible purposes for which WNH could be used. Insights about the use of WNH as a semiotic engineering research instrument emerged from lengthy empirical investigation with different groups of participants, focusing on different aspects of the users' experience.

When a complete working WNH prototype was finally implemented, an in-depth research could at last be conducted. The overall rationale of the research was: (1) to select a website with *interesting* metacommunication features to be explored; (2) to identify a group of potential users who had barriers to interact with the website by themselves; (3) to identify another group of users who did not have such barriers and who expressed their disposition to *help* the challenged users by creating mediation dialogs for them to achieve a specific task in the selected website; (4) to contrast the communication created by *helpers* with the website's communication achieved

through the original interface; and (5) to observe how the group of *helpees* reacted and used the proposed mediation dialogs while achieving a specific scripted task. This research covers a wide spectrum of metacommunication, allowing researchers to have valuable insights on this sort of computer-mediated communication and the technologies that can be designed and developed to explore and enhance it in the context of the Web 2.0.

The first step in our empirical study was to select a website where metacommunication was likely to challenge at least part of the designers' intended audience. Communicability issues were important for two reasons: if there weren't communicability problems, then mediation dialogs would not be needed; additionally, the complete experiment would allow us to appreciate how communicability issues might affect dialog creators and subsequently the dialog end-users. Thus we chose an online mortgage calculator, which was part of a major Brazilian bank's website. As a cultural clarification, we should add that mortgage prices are a big concern in Brazilian society, cross-cutting age ranges (from young adults to elderly citizens) and economic classes (from lower income to higher income). Even citizens who do not have to pay mortgage themselves are usually concerned with mortgage paid by family members or other people with whom they are closely related.

We analyzed the website and identified communicability issues in it. The next step was to think of a group of users that were very likely to have problems *interacting* with the application (but no problems understanding what a mortgage is and the kinds of information required to calculate loan installments if they – or someone in their family – wanted to buy an apartment). Our choice was to work with a group of six elderly users (63-82), who were taking an introductory course on how to use the Internet. These were middle class citizens, interested in gaining digital literacy to benefit from opportunities brought about by the Internet. All of them knew how to use a Web browser and do basic navigation across web pages. In the remainder of this paper we will refer to this group as WNH *helpees*.

Dialog creators, which we will refer to as WNH *helpers* from now on, were two individual selected from a group of four volunteers who designed and implemented mediation dialogs for targeted elderly users to interact with the web application in this study. They were savvy Internet users, with enough technical knowledge to record a mortgage calculation script and define mediation dialogs to address the *helpees* and collect input data from them to complete the calculation script. They were also adequately familiar with the needs of elderly users. We selected dialogs from two individuals from the *helpers* group: one (*helper 1*) was a graduate student doing research in Web accessibility; the other (*helper 2*) was an instructor of an introductory Internet course for the elderly. They were chosen because we wanted to have some contrast in mediation styles.

The *helpers'* dialogs were used in a subsequent test with the group of *helpees*. After they watched a demonstration of WNH and played with it for a while, participants were asked to use it and calculate how much they should pay if they were to buy a property whose value was R$ 100.000,00. We provided them with fictional financial information about the loaner's family income, the period of the loan, etc. None of the participants had any difficulty to understand that. So, we split them in two groups:

three of the *helpees* interacted with dialogs created by *helper 1*; the other used dialogs created by *helper 2*. Their activity was recorded with audio and screen-capture software. After it was over, each participant was interviewed about his experience with computers, his thoughts and impressions about the activity they did in the test, and about WNH. For lack of space in this paper, we will not go into the details of rich evidence we were able to collect. The interested reader should look at [5] for these. In the following we only summarize the main findings and discuss their contributions.

4 Investigating Metacommunication with WNH

One of the richest evidence we got came from the *helpers'* dialogs themselves. In **Table 1** we contrast a portion of the original website's communication (column 1) with the corresponding communication presented by *helper 1* (column 2) and *helper 2* (column 3) for the end users of WNH mediation dialogs. Notice not only the difference in style, when addressing the *helpees*, but also important discrepancies in interpretation. For example, *helper 2* asks the *helpee* to say where he or she *lives* (row 2), whereas the requested information is actually about where the property is located (possibly somewhere else). The same sort of discrepancy appears in row 5, where *helper 2* asks for the *helpee*'s date of birth instead of that of the oldest person who is going to contribute to paying the mortgage. Another greatly interesting piece of evidence in Table 1 is the contrasting style of *helper 1* and *helper 2*. Notice how *helper 2* is fixated on talking about *the mouse*, the *indicator* (the clickable arrow with which to open a dropdown list), the *white space*, while *helper 1* is not worried with it at all.

Table 1. How helpers received the original metacommunication

Original website	**Helper 1**	**Helper 2**
In which city is the property located?	Select the city where the property is located.	Click with the mouse on the indicator below and choose the city where you live.
What is the approximate value of the property?	Inform the value of the property you want to buy. Please, inform the value correctly. It is very important for the calculation.	Write, in the white space below, the value of the property you want the loan for.
What is the gross family income?	Inform the total value of your household income.	Inform in the white space below your monthly income.
What is the birth date of the oldest person contributing to pay the mortgage?	Inform the birth date of the older person contributing to the household income.	Write in the white space below your birth date.

Both groups of *helpees* were able to achieve the task, even if the actual calculation (in view of interpretation discrepancies verified among *helpers*) might not be correct in a real case situation. The accuracy of the calculation was irrelevant for our study, which concentrated solely on mediated metacommunication. So, in the following we discuss further findings and their significance.

One of the most tangible benefits of WNH as perceived by all *helpees* was to break interaction into small steps. This was not only observed during their task activities, but also in their verbal manifestation later, in the post-test interview. For example, one participant said: "There is no way to be complicated. […] You cannot be lost, because it is sequential. […] There is nothing there to complicate [things] and you cannot make mistakes." All *helpees* reached the end of the task, although some of them experienced problems along the way.

One of the recurring problems was that mediation dialogs had no error-recovery resources in place. If a participant entered the wrong input, for example, he or she had to start the script over again. More than that, a close look at Table 1 shows that both *helpers* created dialogs that explicitly concentrated on trying to prevent errors (with detailed information and occasional help pages, not shown in Table 1). One of them (*helper 1*) also used in-line formatting as means to verify input and prevent error for such things as typing "3oo" (with literals instead of digits) when the intended input was "300". This strategy was not used by *helper 2*. So, the group of *helpees* using her dialogs failed to anticipate which was the correct format for currency and dates, for instance, and this led to script errors. A remarkable characteristic of both styles of mediation dialogs – and of the original website interface as well – is the little (if any) attention paid to communicating what to do in case of errors. In Table 1 there is an interesting illustration of how oblivious we can be of our metacommunication interlocutor's real needs. In row 3, *helper 1* warns the *helpee* against errors by saying: "Please, inform the value correctly. It is very important for the calculation." Notice that there is no explicit information about *which format* is right; only a communication about the consequences of using the wrong one.

Valuable evidence for researchers interested in semiotic engineering was the fact that both *helpers* were familiar with the needs of elderly users. Be it because of research activity (*helper 1*) or professional practice (*helper 2*), they knew that this group of users is prone to much hesitation and therefore needs constant coaching and reassurance, especially – as was the case – if they are novice users. Although mediation dialogs tended to take care of the coaching reasonably well, it was evident that *helpers* did not pay as much attention to reassuring the *helpees* along the way. Throughout the test, participants would constantly turn to the researcher in search of approval and confirmation that what they had done was right. The only evidence of dialogs for this purpose was a single *"Congratulations! You've successfully achieved task."* closure dialog designed by *helper 1*. *Helper 2*, curiously, didn't even include a closure communication in his mediation dialog. As a result, dialogs were much more impersonal than they had to be, giving evidence that even in very simple metacommunication dialogs as were necessary in this experiment, savvy end users haven't explored the opportunities to come closer to their interlocutors and thus communicate with them more effectively.

This study gave us privileged access to conditions and effects of actual end-user semiotic engineering. *Helpers* were engaged in the same *kind* of activity as professional HCI designers are when they build interfaces for full-fledged Web applications, for example. Deciding how to address the users, how to tell them what to do and what not to do, providing them with the necessary information and appropriate technical or domain knowledge for productive interaction – all of this was part of the *helpers'* task in our experiment. The study also raised many more questions than it gave us answers, proving its worth in long-term research about topics that the HCI community hasn't been investigating systematically. Could it be doing it? Should it be doing it?

5 Opportunity for New Kinds of HCI Research

With the advent of Web 2.0, crowd sourcing, end-user development and content sharing initiatives have become possible and popular. Data mashups and website deployment are within reach for a rapidly increasing number of non-technical users, eager to participate in novel large-scale social processes enabled by web technologies. Our introductory illustration of what can be done with Greasemonkey [6] and iMacros [7] suggests how technology has been changing our lives in depth and breadth.

Although there has been more communication-centered investigations presented in major HCI conferences in recent years, they tend to rely on social psychology and other social sciences (see for example [14, 15, 16, 17]) but not in semiotics. This paper has shown, however, that semiotic engineering offers an opportunity for new kinds of research in HCI. Let us begin with the possibly disturbing fact that, in our case study with WNH, *helpers* may have led their *helpees* astray by introducing misinterpreted communication in their mediation dialogs. This piece of evidence shows once again the power of WNH as an empirical research tool. It also shows the importance of investigating how end users who build mashups and other kinds of content or applications using previously existing software interpret third party's meanings and express their own with new software. Clearly, the effects of misunderstandings resulting from HCI design blunders are propagated and potentially magnified in important ways. Hence the relevance of this kind of research.

Another line of investigation that we take as equally important is how to promote *good* metacommunication among professional HCI designers in the first place. This kind of research is vital to raise the overall quality of end user software engineering that so critically depends on what development tools communicate to end users who are about to build software of their own. WNH is no exception: one of our immediate concerns is to improve both its interfaces, for *helpers* and *helpees*. Additionally, we are working to support end user semiotic engineering more effectively, which would encourage savvier users to represent their intent, beliefs, values, knowledge and capacities more expressively through software interfaces. In this way, they would be readier to enjoy the new kinds of social participation brought about by the Web 2.0.

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