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Articulation of web site design constraints: Effects of the task and designers' expertise

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Abstract

This paper aims at contributing to a better understanding of the cognitive activities of web site designers and, more precisely, their articulation and satisfaction of various design constraints. In this paper, we first present an experiment in which professional and novice designers have to evaluate a web site developed for reflecting usability errors identified in web sites. Then, the results obtained in this evaluation task are compared with results previously obtained in a design task, in which professional and novice designers had to create a web site. Data analyses focused on the number and nature of constraints articulated by designers in these two types of tasks (evaluation *vs* design). In particular, we distinguished constraints linked with the client of the site and constraints linked with the future web users. The obtained results show effects of both the level of expertise and the task. While designing, all of the designers focused mainly on constraints linked with the client. In contrast, while evaluating the web site, novices focused on constraints linked with the user, whereas professionals shared their attention between these two kinds of constraints (client *vs* user-oriented constraints). Based on these results, we conclude with ways for supporting designers' activities.

Keywords: Web sites; Designers; Expertise; Constraints

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1. Introduction

Much research has focused on the use of web sites and hypermedia systems (see, for instance, Bhatt, 2004; Campbell & Maglio, 1999; Chen, Fan, & Macredie, 2006; Downing, Moore, & Brown, 2005; Lightner, 2003; Miles, Howes, & Davies, 2000). These works showed that web sites are frequently difficult to use and do not fit users' needs and expectations. Such studies also provide designers with guidelines for evaluating usability of web sites (see, for instance, Ozok & Salvendy, 2004; Scapin & Bastien, 1997).

Though these studies offer relevant knowledge and information, we argue that it is also increasingly important to know more about the cognitive processes of web site designers. Indeed, very little research about cognitive activities of web site designers has been conducted. We believe it is essential to study web site designers, activities and to identify difficulties they experience in order to improve the usability of web sites. Toward this end, an experimental study was led with professional and novice web site designers. In this study, we focused on the influence of the designers' level of expertise and of the task on: (1) the articulation by designers of constraints linked with the client and with the user; and (2) the degree to which designers effectively respect articulated constraints. This study is in line with a previous study conducted with web site designers (Chevalier & Ivory, 2003a) and it aims at testing explicative hypotheses from this first study.

In the next section, we describe the role of constraints in design activities and the actors involved in the design process. Section 3 details the experimental study we carried out. In Section 4, we discuss the main results and we conclude with ways for supporting and improving web site design as well as suggestions for complementary work (Section 5).

2. Background and related work

2.1. Specificities of web design

More and more individuals can create web sites with H.T.M.L. authoring tools in particular with W.Y.S.I.W.I.G. (What You See Is What You Get) user interfaces, such as NVU, Adobe GoLive®, and Macromedia Dreamweaver®. As such, even non-professional designers can create web sites (Bonnardel, Lanzone, & Sumner, 2003). Although the use of web site authoring tools can be relatively easy, designers working in small-sized companies experience other difficulties. Typically, they have to develop skills in many related areas: database design, graphic design, user interface design, communications, public relations, focus group moderating, etc. Designers working in large companies may not always need such a broad skill set, because they often work with other specialists.

Although web site design, in small-sized companies, can appear to be an individual activity, it in fact requires the intervention of at least two other actors:

- The designer's clients, *i.e.* the persons who own the web site and fund its development.
- The site's future users, *i.e.* the future customers of the web site owners.

However, one or both of these actors may not be present throughout the design process, so designers have to anticipate these actors' expectations and needs in individual design activities. Designers' consideration of potential and/or real expectations of these actors

is reflected by their conformance to different kinds of constraints during the design process (Chevalier & Bonnardel, 2003).

Two main kinds of constraints can be distinguished (Chevalier & Ivory, 2003a): client-oriented constraints and user-oriented constraints, which we illustrate in the case of a web site developed for a car dealer.

1. *Client-oriented constraints* are explicitly prescribed or inferred from interactions between designers and their current or prior clients. These constraints can be grouped according to four categories:
   - *Site originality*: the car dealer' site must be original in comparison with sites for other car dealers. For example: "To underline specifics of this car dealer in contrast to the national brand of cars".
   - *Branding usage*: the site must respect characteristics of the car dealer's brand. For example: "To use the same typography of the brand".
   - *Sales improvement*: the site must present information to favour an increase in the number of new car purchases. For example: "We will have to work on the text with the car dealer for it to be more attractive and commercial".
   - *Site structure and content*: these constraints refer directly to the web site's content and structure. For example: "We need a page per car".

2. *User-oriented constraints* are inferred by designers from their experiences as web site designers and users. Such constraints may address aspects of general interest for users (*i.e.*, aesthetics), or aspects related to web site usability (*i.e.*, ease of navigation). We refer to the latter class of constraints as ergonomic constraints[1].
   Ergonomic constraints are categorized with regard to Ergonomic Criteria defined by Scapin and Bastien (1997), Scapin et al. (2000) and Nielsen (2000), such as guidance or consistency criteria. Constraints related to the site's *general interest* are grouped into two categories:
   - *Aesthetics*, which refer to the look and feel of the site. These constraints concern mainly visual information; for example, the photographs or colours used (e.g., "the colours of the web site must be pretty" or "to group harmoniously documents on the interface").
   - *Attractive content*, which refers to the kind of verbal information to put on web pages (e.g., "to not design a web site too technical" or "to put a part 'news' and more: to give technical advises, *etc.*").

2.2. Constraints in design activities

Design is considered as a problem-solving activity in cognitive psychology. This is because designers have to produce an artifact that fits a specific function while satisfying various requirements (Malhotra, Thomas, Carroll, & Miller, 1980). These requirements define, to some extent, the goal to be reached, but problem-solving is

[1] Here, ergonomic constraints do not come from checklists or ergonomic criteria. They refer to designers' knowledge about the ease for navigating on web sites.

required because designers cannot directly apply pre-defined procedures to reach this goal.

Design problems are also considered ill defined, because designers have, at least initially, only an incomplete and imprecise mental representation of the design goal and specifications (Eastman, 1969; Simon, 1973, 1995). It is only throughout the problem-solving process that designers can complete their mental representations by choosing design options. Therefore, design activities have been described as based on an iterative dialectic between problem-framing and problem-solving (Schön, 1983; Simon, 1995). To solve the problem, designers have to improve their mental representations so that they can satisfy a constraint condition, effectively transforming an ill defined problem into a better defined one. To solve any design problem, designers have to generate and introduce new constraints that contribute to satisfy the original constraint condition (Bonnardel, 1999; Darses, 2001; Guindon, 1990; Simon, 1973).

Numerous studies show that constraints are extremely important for understanding and solving design problems, but no homogenous definition of this notion is proposed (for a review, see Chevalier & Cegarra, in press). Stefik (1981) defined a constraint as a constructed relationship (*i.e.*, a function) among variables pertaining to the product to be developed. More recent research shows that constraints play an important role in looking for inspirational sources to solve the problem, in the generation and evaluation of proposed solutions (*i.e.*, examining characteristics of the web site) as well as in the control of design activities (see Bonnardel, 2006). Moreover, designers often describe their design process as a set of constraints they must satisfy (Darses, 1997). Therefore, constraints can be considered as elements of the solution, which contribute to designers' problem-solving processes to produce an acceptable solution (Chevalier & Ivory, 2003a).

As discussed in Section 2.1., in the web site design process, designers have to consider the expectations of other actors (*i.e.*, expectations of clients and site users). Designers' consideration of these expectations often reflect conformance to different design constraints. Respected constraints can differ in type and quantity depending on the designer's level of expertise, the designer's personal preferences, and the design problem (Bonnardel, 2000). These variability sources explain, at least in part, why different designers dealing with the same problem produce different solutions (Bisseret, Figeac-Létang, & Falzon, 1988). Moreover, variability in constraint status (Janssen, Jégou, Nouguier, & Vilarem, 1989) and origin (Bonnardel, 1999; Chevalier & Martinez, 2001) also account for variability among designers. Janssen et al. (1989) distinguished validity constraints from preference constraints. Validity constraints correspond to problem requirements that are unavoidable, whereas designers may choose to ignore preference constraints.

When designers have to perform a task, they can activate knowledge that has similarities to the given task (Kolodner & Wills, 1996). Activation of this knowledge allows designers to consider various constraints (Anderson & Evans, 1996; Bonnardel, 1999, 2006) in addition to the prescribed constraints.

In this paper, our objective is to better understand what types of constraints (client *vs* user) are prevalent according to the designers' level of expertise (novices *vs* professionals) and the task they have to perform (designing *vs* evaluating a web site).

3. Experimental study

3.1. Problem position and objectives

In a previous study (Chevalier & Ivory, 2003a), we examined the role of designers' expertise in web site design on the articulation and the respect of client-oriented constraints and user-oriented constraints while designing a site (thus, we will use in this paper the expression "design task" to refer to this study). We noticed that all of the designers (novice and professional) articulated about the same proportion of client and user constraints, but they focused mainly on the respect of client-oriented constraints in their web sites. In other terms, when they had to create the web sites, designers respected very few user constraints that they had articulated. Consequently, their web sites were not satisfying in terms of usability, since numerous usability errors were identified in those web sites. To explain that professional and novice designers articulated user-oriented constraints, but respected only very few of them in their web sites, we suggested several hypotheses:

(1) Designing is a particularly complex activity which requires important cognitive resources (Bonnardel & Piolat, 2003). So, in order to alleviate their activity, designers may adopt a specific strategy that consists in focusing mainly on client-oriented constraints. Indeed, the first person that will judge the web site is the client, so designers prefer respecting constraints linked with the client's expectations (Newman & Landay, 2000).
(2) Designers plan to respect user-oriented constraints, but they experience difficulties in concretely applying them while creating their web sites; especially because it is difficult for designers to anticipate activities of web users.
(3) Although designers are also web users, they have become *expert web users*, so certain aspects linked with the use of web sites are not anymore problematic for them. Thus, they do not respect user-oriented constraints in their web sites, in particular ergonomic constraints.
(4) The experimental duration allotted to designers might have been too short, so they had not enough time to respect user-oriented constraints in their web sites.

In order to test these hypotheses, we conducted new experiments; one of them is presented in this paper. In this study, we changed the task to be performed, *i.e.* designers had to evaluate a web site and not to design one.

If we suggest to designers to evaluate a web site developed by someone else, will designers consider more user constraints than when they are engaged in designing a web site or will the client remain as important as s/he is in the design activity?

This new experimental study aims at answering this question and, thus, determining the influence of the designers' level of expertise on the articulation of constraints, while evaluating a web site developed by another designer.

3.2. Hypotheses

Our general hypothesis is that designers will not assign the same importance to client-oriented constraints and user-oriented constraints when they have to create a design or to evaluate a design created by another designer.

In design tasks, generating key elements for the design solution constitutes the main objective of the designers' activities. Towards this end, designers may directly consider future expectations of the client, especially since they are provided with a set of constraints defined by the client before starting their design activities. In contrast, in evaluation tasks, designers can change their viewpoints to be more focused on user activities. We hypothesize that they will articulate more user-oriented constraints, since in this case, they are really acting as web users, which is not the case when designers evaluate their sites throughout their own design activities. This hypothesis is in line with results obtained by Hartley (1997), which showed that, in the writing domain, it is easier for writers to evaluate text written by another person. Although designers evaluate their products at different stages of the design process (see Bonnardel, 1999, 2006; Ivory, 2001; Newman & Landay, 2000), we expect that it should be easier for them to judge a web site made by someone else. A consequence would be that, whatever their level of expertise, designers mainly focus on user-oriented constraints while evaluating a web site created by another designer (we will use the term evaluation task to refer to this last type of activity).

Based on this general hypothesis, specific hypotheses for our new experiment on web site evaluation are the following:

Hypothesis 1. *Number of articulated constraints*

As it was observed in the design task, professional designers will articulate more constraints than novices for evaluating the web site at hand. Indeed, being more experienced in designing web sites, professionals may have a more complete and precise mental representation (or mental schema) of suitable characteristics for a web site. Thus, they better know than novices what they wish to find (or not to find) in web sites, which will allow them to define and express more constraints than novices will.

Hypothesis 2. *Articulated client-oriented constraints*

As in the design task, professional designers will articulate more client-oriented constraints than novices. Novice designers never dealt with real client, so they will infer few client-oriented constraints. In contrast, professional designers are used to deal with clients' expectations, which has allowed them to develop mental representations or schemata including constraints that reflect these expectations. We argue that such client-oriented constraints will be used not only in design tasks but also in evaluation tasks.

Hypothesis 3. *Articulated user-oriented constraints*

In contrast to client-oriented constraints, novices will articulate more user-oriented constraints than professionals. Indeed, novices can use the experience they acquired as web site user for evaluating the web site they are provided with. Moreover, novices have not yet created real web sites, so they can develop an activity close to web users' activities. Therefore, novices will identify more usability errors introduced in the site than professionals.

3.3. Method

Fourteen web site designers participated in this study:

- Seven novices, who had just attended a class to learn how to create web sites using a W.Y.S.I.W.Y.G. – H.T.M.L. authoring tool.
- Seven professionals, who have been created web sites, for about 3 years, in small-sized companies. These designers had different backgrounds (*e.g.* architecture and arts, but not in computer science), but they all specialized in designing e-commerce sites. They use authoring tools for designing web sites.

All designers have no specific knowledge in web site usability and ergonomics.

All designers had to evaluate, without limitation of time, a web site presenting a music store and comprising usability errors (see instructions in Appendix A).

To develop this experimental web site, the web sites elaborated by designers in the design task (see Chevalier & Ivory, 2003a) were analysed to identify usability errors with regard to the Ergonomic Criteria defined by Scapin et al. (2000) and Nielsen (2000). All of the identified usability errors were then introduced in the experimental site designers have to evaluate in this study.

Participants in this evaluation task were provided with 11 constraints prescribed by the client. These constraints were isomorphic (regarding their type) to the ones presented to participants in the design task (see Table 1 and Appendix A).

In order to identify the constraints designers articulated in the evaluation task, they had to think aloud (see Ericsson & Simon, 1993). Researchers often use this technique to study cognitive processes involved in design activities (*e.g.*, Dorst & Cross, 2001; Gero & Mc Neill, 1998). This technique allowed us to identify the number and the nature of constraints that designers articulated.

The participants' verbalizations were then analysed by two judges and a good degree of agreement was obtained (.95). This data analysis was performed in order to determine:

Table 1
Description and nature of prescribed constraints in the evaluation task

Prescribed constraints	Constraints type
To integrate the music store *Espace culture* presentation	Content
To indicate mailing address and directions to the store	Content
To present the CDs, video VHS, etc.	Content
The name of the store must appear on overall pages	Structure and content
The design time must be quick, because the owner of the store wants his site on the Web before two months	Temporal
The web site must be short: 10–15 pages maximum	Structure
The site's colours must be well matched with colours of *La Provence* logo	Aesthetic
In the future, this site will be able to be improved	Structure
The on-line services must be presented: to command on line, to subscribe to become a member and receive promotions, etc.	Content
To present the advantages for members	Content
The budget is 4000€	Financial aspect

- The number of constraints articulated by designers.
- The number of client-oriented constraints and user-oriented constraints articulated by designers and, inside these two kinds of constraints, specific categories described in Section 2.1.
- The number of usability errors identified in the web site by designers.

Examples of coding of designer's verbalization are given in Appendix B.

The quantitative results were analysed with Student's *t*-test, since we compared two groups in order to assess whether the means of the two groups were statistically different from each other.

3.4. Results

We first present results about the constraints that designers articulated during the evaluation task. Then, we compare results from this experiment with the results obtained in the design task.

3.4.1. Designers' articulation of constraints in the evaluation task

In accordance with the hypothesis 1, professional designers articulated significantly more constraints than novices: in mean, respectively, 38.1 *vs* 23.8 constraints ($t(12) = 4.435$; $p < .001$).

3.4.1.1. Designers' articulation of client-oriented constraints. In accordance with the hypothesis 2, professional designers articulated significantly more client-oriented constraints than novices: in mean, respectively, 19.1 *vs* 7 ($t(12) = 6.676$; $p < .0001$).

This general effect results from the facts that (see Fig. 1):

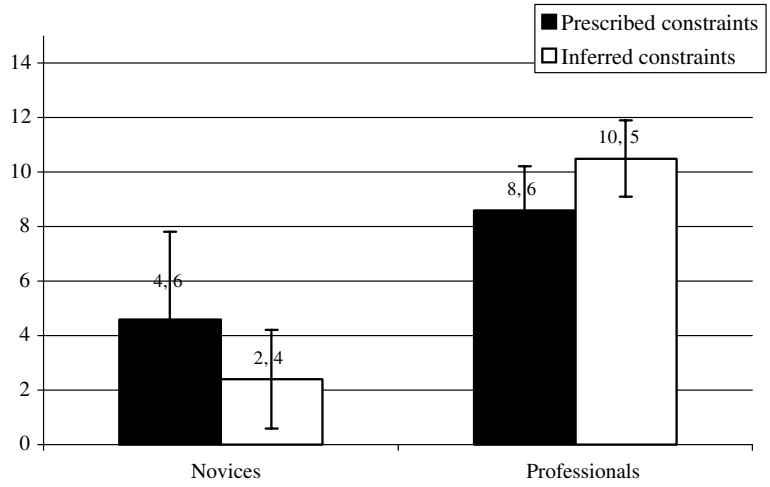

Fig. 1. Mean number (and standard deviation) of client-oriented constraints articulated by designers according to their levels of expertise.

- Professionals articulated significantly more prescribed constraints than novices: in mean, respectively, 8.6 *vs* 4.6 ($t(12) = 2.946$; $p < .05$).
- Professionals inferred significantly more new client-oriented constraints than novices: in mean, respectively, 10.5 *vs* 2.4 ($t(12) = 9.248$; $p < .0001$).

The qualitative analysis of designers' verbalizations shows that three categories of constraints are preponderant, whatever the designers' level of expertise: site originality, branding usage, and sales improvement.

Significant differences are observed in web site aspects on which professionals and novices focused: professionals were focused mainly on the improvement of the sales whereas novices firstly took into account the originality of the web site.

3.4.1.2. Designers' articulation of user-oriented constraints. Contrary to the hypothesis 3, no significant difference appears between novices and professionals about the number of inferred user-oriented constraints: in mean, respectively, 16.7 and 19 ($t(12) = .85$; $p > .1$).

Two different kinds of user-oriented constraints were considered by designers for evaluating the web site (see Fig. 2):

- Ergonomic constraints.
- Constraints linked with the general interest and utility of the site for web users.

These results show that all of the designers spontaneously articulated ergonomic constraints. No significant difference due to the designers' level of expertise was observed in the total number of articulated ergonomic constraints ($t(12) = -0.717$; $p > .1$).

However, novice designers identified more ergonomic errors than professionals: in mean, 23.8 for novices *vs* 12.4 for professionals ($t(12) = 2.818$; $p < .02$). Nevertheless, very few problems were identified by designers with regard to the total number of usability

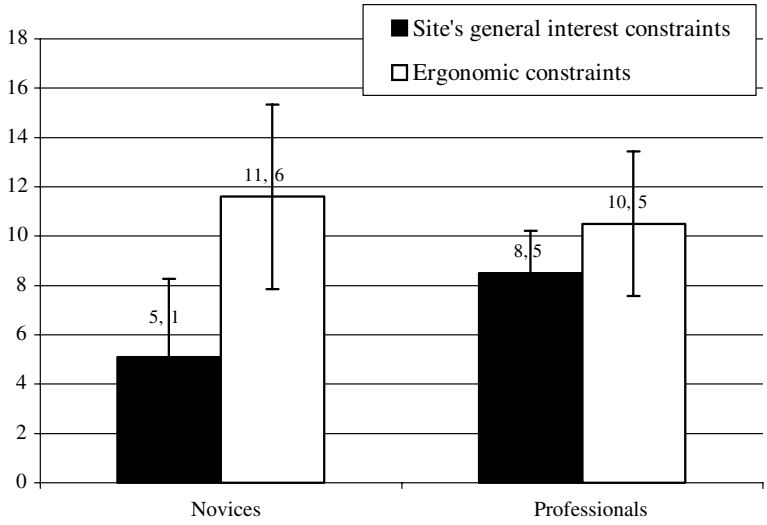

Fig. 2. Mean number (and standard deviation) of user-oriented constraints by designers according to their levels of expertise.

Table 2
Mean number (and standard deviation) of constraints articulated by professional and novice designers while designing or evaluating a site

	Design task	Evaluation task	Significance
Novices	14.8 (2)	23.8 (7.62)	$t(9) = -2.197$; $\mathbf{p = .05}$
Professionals	30.3 (4.72)	38.1 (3.8)	$t(8) = -2.791$; $\mathbf{p < .05}$

Significance results are from the Fischer tests (significant results appear in bold characters).

errors introduced in the web site to be evaluated (only 7.1% for novices and 3.7% for professionals).

On the other hand, professionals inferred more site's general interest constraints than novices did ($t(12) = 2.402$; $p < .05$ – see Fig. 2). The qualitative analyses of designers' verbalizations about these last ones show that professionals mainly focused on the attractive content constraints whereas novices focused mainly on aesthetical constraints. Attractive constraints concern aspects of the web site that allow to attract web users and favor the purchase of products from the site's owner; aesthetical constraints play a role less direct on user's behaviour.

3.4.2. Comparison of the evaluation task and the design task

3.4.2.1. Designers' articulation of constraints. Designers inferred more constraints in the evaluation task than in the design task[2]: respectively, in mean, 30.95 *vs* 22.55 ($t(19) = 5.176$; $p < .0001$ – see Table 2).

3.4.2.2. Designers' articulation of client-oriented constraints. Though professionals articulated more client-oriented constraints than novices, Fig. 3 shows no significant difference due to the task (designing *vs* evaluating a web site). This result is not in accordance with our general hypothesis, since we expected that all of the designers would articulate more client-oriented constraints in the design task than in the evaluation task. Nevertheless, in the design task, all of the designers respected in their sites most of the client-oriented constraints and only few user-oriented constraints.

3.4.2.3. Designers' articulation of user-oriented constraints. Table 3 shows significant differences in the articulation of user-oriented constraints in the design task and in the evaluation task. In accordance with our general hypothesis, professionals as well as novices articulated more user-oriented constraints while evaluating than designing a site.

3.4.2.4. Proportions of client and user-oriented constraints. By comparing the proportions of client-oriented constraints and user-oriented constraints in the design and in the evaluation tasks, we observe that (see Table 4):

- Novices proportionally articulated mainly client-oriented constraints in the design activity, and mainly user-oriented constraints in the evaluation activity.
- In contrast, professionals articulated about the same proportion of client-oriented constraints and user-oriented constraints, regardless the task to be performed.

[2] Results about the design task are extracted from Chevalier and Ivory (2003a).

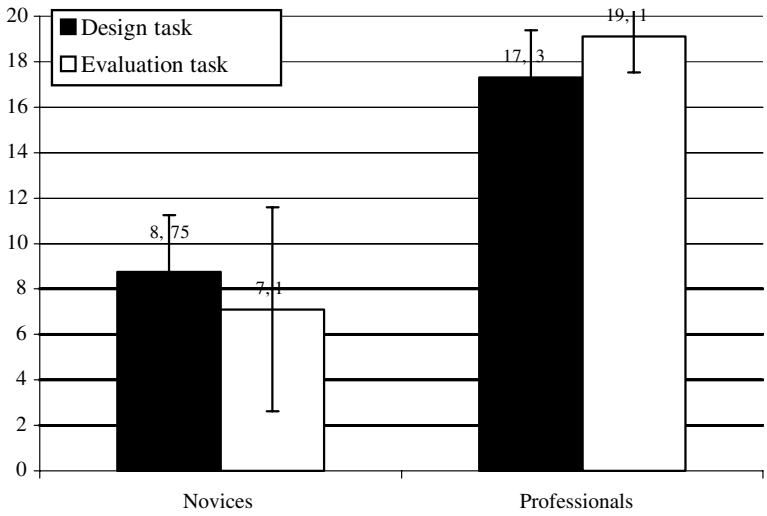

Fig. 3. Mean number (and standard deviation) of client-oriented constraints articulated by professional and novice designers while designing or evaluating a site.

Table 3
Mean number (and standard deviation) of user-oriented constraints articulated by professional and novice designers while designing or evaluating a site

	Design task	Evaluation task	Significance
Novices	6 (1.63)	16.7 (6.42)	$t(9) = -3.209$; $\boldsymbol{p < .02}$
Professionals	13 (3.1)	19 (3.06)	$t(8) = -3.168$; $\boldsymbol{p < .02}$

Significance results are from the Fischer tests (significant results appear in bold characters).

Table 4
Mean number and percentage of client and user-oriented constraints articulated and respected by professional and novice designers while designing or evaluating a web site

	Design task		Evaluation task	
	Client-oriented constraints	User-oriented constraints	Client-oriented constraints	User-oriented constraints
Novices	8.75 out of 14.75 (40.7%)	6 out of 14.75 (59.3%)	7 out of 21.6 (32.4%)	14.6 out of 21.6 (67.6%)
Professionals	17.3 out of 30.3 (57.1%)	13 out of 30.3 (42.9%)	19.2 out of 37.9 (50.7%)	18.7 out of 37.9 (49.3%)

A last comparison aims at determining whether the ergonomic constraints that were spontaneously articulated in the design task but not respected in the web sites produced by designers (see Chevalier & Ivory, 2003a), were or not articulated by designers in the evaluation task. This comparison allows us to determine if designers did not respect ergonomic constraints they articulated because they did not have enough time while designing

their sites or if they experienced real difficulties in concretely and effectively considering them.

Results show that in this last experiment:

- Novices took into account about 45% of the ergonomic constraints articulated in the previous experiment.
- Professionals took into account about only 21% of them.

This result tend to show that all of the designers seem to experience difficulties in effectively considering ergonomic constraints even in an evaluation task.

4. Discussion

These two experiments conducted with professional and novice designers of web sites show differences in the importance of considered client-oriented constraints and user-oriented constraints, depending on:

- The designers' level of expertise (novices *vs* professionals).
- The task to be performed (design *vs* evaluation).

Professional designers, in the design task as well as in the evaluation task, articulated more client-oriented constraints than novices did. All designers (novices and professionals) seem to consider prescribed client-oriented constraints as validity constraints and user-oriented constraints as preference constraints (from Janssen et al.'s perspective, 1989).

This result may be due to the fact that professionals have constructed mental schemata based on their professional experiences. They activate such mental schemata when they identify similarities between the problem at hand and problems previously solved (Bonnardel & Marmèche, 2004, 2005; Kolodner, 1983; Kolodner & Wills, 1996; Schank & Riesbeck, 1989; Visser, 1996). Since mental schemata result from various interactions professional designers had with real clients (see, for instance, Hunt, 1989; Richard, 2005; Schank & Abelson, 1977), it may be easier for professionals than for novices to check whether constraints prescribed by the client are respected in the web site. These schemata may also allow them to infer additional constraints related to the client.

Novice designers also articulated client-oriented constraints, although they articulated less constraints than professionals. More precisely, novices also succeeded in inferring client-oriented constraints supplementary to the prescribed constraints. This inference activity may be explained by the fact that novices also have specific knowledge, especially mental schemata. Nevertheless and contrary to professionals, this knowledge is only linked with their activities as web users, since they never had to deal with real clients. Thus, certain knowledge, mentally constructed *via* their web user experiences, has been used to solve the current problem and so to define supplementary constraints.

Results about the number of articulated constraints show that client-oriented constraints were as important in the design task as in the evaluation task, regardless the designers' level of expertise. Nevertheless, the analyses of the web sites produced in the design task showed that both professional and novice designers respected mainly client-oriented constraints to the detriment of user-oriented constraints. Thus, we can conclude

that the client plays (at least indirectly) a more important "role" in designers' cognitive activities when they are engaged in a design activity than in an evaluation activity.

In the design task, professional and novice designers articulated user-oriented constraints, but respected only very few of them in their web sites. To explain this result, we suggested several hypotheses (see Section 3.1.). Among these hypotheses, the first and third ones seem the most appropriate. With practice, designers became *expert web users*, so certain knowledge linked with the use of web sites (*e.g.*, navigation) became automatic. Therefore, designers focus their attention mainly on constraints linked with the client's expectations. Nevertheless, when designers have explicitly to consider ergonomic constraints at the beginning of their activities, they consider more user-oriented constraints than when they are not provided with these constraints (see Chevalier, 2004). To be both designer and user is a real problem for designing a web site, because designers can believe to accurately take into account users' expectations, though they generate very important usability errors in their productions. It is what Van Duyne, Landay, and Hong (2002) describe as the *designer ego bias*. That is not the case for designers who are not also users, as for instance in aerospace domain, because they have to effectively take into account the users' expectations and so they have to collaborate with human factor specialists.

Results obtained in this second and new experiment tend to show that is easier for designers to focus on users' expectations in the evaluation task than in the design task. All of the designers engaged in the evaluation activity articulated more user-oriented constraints than the designers engaged in the design activity. This result can be explained by the fact that web site designers are, before being designers, web users. Therefore, being involved in an evaluation activity (and not in a design activity) can facilitate the activation of knowledge linked with their web user activities. In the evaluation task, designers may manage to articulate more user-oriented constraints without requiring an anticipative activity, since they are involved in a user activity. That is not the case in the design task, which mainly activates design knowledge, especially knowledge linked with clients' expectations. Nevertheless, these results have to be modulated for two main reasons. First, all of the designers identified very few ergonomic errors introduced in the site to be evaluated. So, in the evaluation task, designers took into account more user-oriented constraints than in the design task, but they experienced again difficulties in identifying ergonomic errors introduced in the site to be evaluated (these errors are the same as the ones identified in the design situation – see Chevalier & Ivory, 2003a). The second reason concerns specifically the professionals and the user-oriented constraints they inferred: they mainly inferred attractive user constraints. These constraints, though linked with the user's expectations, are very close to the client's constraints, since they concern aspects to develop for attracting web users and inciting them to stay on the site and buy products.

In addition, results obtained in this second experiment allow us to delete the fourth hypothesis. Indeed, in this experiment without time limitations, all of the designers articulated only few ergonomic constraints that were articulated by designers in the first experiment but not implemented in their web sites, and they identified very few ergonomic errors.

5. Conclusion

The comparison between design and evaluation tasks showed that designers focus more on user's expectations when they are engaged in an evaluation activity than in a design activity. Based on these results, our objective is to support designers in taking into account

more user-oriented constraints during design activities without neglecting client-oriented constraints. Towards this end, two main ways are suggested.

First, training designers to both taking into account and applying usability criteria for evaluating and improving web sites, should be included in web design classes. Indeed, novice designers, who had attempted a training in applying usability criteria, developed web sites easier to use than novices without such a training (Chevalier & Ivory, 2003b). This study has to be replicated with professional designers.

Second, a specific expert critiquing system (see, for instance, Fischer, Lemke, Mastaglio, & Morch, 1991) could be developed. This system would evaluate the current designer's work and suggest her/him user-oriented constraints. It could allow web site designers to turn off client-oriented constraints (without deleting them) in order to allow them to articulate and respect more constraints linked with the user. This system should take into account the designer's level of expertise, for instance in order to suggest supplementary constraints at different stages of the design activity, when these constraints are the most useful with regard to specificities of the designer's activity.

In this direction, we conducted studies with the MetroWeb system (Mariage & Vanderdonckt, 2004). MetroWeb aims at helping usability experts to gather usability guidelines coming from different sources and to organize them in a structured way. MetroWeb then provides designers with guidance in using these guidelines according to a semantic network of concepts structured around the notion of guidelines, such as ergonomic criteria, development phases, bibliographic references, etc. MetroWeb may support both design and evaluation web activities and may be used by novice and professional designers. A first experimental study conducted with professional designers showed that professionals using MetroWeb developed web sites with less usability errors than professionals who did not use this system (Mariage, Vanderdonckt, & Chevalier, 2005).

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Appendix A. Instructions and prescribed client constraints for the experimental study

The experimenter gives to the novice and the professional designers the same instructions.

"This web site presents a music store, *Espace Culture*, situated in Aix en Provence. The owner of the store would like to present the products that he sales. Toward this end, he asks designer to create a first web site. This designer would like to obtain advice about a web site that he has developed before to put it on the Web. So, I ask you to indicate positive and/or negative points about this web site. I also ask you to think aloud, *i.e.* You have to say aloud all you think".

Before to start their design activities, we practise them to think aloud during few minutes.

"To create this first web site, the client gives you elements about his future web site. More precisely, he wants:

1. To integrate the music store *Espace Culture* presentation.
2. To indicate mailing address and directions to the store.

3. To present the CDs, video VHS, etc.
4. The name of the store must appear on all pages.
5. The design time must be quick, because the owner of the store wants his site on the Web before two months.
6. The web site must be small: 10–15 pages maximum.
7. The site's colours must be well matched with colours of *La Provence* logo.
8. In the future, this site will be able to be improved.
9. The on-line services must be presented: to command on line, to subscribe to become a member and receive promotions, etc.
10. To present the advantages for members.
11. The budget is 4000€.

When you are ready, you can start".

Appendix B. Data analysis and example of coding of an extract of designer's verbalization

Designers' verbalizations were recorded and transcribed. Two different analysts examined the transcribed protocols. Then, the two analysts compared their results and there was 95% agreement between them.

B.1. Number of articulated constraints

During this analysis phase, we counted each constraint articulated by each designer. A designer's extract of verbalization corresponds to a constraint each time it limits the space of research and allows the designer to have a better representation of the site to develop (see Appendix B).

B.2. Type of articulated constraints

The analysis was performed according to the typologies of constraints defined in Section 2.1:

- Client-oriented constraints *vs* user-oriented constraints.
- Prescribed *vs* inferred constraints.

To determine if the designers' articulated constraints were linked with the client or with the user, the two analysts categorized constraints as follows:

- Client-oriented constraints: These constraints typically refer to the client's need to improve sales, commercial arguments, etc. They are similar to the 11 prescribed constraints (given in Table 1) or the designers inferred them from previous interactions with other clients.
- User-oriented constraints: These constraints refer to site navigation (considered as corresponding to ergonomic constraints), and to aesthetical aspects of the site (e.g., page layouts, colors, and photographs). They were mentally constructed during the designers' prior experiences as web users.

Example of coding of an extract of designer's verbalization

Verbal cuttings of articulated constraints (constraints appear in bold characters)	Type of constraints
So … I read. So, **a small web site is important** because … in fact … when you are on the Web… You have various pages, thus several ways when you click on a hyperlink, you are on another web page and … **if the client wants a small site, I can make only one long page and a small-sized site about the number of pages**	Constraint prescribed by the client Client-oriented constraint inferred by the designer. This constraint is linked with the structure and content
The color of the site … colour of the site … **it must be well matched with the logo**. Anyway, I have the X logo on the computer	Constraint prescribed by the client
He is a car dealer in Aix en Provence (city). So, this site is only for this area. It is not international, I guess. Thus, no english version. In contrast, **it must have the Provence area atmosphere so the users can localise it quickly**	User-oriented constraint inferred by the designer. This constraint is linked with the site's general content

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