

Redesigning Web Sites for Older Adults

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ABSTRACT

Practical approaches and examples that incorporate the requirements of older adults into the development lifecycle are particularly useful for web design practice. In this paper, we present a case study of the redesign of a touristic Web portal that presents holiday destinations and supports online hotel booking for older adults. The redesign process involved (a) the identification of a set of 7 principles and 45 guidelines for Web design for older adults; (b) the validation of the identified set with heuristic evaluation; (c) the redesign of the website in a working prototype. The evaluation process compared the existing and the redesigned Web sites through a summative usability test that involved 12 older users and post-hoc interviews and questionnaires. The results showed that the redesigned web site was significantly more usable than the existing one. Finally, we discuss a number of practical issues on the basis of our reflection and experience.

Categories and Subject Descriptors

H.1.2 [User/Machine Systems]: Human factors.

General Terms

Human Factors.

Keywords

Web design; older adults; principles; guidelines; prototyping; comparative evaluation.

1. INTRODUCTION

It has been widely argued that the practice of Web design has to be inclusive in the sense that it incorporates the requirements of the widest set of users including older adults. According to the United Nations [19] and the World Health Organization [21], the ageing of population worldwide will be increasing continuously for the next decades. By 2025, there will be around 1.2 billion persons aged 60 years and over, and this will reach to approximately 2 billion by 2050.

An increasing number of senior citizens use computers and computer related systems to avoid social exclusion and live more independently [23], while it has been reported that in many cases

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PETRA'12, June 6 - 8, 2012, Crete Island, Greece.

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older adults now make up the fastest growing consumer segment of Internet users [19]. Therefore the older population presents a sizeable market opportunity for the IT industry [6][20]. Thus, a serious attempt has been carried out in order to discover how new technologies can be effectively designed to include the requirements of older adults. One important area of this work has focused on how to design web services for older computer users in a way that will enable them to access and make sense of them, without being confusing, and facilitate learning and progression in web usage [5].

Although there are several sets of guidelines for web design which are directly or indirectly targeted on older adults, it is not clear what a designer should do to practically apply them to web design and also to assess their implementation. In this paper we present an integrated case study of redesigning a web site for older adults, that includes: (a) development of a set of 7 principles and 45 guidelines from related work; (b) preliminary, expert-based evaluation of the set via heuristic evaluation of a target web site; (c) redesign of the target website according the set; and (d) comparative usability evaluation of the target website by older adults. We envisage that this integrated work can provide some answers to web designers about how to incorporate the requirements of older adults into the Web development lifecycle.

2. RELATED WORK AND STUDY DESIGN

2.1 Principles and guidelines

A considerable number of principles and guidelines concerning web design for older adults have been developed in academia and the industry.

A basic and popular set of design principles is the “Seven Principles of Universal Design” (The Center for Universal Design, NC State University: <http://www.ncsu.edu/project/design-projects/udi>) which may be applied to the design of environments, products and services. Due to their generality, these principles cannot be readily applied for web design. Of course, this is recommended as a starting point of study to every designer in order to achieve Universal Design.

Web Content Accessibility Guidelines have been developed by Web Accessibility Initiative (W3C.WAI) and they constitute the basis of web accessibility policy worldwide. A considerable part of the second edition's guidelines, WCAG 2.0, have been specifically developed by WAI to address constraints that seniors users face, this way covering relevant aspects concerning web accessibility (Web Accessibility Initiative: Ageing Education and Harmonisation: <http://www.w3.org/WAI/WAI-AGE>).

Another set of basic Web accessibility key principles has been developed by the WebAIM project (Web Accessibility in Mind, <http://webaim.org>). This set does not necessarily include all kind

of accessibility matters but the most essential ones; however it can easily be applied ensuring an improved access in web content. Most of the principles can positively contribute in designing for older adults.

The “Research-Based Web Design & Usability Guidelines” have been assembled by the Department of Health and Human Services in the USA (GSA, 2006), in order to provide practical, yet authoritative guidance on a broad range of Web design and communication issues. Although this set is certainly considered as a reliable reference for website designers, its “general purpose” does not necessarily specialize in aspects of design for the senior citizens. Moreover, with reference to the same set and due to its large number of guidelines, it is not easy for designers to identify the ones complying to design for the seniors.

Kurniawan and Zaphiris [9] have developed a list of thirty eight (38) design guidelines suitable for web applications targeting the older adults. This set of guidelines focuses exclusively on solutions related to problems that older adults face and suggests issues which are required to be taken under consideration by designers who wish to address to this particular group of users.

The National Institute of Aging and the National Library of Medicine have provided several web design guidelines that have to be taken into account when addressing senior users. The book entitled “Making Your Web Site Senior friendly: a checklist”, (<http://www.nlm.nih.gov/pubs/checklist.pdf>) presents guidelines related to almost all elements that a user can interact with while navigating through Web.

All of these sets of principles and guidelines are related to the redesign of web sites for older adults since they refer to accessibility, usability and design for the Web. However, with the exceptions of the last two works, they do not specialize clearly for the particular requirements of older users. These works have been applied in case studies that aim to either identify or validate related guidelines [3][9][24] or apply these to the evaluation [8] of web sites for older adults.

2.2 Case studies

A considerable number of studies have investigated the requirements of older adults for the identification and validation of design guidelines as well as for design and evaluation of Web sites.

Chadwick-Dias et al [3] have conducted two usability studies to investigate how redesigns can improve performance of senior citizens. Both studies included a total of 49 participants ranging in age from 20 to 82. The goal of Study 1 was to learn whether there were differences between the older adults and their way of interaction with the web and whether the same sample of adults is affected in their performance when changes in text size are applied. Results indicated that senior users (55 years or older) had significantly more difficulties while using the Web site than younger users. In Study 2 new participants performed the same tasks on a version of the site that was redesigned to address the usability problems encountered by older adults in Study 1. The purpose of that study was to investigate whether redesigning the prototype could improve the performance of senior users. That was certainly improved significantly for both older and younger users since it was confirmed by the experiment conducted.

Kurniawan and Zaphiris [9] developed a set of research-derived ageing-centred Web design guidelines through an extensive

review of the HCI and ageing literature. They conducted heuristic evaluation in order to identify any usability problems in that set of guidelines and then a group of senior Web users (mean age = 59.2 years) were involved in evaluating the usefulness of the guidelines through navigation of two websites. That study was perhaps the first manuscript that proposed ageing-friendly guidelines that were for most part backed by published studies. Moreover, the guidelines proposed in that study had been thoroughly examined through a series of expert and user verifications, giving confidence of their validity. This second case study lacked the fact that there was no further examination of the guidelines’ effect on the accessibility and usability of websites.

Zaphiris et al [24] report on an evaluation of a set of age-centred web design guidelines with older web users. They invited 24 older web users and used a cooperative evaluation to validate the guidelines. As a result of the experiment, 36 out of the original 37 guidelines were accepted, 1 guideline was disagreed with, and 5 new issues that were not covered by the guidelines were identified by users.

Hart et al [8] present two evaluation studies of web sites for older adults. In the first study, 40 websites designed for older adults were heuristically evaluated based on their adherence to usability guidelines derived by the National Institute on Aging and the National Library of Medicine. In the second study, three websites with varying levels of guideline compliance were evaluated by older adults in a usability test. Results from these studies indicated that the website most compliant with the ‘senior-friendly’ guidelines resulted in higher task success, but did not result in significantly better efficiency, satisfaction, or preference. These findings demonstrate the importance of using both guidelines and usability testing when designing websites for older adults; this is also the approach taken under consideration in our work.

Furthermore, a considerable number of studies evaluate Web sites with the participation of older users with various research methods like surveys [17] and usability testing [14]. Those studies suggest specific guidelines for design, research methods and/or particular requirements of older adults to the use of the Web.

These studies refer to the issues of guideline identification, validation and the evaluation of Web sites with user adult participation. However, it is still not clear what designers should do in the Web development lifecycle, when they are confronted with the (re-) design of web applications for older adults. In order to provide Web designers with practical examples and approaches that incorporate the requirements of older adults into the development lifecycle, we argue that there is a need for integrated case studies that examine the (re-) design practice in a holistic manner. In this paper we present an integrated case study for the (re-) design of Web sites for older adults, which includes 1) the identification of related guidelines, 2) their expert-based validation, 3) their application for a target web site that was redesigned to conform with the identified set of principles and guidelines and finally 4) the comparative evaluation of the two web sites (existing and re-designed) with older adults.

2.3 Case study design

The target website was a touristic and geographical guide of Greece. This is a thematic portal presenting holiday destinations and supporting online hotel booking. The web site is one of the most popular in its kind in Greece, and it is targeted primarily to

Greek users including destinations for both summer and winter holidays. The study design can be distinguished into two major phases, the redesign and the evaluation of the target Web site with the incorporation of requirements of older adults.

The redesign process started with the identification of a set of 7 principles and 45 guidelines for Web design for older adults, hereby referred to as 7p/45g set, on the basis of literature review of related guidelines and case studies. This was then validated with a heuristic evaluation of the target Web site conducted by 3 usability and accessibility experts who (a) identified usability problems and (b) matched them to each one of the principles and guidelines of the set in order to examine its coverage, distribution and redundancy [22]. Then, a working prototype of the redesigned Web site was developed with the use of the Pidoco (<https://pidoco.com>) online prototyping tool.

In order to evaluate the redesign we conducted a comparative evaluation of the two Web sites with the participation of 12 older users. The evaluation methods used were controlled usability testing and post-hoc interviews and questionnaires. The results of the evaluation showed that the redesigned web site was significantly more usable than the current design; this was also validated with various qualitative findings from the post-hoc interviews.

3. (RE-) DESIGN PROCESS

3.1 Identification of a set of design principles and guidelines for older adults

We have developed a set of 7 principles and 45 guidelines based on previously mentioned sets, concepts, principles and guidelines as those reported in earlier literature:

- The “Seven Principles of Universal Design” (The Center for Universal Design, NC State University: <http://www.ncsu.edu/project/design-projects/udi/>)
- The ten usability heuristics proposed by Nielsen [11],
- Web usability factors [12]
- Principles of accessibility for the web according to WebAIM (Web Accessibility in Mind): <http://www.webaim.org>
- WCAG 2.0 accessibility guidelines applied to web design for older adults (Web Accessibility Initiative), <http://www.w3.org/WAI>
- Heuristics of website design for older adults by AARP [4],
- Research-based guidelines for website design developed by National Institute of Aging (Making Your Web Site Senior friendly): <http://www.nlm.nih.gov/pubs/checklist.pdf>
- Research-Based Web Design & Usability Guidelines [7]
- Research-derived web design guidelines for older people [9].

The proposed principles and guidelines were grouped according to similar semantic topics and overlaps were removed eventually creating seven important sections; the seven principles of the new set. Those principles also take into account work that refers explicitly to the barriers that older adults face when interacting with the Web (e.g. [6][15]). The set consists of 45 guidelines (Table 1) and has been described in detail in [13], where each guideline includes a brief explanation of its usefulness to the older

adults as well as a few practical examples of application which may essentially guide novice designers.

3.2 Initial validation with heuristic evaluation

In order to assess the validity and usefulness of the 7p/45g set, we conducted a heuristic evaluation [11] in which experts had to evaluate the target website according to this specific list of heuristics. The purpose of heuristic evaluation was two-fold: first to confirm that the 7p/45g set is well organized, useful and relevant for designers to use, and second to identify the usability problems of the target website and suggest redesign solutions.

3.2.1 Participants and procedure

Three evaluators participated in the heuristic evaluation. All of them were researchers with over 5 years experience in design and usability evaluation of websites and usability (i.e. “double experts” according to [10]). Each of the evaluators was provided with an evaluation report which included: the goal of research and six specific actions to be carried out in that website. They were also provided with the set of heuristics and guidelines with corresponding examples for each guideline together with a relevant form, which had to be exported by them. The results were collected in a five days period.

3.2.2 Results

The heuristic evaluation resulted to a list of positive elements of the web site as well as a sorted number of problems found. The positive elements included (1) very rich content, (2) satisfactory use of colors; (3) good use of language; (4) warm and welcoming web site in terms of icons and colours used; (5) structured and detailed user review of rooms, that helps users get a detailed overview according to their requirements.

With regard to the usability problems found, these were a total of 52, out of which 9 were considered severe and should be fixed immediately, 25 were major and should be given high priority, and 18 were minor usability problems that could be given low priority. The 9 severe usability problems found were: (1) overload of graphics and texts throughout the web site; (2) visibility problems of important user information in various pages; (3) information organization not satisfactory with regard to main user tasks; (4) not self-explanatory text for important hyperlinks and buttons; (5) confirmation of booking reservation not clear; (6) too many choices for users in several pages/steps of the booking process; (7) the homepage does not serve the purpose of one in terms of message and look; (8) too many steps for important user tasks; (9) need for enhancement of quality and credibility mainly through the redesign of many graphic elements and visible page updates.

To verify the relevance of the set, an adaptation of the approach suggested by [22] was taken into account. According to this, the principles and guidelines were matched with the usability problems detected by the evaluators using the criteria of: coverage, distribution and redundancy. With regard to the first criterion, the 7 principles exhibited high coverage, incorporating 50 out of 52 (96%) of the usability problems identified (and also, the 2 problems not matched with the principles, were minor problems). That implies that the set is highly robust without omitting important usability issues. With regard to distribution, all heuristics attracted usability problems, with visibility (23%) and efficient design (21%) attracting most problems. With regard to

Table 1: Set of principles and guidelines for the re-design of Web sites for older adults.

<p>P1 Visibility: All interactive elements, information, user choices and feedback should be clearly visible throughout the website whenever required.</p>	<p>G 1.1: All the elements of the website should have suitable default size. G 1.2: There should be appropriate form of feedback with clear indication of any change that may happen. G 1.3: The most important content of the website should be visible and directly presented, where possible. G 1.4: The colours, textures and graphics should be properly chosen. G 1.5: There should be blank space, properly sited between the elements of the website. G 1.6: The text content should be easily readable. G 1.7: All interactive data should be visible.</p>
<p>P2 Ease of understanding: The presentation of information, content and available user actions should be understandable and effective throughout the website, regardless user's experience, knowledge, reading ability and level of concentration.</p>	<p>G 2.1: The content should be provided in a format that does not require great user experience and advanced reading literacy. G 2.2: Each interactive element should be perceived and be understandable, without the need of documentation. G 2.3: There should be clear indication of the action that the user should do to interact effectively. G 2.4: There should be clear indication of whether a mandatory or an optional action is requested by the user. G 2.5: The content should be presented in the best possible way depending on the case as to achieve the desired objective. G 2.6: The content should be presented in a normal and conceptual form and sequence.</p>
<p>P3 Control and Flexibility: The user must always exert control of the interaction and the web site should offer the user a range of individual choices and alternative modes of action according to his/her preferences, expectations and capabilities.</p>	<p>G 3.1: There should be controlled navigation at all times. G 3.2: There should be controlled actions in dynamic content (eg. sounds, videos, etc.). G 3.3: The size of all elements of the website should be adjustable in accordance with user's requirements. G 3.4: There should be an option to choose alternative ways of presenting non-text elements of the website. G 3.5: There should be a possibility to correct or cancel any action. G 3.6: There should be an option to overcome any repeatable element or action. G 3.7: There should be a possibility to control the unexpected changes that may occur during the interaction. G 3.8: There should be an option to select ways of searching content according to user preference.</p>
<p>P4 Static and Dynamic Help: Assistance should be provided to users when asked or at any time required while interacting, throughout the website.</p>	<p>G 4.1: Assistance should be provided during navigation. G 4.2: Assistance should be provided in the execution of an operation. G 4.3: Assistance should be provided while performing an incorrect action. G 4.4: Assistance should be provided while searching. G 4.5: Assistance should be provided while completing forms. G 4.6: Major helping elements should be provided for inexperienced -with the web- users.</p>
<p>P5 Consistency of organizing information: All interactive elements should be functionally and visually consistent throughout the website. The layout, information and content should be coherently organized throughout the website.</p>	<p>G 5.1: All elements of the site should be consistently displayed. G 5.2: There should be a layout consistency. G 5.3: The conceptual organization of information should be consistent. G 5.4: There should be navigation consistency. G 5.5: The actions required should be consistent. G 5.6: The design style and format should be consistent. G 5.7: There should be terminology consistency.</p>
<p>P6 Efficient design: The design of the website should be lean, predictable, functional and attractive to the user creating a pleasant, friendly mood and inspiring confidence, both for the user's effective and satisfying interaction with the website.</p>	<p>G 6.1: There should be wise selection of the components in the website. Any distraction should be avoided. G 6.2: Efficient ways to perform any action should be provided. G 6.3: The content should be presented in a diffuse spirit of friendliness. G 6.4: The design should be predictable with regard to the way of performing actions. G 6.5: Any surprises in the design should be avoided. G 6.6: The design should inspire trust.</p>
<p>P7 Focused design: The design should be effective, focusing on the object of the website, without presenting unnecessary information.</p>	<p>G 7.1: The purpose of each component that constitutes the website as well as the overall purpose of the website should be clear. G 7.2: The function and content of each element should be clear. G 7.3: The presentation of the most important information for the success of the purpose of the website should be unequivocal. G 7.4: Locating specific information should be easy. G 7.5: The information should be displayed in a hierarchical way of importance through the website.</p>

technique [1], the users were externalizing their thoughts and comments out of which probable difficulties were encountered during their interaction. After the completion of all six tasks with each website, a questionnaire regarding the interaction with it was completed by them. The duration of the entire process for each participant ranged from one to two hours, depending mainly on his/ her level of experience. The other elements of the metric diagram were completed by the researcher at the end of the experiment and after having processed the recorded interaction of each participant.

The metrics (dependent variables) of the experiment were selected as some of the most typical in measuring the user experience [18]:

1. Task success; as a binary metric: each user could either succeed or fail on each task.
2. Time on task; measured through timekeeping.
3. Errors; measured through video recording and researcher observation. In order to determine what could constitute an error, four different types of errors were defined as follows: navigation error, selection error, insertion error and interpretation error.
4. Efficiency; measured through the indicator “lostness” [16] i.e. the extent to which a user may be lost while navigating in a website. Lostness is calculated by the formula:

$$L = \sqrt{[(N/S-1)^2 + (R/N-1)^2]}$$
, where

N: the number of pages visited while performing a task,

S: the total number of pages visited while performing the task, counting revisits to the same page,

R: the minimum (optimum) number of pages that must be visited to accomplish the task.

A lostness value less than 0.4 is considered satisfactory, while a value greater than 0.5 indicates that users have experienced lostness in the Web site.

4.2 Results

4.2.1 Quantitative results

Task success: The binary success for the redesigned version of the website was higher than that of the redesigned for all tasks (Table 2).

Table 2. Binary success for each task

Task Mean	1	2	3	4	5	6
Original version	11/12 (92%)	10/12 (83%)	10/12 (83%)	10/12 (83%)	8/12 (67%)	9/12 (75%)
Redesigned version	12/12 (100%)	12/12 (100%)	12/12 (100%)	10/12 (83%)	12/12 (100%)	11/12 (92%)

Time on task: For this metric, the amount of time spent on each task for all participants was measured separately. Time-on-task was found considerably lower in the redesigned version of the website for all tasks. Figure 3 provides an overview of these results. For example we see that users spent an average of 136 seconds to perform the first task at the original web site and 37 seconds respectively at the redesigned web site.

For this metric, a t-test was conducted to determine if there was a statistically significant difference between the two versions of the

website. The results indicated that for the first three tasks, the difference was statistically significant ($p < 0.02$).

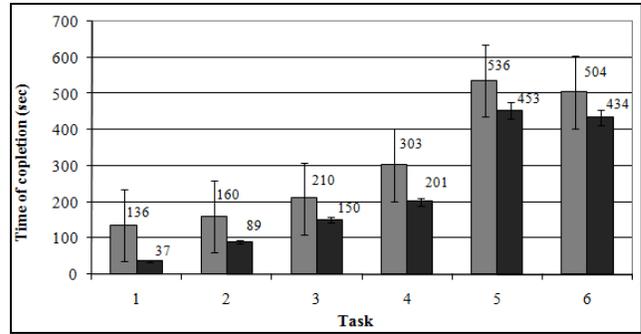


Figure 3: Comparative average time on task both in original and redesigned website

Errors: In order to determine quantitatively the difficulty experienced by the participants during their interaction with both versions of the website, the number of errors performed by all of them was calculated. The number of errors performed in the original version of the website was much more comparable to those of the redesigned version for all tasks. Figure 4 provides an overview of errors for both web sites: for example we can see that for the first task users made 7 types of errors at the original web site and 2 at the redesigned web site.

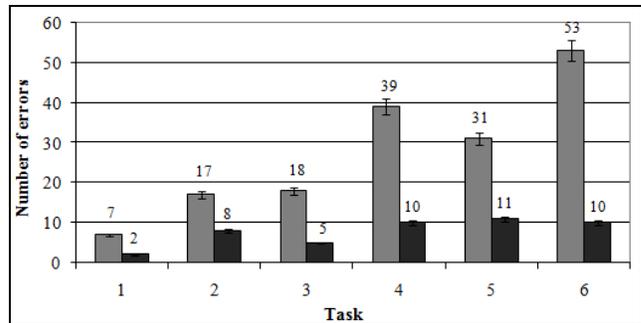


Figure 4: Comparative number of errors both in original and redesigned website

Another useful descriptive representation about errors is the scatter plots of the time on task and the number of errors carried out by the user while performing this task. Figure 5 and Figure 6 show two scatter plots for task 4, where the spread of errors for time on task is much wider for the original web site in comparison to the redesigned one. This was the picture for all tasks, indicating that design errors severely affected user performance at the original web site in comparison to the redesigned.

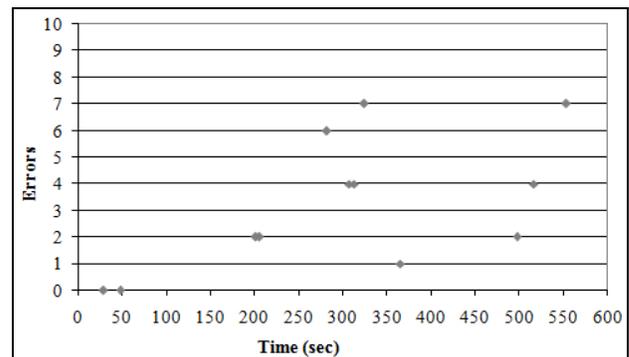


Figure 5: Scatter plot showing the errors carried out by users in relation to time spent for task 4, in the original website

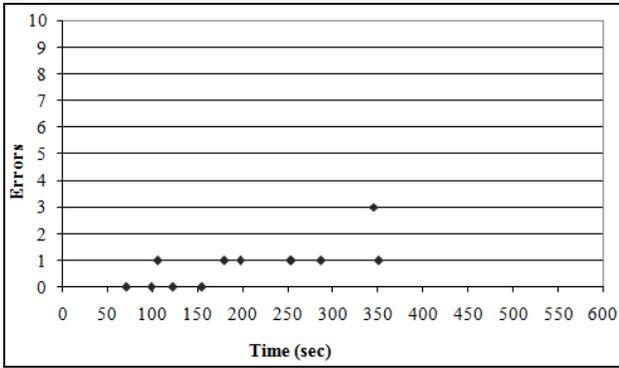


Figure 6: Scatter plot showing the errors carried out by users in relation to time spent for task 4, in the redesigned website

Efficiency: The calculation of the lostness metric was combined in scatter plot diagrams with the time on task metric to provide a descriptive indication of user disorientation during navigation (Figure 7, Figure 8). For the original version of the website, the lostness rate was increased and consequently that increased the time on task. On the contrary, in the redesigned version, the level of lostness seemed to remain lower despite the limited increase in time on task. This fact demonstrated that the participants were disoriented more easily through the original website rather than in its redesigned version.

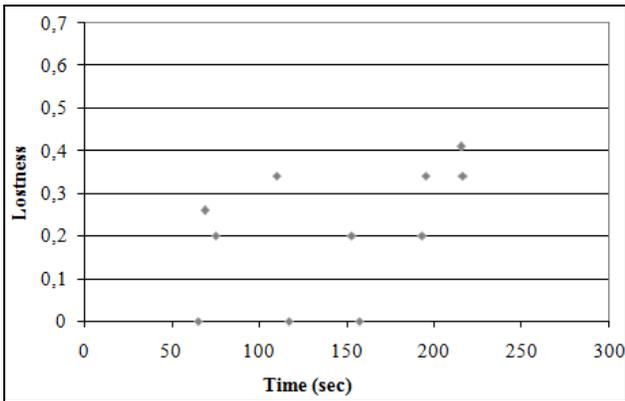


Figure 7: Scatter plot showing the lostness of users in relation to time for task 2, in the original website

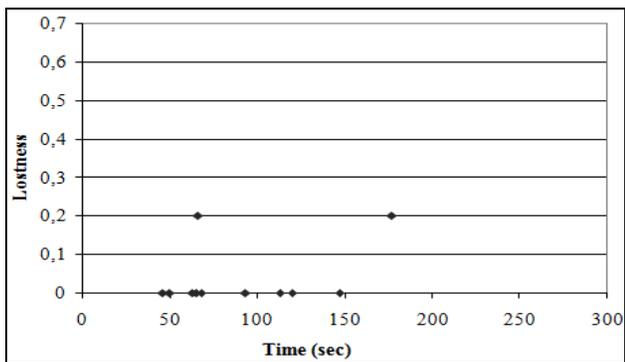


Figure 8: Scatter plot showing the lostness of users in relation to time for task 2, in the redesigned website

Overall, the results of the comparative evaluation strongly suggest that the redesigned website was considerably improved from the original version, for each one of the criteria employed.

4.2.2 Qualitative results

Qualitative data were gathered both through the retrospective probing technique and through the questionnaires that were filled in from the participants. After the analysis of the questionnaires, various elements of personal satisfaction of each user were collected, which can also be matched to some extent with the 7p/45g set.

The general picture derived from the participants for the redesigned version of the website seemed very positive. They all argued that the interaction with the new version of the website was far more satisfying compared with the original one. The comparative evaluation made the participants realize that the difficulties they had to face when completing a task in any website, were not due to their weaknesses or inabilities, but due to the way that the information in the website was presented to them. More specifically, the difficulties they faced in the original version of the website and the way they were dealt in the new version, made them also realize that a number of accessibility issues they are facing daily in various websites, could be easily overcome with appropriate redesigns so to facilitate them while interacting with them.

5. DISCUSSION & CONCLUSIONS

The paper presented an integrated case study of redesigning a Web site for older adults that spans from identification of a set of principles and guidelines to the comparative usability evaluation of the two web sites (existing and re-designed) with the participation of older adults. The results out of the experimental work proved that the redesigned website was considerably more usable and satisfactory than the existing one.

The paper contributes to the development of a practical and integrated approach to redesigning web sites for older adults that comprises of the following steps:

1. Identification and validation of a set of principles and guidelines for web design for older adults; the proposed set complements related work, it was validated via heuristic evaluation and it can provide Web designers with an additional resource that may be used to principally redesign Web sites for the older population.
2. Identification of usability problems for older adults of the system target; this was achieved through heuristic evaluation on the basis of the 7p/45g set.
3. Redesign (guidelines and prototype); the guidelines were identified from the examination of usability problems found, and an online prototyping tool was employed to construct an interactive version.
4. Comparative usability evaluation has performed by testing the usability of the two web sites on the basis of important metrics (task success, time-to-task, errors and efficiency) and qualitative user responses.

With respect to the practice of re-designing web sites for older adults, we have seen that the whole process of evaluation and redesign of a website can be rather fast. Provided that the design team is familiar with the set of guidelines and that there is availability of experts and users (for heuristic evaluation and user

testing respectively), the whole process involving the heuristic evaluation, the construction of the working prototype and the comparative evaluation can last for two to three (at the most) working weeks. This of course can vary depending on the usability problems identified and required alterations too. Thus, in this timeframe the design team can reach to a user-centred and documented proposal for Web redesign that will be ready for implementation.

We envisage that this work can inform and enhance the practice of inclusive Web design by demonstrating the integrated use of user-centred methods with the participation of older adults.

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