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7 Web Usability Today: Theories, Approach and Methods

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Abstract. The aim of this work is to introduce the constant transformation and evolution of the usability concept. An overview of methods, techniques and theories concerning usability is supplied. The reported review starts from the description of traditional ergonomic methods and models, coming to the suggestion of innovative theoretical and methodological proposals. We claim that usability should always take context into account when studying artifacts such as hardware and software, as they are not to be considered as mere tools, unrelated to the concrete situation in which they are used. Thus, usability has to be implemented within a cultural framework, from which actions take their meaning.

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7.1 Usability: a concept in continuous evolution

The concept of "usability" is formally defined by the International Standards Organization (ISO) as: "… the effectiveness, efficiency and satisfaction with which a certain user may achieve a specific objective in a particular environment" (ISO DIS 9241-11). According to these standards, "effectiveness" represents the percentage of the use of the machine in reference to its possibilities, "efficiency" concerns the quantity of "effort" required for the purpose: the more effort that is required, the lower the efficiency of the object in question.

The concept of "satisfaction", finally, is related to the comfort that the user experiences in using a certain product. Despite this rather precise definition, various authors agree on the fact that the concept of usability is not an easy one to express. The limits of the meaning of usability are often blurred or poorly defined [1], and with their constant changes reflect the characteristics of the artifacts that we use on a daily basis. It concerns the way in which we learn to interact with the world using rapidly changing technological products that transform themselves and expand their range of characteristics and functions.

To have an idea of how vast this field of action is, we can simply observe the heterogeneity of a number of situations related to new technology, of which we have scientific demonstration. Observing the staff at Xerox when they use the web as a communicative knowledge medium, replacing a failed expert system for the recognition of faults [2], studying the suitability of a system of immersive virtual reality as preventative training for emergency situations [3], providing systems of artificial intelligence for adaptive web sites, that is, sites capable of modifying their structure and their interface according the preferences of the users [4], designing asynchronous computer networks as aids to university courses to improve the interaction between students and teachers [5], means in any case discussing usability, while not being bound by definitions that are difficult to propose.

We will run through the facts from the beginning. Traditionally, usability has been considered important in the professional field for reasons that range from safety, to annoyance, frustration, and factors of an economic nature that may involve productivity or the sale of products. Even everyday objects such as VCRs, washing machines and telephones may cause or help cause annoyance, frustration and stress, and in the worst cases even accidents [6]. Donald Norman, in his historic "*Psychology of everyday things*" [7] describes, starting from the everyday use of these objects, a model of user-world interaction, characterized by a constant cycle that recurs between the user's goal (intention, action specification), execution and evaluation of new world state. Based on his strongly cognitivistic theories, Norman argues four high-level design principles:

- Propose a *good conceptual model* with the aim of: allowing the correct planning of the actions to be performed, intervening in anomalous situations or in the event of faults, and reducing operating errors.
- *Visibility:* make the things visible. Allow the user to observe how a mechanism is made, what parts it is made of, and how these interact, showing the consequences that may arise from a certain action.
- Provide a good relationship between the parts of the product (*natural mapping*), above all between the control devices and the parts that are operated. The mapping must where possible be natural, that is, be based on physical or cultural analogies, so as to be immediately understandable by the user.

- Envisage the use of *feedback* telling the user what action they have performed and what consequences this has caused.

Another recent study on usability that has received considerable attention, regards a model whereby the usability of objects is taken apart and described in its fundamental elements.

This is the model with five components proposed by Jordan and colleagues [8], [9]. The final model [9] indeed proposes five reference concepts, which are, guessability, learnability, experienced users performances (EUP), system potential and re-usability. These are associated, respectively, with the first time use of a product for a particular task, the number of task repetitions required until an acceptable level of "competence" is reached, relatively stable level of performances, the practical best performance obtainable, and finally the level of performance achieved when a user returns to a task after a long period of non use [10].

The idea of contributing to the development of knowledge in terms of usability by building descriptive-interpretative and heuristic frameworks to support developers and designers, has accompanied the work of many researchers until the present day. It is within this interpretative framework that web usability has begun to be discussed, that is, how to make the most widespread system of Internet-based communication more usable.

7.2 Theories and approaches to WEB usability.

7.2.1 Interfacing with the Internet: Web usability and Human Factor Engineering

With the advent of the computer, studies on usability have found a wide basis for application and today, following the mass introduction of the personal computer and software into the home, concepts such as "user friendly" or "ergonomic design" have become part of everyday language.

The most common perspective on usability and computers today originates from human factor engineering and human machine system engineering literature. In these studies, which include the research carried out by Nielsen [11,12] focused on the web, and the above-mentioned works by Norman, the accent is placed on human performances as the activity evaluated within contexts defined mainly or exclusively by the task and its subcomponents. The measurements made as part of these studies are typical of cognitive ergonomics, such as reaction time [13, 14] and those based on the detection of human error [15-17]. The best performance is generally the fastest and most accurate; this is commonly measured during the interaction between man and one or more products in strictly experimental situations or in more ecological conditions, such as work situations.

Various authors have subsequently built practical models and laid down guidelines based on these theories and aimed at the designers of World Wide Web sites. In this approach, focused on the concept of the interface, the importance is placed on one hand on the contribution of technology, which aims to provide hardware and software systems that are increasingly fast and reliable, and on the other, on the knowledge of the cognitive processes underlying human actions. The general focus is as mentioned the development of user-centered design techniques that can be rapidly adopted by the teams that build web sites [18], for example, provides one definition of usability by identifying five attributes of a usable interface: (1) it's easy to learn, (2) it's efficient to use, (3) it's easy to remember, (4) it causes few errors, (5) it's pleasant to use. The interdisciplinary character of Human Factor suggests the consideration of the variables of the design environment, such as the web design languages (HTML, XML, XHTML, Java) and the browser or bandwidth, which are substantially technical and psychological variables implicated in the

interpretation of graphic options and colors [19], different typographic characters (fonts) in the text [20], the links and the hypertexts [18, 21], and the hierarchical structures of the sites, [22].

Studies on navigation in multimedia hypertexts represent a significant part of the studies on Web Usability deriving from the human factor approach. These studies describe the problem of usability through the examination of the cognitive skills involved during the navigation of a web site [23]. Generally, the overall purpose of such research is to provide a supplemental navigation system, also called remote navigation element, or more simply navigational aid.

These are elements that help a user to locate information on a web site, and allow the user to easily move from page to page [24]. Such aids may be separate from or included in the structure of the site. They may be made up of elements that are commonly present in the browsers (forward, back, home, bookmark) or specific elements on the web pages we visit, such as the names of the pages, the URLs, a site search engine, or a map that graphically illustrates a web site's architecture. Some works also propose specific tools that are able to simplify the users' tasks, by providing them with new and specific "instruments" [25], for example, analyze the relationship that is established between the type of client (browser) and the user's cognitive processes during navigation. What appears clear it that the users make a large number of errors due to the models of hypertext navigation facilities provided by the web client application. The authors present a system (WebNet) that extends the navigational facilities of conventional WWW through the creation of dynamic graphical overview diagrams (also see Zizi and Beaudouin-Lafon, [26]), which can provide users effective indexes for moving between the links on the Internet.

Other navigational aids have been proposed to support user browsing. Recently, Head, Archer and Yuan [27] have presented MEMOS, an on-line history tool that allows users to organize information retrieval sessions with better success compared to the traditional tools offered by the browser. Campbell [28] proposes a sort of Road-signs on Web, with the aim of letting the user know the connection speeds of the proposed links; these signs have the result of improving the performance of the users, by improving link evaluation and decision processes. Sørensen, Macklin and Beaumont [29] assume that "supporting Web navigation implies the provision of tools and techniques enabling users to access Web resources and maintain an index to these resources". These authors present the study of six experimental prototypes to support various aspects of bookmark maintenance and information filtering.

It is perhaps starting from studies on a complex activity such as navigation that we can understand how the task of making a web site useable cannot be separated from the aims of the navigator, from the new ideas that emerge during netsurfing, from the context in which information retrieval occurs or the economic transaction takes place during an e-commerce session. Navigation in these electronic environments does not imply only cognitive operations of a spatial nature: when navigating in a hypertext structure, we participate in the birth of new concepts, the sharing of meanings, the formation of new knowledge, the recontextualization of old ideas. If we try to set aside the idea of the web as a means of information broadcasting and prepare to accept its cultural validity and social dimension, the concept of usability acquires, as we will see in the next paragraph, new and interesting dimensions.

7.2.2 The situated dimension of usability

The classic metaphor of the computer used in cognitive sciences to represent the human mind clarifies the theoretical concept from which Human Factor Engineering research

derives: the human cognitive system is seen as a hierarchical structure made up of various units, each of which handles a specific function. The organization of the functional components or "architecture" is what allows the system to generate suitable interactions with the world [30]. Perception, reasoning and action are thus seen as "separate" processes that allow us to find and interpret the information from the outside world and allow the creation and execution of pre-established plans present in the long-term memory. In this theoretical framework, knowledge is represented as a symbolic system and conceived as the transfer of information from one place to another, without considering the context in which this knowledge is developed and put into action.

The context is, indeed, the focus of a more recent survey paradigm, that of situated cognizance proposed by Clancey [31]. This theoretical framework encloses the psychological aspects that are closely correlated to the physical and social world. Perception, learning, reasoning and action are here proposed "in a new perspective that does not define them as independent processes that are linked in a linear fashion, but rather as coupled aspects of the mind, that is, linked by a relationship of co-determination" [30].

Knowledge too takes on a different connotation and becomes a process that develops into action, which in turn is created in the contingent circumstances, that is, situated in the context. Embracing a concept of this type means shifting the focus from processes linked to the individual, to social dynamics. As stressed in the Theory of situated action by Suchman [32], "… the dependence of the action on a complex world of objects, artifacts and other actors, situated in time and space, is no longer treated as an extraneous problem that the individual actor must face, but is rather conceived as the fundamental resource that makes knowledge possible and gives action its meaning." (p. 179) [32]. In this theoretical framework, individuals are recognized as social actors who carry their own baggage of interests and purposes, which are modified and redefined as a result of their continuous interactions with the environment. Hert [33], for example, in a study based on the retrieval of information using a system of on-line publication cataloguing (OPAC), found that the actions performed by users during the search for information were not completely defined in advance, but rather depended on the elements present in the situation. The users modified their initial objectives according to the elements that emerged during their interaction with the system. Bardram [34] also shares the view that plans, considered as forecasts of purposes, are central in human activity, and that purposes are revised and reconstructed based on the elements and circumstances of the context. The author thus proposes the redefinition of the role of plans and rules within the working activities of a hospital.

The model proposed - "The Patient Scheduler" - is a system based on the communication, planning and sharing of information relating to the care and treatment of patients. Such information, organized chronologically, is made available to all doctors in all hospital departments. Interacting with the computer network, the professionals from the various departments can gain a global view of the treatment of the patients, and work together with the other departments to organize and optimize the various activities. In this way, plans can be continually modified and redefined based on the situations that emerge during the care of the patients and the hospital's activities. The plan thus becomes socially co-constructed, and is shared between the actors, taking on a central role in the working practices of an organization; the situations become the place where the expectations of the actors and the opportunities of the environment meet and are constructed reciprocally [35].

In a wider perspective of situated action, which includes some assumptions of cultural psychology, the concept of "artifact" is also included, which is essential for studying people and the environment. Artifacts are tools that are "invented" for specific purposes, and are used to reach the objectives that such contain. Artifacts in this sense take on an essentially social role, and their meaning no longer exists separately "but emerges only

through their incorporation in social procedures" [36]. Artifacts, to be shared socially, must be easy to interpret, and not create too many problems regarding their use, that is, they should be "transparent". The importance of the sharing and the "cognitive transparency" of artifacts is also stressed by Blackwell and Arnold, [37]. Their study was based on role-playing methodology in which a number of planning psychology experts had to design a software application. The task was situated in a setting conceived to be related to reality.

The simulation of the exercise was performed successfully, in that the participants had understood the characteristics of the software from the very beginning. This made it possible to shift the focus of the participants from the interaction with the artifact to the negotiation between the demands of the social context and the purposes of the individual actors, highlighting the influence of the "transparency" factor.

A subsequent assumption borrowed from cultural psychology involves that of not considering individuals as isolated, but as belonging to communities. Inside these communities the expectations, purposes and meanings of each actor are shared and negotiated on common ground. In this sense, communities of practice are a privileged space, in which the social meaning of the artifact is learned. Lave and Wenger [38] sustain that learning is essentially situated and is the result of the increasing participation by an individual inside a community of practice. Pennell, Durham, Ozog and Spark [39], sharing this view, conducted a study to confirm its validity. This study was based on the consideration that young people, during their education, do not have the possibility to learn a professional writing style suitable for communication inside a work organization. With the aim of ensuring such skills were acquired, a virtual organization was created based on the use of the web. The situated learning of the students was allowed by the interaction of each with their own tutor and a mentor from inside the organization, by carrying out interviews and by the drafting of reports to be handed in at set intervals.

The self-assessment of the participating students, as well as the assessments made by the mentors and the tutors, provided positive results, demonstrating the effectiveness of the virtual environment created. In recent years, the computing artifacts that have pervaded social communication, games, free time, companies and organizations, have forced the individuals belonging to the various communities of practice to redefine tasks, identities, roles and meanings. Computer mediated communication (CMC), is transformed from being a purely cognitive artifact into a social artifact that is able to exceed geographical barriers and allow actors from different parts of the world to relate to one another. It also changes the ways of communicating, and increasingly takes on the forms of negotiation and construction of shared meanings. "The meeting place becomes the Internet, the World Wide Web (WWW), which is increasingly considered no longer as a purely physical structure, but as a cultural space in which new forms of social relations and identity are experimented" [35].

7.3 Approaches, methods and techniques for Web usability

7.3.1 Method and context.

The relationship between the theories described in the first part of this work and the methodological approaches that will be presented in this part of the article, is not strongly structured and has a rather dynamic character. It will not however be difficult for the reader to recognize how some of the methods presented do not -at least in their original version- pay particular attention to the context in which the actions of the participants are determined. According to [40], the use of decontextualized techniques in reality poses significant obstacles for the designer dealing with usability: the strongly abstract nature

that the guidelines resulting from this approach assume lead to a "wide variety of interpretation in different contexts" (p. 228) [40] that may induce inappropriate choices.

Other methods that hold the context in better consideration follow rather faithfully the theoretical suggestions described in cultural psychology [41] and cognitive-cultural ergonomics [35]. These adopt the ideas behind distributed cognition and situated action [42, 32] and show interest in the analysis of the "context" in terms of social and cultural factors, including the presence of pre-existing plans or procedures, cognitive tools, organizational structures, the context where the action occurs. The fact remains, however, that even "non-contextualized" methods can be applied so as to consider "situated" aspects, or vice-versa, even the best "contextual" method can be poorly applied without respecting the theoretical framework that supports the function.

Another factor that complicates the work even further is the absence of individual methods capable of independently measuring and assessing web usability. The trend we find, above all in the aspect of works of an applicative nature, is the use of a series of methods together. These can be applied at the same time, that is to say at the same moment in the development process, or, as is more commonly the case, by spreading them across the various phases of design and development of the sites. The use of a series of methodological approaches allows more reliable assessments to be obtained by comparing the results and the suggestions that derive from the various different investigations. In reality, the apparent weakness that appears from this picture is not an indicator of methodological insufficiency as such. It rather reflects the complexity that the Internet assumes if examined not only as a reservoir of information, but also as "an environment that allows us to reconsider our way of conceiving knowledge and communication" [43].

7.3.2 Log analysis

Server log files are records of web server activity. Log files contain mainly data on the identity of the visitors, on the paths followed by the navigators through the site and the time spent navigating on the pages. These records had the original function of helping site administrators know if the bandwidth capacity of their server was consistent with the activities of the web sites they hosted. In recent years, above all due to the needs deriving from the increase in e-commerce sites, log files are used to track the activities and profiles of the users who connect to the site. The knowledge that the analysis of the log leads to, unlike all the other methods reported in this work, concerns very large numbers of people, observed for relatively long periods of time, working in perfectly natural conditions. These specific characteristics of web analysis allow “top down” evaluation of what the users as a group spontaneously do inside the entire site during navigation. On the contrary, for technical-methodological needs, most of the systems for evaluating the usability of web sites are performed on limited samples of participants, using specially prepared situations and over a normally brief time span that is restricted by the conditions of the experiment.

Using this technique, Cooper [44] has recently performed an analysis on a university’s web-based library catalogue. He investigated usage patterns over 479 days, based on the traces left by 2.5 million sessions carried out by the users.

Usability specialists adopting this method should however be careful that the log files contain the complete package of data so as to be able to retrace all the actions that the users performed during their visit. The ideal data that we should obtain are therefore: who visited the site, how much time was spent in the various sections of the site, what path the visitors took through the pages of the site, where visitors left the site and data about the success of users’ actions, such as the download of files or economic transactions completed. In any case, it should be stressed that the simple fact that a user has visited a page and has spent some time there doesn’t allow us to claim with extreme certainty that they have read the

contents of that page. Not always then is the analysis of logs useful for the purposes established. The use of log files for usability evaluation is besides an often imprecise method, for reasons that depend on the environment of the server, the client systems, and the use of tools that are "external" to the hypertext in order to reach a particular page. For example, navigating using bookmarks, addresses sent by e-mail or typing the URL in the corresponding field takes us directly to a page. This leads to a substantial failure in the recording of the paths, which no longer describe a linear structure [45]. Currently, despite the fact that the more commonly used measurements are still those involving accesses and the path followed by the users, attention is also paid to the measurements of the transit times on the pages in the site.

Fuller and De Graaff [46], for example, describe how these times can provide a path-independent measurement of the behavioral trends in a distributed and diverse community. The time spent on a page by users allows us to monitor the entire web site or some of its parts, measuring which pages have aroused more interest among the visitors, and allowing forecasts of future trends. In any case, even the measurement of the transit times on web pages cannot be considered, in our opinion, a complete indicator of the usability of a site. The method of log analysis for ergonomic purposes must in this way be integrated with other methods of investigation. Kantner and Rusinski [47], with the aim of analyzing a Beta-Version Web Site, used, together with automated data collection provided by the log files, an on-line questionnaire and a follow-up interview able to provide qualitative information on the opinions of the users. This data was added to the information on users collected using a form that the users had to fill in when accessing the site. The authors concluded their work by stressing how the combination of these methods provides results that are more reliable than those provided by any one of the methods alone.

7.3.3 Heuristic Evaluation

This is an inspection method where usability experts study the software interface by evaluating each individual element, such as the buttons or the links, and comparing these with a list of widely approved and shared design principles that take the general name of guideline checklists. Nielsen originally developed a checklist for the heuristic evaluation of the web in collaboration with Rolf Molich [48], [49]. The checklists of optimal characteristics that before these works consisted of long, all-inclusive lists, have today been reduced to just a few elements, for practical reasons.

Nielsen [18] proposes 10 elements, for example. These are: visibility of system status, match between system and the real world, user control and freedom, consistency and standards, error prevention, recognition rather than recall, flexibility and efficiency of use, aesthetic and minimalist design, help users recognize, diagnose, and recover from errors, help and documentation.

A refined version of the checklist based on a factor analysis of 249 usability problems [50] has been proposed in order to derive a set of heuristics with maximum explanatory power and to face the problems of time that often dictate the rhythms of the analysis of usability during the design of the web site [51]. Once the experts finish their work, they provide feedback to the designer.

This feedback on the status of the system may be provided in the form of a structured report, that is to say, a formal, independently written report. To make the work of the experts more accurate, they can be accompanied by an assistant to transcribe the verbalized findings.

This evaluation technique can be used at any time during the web site development cycle, but it is best suited to the earlier stages [52].

7.3.4 Cognitive walkthrough

This too is a form of expert usability evaluation. Nonetheless, while in an expert appraisal the investigator observes and studies above all the design of the site, providing comments from time to time, in cognitive walkthrough the expert navigates by assuming the point of view of a typical or inexperienced user. This method is often used to help orient designers during the creation of the sites, providing feedback on the progress of the work, and on the ease of learning of the interfaces that are proposed. De Villiers [53], for example, conducted a study to evaluate the usability of two South African e-commerce web sites - the Fortes King Hotels site, and the Cellular Shop site- using a set of techniques, including cognitive walkthrough.

The participants, computer science students, used this technique to evaluate the two sites, according to four parameters: the general characteristics of the sites, the task that the users must perform, the actions required to complete the task, and the characteristics of the users. The information collected allowed the identification not only of the sites' merits, but also of some aspects that could be improved, such as the excess of information that made the consultation of some pages boring.

This method is suitable for testing the operation of the site even with completely inexperienced users. Lisle, Dong and Isensee [54] used the cognitive walkthrough method to identify potential problems for users visiting the IBM Web Ease of Use site for the first time. The purpose was to study how the users handle the information presented and interpret the feedback from the system.

This method of investigation contributed to the development of guidelines for improving the usability of the site; some basic principles set down by the designers at IBM were: maintain the simplicity of the interface, not allow the user to make errors, and provide immediate feedback on their actions.

Pluralistic walkthroughs [55] involve a large group of end users, developers, product designers, health/safety professionals and usability professionals, generally guided by a session leader and facilitator. These navigate together, step-by-step, through a task scenario, analyzing and evaluating each element of interaction. The advantage of this pluralistic version of cognitive walkthrough is that it involves a greater number of points of view, and thus also of a larger number of comments, which, originating from quite different experiences and levels of knowledge, is assumed to be more significant in identifying the problem areas of a web site. Cognitive walkthrough too, as in the case of the heuristic evaluation above, is best used in the early stages of web site development.

Despite the fact that cognitive walkthrough is one of the most used methods in the study of Web Usability, the general orientation provided to designers should however be considered partial, in that it is now well-known that not all usability problems emerge from the application of this technique.

7.3.5 Questionnaires

Questionnaires can be used in the evaluation of the usability of web sites, in that they allow information to be obtained on the opinions, desires and expectations of the potential users of the sites. These investigation tools are made up of a list of written questions that are created and formulated according to what knowledge the team of designers considers to be useful in order to develop the web site. In this sense, questionnaires are useful and informative in all phases of the development and design of the site; indeed, they can be used: before its creation for the purpose of knowing the expectations and desires of users in advance, for the evaluation of a prototype or a site under construction in order to discover

the merits and aspects that may be improved, and after the final creation of the site, to measure user satisfaction. Lisle, Dong and Isensee [54] developed an on-line questionnaire to evaluate the usability of a site on the HCI they built. They included it in a series of IBM sites with the aim of acquiring feedback from the users of such sites. They wanted to obtain new comments on the site not from the usual fixed group of designers, but rather through the participation of most of the users. The results were positive, in that they received a large quantity of feedback through the compilation of the questionnaires by the users.

7.3.6 Interviews and focus groups

These two techniques differ from questionnaires in that the experimenter interacts directly with the users, eliciting opinions and comments on the product. The participants in this type of investigation answer the questions on their experiences and preferences regarding interaction with the site. While the interviews are often structured formally, the focus group is less formal, and allows a large number of users to discuss the matters together, with the aim of eliciting common problems and important issues for the evaluation of the site in question. Vaughan and Schwartz [56] conducted a study in which a focus group was used in the construction of a web site. The participants were asked to express their opinions as potential users of the site, so as to obtain suggestions for adding new services or improving those already present. In this case, the site was tested by eight participants, each of whom was assigned tasks to be completed; in some cases, on the other hand, free navigation can also be proposed. The results of Vaughan and Schwartz demonstrated the appropriateness of the choices suggested by the group and used to orient the development of the site.

These investigation techniques can be used, as in the case of questionnaires, in all phases of the development and design of web sites and portals, in that the experimenter can sort the questions according to the information that they wish to obtain from the users.

7.3.7 Think Aloud Protocol

This method involves a participant speaking about what they are doing or thinking when they interact with an artifact. The method can be applied by assigning the subject a specific task (for example, that of finding a particular subject on a site) or even allowing free navigation, provided that a special hypertext system has been created for the participants to work on; in this sense, the think aloud protocol is used especially for the evaluation of prototypes or already existing sites.

The role of the experimenter during these work sessions is that of a group leader: they must stimulate the participant to continue to think aloud, motivating them to describe what is happening, the difficulties met, and the reasons for certain actions. This technique is especially useful, as it is able to capture a wide range of cognitive activities of the users, and is not limited to the identification of problems, but rather aims to provide information on their origins and on which cognitive mechanisms they involve. Eveland and Dunwoody [57], for example, used the think aloud protocol to analyze the activities of information processing during the learning of information contained in the hypertext. Using participants with different levels of experience and frequency of use of the web, the authors performed a quantitative analysis of think aloud protocols obtained during navigation. The authors found that users spend a substantial proportion of their cognitive effort orienting to the content and structure of the web, and this effort weighs down elaborative and evaluative processing, affecting the level of learning of the contents of the pages on the site.

One disadvantage of this method may arise in the case of interference between the participants' verbalizations and the task that they are performing [10]; in this case, people are not performing one simple task, but rather two, that is, navigating in the hypertext and verbalizing their actions, which distorts the results of the research. To overcome this problem, two variations of the protocol have been created: Critical Response, in which the users are asked to speak only during the execution of predetermined subtasks, and Periodic Report, which involves, when the task is complex, verbalization only at predetermined intervals of time. Another disadvantage of this method derives from the fact that the reports may be adapted to the interlocutor, that is, the experimenter. This could involve a "rationalization" of the report and a stiffening in the style of interaction with the web pages. Therefore, to make the results more reliable, this technique is not normally used alone, but rather integrated with other investigation protocols, such as for example the co-discovery method.

7.3.8 Co-discovery method.

This method allows the usability of a site to be tested in all phases of its development: during the design, the development of the prototype, and its final use. It involves the interaction of two participants who must complete preset tasks while being observed by the experimenter. They must help each other, as if they were working together to reach a common objective using the web. As happens with think aloud protocol, they are encouraged to perform the tasks and to explain aloud what they think of their actions and the feedback received from the system. The advantage over the latter investigation protocol consists in the fact that the verbalizations of the participants occurs more naturally, and the interaction of two people working on the same task, comparing opinions, can lead to a greater amount of important information than the thoughts of a single person. This has been experimentally verified as part of a research study carried out by Lim, Ward and Benbasat [58]. These authors compared the techniques of self-discovery and co-discovery in evaluating the learning of a series of procedures during the execution of computer tasks.

The results show that the group with which the technique of co-discovery was used obtained better performance, highlighting the greater effectiveness of the social technique compared to the individual one.

7.3.9 Contextual Inquiry.

Contextual inquiry is a method of analysis and investigation, a process of discovery and learning that synthesizes some aspects of ethnographic research studies and participatory design methods. Proposed by Hugh and Holtzblatt [59], this method consists of interviewing people in their own workplace while they perform their own real tasks. The methodology involves the designer teams conducting the interviews at the same time, each with one user, regarding the site in question. One of the assumptions underlying this technique is that the environment where people work influences the way in which they use artifacts. This technique thus has the purpose of providing the designers of sites with deep and detailed knowledge of the work of the user, their scenarios and the terminology that they use. These elements can then constitute the basis of the design. Traditionally, designers have obtained information about the potential users of their sites using techniques such as questionnaires or focus groups, which however do not consider the context in which the users work. Understanding how the users work, on the other hand, depends on the knowledge of the specific situations in which they act. To build a usable product, then, it is necessary to clearly understand the context in which people will use it.

In this perspective, the user is seen as a partner who contributes to the design of the site, in that they provide important data on the way in which the information is handled in their specific workplace and on the limits that this sets. Given its characteristics, the contextual inquiry method is used above all during the design or re-design of the system to correct the poorer aspects of the site emerging from the application of this technique.

Lau and Staczek [60], for example, used the contextual inquiry method to evaluate the important aspects in the maintenance of web sites. This evaluation was performed using a system designed by researchers at AT&T, called Strudel. Following the Contextual Inquiry methodology, the designers interviewed, in their workplace, six people involved in the maintenance of web sites. As expected by the Strudel system, three basic issues emerged in the maintenance of the sites: the content, the structure and the graphics. The results, overall, provided suggestions on improving the usability of each of these specific aspects.

Another interesting application of this method was reported by Ritchie and Gosbee [61], who conducted a research study to build the site of the Michigan Center for Rural Health.

The purpose of the site was to promote interaction between the experts at the various rural health clinics and between the medical and administrative staff. As the users had different degrees of expertise in the use of computers, the problem of the usability of the site was fundamental.

The subjects, members of the medical and administrative staff at eight rural health clinics, were interviewed in their workplace in relation to their problems and needs. By the application of the contextual inquiry method, it was discovered that the features required to make the site more easy to use were a simple home page, more visible distinction between links relating to the clinical area and the administrative area, and on-line instructions relating to the site search engine.

7.3.10 Object-Oriented and Scenario Based Techniques

Increasing attention to the contextual aspects of HCI has led to the development of a project-related approach known as Object-Oriented Design (OOD) [62], which is characterized by the emphasis being placed on the relationship between the tasks, the skills of the designer and the elements that the situation-problem they have to work on is made up of [36]. This model acts on two levels; at a lower level, it sets the objective of identifying classes of users and purposes, as well as the relationship that links them together and their implementation in the design of the system.

At a higher level, the objectives are the conceptualization of the most important requests of the users, the analysis of a model of their behavior, and the design of the architecture of the system to include all of these elements. As claimed by Carroll, Mack, Robertson and Rosson [63], OOD represents an important step forward in the study of software technology, because it offers new opportunities and possibilities for change. They also stress that the key idea for promoting this new form of development is to link object-oriented design to the use of scenarios.

The technique of including scenarios as a support to the design of computing artifacts takes the name of scenario-based design. In its original meaning, scenarios are stories that describe people and their activities [64]. These descriptions, which refer to concrete situations, offer information on behavior in the use of computerized systems: what the people who interact with the system try to do, which procedures they adopt or do not adopt, which tasks they complete successfully or which errors they make and what interpretations they give to what happens to them during their interaction with the artifact [65]. This method has recently been applied by a number of academics in the evaluation of web pages.

Erskine, Carter-Tod and Burton [66], for example, conducted a study to evaluate the usability of the web site of the College of Education at Virginia Tech. The methodology adopted was based on the use of scenarios built by the users. The participants in the study, who didn't have much experience with the web, were selected as potential users of the site.

Initially, they were provided with information on the functional characteristics that define the experience of the user and the importance of user input in the design process.

The scenario built by the participants was divided into three sections: context (e.g. the working environment of the user), purpose (e.g. the information required) and action (the imagined path of navigation). The users were asked to build some scenarios without referring to the elements (e.g. the links) that were effectively present on the site. In this way, the scenarios produced were authentic indicators of the information required by the users, how they planned to use it and how it should be structured.

The evaluation of the site was performed by comparing the actions imagined in the scenarios, which reflect the desires and the expectations of the users, with those effectively feasible on the site. This comparison led to the acquisition of useful information for the re-design of the site and the creation of specific guidelines concerning the hierarchical organization of the information, the basic characteristics of the home page and the characteristics of some specific contents.

Osterbauer, Köhle and Grechening [67] conducted a study on the usability of web sites based on the use of scenarios. They selected fifteen sites from the following categories: banks, newspapers and insurance companies. The thirty-five participants, potential users with different levels of web experience, were divided into five groups. Each group was asked to evaluate three sites, one per category.

The scenarios involved the simulation by the participants of real situations using the site. These simulations were videotaped. At a later time, the subjects were asked to design, based entirely on their memory, a map of the hierarchical structure of the site. The procedure used allowed the measurement of the capacity of the users to develop an understandable and aware image of the structure of the information presented. This capacity is a fundamental parameter in evaluating the usability of sites with a complex hierarchical structure.

Scholtz, Laskowski and Downey [68], on the other hand, evaluated the usability of the National Institute of Standards and Technology virtual library site, the resources of which are mostly available to the public. They collected 28 scenarios provided by the employees of the library, which included, following a scheme supplied by the researchers: a general description of the scenario, the benefits of the proposed operations, the beneficiaries of such operations, the frequency and the estimated importance of the scenario, and any negative aspects.

The results, which led to the identification of the aspects to be revised in the organization of the library, were particularly important, given the creation of an actual virtual participatory design meeting. The methodology of collecting the scenarios, in fact, involved these being made available to all the participants, the use of e-mails to advise the participants of the arrival of new scenarios, comments on the scenarios proposed by the others, and indications on the use of the information collected for the re-design of the site.

One particular approach of scenario-based design, finally, was used by Neale and Kies [69]. They analyzed a series of brainstorming sessions in which the usability of the site of the Human Factors Engineering Center at Virginia Tech was evaluated. The groups considered were made up of between two and five participants. The participants were representatives of potential users. The brainstorming task involved the generation of scenarios using the elements of a number of lists relating, for example, to the needs and the objectives of the users, or to the information to be included on the site. Scenarios useful for

the evaluation of the usability of the site were obtained regardless of the background and the expertise of the participants.

7.4 Conclusion

Some more general considerations allow us to understand the importance of Web usability today, and define the role it plays or may play in the development of the Internet.

According to Riva and Galimberti [70] "…the technological evolution of the media leads us to believe that Internet could become, in the very near future, the predominant medium, or rather, it is possible that it will become a general communication interface..". It is clear that most of the interest in Internet as a medium is now focused on the World Wide Web.

The Web, which may be described as the hypertext [71] and hypermedia part of the Internet, today embraces new tools for group communication and navigation systems that are able to combine the potential of the hypertext with the advantages of virtual graphic environments [72]. The Web favours the exploration logic of the user, the multiplication of the means of access to information [73], the creation of new work environments [74], and the possibility, in the widest sense, to connect communities of practices so that they can share their expertise [43]. These are the systems that usability must guarantee, refine and make available to a growing public. In this way, it seems clear that the role of usability is today expanding and undergoing complete transformation.

Having overcome the metaphor of "the impact" of technology on society, and moved in the direction of the co-construction of social situations, the idea of web usability has acquired importance. Usability, for some time now successfully experimented within the context of interface problems, is no longer required to respond in a decontextualized manner to aspects linked to software or hardware as ends in themselves, separate from the rest of the world and in particular the context in which they are used. Motivated by the imminent mass diffusion of so-called "mobile technology", the interest in web usability is focused on the combination of "real" and "virtual", on new communication and work environments, on the hybrid nature of these [35], on the intermittence with which the social life of the individual is mediated by these technologies, on the cultural framework that surrounds actions and makes them understandable to all, and on the complexity of the cultural, political and economic accessibility of the Web within the various different contexts and range of situations.

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