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Website Usability in Context: An Activity Theory Based Usability Testing Method

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Keywords

testing, method, website, context, theory, activity, usability

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ABSTRACT

Traditional laboratory based usability testing methodologies are plagued with shortcomings which affect the results of the testing process and their validity. The results of a preliminary study of this type of usability testing with 34 users indicate two categories of key shortcomings. A new summative website usability testing methodology based on the notion of distributed usability and Activity Theory is presented as a means of overcoming these problems. This paper describes the theoretical foundations and development of the methodology which is currently being evaluated and refined.

Keywords: website usability testing, activity theory, methodology

1. INTRODUCTION

Traditional laboratory based World Wide Web (WWW) usability testing (UT) methodologies primarily investigate how individual users interact with WWW interfaces. This type of testing enables evaluators to obtain data about the interface and the cognitive processes involved in the direct interaction between a human and the interface over a short period of time. However, it also has several shortcomings. The focus on relating internal cognitive processes and perceptions of the individual to discrete interface elements (e.g. site navigation, content, structure, etc.), and the failure to take into account the physical, social and historical context in which the interaction occurs are amongst these shortcomings. Cognitive science, as a theoretical basis for traditional UT methodologies, makes no provisions for the study of users' real and practical activities which develop over time, and the way in which users employ a website as *one* of the many alternative tools which support their activities. According to Kuutti (1996, p.19) "the Cartesian ideal of cognitive science [...] has been seen as unable to penetrate the human side of the interface". Whiteside and Wixon (1987) called for studying real users and systems in rich contexts, as early as 1987, while Bannon (1991) pointed out that actual system use is a long-term process and, as such, it is inappropriate to research inexperienced users over brief periods of time. Thus the need for alternative testing methodologies has been paramount for some time.

This paper provides a general description and overview of an Activity theory (AT) based summative website usability testing methodology that has been developed and is currently being evaluated. The methodology aims to overcome the problems associated with traditional laboratory based testing by focusing on the role of the interface in the context of practical user activities rather than as a set of discrete interface elements, and still retaining the level of control afforded by a laboratory. The paper begins with a discussion of the rationale behind developing the methodology, which includes empirical evidence of the problematic nature of traditional laboratory based UT from usability tests conducted with 34 users, along with the propositions on which the methodology is based. The paper then aims to describe in detail the phases of the methodology, which has been developed, including the theoretical bases. Finally the paper concludes with a statement of potential benefits and pitfalls, along with future refinements and research.

2. RATIONALE

This section aims to explain the rationale and motivation behind developing an Activity Theory based UT methodology. It begins with a closer examination of some of the issues associated with traditional UT in a laboratory setting and then describes the results of 34 usability tests conducted to empirically derive a catalog of key shortcomings of traditional usability testing of websites.

2.1 Traditional UT: Problems

Traditional usability testing methods employed in a laboratory setting are constrained by the lack of contextual factors inherent to real user activities. These factors include the work, time, motivational and social contexts (Whiteside et al., 1988) that encase human activities. Experiments carried out in a laboratory are radically different to the natural, everyday practices that humans engage in through interaction with various 'tools', including websites, objects and other humans, and the real-life needs of those humans.

The testing methods used in a laboratory setting, such as the ones described by Rubin (1994), tend to focus on how one individual interacts directly with a computer in an isolated setting. The cognitive processes and abilities of the individual, including memory, perception and motor skills, are scrutinised and measured using performance based metrics such as time taken to complete a task, number of errors made and perceived ease of use. However, this micro-level of analysis does not take into account users' needs, the social setting in which the human-computer interaction takes place in the real world, and the historical development of the users' activities. In fact, usability testing done in a typical laboratory environment tends to be technology driven (Sweeney et

al., 1993) rather than focused on users' activities, motives and goals.

The following section will illustrate some of the shortcomings of traditional usability tests derived from an empirical study.

2.2 The Study

A series of traditional usability tests was carried out with 34 participants (who were also typical website users) at an Australian university in April 2002. The participants included 19 mature-age students and 15 first year students who had completed the Higher School Certificate in 2001. A pre-test survey was prepared to collect data about the users' background, computer and Internet experience and previous usage of the website being tested. The participants were then asked to evaluate a specific part of the university's website by completing two typical task scenarios which required participants to use the website to find specific information about courses, fees and entry requirements. The scenarios were developed in consultation with the designers of the website and aimed to reflect typical uses of the website. Participants were asked to think aloud while doing the scenarios. A facilitator was also present in the room during the testing to prompt the participants and deal with any technical issues. Following the scenarios, users were asked to complete a post-test survey which consisted of 32 statements about the perceived usefulness and ease of use, as well as the navigation, content, structure and appearance of the website. Users were required to rate these statements across a standard five point Likert scale. Finally, the users were briefly interviewed about their prior personal usage of the website. Initially, a pilot test was used to verify the surveys and scenarios and minor adjustments were made where required. Since the purpose of the usability testing was to compile an initial list of problems and shortcomings of the actual testing process, the results of the tests will be reported only to the extent that they are relevant to the discussion of the list of shortcomings drawn from the tests. This list was compiled based on observing the participants, noting comments and questions by the participants and analyzing the responses provided by the participants during the interview. The key shortcomings have been categorised into two types: user related and process related. They are shown in Table 1 below.

Shortcomings	**Evidence**
1. User-related	
User motives: users not engaged in tasks that are of direct relevance to them. Users' motives aren't real.	Users observed being uninterested in completing scenarios. Interviews reveal that motives and needs for using the site differ and are not reflected by the scenarios used in the testing process.
Previous experience with website: users' impressions of website are based on previous experiences and usage of the site (including the learning process).	Users observed experiencing difficulties using the website and expressing frustration, but results of post-test survey indicate positive attitudes. Interview responses generally showed that users were satisfied with the website in previous usage and these impressions took precedence over the usage during the usability test. This has some interesting implications for scenario design, which will be discussed in later sections of the paper.
Previous knowledge and experience with the given tasks: users who had previous experience with a task specified in the scenario perform better and rate site more favourably.	An example will be used to illustrate: Those users who had paid university fees previously were able to find fee information more easily on the site because they had prior knowledge of the task itself and the terminology associated with it (e.g. refunds, credit points, Higher Education Contribution Scheme (HECS), etc.) and could do more specialized searches.
2. Process related	
Scenarios of isolated, non-representative user activities: users given unrelated and non-typical scenarios to complete using only the website. In real life, users' activities are often driven by specific needs and context dependent, without a well-defined boundary.	In the interview users were asked what they had previously used the website for. They indicated that, as prospective students, they had used the website for exploratory purposes, rather than finding specific information, one piece of information often leading to another activity. The scenarios were also designed to test whether the website did what the website *could* do, rather than what it *should* do for a typical user.
Analysis of individual interface elements: interface elements, including navigation, content, appearance and structure were examined and analysed separately.	Scenarios and user questionnaires were designed to test the various interface elements. No provision can be made for the analysis of the interface in its entirety as a user tool or the ways in which the interface supports real-life activities.

Reliance on other sources of information: users do not rely on the website exclusively for information. They use other sources, such as other websites, books or people.	Users were observed following links external to the website being tested to find information. The pre-test survey indicated that the majority of users did not use the website as an exclusive source of information when applying for university, while the interview revealed that users also used the University Admissions Centre (UAC) guidebook, and contacted the university directly either by telephone or e-mail.

Table 1: Shortcomings of traditional usability testing.

Despite the problems associated with conducting UT in a usability laboratory, this type of testing environment is practical, affords the highest degree of control and allows evaluators to manipulate the testing process by making necessary adjustments as the testing proceeds. Furthermore, the advantages of video-recording users' interactions include the possibility of obtaining comprehensive recordings which can later be replayed and analysed in detail, the reliability provided by having several evaluators analyse the same recording, and the opportunity to edit a compilation tape for presenting to clients as an illustrative accompaniment to the report (Sweeney et al., 1993).

Considering the above mentioned factors, the key issue then becomes how to overcome the shortcomings identified and still retain all the benefits of using a laboratory. This is particularly relevant since the current shift is increasingly towards the study of human-human interaction mediated by computer technology (Aboulafia, 2001). By adopting this perspective, the cognitive model to which traditional usability laboratories subscribe is made redundant. In order to gain an authentic insight into how users actually use the technology in a social context, there is a need to reveal to mediating role of technology in the network of human-human and human-computer interactions and develop an understanding of the different ways in which users, as members of a communal domain, use the technology and other mediating tools. In other words, there is a requirement to re-examine the way we think of usability. In the following section Spinuzzi's (1999) notion of distributed usability and Activity Theory are presented as the underlying propositions and theoretical basis for the development of new the methodology.

3. THEORETICAL BASIS

3.1 Re-defining Usability

The notion of usability has conventionally been viewed as the extent to which an intended user can meet his or her goals by using a particular technology, in this case a website. According to Spinuzzi (1999) this implies that usability is located within the interface itself and as such it is inadequate for understanding how users carry out activities which involve the interaction of various users with several different tools, other than the interface. Instead, Spinuzzi (1999) argues that usability is distributed across the activity network which is comprised of assorted genres, practices, uses and goals. Nardi and O'Day (1999) view this arrangement of tools, which jointly mediate activities, as belonging to an information ecology. They define an ecology as a "system of people, practices, values, and technologies in a particular local environment" (p.49) which focuses on human activities served by technology, rather than technology itself. Through this idea, we see further movement away from the cognitive viewpoint utilised in traditional laboratory testing methods.

The re-defined concept of usability and the notion of an information ecology form the starting point of our interest in developing an Activity Theory based methodology for usability testing. In addition to studying the direct interaction between a user and a computer, it is necessary to gather an in-depth understanding of users' activities in the context in which they occur by investigating the real ways in which users interact with websites and use other tools such as manuals, documentation, pens and paper, to support their activities. As Sweeney et al. (1993) correctly point out, usability laboratories often invest heavily into technology and equipment at the expense of developing an appropriate, user-driven and user-based evaluation methodology. The theory on which we base our methodology will be described next.

3.2 Cultural Historical Activity Theory

Cultural Historical Activity Theory, or simply Activity Theory (AT) as it is widely known, provides a broad conceptual framework that can be applied to the human-computer interface in such a way as to empower the computer user with the necessary tools to work though the interface in order to achieve desired outcomes without the need for them to embark on lengthy periods of training. Historically, AT draws on the Vygotskian theory of tool mediation or the mediation of human activities by the use of tools. This approach deviates from the cognitive approach in that the computer is seen as distinctly different in both character and composition to its human user. From an AT perspective, people are embedded in a socio-cultural context and their behaviour cannot be understood independently of it. Furthermore they are not just surrounded by the context but actively interact with it and change it. Humans are continually changing activities and creating new tools. This complex interaction of individuals with their surroundings has been called an activity and is regarded theoretically as the fundamental unit of analysis, a system that has structure, its own internal transitions and transformations, its own development (Leontiev, 1981). AT is becoming more widely known by human computer interaction researchers in the west (Kuttii, 1996; Engeström, 1995; Kaptelinin, 1994; Bødker, 1996, 1991; Nardi, 1996) since it was introduced in Russia in the eighties and early nineties. Its most current and widely-adopted form is Engeström's (1987) systemic model shown in Figure 1 below.

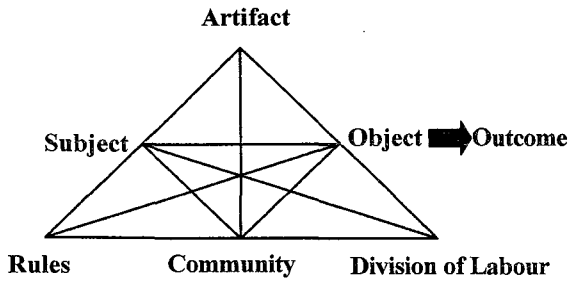

Figure 1: Human Activity System (Engeström, 1987).

Kuutti (1996) describes the key principles of AT as follows:

- *Activity as the basic unit of analysis*

Instead of analysing only human actions, AT proposes that a minimal meaningful context for these actions should be included in the analysis and this unit comprising actions in a context is an activity.

- *History and development*

Activities are in a constant state of evolution and therefore, it is necessary to historically analyse an activity in order to gain an understanding of the current situation.

- *Artifacts and mediation*

Activities are mediated by artifacts and artifacts themselves are created during the development of an activity. This dual relationship further implies the developmental nature of activities.

- *Structure of an activity*

An activity is directed towards an object and the object is what distinguishes one activity from another. The transformation of the object into the outcome motivates the existence of the activity. Furthermore, the object and motive could undergo changes during the development of an activity.

- *Levels of an activity*

An activity is realised through conscious actions which have defined goals. Those actions, in turn, consist of operations which are dependent on the available conditions. The relationship between the elements of this hierarchy, depicted in Figure 2, is dynamic so that initially operations are actually conscious actions. Through practice, these actions will collapse to the level of operations. However, if conditions change, the operation can return to the level of a conscious action.

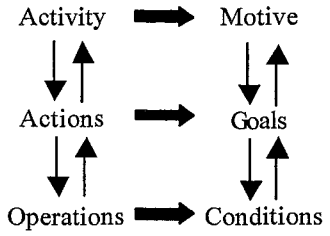

Figure 2: Structure of an Activity (Leonti'ev, 1981).

- *Zone of Proximal Development (ZPD)*

A person has two levels of performance: the level he/she can achieve alone and unaided, and the level that can be achieved with help of a more experienced individual. The latter performance ability is referred to by Vygotsky (1978) as the zone of proximal development (Bellamy, 1996).

The principles of Activity Theory described above are of direct relevance to overcoming the shortcomings described in Table 1. The proposed usability testing methodology, which incorporates these principles, will be described in the following section.

4. ACTIVITY THEORY UT METHODOLOGY

The Activity Theory based usability testing methodology offers evaluators an insight into the natural context of use in an artificial laboratory setting which offers a high degree of control. In this methodology, the computer is reduced to a support role as one of the many mediating tools in user activities. The focus, instead, is on identifying usability issues and problems across the entire activity network or humans and tools. No specific usability attributes or distinct interface elements are examined in an attempt to create a holistic, rich, qualitative representation of the usability of a website in terms of user activities and real user needs. A working model diagram of the methodology is shown in Figure 3. The methodology is intended for summative evaluation purposes. Each of the methodology phases is described in the following sections.

4.1 Defining User Activities

The initial phase involves defining real user activities and needs by observing and interviewing users. The key objective of this phase is to explore the users' work practice (Borgholm & Madsen, 1999) and gain an understanding of real user activities. It is important to allow the evaluators to immerse themselves in the users' practice. Where appropriate field interviews and observations can be carried out in order to understand users' needs, desires and their approach to the work they do (Beyer and Holtzblatt, 1999). The interviews can be carried out on a one-to-one basis or in focus groups involving teams that carry out the same activity. This provides a forum for discussing and observing the social interactions between users, and for developing an understanding of the social context. The primary aim is to establish what the users using the website being tested would use it for in order to satisfy their needs and carry out real-life activities. Due to the problematic nature of gathering this type of ad hoc information, the AT first five principles described previously can be used to make sense of the information gathered and also provide evaluators with a common vocabulary (Nardi, 1996) as AT terminology is a close reflection of users' activities and, as such, easily understood by users. Based on the AT principles described previously, this stage would yield the following information:

- The real needs of users, including a description of the relevant user activities indicating how the activities were carried out prior to the existence of the website being tested (historical viewpoint) and how the previous website (if one existed) was used for the same activities;
- The current activity which the website supports, including user motives and the activity object;
- The actions required to carry out the activity (including alternatives);
- The various online and other physical tools that operationalise the activity and the mediating effects of those tools;
- The rules of the community.

This information would provide an integrated, historical view of the main user activities and the tools that support these. The outcome of the initial phase is a description of "primary user activities" which explains the relevant activities that users engage in and the tools that support those activities (including the role of the previous website, if one exists). The primary user activities

indicate the needs of the users and *what users would want to do* with the website being tested. Once this has been done the evaluators can proceed with phase two, which involves developing activity scenarios to be used during the actual usability testing process. The scenarios developed for the purpose of usability testing need to be an accurate reflection of the information gathered from the first phase about user activities.

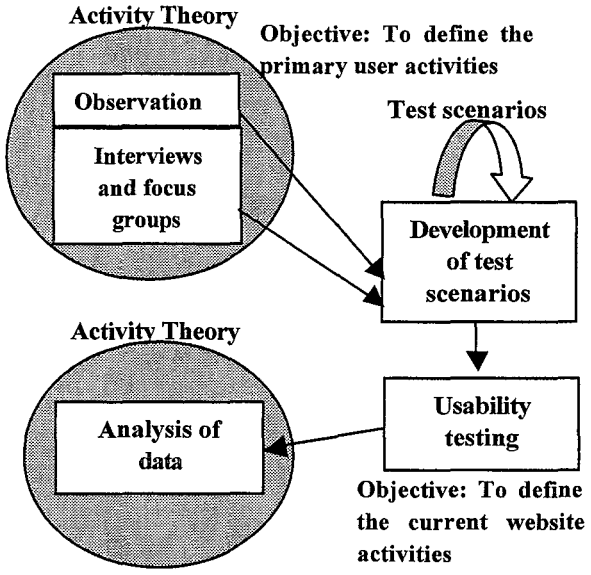

Figure 3: Activity Theory based usability testing methodology

4.2 Activity Scenario Development

Having gained a rich and detailed understanding of the users' context in terms of activities and mediating tools, the methodology proceeds by designing a set of activity scenarios for use in the actual usability testing phase. Carroll (2000) has advocated the use of scenarios for understanding human activities and designing tools to support these activities. Scenarios have been widely used at all stages of the systems development process, and in particular for designing evaluation tasks, both for summative and formative purposes (*ibid.*). According to Kahn (1962), using scenarios offers several important advantages, including providing an emphasis of various circumstances that may arise, and, as such, a focus on the contextual issues. The use of scenarios also makes the evaluators' understanding of the context more material, and it helps them reflect on the knowledge they have gained from the interviews, focus groups and observation.

The activity scenarios developed in this phase are grounded in and reflect the information gathered in the first phase. This is different to traditional usability testing which uses the website as the starting point for developing scenarios. Rather than testing how well the website does what it does, the aim is to design scenarios which will test how well the website does *what users would want to do.* The results of the empirical study described previously show that users expressed a positive attitude towards a website even when they were observed to be experiencing difficulties using it. Interviews with the users following the testing revealed that the task scenarios used in the testing were not representative of what they actually use the website for. Therefore, despite the difficulties they were having, users were still rating the website positively because it did what they wanted it to do.

When developing activity scenarios, the evaluators also need to consider the notion of distributed usability as defined by Spinuzzi (1999). This means considering the usability issues in terms of the support afforded for the whole activity and its ecology of tools, and not only in terms of the website itself. This will affect the scenario design because the activity scenarios need to reflect this type of distributed usability and should allow such usability issues to emerge during the testing process. The development of scenarios is an iterative, prototyping process in itself involving. Once the final versions have been developed, the actual usability testing in the laboratory can proceed.

4.3 Usability Testing

During this phase the key user or users are invited to the laboratory where they are asked to test the website using the developed activity scenarios. The main objective of this phase is to define the "current website activities" and gain an understanding of how well the website performs those activities which the users would want to use it for. Therefore, the website itself is not being evaluated in terms of its navigability, content, structure, etc. Instead, the focus is on the website as a whole, as one of the mediating tools in the context of real user activities. While traditional usability testing may show that a website performs well and what it is built to do, this methodology would indicate whether the website actually performs what users actually want it to do. If the nature of the activity is such that it involves interaction with other users, they are also invited to be present and part of the usability test. The laboratory should be set up in such a way that enables the monitoring of social interactions in the room and allows evaluators to design a realistic setting closely resembling the users' actual environment. Cameras placed strategically and around the room should enable the observers to view the interaction between the user and the website, as well as the interaction between all the users in the room.

A typical usability laboratory is often a sterile, empty room with one desk and a computer. It is usually quiet and a far cry from the typical user environments which may be noisy and sometimes crowded. To mimic this environment the laboratory should be set up to include typical artifacts used in the user's setting, including shelves with books, a noticeboard, filing cabinets, various chairs and desks, etc. A telephone on the desk would afford interruptions while users are doing the testing. Other interruptions may be in the form of intermittent queries and questions from other users in the room. There should be no one-way observation mirror because this is not natural to the typical user environment. The cameras should be placed inconspicuously behind plants and on top of high shelves in order to get a wide-angle view of the events taking place in the room. This setting enables evaluators to study both the ecology and social context of an activity supported by the website being evaluated.

For the purposes of the next phase, data about users' prior experience with using the WWW (including the previous website if one exists), as well as users' familiarity with the activities which

the website supports, is also collected during the usability testing using a standard questionnaire. These two factors will form the basis for defining the user categories in the analysis phase.

4.4 Analysis

When the usability testing is complete, the results are analysed to identify breakdowns between what the website does and what it should do. For this purpose, the concept of contradictions is used. A hierarchical system of contradictions is inherent to activity systems. Engeström (1987) states that contradictions emerge as a result of conflicts within and between activity systems, and cause an activity to develop. He categorizes four levels of contradictions. Primary contradictions occur *within* the elements of the central activity, while secondary contradictions arise *between* the elements of the activity. Tertiary contradictions take place between the object of the activity and the object of a more culturally advanced activity and quaternary contradictions between the activity and its 'neighbouring' activities.

During the first phase, the primary user activities were identified, while the actual usability testing defined the current website activities. For each activity that the website supports, corresponding primary and current activities are then mapped for different categories of users during the analysis phase and contradictions between them are identified. Generally, for experienced users, if there are no contradictions between the primary and the current activities which cause a breakdown in the interaction, the website being tested is found to be successful in supporting the users' real activities. Where contradictions are identified, these are deemed to be where the problems in the interface lie and recommendations need to be made to resolve them. For novice users it is also necessary to establish the level of performance that can be achieved with help of the website (the ZPD). This will indicate the extent to which the website is built to help users learn how to carry out the activities using the website and how to use the WWW. Based on these factors, there are two types of ZPD levels that need to be established for the website:

- *Activity ZPD level:* the level of help users receive if they are unfamiliar with the activity itself;
- *WWW ZPD level:* the level of help users receive if they are unfamiliar with using websites.

The matrix below shows the mapping and analysis process for different user categories. The X axis indicates the level of users previous experience with websites.

Online Knowledgeable Users Users in this category have prior experience with websites, however they have minimal knowledge of doing the activity itself. The analysis needs to establish the activity ZPD level of the website and determine which contradictions exist between the primary and current activities.	**Expert Users** Users in this category have prior experience with websites and they are knowledgeable about the activity itself. The analysis needs to primarily determine which contradictions exist between the primary and current activities.
Novice Users	**Activity Knowledgeable Users**
Users in this category have no or minimal prior experience with the previous website and are not familiar with the activity itself (i.e. have never or rarely done the activity). The analysis primarily needs to establish the activity and WWW ZPD level of the website.	Users in this category have no or minimal prior experience with the previous website, however they are knowledgeable about the activity itself. The analysis needs to establish the WWW ZPD level of the website and determine which contradictions exist between the primary and current activities.

Low ***Knowledge of Primary User Activity*** High

Figure 4: Analysis Matrix

Preliminary results from evaluating the Activity Theory methodology indicate that the analysis phase yields more holistic and integrated results than traditional usability testing.

5. BENEFITS AND PITFALLS

The Activity Theory based usability testing methodology described in this paper will offer several advantages to both researchers and practitioners once it has been fully tested. These include: providing a rich and comprehensive view of the actual use of the websites being tested in the context of real user activities; providing a profile of the intended users', the mediating tools with which the website is being used in conjunction with as well as the various activities it supports and the different ways in which it does so; and providing a common AT-based vocabulary for conducting qualitative usability testing.

However, several practical problems associated with traditional usability testing remain. The methodology is time consuming due to the extensive nature of initial interviews, focus groups and observation, and consequently it may be expensive; it also requires trained evaluators; and relies on intended users to be available at the testing site.

6. FURTHER DEVELOPMENTS

The methodology is currently undergoing extensive testing and initial results, to be reported shortly, are positive. The development of this methodology has been and continues to be an iterative process. Further refinements may be made where required and as other relevant issues emerge during the evaluation process.

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