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Usability in the Development of Consumer Electronics: Issues and Actors

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Abstract

The goal of this study is to identify issues and actors with a relation to usability in the product development of consumer electronics. Literature regarding the practice of usability has been analysed for issues and actors in product development that are thought to influence usability. In addition four usability professionals in consumer electronics (in different positions and companies) were interviewed.

The results touch upon a broad spectrum of topics, such as development process architecture, company culture, organisation of the usability department, management issues, methods available to the usability department, and attitude, background and experience of the actors in the product development process. The broad range of issues justifies an integrated approach towards the research of usability in practice, including more than just the 'core' usability aspects.

Keywords: usability, product design, business, consumer electronics

1. Introduction

Steam is pouring out of the ears of my colleague. Angrily he points at a stereo set. "It's supposed to be able to connect to the Internet, to listen to Internet radio stations. I've just spend one and a half hour on it and I still can't get it to work." I ask him whether he had problems configuring the proxy server or the firewall (network security is rather tight at our location). "No way, I had that figured out in no time. I just don't know how to use it. I don't know what buttons to push." The stereo set looks spectacular. A well known, premium-brand consumer electronics developer, renowned for its user-centred attitude, developed it. But on inspection the device reveals design choices that - even at first glance - indicate some of the sources for the problems my colleague is experiencing: technical terminology for the description of functions, buttons that don't look like buttons. It leaves me to wonder: how is it possible that a company that is so advanced and user-focused ends up producing a product with such a poor ease of use that someone with a PhD in electro technical engineering can't figure out how to operate in one and a half hour? Was there no time for a usability test? Did the designer have no idea how to design a product with better ease of use? Was usability not part of the product specifications? In short: what happened?

2. Usability: Status Quo

2.1. Usability and Usability Engineering

The term 'usability' originated in the area of Human Computer Interaction (HCI), where it was introduced to conceptualize the ease of use of 'visual display terminals' [1]. The ISO9241-11 standard [2], which is considered the most accepted approach to measuring usability [3], defines usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use." In this definition effectiveness refers to the "accuracy and completeness with which users achieve specified goals", efficiency to "resources expended in relation to the accuracy towards the use of the product", and satisfaction is defined as "freedom from discomfort and positive attitudes towards the use of the product." Context of use is defined by the "users, tasks, equipment (hardware, software, and materials), and the physical and social environments in which a product is used."

Jordan extends the ISO definition by providing a model of usability in the different phases of product use (i.e. installation, first-use, extended use) [3, 4]. Thus Jordan stresses that the usability of a product can differ from phase to phase of the product life-cycle. Another definition of usability that is widely used is provided by Nielsen. He distincts five dimensions of usability: learnability, efficiency of use, memorability, few and non-catastrophic errors, and satisfaction [5].

The process of ensuring the usability of a product was described by Nielsen as Usability Engineering (UE): a process with the aim of improving usability, involving user testing, prototyping and iterative design as the key elements [6]. Usability engineering activities can be categorized into two major types of activities: summative and formative usability activities [7]. Summative usability activities have the aim of determining how good a particular product is in terms of usability compared with a previous version or competing products. Formative usability activities have the aim of finding out what problems are occurring in product use, what the causes are, and suggesting possible solutions [8]. For both categories there are empirical and analytical methods. Empirical usability methods usually feature participants using a product or a prototype. The researcher observes or measures the behaviour and draws conclusions. Analytical usability methods, such as heuristic evaluation or cognitive walkthrough [9], rely on experts or participants that do not interact with the design as a user. The participants inspect a prototype or task list and try to come to a conclusion about usability improvements on the basis of their expertise, guided by heuristics or guidelines.

2.2. Usability and consumer electronics (CE)

The increasing incorporation of information technology into consumer products has led to miniaturization and increasing complexity of these products [10-12]. Firstly the integration of information technology allowed for the number of functions a product offers to increase, which generally makes a product harder to operate. Secondly, miniaturization allowed for products to become smaller, and with it the size of the interface decreased. Consequently an increased number of functions needs to be accessed through an ever smaller user interface [13]. Finally, there is no longer a direct relationship between the functions a product offers and its appearance. This strongly reduces the amount of inherent feedback (i.e., product sounds, visual clues about use) the user receives about how to operate the product [14, 15]. As a consequence of these developments users are faced with interfaces for everyday use that require considerable sensorial, physical and especially cognitive effort to operate them [14, 16, 17].

In addition to these developments it is suggested that consumers are exhibiting a decreased tolerance for products that feature a lack of quality, including 'soft' qualities such as ease of use [11]. The fact that it is becoming harder to operate consumer electronics, and a decreased tolerance for a lack of usability seem to justify an increased focus on the ease of use of consumer electronics.

2.3. HCI usability and CE usability

The concept of usability and the methodology for usability engineering were mainly developed in the human-computer interaction (HCI) domain [18]. However, there is a number of aspects of the use of consumer electronics that differ from the use of on-screen software. Jordan et al. [18] and Han [19] argue that one should take into account a less performance-oriented approach when considering the usability of consumer products because of the voluntary use of the products. Another salient difference is the physical aspects of use that come into play for consumer electronics. These products do not have a (near) standard physical user interface as in computing, which

means that the physical interface needs to be included in the evaluation (an evaluation of software normally wouldn't include an evaluation of the mouse and keyboard). In addition, consumer electronics, especially wearable consumer electronics, can be used in a broad range of environments. This makes the context of use less predictable than that of software applications, which are usually used in office or office-like environments.

Though products in CE and HCI differ considerably in product properties, the definition of usability offered by the ISO 9241 standard seems applicable to consumer electronics. The ISO definition stresses the situatedness of usability. *The* usability of a product does not exist. Usability can only be evaluated for a particular product, for a specified user, in a specified situation, for a specified goal. Thus, as long as we take into account the less performance-oriented context of use for CE and choose measurements accordingly when evaluating usability, the ISO 9241 definition seems applicable for consumer electronics. This is supported by the fact that the ISO definition for the usability of everyday products [16] only differs slightly from the one intended for the evaluation of 'visual display terminals' [2].

2.4. Usability: essential but not the whole story

In recent years the HCI and design community have started to expand their horizon beyond usability, and explored notions such as pleasure [20, 21] and experience [22]. The basis of this development seems to be the notion that having a product that people *can* use is no guarantee at all that people *will* use it. Therefore some authors [19, 23] argue that, in order to cover the user experience, the definition of usability should be expanded to accommodate for i.e., the hedonic aspects of products or the user's appraisal of the aesthetic quality of a product.

However, we do not believe that, in order to have the definition of usability better reflect the *ability* of users *to use* a product, the definition of usability needs to be expanded as to cover the entire user experience or to add notions such as pleasure or hedonic value. Usability specifically addresses the question whether people are *able* to use a product. Other concepts, such as acceptance or pleasure relate to whether people *will* use a product, and whether they *enjoy* having or using a product. A product with a high level of usability offers no guarantee that users will buy it, fall in love with it, or like its aesthetic qualities. It does however lower the chance of frustrating a user, because of a lack of ease of use of the product.

Instead of being integrated into the notion of usability, other concepts evaluating aspects of a product should complement usability, as suggested by Kahman and Henze [24]. Usability is one of many evaluative concepts that can be used to chart the 'user experience' [22] of a product. As Jordan puts it "Usability is vital, but not the whole story" [25].

3. Usability Engineering practice

3.1. Gap between theory and practice

In the past years, the field of usability has matured considerably in both the academic world and in the product development practice [26]. In the academics much work has been done on defining usability [2, 5] and developing a methodological basis [9, 27]. In the meantime companies have taken an interest in usability and many companies have, to some extent, implemented usability engineering in their development process. Despite the increase of knowledge about usability and the increased focus of industry on usability, the usability of consumer electronics leaves much room for improvement. There seems to be a big gap between the theory of usability and the effective integration of that theory in the practice of product development [28]. A study performed by Philips in 2003 claims that: "Around 30% of home-networking products, for example, are returned because people can't get them to work. And 48% of people have put off buying a digital camera because they see them as too complicated" [29]. Den Ouden [11] mentions the case of a consumer electronics company that has detected a considerable increase in consumer complaints since the mid 90's, which may largely be attributed to 'non-technical' issues: the product is functional from a technical point of view, but it does not live up to user expectations. This could include user expectations about the ease of use of the product. Nielsen discusses two examples from well-known companies that fail spectacularly from a usability point of view: BMW's iDrive and a Panasonic remote control [30]. Other examples can be found in numerous magazine articles [31, 32].

3.2. The Practice of Usability: current literature

How companies integrate usability in product and

software development has been the subject of a number of publications. Most of the current literature about the practice of usability engineering features self-reports [33, 34] in which usability practitioners present a description of their own practices or a specific case. Other studies paint a more general picture of the practice through questionnaire-based surveys [35-37]. Though these studies do provide insight into the practice, they might include a certain bias because of their self-reported nature, as pointed out by Vredenburg [35]. Linholm et al. make the following comment with regard to case descriptions, as documented in, for example, Wiklund [33]: "Reading such material from a Nokia point of view, especially for the editors of this book, creates ambivalence. How can they keep the whole thing on track so well?" [10]. In addition to this, most of the literature on the practice of usability comes from the field of HCI, not from consumer electronics. As a consequence the current literature does not provide a coherent, in-depth insight into the practice of usability in the development of consumer electronics.

4. Identifying issues and actors

In this phase of the study, the aim is to identify issues and actors in product development that have a relationship to the usability of consumer electronics.

4.1. Literature *Research*

In our literature survey of usability-related publications we searched for literature that provides descriptions of the practice through case-descriptions of products and usability departments, surveys of the usability practice and descriptions of methodology-related issues from the viewpoint of the practitioner. When selecting the literature we have aimed to focus on the development of consumer electronics. Unfortunately there is only a relatively small number of publications on CE specifically. Because information about the practice of usability in HCI might include issues that are relevant for CE as well, we have also included literature from HCI.

4.2. Interviews

Four exploratory interviews were conducted to supplement and cross-check the information found in the literature study with information from the product development practice. The participants were usability professionals and/or researchers in the following positions: a partner of a human-centred consultancy firm; a product manager at a telecommunications provider in the Netherlands; a usability professional within a large consumer electronics developer and a researcher in ergonomics and business strategy.

They were approached to take part in an informal conversation about usability and consumer electronics. The structure of the conversations was left open, though in advance the participants were presented with four topics regarding the practice of usability to focus on. All participants were asked for their opinion on the biggest barriers and enablers for usability in practice. The conversations took 1,5 to 2 hours. The interviews were not recorded; the interviewer took notes during the sessions.

5. Results

5.1. Issues identified

A broad spectrum of issues was found in literature and through the interviews, ranging from 'core' usability issues, such as the recruitment of test participants, to more general issues such as top-management support. At the moment we have clustered them in ten main categories.

Usability evaluation methods & tools: i.e., width of the methods portfolio, access to appropriate test-participants, ecological validity of evaluations, and appropriateness of methods (fitting i.e. time pressure and capabilities);

Design phase: i.e., experience and background of designers employed, time for iterations, common design philosophy;

Product definition phase: i.e., possibility to challenge specs, knowledge about target group and context of use, inclusion of usability goals in specs;

Product development process: i.e., type of process architecture (waterfall or rapid iteration), process includes evaluation steps with users, actors involved in the process, quality of the implementation phase, time-pressure;

Product properties: i.e., complexity of the product, completely new product or new version, possibility of incremental improvements in new product generations;

Communication issues: i.e., timely reporting of

test results, common understanding of usability, presence of team members at test, medium for reporting results, feedback coming back from the field regarding usability of products;

Management aspects: i.e., usability goals in rewards system, quality management program, explicit business goals, tracking system for usability issues;

Organizational aspects: i.e., size of product portfolio, size and organization of company, organizational aspects of design, usability and product development units (internal/external, centralized/ decentralized);

Corporate culture: i.e., technology or customer focus, attitude of actors towards usability, decision-making style, co-operation between disciplines in PDP, internal champion for usability;

Market properties: i.e., market demand for good usability, business-to-business or business-to-consumer, type of retail channel, broadness & diversity of target group.

5.2. Actors identified

The results from the interviews and literature survey seem to indicate that the following primary roles in product development of consumer electronics have a relation with usability. It should be noted that though their (primary) responsibilities are the same, actors might be found under different names in different companies.

Product/project manager: manager of project or product. Activities include the product specifications, setting priorities, planning, coordinating efforts;

Designer (includes both industrial designers and interaction designers): creatively integrates all the requirements of the product into a design of the product behaviour and appearance;

Usability specialist: (also known as the user centred design or user experience specialist) performing activities that specifically aim to improve the usability of the product such as usability testing, concept testing;

Development engineer: responsible for technical aspects of the product design. Responsibilities include technical feasibility and production;

Marketing manager: responsible for obtaining market information and developing and executing the marketing strategy for a product.

General management: overseeing and managing the organizational and business aspects of a company.

6. Discussion

6.1. Integrated approach to usability required

The results of the interviews and the literature survey seem to indicate that if the goal is to research usability in practice, one cannot research the usability-related activities as an isolated unit. One needs to take into account the context of the usability research activities, such as the product development process, and company culture. All these issues influence the end result. They influence how usable the developed product will be, so they need to be included in the study. On the other hand, the scope must not be so wide, that we end up researching the basics of good management: the focus of this study is on usability issues, not general management issues.

6.2. Further research

These findings are used as input for the next step in this research project. We opt for a case-study approach to study the practice of usability in product development *in vivo,* as proposed by for example Wixon [38]. Currently five in-depth studies are being performed at consumer electronics manufacturers. In each company the primary actors in product development, as identified in this study, are interviewed, creating a broader and more in-depth insight of the issues found in this first study.

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