

Enabling e-Services for All. A User-Centered Design Approach for Audio-Based Information Services.

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Abstract: In the modern Information Society some groups of citizens find it difficult to utilize e-services offered over the Internet. For people with reading difficulties and dyslexia, visually impaired and elderly, audio-based information access can offer a partial solution. In the Audio4all project, a system offering e-services in the areas of news distribution, personal messaging, health care services and banking information was developed and tested with real users in their everyday environments, in particular in their homes. In order to cater for the special requirements of the intended user group, an eclectic user-centred design and development methodology framework was employed. The paper summarizes some of the experience and lessons learnt from the implemented system and applied design methodology.

Keywords: Methodology, Service Design, Interaction Design, Information Services, e-Services, Domestic Technology.

1. Introduction

The modern Information Society assumes to an increasing degree that the citizens can utilize the Internet and computing appliances for getting information, paying bills, buying things and to communicate with health care and public sector service suppliers. However, some groups find it difficult to access and manage e-services and ordinary computing devices, due to the general complexity and lack of convenient terminal designs and user friendly interfaces for the intended user.

As a contribution to alleviate these difficulties for a specific target group, we have investigated solutions suitable for adoption primarily by people with visual or cognitive handicaps. In an applied project together with the company Audio To Me AB, we have studied and developed services for audio-based Internet information access for people with reading difficulties, including visually impaired, people with dyslexia and elderly in general. Our project implements an "Information Hub" approach by studying support for different terminal technologies, ranging from normal computing devices to enhanced radio receivers, and for various independent information vendors, such as newspapers, radio stations, banks, health care providers and other public sector services. The project has been financed by the Swedish National Post and Telecom Agency, PTS. Their area of concern includes telecommunications, IT and radio. The objectives for PTS also include promoting convenient access to e-services for all citizens.

The overall research project takes a broad approach, addressing also other user categories than visually impaired, elderly and people with dyslexia. Our ambition has thus been to develop a general user-centered service design method framework with the long-term goal to provide well-founded solutions for convenient access to e-services that can be

applied for different groups of users, who find conventional computers and mobile phones too difficult or unpractical for everyday applications.

In this paper, we report some of the outcome and experiences from the implementation of the Audio4all distribution system based on systematic user studies. The distribution system itself is implemented as a commercially available infrastructure, offering sound-based information services also for ordinary users in situations where ears, rather than eyes are the preferred information access channel. In the Audio4all project, this platform serves as a test ground for our design and development approach, where different information vendors and content suppliers can contribute their services.

The overall purpose of the Audio4all project is to provide an open infrastructure for distribution of sound-based information, with special concern for elderly and other users that find “ordinary” ICT too complex. Useful experiences from the project include:

- A documentation of the user community in the form of “Personas” [8, 9], illuminating individual user contexts and requirements.
- An evidence-based eclectic design methodology, aiming at inclusion of the target users throughout the development process
- Studies of terminal appliances, including user interface requirements and service design.
- A documentation of overall requirements for e-services in the area of news distribution, payment of bills and health care applications, adapted to users with limited propensity to use main-stream ICT solutions.

The main purpose of this paper is to give an overview of the Audio4all system with the special e-services offered, and in particular to describe the developed method framework and the experience from its application in the project.

2. Background and Research Objectives

The project activities reported in this paper are part of a larger R&D effort combining empirical studies of user needs and product design with long-term research on new technical solutions. This research is focused on consumer-oriented solutions for everyday e-services for health, care, and life-long living in the home, enabling access to IT-based services also for individuals with a low propensity to use computers and Internet.

The core of the infrastructure is an information hub with connected channels for content providers. Information and e-service consumers have the opportunity to connect to the hub through various terminal devices, which can be regular consumer products or specially designed appliances for users with special needs. In a related project, we are also investigating the use of digital paper and pen technologies for convenient input of data as a complement to the sound-based information services in Audio4all [14].

The research objectives of the work reported in this paper were twofold. The first objective was to investigate how a broad variety of sound-based e-services can be designed and delivered for users with special needs. The second was to design and test an eclectic method framework for involving end users throughout the development process.

2.1 The Audio4all technical Infrastructure

The Audio4all project is run as a collaboration between the Swedish Post and Telecom Agency, Santa Anna IT Research Institute AB and Audio To Me AB. The implemented system for production and distribution of sound-based content is built as a centralized server application run by Audio To Me AB, offering for instance regional newspapers. In the implemented system used for field tests with home users, we also included pod radio distribution and a personal message box used for health care and banking services. The sound representation of delivered content can be produced either by a person reading the information or else by synthesizing sound from data files. Three types of distributions

channels, with different access terminals, have been tested, PC, mobile phone and a special sound receiving terminal, called the “Adela”, which is an internet-connected device especially designed for distributing information to elderly people.

The Adela is a commercial product, previously used by visually impaired people for receiving broadcasted newspapers from local radio stations. The user interaction is established through a speaker, navigation buttons and a volume control knob. The user navigates through the information with a sound-based menu system.

The sound based message box is an e-service that can supply information from many different content providers. Figure 1 shows the Audio4all service platform.

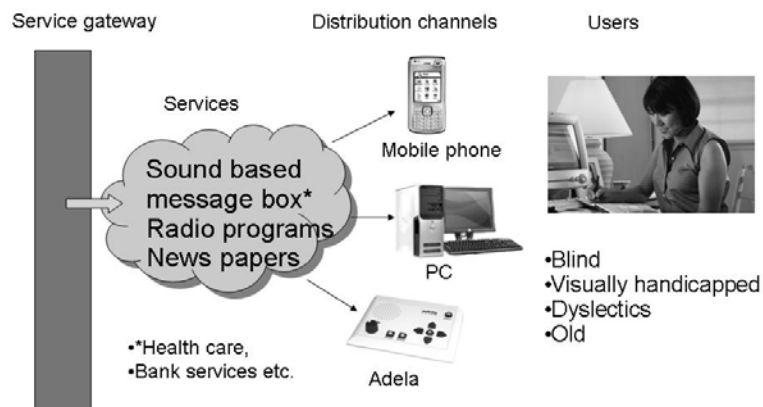


Figure 1. The Audio4all service platform and distribution channels.

It was important to build a service gateway that entails the possibility to launch the services on a future market. In order to meet the requirements implied by the special needs of the intended users, it was crucial to get an in-depth understanding of the target user groups, their needs, abilities and preferences. A user-centred design and development process was therefore adopted, including several case studies in order to capture the users’ needs and everyday situations. The main test site for the services and the technical platform has been a residential area with about one thousand apartments built in the early fifties and with a present population including many elderly.

3. Design and Development Methodology

The starting point for the Audio4all project is the Scandinavian tradition of system and product development, aiming at a high degree of user participation and early influence on requirements and design decisions. This tradition has its foundation in participation and democratic values in the society [12]. It has distinct elements of the socio-technical approach to system development [1] and includes social responsibility as an important part of technical development [27]. The Scandinavian type of society assumes that the citizens have a relatively large influence on what happens in the society and affects their life situation. In the context of systems development, this involves an ambition to employ specific ways of organizing development work in order to create space for user participation and influence on how technical products and services are realized. This means primarily a need-driven product development by involving users in the development process and to describe anticipated use and use qualities of developed products [11, 13]. This way of working emphasizes interdependencies between technical and social systems and their role for a successful and modern development and use of technology [20, 25].

Within the area of user-centered methodologies there are many different methods and ways of working supporting development of new technical solutions. At a general level, it can be said that the central issue is an early focus on target group users and to describe their

needs, wishes and abilities to use the product under development. So, a couple of important questions arise: Which user-centered methods can be used in order to offer an optimal support in the planned development work? How can they be combined in order to work well together during development work? The latter is, for instance, important in order not to create a lack of support and perspective when using eclectic approaches [23].

In order to create a useful framework for the development in the Audio4all project, we selected a number of well-established methods from the area of Human-Computer Interaction, based on literature and our own earlier experiences. The literature suggests that projects characterized by high complexity and uncertainty can be supported by a mixed methodology [3]. The point of departure was that candidate methods should support a distinct focus on user needs and preferences throughout the development process from requirement analysis to field trials. In addition, there were demands that no special training of participants in user-centered design methods should be required in order to carry out the work, only support from an experienced mentor.

3.1 The design and development method framework

The choice of design and development methods was founded in earlier experience of user-centered work with development of ICT products and academic research-based knowledge. Since the project aimed at a new type of product, even if the distribution channels were relatively established, it was important to offer an effective methods support in the early phases of the development process. The target users were not well-known beforehand, which created an early need to establish a description of their characteristics. For instance, physical and mental impairments, maturity, interests and earlier experience affect how a product can be designed in order to provide a high degree of relevance and accessibility for its user.

Our choice of method framework includes target group segmentation, user surveys, personas, scenarios, sketching/storyboarding, prototyping, usability testing and field tests. These approaches are used within an iterative design process and are shown in figure 2. In addition to this, we have also employed a reference group with participants representing the user categories that are addressed within the project. The group was formed with representatives from associations for visually impaired, blind and people with dyslexia.

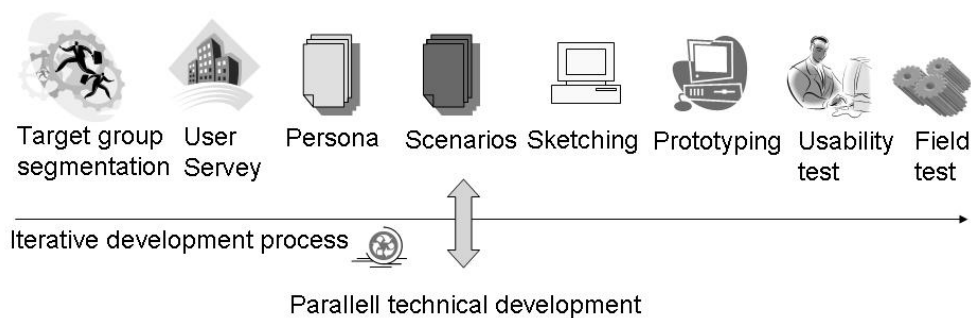


Figure 2. The Audio4all eclectic development methodology.

A condensed summary of the various steps and components in our eclectic method framework and how it was applied in the Audio4all project is given below:

1. Target group segmentation. A systematic approach to describe and classify the target user groups for intended applications [17, 26], forming a frame of reference for design decisions aiming at high accessibility for planned services. The target user groups are segmented into prioritized categories of users and special characteristics of each user category are identified, together with critical factors affecting the degree of anticipated acceptance for various kinds of solutions. This segmentation in the Audio4all project

resulted in the three prioritized user groups visually impaired, people with dyslexia and elderly. The identified groups exhibit a comparatively large variability with respect to their functional handicaps and individual ability to handle technology.

2. User survey and documentation. In order to create a deeper understanding of the individuals' life situation, technology experience, preferences, shortcomings and information needs typical users are interviewed and observed in typical use situations [2, 17]. In our study we employed structured and semi-standardized deep interviews, supported by interview guides, with a direct link to the anticipated use situation.
3. Personas. For documentation of user characteristics the Persona methodology can be used, a form of user portraits visualizing specific individuals representing important users or user categories [8, 9]. These portraits can be supplemented with scenarios focusing typical use situations related to the various access terminal technologies, which were candidates for implementation in later field tests. However, our application of the Personas methodology did not include formulation of persona hypotheses or behavioral variables as suggested by Cooper. Instead we adapted the approach to include descriptive categories related to the users' information habits and information needs.
4. Scenarios. In order to link material from the survey and documentation of the user groups to the actual development work, scenarios can be created [6, 7]. These scenarios are product-related stories describing current and future use of the services related to the users' abilities and life situation. Our descriptions include requirements related to for instance utility, functionality, interaction, navigation and physical form.
5. Sketching and visualization. Of prime importance in order to offer solutions with a high degree of user acceptance, is the quality of the user interfaces and the interaction design [18]. By employing sketches, LoFi- and HiFi-prototypes and other means of visualization early in the development process, users can be actively involved in the design process [4, 16, 21]. This allows the users to contribute with their invaluable opinions and suggestions at early phases in the development of the product. Early contributions of this kind also avoid possible conflicts between developers and users requirements as often happens when it surface in later stages of the development process. This is often the case when only late usability testing is included. In our framework the sketching also includes some storyboarding [24].
6. Prototyping. Building working prototypes, both for laboratory experiments and field testing, is an important prerequisite for a realistic assessment of which problems and obstacles are like to occur for later users [5, 28]. It also gives a second valuation of the design decisions from the visualization work. In the Audio4all project, we have primarily worked with machine based prototypes [15] in an evolutionary process. Based on the identified information needs, user preferences and technology opportunities, we applied a prototyping methodology to study the interplay between proposed design solutions and experience of actual use. By early implementations combined with usability tests, we were able to modify the designs in an iterative process.
7. Usability tests. A central ingredient in a user-centered development methodology is frequent use of usability testing [10, 22]. Even with extensive user groups, good results in terms of increased usability can be achieved with relatively limited samples from each target group segment [19]. Our tests also revealed that a large part of the problems encountered were present for most participants in the test group. The usability evaluation is a very important part of the user centered design approach. In the eclectic methodology approach described here it is also easy to conduct usability testing with very simple prototypes in early phases of the development.
8. Field tests. The purpose of field testing is to get a more realistic view of product use in the actual context [29]. In Audio4all, the final feasibility investigation was carried out

as a field study in a real-life environment with users living in their homes or in special service apartments. The target group segmentation was used for informing the selection and recruitment of people for the user survey, usability testing sessions and the pilot study carried out with real users in their ordinary everyday home environment. Selected users were offered access to a small but useful set of information services over an extended period of time. By using several independent documentation methods, such as user diaries, structured interviews in the home environment and logging of actual use, we expect to have a valid and reliable picture of the target users' ability to handle the e-services offered and the supporting technology.

9. Reference group. A reference group with representatives for typical users and for organizations representing collective interests of the concerned user communities can serve the purpose of providing inspiration and guidance throughout a development project. In Audio4all it was also used for pilot tests before the field study.

3.2 Experience of the eclectic design and development framework

The user group segmentation primarily served as a frame of reference for design decisions and guidance for the development work. In addition to providing a necessary and important foundation for controlling the development process, the target group segmentation also contributed as a background for selection and recruitment of participants in the referenced group, the usability tests and the pilot field tests. Without this we would have had a difficulty in addressing relevant users in accordance with the aim of the project.

The survey and documentation of anticipated users contributed useful knowledge about the users' needs, opportunities and prerequisites for using new technology, as well as an insight into their everyday environment and current technology use. It is a significant difference within the design process to make assumptions about the user, compared to having empirical data from real users.

An important contribution from the introduction of personas and scenarios was to provide support for a description of developed products and services, emphasizing a direct relation between technical functionality, design of the product and interfaces, and user needs. The use of sketches and visualizations significantly increased the communication concerning various solution proposals within the design team. The ability to effectively communicate thoughts, ideas and the anticipated designs of different solutions is an important quality to be pursued in technology development for everyday applications, also contributing to a more rational development process. The ease in which these descriptions can be altered is also a very important contribution to a design process that is explorative.

The development and implementation of prototypes created important opportunities to design the services with a high degree of effectiveness and relevance within the framework of the project. To use hands-on models in this way imply an emphasis on actual use qualities, which might be difficult to ensure otherwise. The models provide a user-centered picture of prioritized requirements during the development process, which was particularly important with respect to the concerned user groups. The prototype implementations were also a necessary prerequisite for the usability tests, which were a central part of the project.

4. Results and Discussion

The user study in Audio4all clearly documented the need for development of new e-service solutions for user groups with difficulties or lack of interest in adopting standard computing and communication technologies. The system for production and distribution of sound-based content designed and developed in the project shows a way to move in the direction of offering better accessibility for the intended target groups. In particular, the user-centered design methodology elaborated in the project demonstrates an effective approach to

designing innovative e-services for users with special needs. In addition, we have contributed a thorough and diversified description of the target user groups.

4.1 Technology use within the studied target groups

The target users in the Audio4all project are elderly, visually impaired and people with dyslectic handicaps. In addition to usability tests, 38 test persons have tried the Audio4all e-services with different terminal technologies over an extended period of time. The tests included 20 users using the mobile phone, 10 users for the PC and 8 users for the Adela.

A general result from the evaluation of the users' experience is that the offered technical solutions can be managed, given that the content is of interest and really addresses the needs of the individual user. Still, user interface solutions and the design of e-services need to be further improved. The well-known fact that today's mobile phones do not offer convenient interfaces for elderly users was confirmed in our study. At the same time, the addressed user groups clearly prefer mainstream consumer products before products specially designed for impaired users, if possible. Users with some sort of handicap (visually impaired and dyslectic) were in general quite open for new service solutions and technologies that could be helpful in everyday life. Several of the participants in the field study expressed a wish for enlarged service content in the personal message box, for example information from the Health Services, Bank, the Homemaker Services, the pharmacy, the library, and the supermarket.

4.2 Experience of the eclectic design and development method framework

Design and development methods for ICT applications can be seen as a recipe or cook book, implying a proposed work flow following a sequence from start to finish. An alternative approach assumes that the professional developer employs a toolbox with a repertoire of actions and measures to be employed whenever appropriate, depending on the situation. Both approaches have their pros and cons, but our experience is that the toolbox approach has better prospects, not the least in the type of development situation encountered in the Audio4all project with very open objectives and many involved parties.

The eclectic development approach, as illustrated in figure 2, has thus served well in the Audio4all project. Such a methods framework is especially relevant in a development project for an external customer group, especially when the needs and preferences in the group are poorly known in advance and where individual users cannot be expected to express their real priorities before they have been exposed to and tested offered solutions.

Some method deficiencies observed are the weak theoretical support in the early phases of user target group segmentation, where difficult decisions concerning granularity and selection of characterizing factors have to be taken. On the other hand, in the Audio4all project both the user survey and usability tests contributed important insights by revealing unexpected facts about user abilities. For instance, the difficulties for dyslectic users to manage even short texts, while their ability to interpret symbols and pictures were high.

The eclectic approach proved to be a solid support for user preferences and abilities throughout the whole development lifecycle. For example it helped us to avoid problems with requests for late changes when the solutions were implemented and the services were offered to the users. The study also shows that our application of the chosen methodology framework (as it is possible to use it in many different ways) invited the user to participate and contribute in the development process without having special knowledge of the technology itself. The use of simple prototypes also gave the participants an understanding of a product under development that supported their participation.

The framework supported the development team to avoid too much focus on technical aspects early in the design process, as is often the case in a more traditional development process. The eclectic approach also gave a good support for a more iterative development

process. In our project it was easy to work in parallel and between “phases”. The user involvement affected the design solution in different ways. For example we made changes in the navigational structure and choices of words and symbols in the user interface. We also learned a lot of the users’ interaction problems with standard terminals and also captured requirements and expectations for contemporary and future services and content.

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