Modelling the User

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Abstract: The relatively high percentage of people with disabilities in Europe combined with the facts of ageing population, strong relation of impairment to age, and as State of the Art shows, dissatisfaction or even unawareness of people with disabilities of available assistive technology are revealing the necessity to incorporate a user-centric approach that beyond 2nd generation practices will achieve to provide embedded and built-in accessibility solutions, as well as toolkits for developers, for "engraving" accessibility in existing and emerging mass-market ICT-based products, aiming to make accessibility open, plug and play, personalised and configurable, realistic and applicable in various contexts, keeping always the user in the loop. The AEGIS (Accessibility Everywhere: Groundwork, Infrastructure, Standards) IP (Integrated Project) of the 7th European Framework Programme seeks to determine whether 3rd generation access techniques will provide a more accessible, more exploitable and deeply embeddable approach in mainstream ICT (information and communication technologies). This paper presents the holistic UCD (user-centered design) implementation plan, upon which AEGIS has been based in order to achieve its targets, starting from modelling its target users, in the most efficient way possible.

Key words: Accessibility, open source, UCD, mobile applications, desktop applications, RIA (rich internet applications), people with disabilities.

1. Introduction

The number of people with disabilities in Europe is estimated to be between 10% and 15% of the total population (between 50 and 75 million people in the EU27), which gives an idea of the number of Europeans at risk of exclusion, as well as the number of potential beneficiaries of accessible ICT. Also, the prevalence of both disabilities and other minor functional limitations is strongly related to age. Thus, the already high level of demand for accessibility solutions will increase substantially with the ageing of the population. The ageing population in Europe is the most important demographic process in recent years. It is a forecast to increase sharply over the coming years

due to two main factors: the increase in life expectancy and falling birth rates. The findings of Labour Force Survey and other surveys indicate that disability increases with age; approximately two-thirds of disabled people are elderly [1].

The AEGIS Integrated Project (IP) (Open Accessibility Everywhere: Groundwork, Infrastructure, Standards; http://www.aegis-project.eu) of the 7th European Framework Programme seeks to determine whether 3rd generation access techniques will provide a more accessible, more exploitable and deeply embeddable approach in mainstream Information and Communication Technologies (ICT) [2]. This approach is being developed and explored with the Open Accessibility Framework (OAF) through which aspects of the design, development and deployment of accessible mainstream ICT will be addressed. OAF

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will constitute a comprehensive, holistic approach to programmatic support for assistive technologies to provide embedded and built-in accessibility solutions, as well as toolkits for developers, for "engraving" accessibility in existing and emerging mass-market ICT-based products, thus making accessibility open, plug and play, personalized and configurable, realistic and applicable in various contexts.

AEGIS is targeting users with visual, hearing, motion, speech/communication and cognitive impairments, elderly persons (since, as aforementioned, functional impairment increasingly appears in old age), as well as developers of ICT infrastructures, applications and services and relevant stakeholders and groups with interest in design processes (public or private, institutional or community groups) and aims to develop open source based generalized accessibility support into the major mainstream ICT devices/applications domains, namely the desktop applications area, the rich internet applications (RIA), and the Java-based mobile devices domain.

One of the very first activities of AEGIS was a state of the art undertaken regarding the European assistive technology (AT) industry and the availability of past (European) surveys and data regarding the usage of and satisfaction with AT of end users [3]. As shown from this literature survey, AT is widely used, and in many cases has improved the life of many end-users. However, data seem to indicate that a majority of the people with disabilities (people with vision impairments seemingly being an exception) do not use AT, or are simply unaware of existing AT, may lack appropriate training to properly use it and, if they do, are often disappointed with what it offers in relation to what they need. All findings emerging from this survey, like the lack of local language versions of AT or a common policy regarding reimbursement schemes, etc. were cross-checked and confirmed with the findings of the studies undertaken by the project. However, they constitute some first evidence that UCD is necessary in the context of AT/Augmentative and Alternative

Communication (AAC) prototype development in order to place the end user, user organisations and support teams at the fulcrum of the overall iterative design and testing process. This is essential for a genuinely iterative approach to AT/AAC design and is being strictly followed within AEGIS.

This paper presents in Section 2 the UCD implementation plan defined and followed in AEGIS, mostly focusing on its two first phases, which correspond to the "modelling the user" stage of the project, namely Phase 1: Gathering user needs and Phase 2: Specifying user requirements (Section 3), providing some indicative results emerging from each, whereas in Section 4, the main conclusions and further research steps are being summarized.

2. AEGIS UCD Implementation Plan

The centric principles followed for the construction of the UCD implementation plan in AEGIS, and is also relevant for all AEGIS-like initiatives, is that (1) active user involvement in the project is not simply at the end, (2) user involvement in this project is a particularly challenging priority due to the extremely diverse nature of the target user audience and the inclusion goal, and (3) everything users see, hear and touch shall be designed together with a multidisciplinary team.

The UCD implementation plan as proposed by AEGIS has four sequential phases. In the first phase, analysis of the users (both end-users with disabilities and developers and experts), their tasks and their contexts are the main focus. Based on these analyses, insight in the problems and needs of the users are collected. Central to phase two is the translation of these problems and needs into a format which can be used throughout the remainder of the project, such as personas, use cases, user scenarios, user requirements, conceptual models, etc.. In the third phase, the conceptual models will be developed into prototypes in an iterative, co-design approach. The prototypes of increasing fidelity will be iteratively evaluated with users. In the fourth phase, the final, working prototype

which is the result of the previous phase is tested in the field. The four phases are schematically presented in Fig.1. The interdependencies between the research activities are indicated in the overall context of the iterative process. The four phases are followed for each of the AEGIS application domains (i.e., mobile, desktop, RIA). When possible, the UCD activities will run in parallel for each of these domains, or will even be combined. For instance, in the first phase, the user, task and context analysis have been conducted for each application domain simultaneously. The focus of this paper is the description of the first two phases of the UCD plan, which are the ones that correspond to the overall "modelling the user" stage of the project, as indicated in the following figure. Thus, in the following sections of this paper, each phase goals, expected results, UCD techniques deployed, and, finally, indicative results are described in short. It should be mentioned that the applicable for AEGIS UCD techniques in each phase have emerged from an extensive literature survey held in the early beginning of AEGIS project [1].

3. "Modelling the User" Phases

3.1 UCD Phase 1: Gathering User Needs

3.1.1 Phase Goals

To design and develop technology and applications that are useful, usable and that provide a pleasant user experience, a first step is to understand the user, his/her tasks and context. By understanding these factors, insight is gained in problems that could be solved and in the users' needs with respect to the topics of AEGIS.

3.1.2 Expected Results

The expected result in this phase was the gathering of deep and rich insights from a substantial panel of users regarding their needs, problems and wants that it should be fulfilled within the scope of the AEGIS project.

3.1.3 UCD Techniques

To understand the users and to identify user needs, thorough analyses of the users, their tasks and their contexts were scheduled. A combination of quantitative and qualitative methods was being used. On a quantitative level, the user, task and context analysis were done by means of questionnaire surveys (that were conducted by phone, e-mail or face-to-face where necessary [3]. The surveys addressed both the end users with disabilities and the experts for all three areas of the project. On a qualitative level, some of the questionnaire participants have been interviewed face-to-face. This was necessary for some users with severe disabilities and it also allowed the discussion of relevant topics on a deeper level as well as a more ethnographic approach in doing contextual inquiries to observe the users while doing relevant tasks. Based on the observations of participants performing everyday tasks in their personal context, a HTA (hierarchical task analysis) was done, to allow the investigation of existing situations.

3.1.4 Indicative Results

According to the UCD plan, a series of field studies and workshops were held in four European countries, namely Belgium, Spain, Sweden and UK. Both activities targeted end-users, end-user representatives (e.g. trainers, accessibility assessors), domain experts and developers to gain an in-depth understanding of the context of the use of ICT, i.e., mainstream and assistive technologies.

The main goal of the field studies was to uncover all possibilities and challenges that arise when end-users engage with mainstream or AT. A detailed analysis of the results per test site, and herein per application domain, as well as a cross-comparison between the respective sites, also per application domain and per target group, uncovering similarities and differences has emerged and is publicly available through the project web site [2].

In short, the AEGIS field studies pointed out that the use of technology is reasonably widespread within each of the three application domains of the project. However, the technologies and devices that would be most helpful for the end-users targeted by the AEGIS consortium, are seldom reaching this target group, as
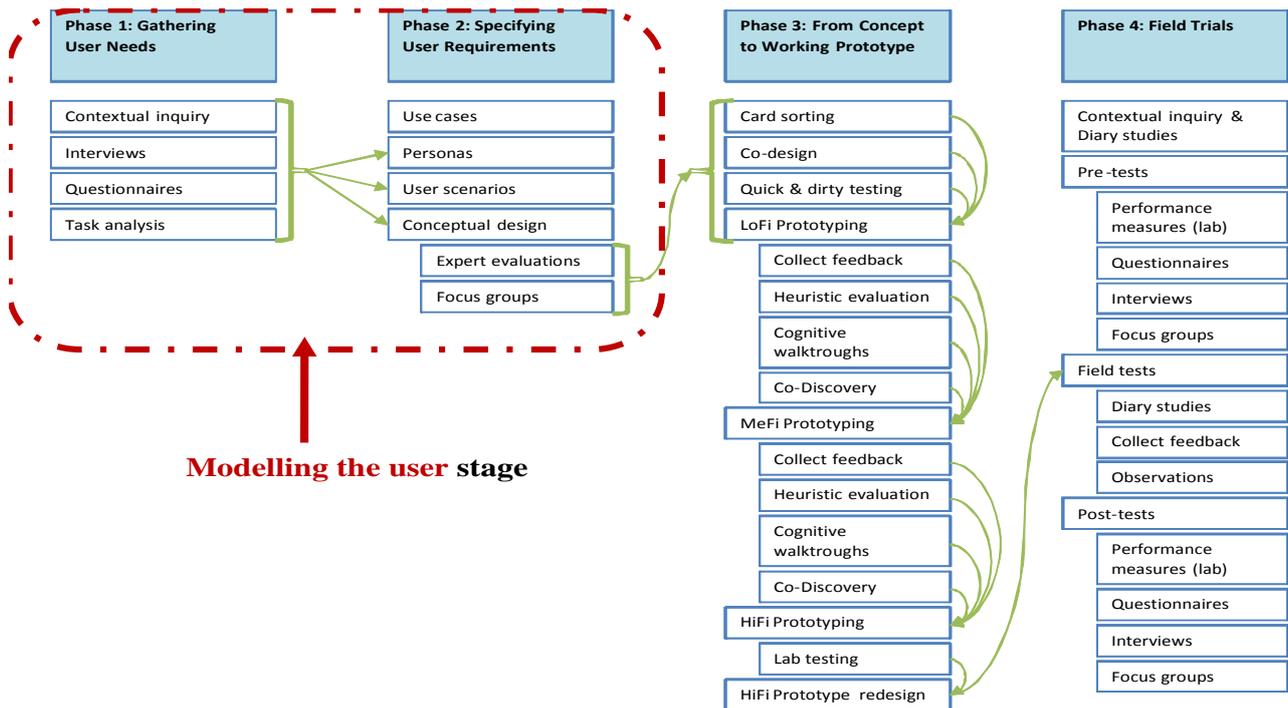
Fig. 1   The UCD phases and the interdependencies between the research activities as defined by AEGIS [1].

pointed out also in the state of the art. Instead, the interviewed impaired end-users tend to own only the cheapest and/or outdated devices and technologies. Basic functionalities like editing documents, sending emails or text messaging are frequently used. Nevertheless, the outcomes show that end-users still face many challenges when trying to access these basic functionalities. This implies the need for a stable groundwork when considering accessibility. This need for better ways of accessing basic device or technology functionalities—before moving on to more complex or advanced features—is confirmed by the end-user representatives and developers. Nonetheless, this does not signify that end-users are not interested in more advanced multimedia features.

The field studies brought many recurring themes and arguments to light which were also highlighted in the initial state of the art. These include anticipated issues like the cost of (assistive) technologies as well as less obvious barriers. A common problem resides around the lack of training or instruction materials presented in an adequate format that targets specific needs following specific impairments. As a result, the poor

accessibility of basic functionalities typically forced end-users to spend a lot of time and effort to master merely the most fundamental features. Related to this lack of training is the general lack of knowledge; many interviewed end-users were simply unaware of available solutions. In particular people who have limited mobility, and as a consequence also have more trouble meeting people, seem to experience difficulties finding relevant information sources.

Recent evolutions in desktop computing, mobile devices and rich internet applications hold much promise for another recurring theme, namely the need for customization or personalization. Practically all impairment user groups would benefit from simpler, more straightforward interfaces; menus, lists, applications, etc. that allow being configured towards personal needs and preferences. However, these new possibilities have not yet fully reached the end-users yet, partially due to the barriers mentioned above. Another remark here needs to be made about the dangers of over-customization, where too many options might overwhelm users. Good default values are therefore still an effective measure to successfully

operating a device or technology.

Another recurring theme, especially mentioned by the end-user representatives and developers, is the lack of open source initiatives or active communities in the field of accessible technologies. The experts are looking at the international market leaders to push standardization, make the prices drop and incorporate accessibility as a norm, condemning the current practices of reverse engineering. Also, on a more abstract or policy level, experts claim focus should be placed on allowing people to come to terms with their disability and then introduce them to specific technological solutions that could assist in their daily activities.

3.2 UCD Phase 2: Specifying User Requirements

3.2.1 Phase Goals

The aim of this phase was to translate the insights in the users, their tasks and their contexts which were gathered in phase 1, into system and user requirements.

3.2.2 Expected Results

The aim of this phase was to translate the succinct ranked list of the major end user, developer and system requirements, as emerging from Phase 1 to specific personas, use cases and scenarios and conceptual models to enable the realisation of Phase 3, which aims to interpret, finally, the first concepts to working prototypes.

3.2.3 UCD Techniques

Starting from the functional and upper level requirements emerging from the previous phase, these have been specified in a specific and usable format, namely a set of personas, use cases and user scenarios as well as conceptual models [4]. To verify the relevance and accuracy of all aforementioned, focus group meetings with end users and experts have been organised [3], some of them on Pan-European level [4]. The aim of these activities was to present preliminary results and ideas in an open discussion format to obtain feedback from individual end-users and stakeholders (developers, end user representative organisations) in an early design phase.

3.2.4 Indicative Results

The UC's (use cases) emerging, and before being reviewed in the context of focus groups and workshops mentioned above, were based on the original targets of the three areas of the project, namely the open accessible desktop applications area, the accessible RIA and accessible mobile applications as these were interpreted in a more specific technical wise context by the AEGIS developers and the needs of the target user groups and sub-groups of the project (one of the first and necessary outcomes of Phase 1, [3]), as emerging from UCD Phase 1 in the form of generic functional requirements.

All UC's have been formulated upon a consistent format, addressing the same major fields namely, context of use (describing the goal of the UC), primary actor (retrieved from AEGIS User Groups), secondary actor(s) (the interacting persons and/or objects), connected UC's (referring to other UC's that each UC is related/linked), priority level (for implementation), which may be essential, secondary or supportive, depending on the of value or primacy for AEGIS stakeholders as well as on the importance for system operation, background info/reason on selection and on assigning the priority level, scenario(s), describing the task(s) that the user has to accomplish, system output, meaning what should be the system's functionality, as reaction to the user actions/triggering, preconditions, that should be fulfilled for the UC to take place, services involved if applicable, application area (desktop, mobile and/or web), devices and restrictions PDA (Personal Digital Assistant) mobile phone, browsers and relevant possible limitations), critical success parameters (thresholds to be taken into account during evaluation), environmental restrictions related to the generic context of use, interaction level, depicting the interaction between the user(s) and the system in subsequent steps, important accessibility attributes (per user group), related also to critical success parameters, if applicable, relevant personas, references and comments.

In addition to the textual descriptions of the UC's, and in order to allow their easy digestion by the development teams in the future phases of the project, UML (Unified Modeling Language™) diagrams have been developed for each of them, through the Star UML tool [5] and the Enterprise Architect (version 7.1) [6], showing the relationships among actors, sub-modules and activities/actions identified within each UC.

The overview of all UC's developed in the project is shown in Fig. 2, while the supportive use cases are quoted in italics. The "essential" and "secondary" use cases are the ones that have to be tested in the context of the evaluation activities of the project, while the "supportive" ones will be tested only if the specific UC

is not covered / tested through another UC. It is worth highlighting here, that out of the 36 use cases developed in total, 12 of which cover the accessible desktop applications, 9 the accessible RIA, and 15 the accessible mobile applications / services area, only 4 of them are considered supportive, whereas the rest of them are all considered essential for the project, and as such, one should expect their implementation during the development phases of the project, the years to come. Beyond the following clustering, it may happen that a use case is applicable for more than one application areas, and this mainly concerns cases, where the background technologies or back-end modules to be developed are common for more than one application areas.
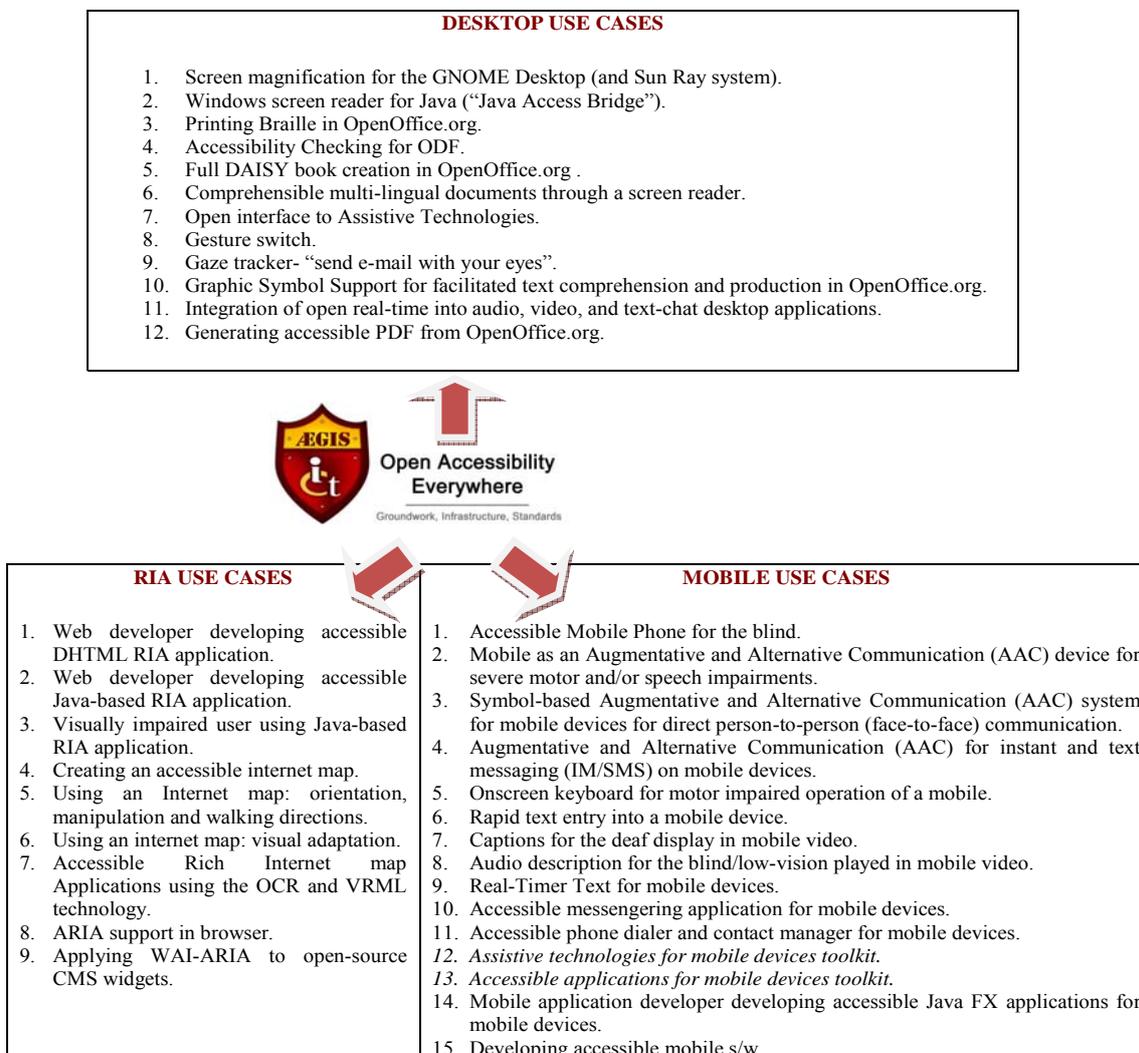

DESKTOP USE CASES

1. Screen magnification for the GNOME Desktop (and Sun Ray system).
2. Windows screen reader for Java ("Java Access Bridge").
3. Printing Braille in OpenOffice.org.
4. Accessibility Checking for ODF.
5. Full DAISY book creation in OpenOffice.org .
6. Comprehensible multi-lingual documents through a screen reader.
7. Open interface to Assistive Technologies.
8. Gesture switch.
9. Gaze tracker- "send e-mail with your eyes".
10. Graphic Symbol Support for facilitated text comprehension and production in OpenOffice.org.
11. Integration of open real-time into audio, video, and text-chat desktop applications.
12. Generating accessible PDF from OpenOffice.org.

Open Accessibility Everywhere
Groundwork, Infrastructure, Standards

RIA USE CASES	**MOBILE USE CASES**
1. Web developer developing accessible DHTML RIA application.	1. Accessible Mobile Phone for the blind.
2. Web developer developing accessible Java-based RIA application.	2. Mobile as an Augmentative and Alternative Communication (AAC) device for severe motor and/or speech impairments.
3. Visually impaired user using Java-based RIA application.	3. Symbol-based Augmentative and Alternative Communication (AAC) system for mobile devices for direct person-to-person (face-to-face) communication.
4. Creating an accessible internet map.	4. Augmentative and Alternative Communication (AAC) for instant and text messaging (IM/SMS) on mobile devices.
5. Using an Internet map: orientation, manipulation and walking directions.	5. Onscreen keyboard for motor impaired operation of a mobile.
6. Using an internet map: visual adaptation.	6. Rapid text entry into a mobile device.
7. Accessible Rich Internet map Applications using the OCR and VRML technology.	7. Captions for the deaf display in mobile video.
8. ARIA support in browser.	8. Audio description for the blind/low-vision played in mobile video.
9. Applying WAI-ARIA to open-source CMS widgets.	9. Real-Timer Text for mobile devices.
	10. Accessible messengering application for mobile devices.
	11. Accessible phone dialer and contact manager for mobile devices.
	12. *Assistive technologies for mobile devices toolkit.*
	13. *Accessible applications for mobile devices toolkit.*
	14. Mobile application developer developing accessible Java FX applications for mobile devices.
	15. Developing accessible mobile s/w.

Fig. 2   Overview of AEGIS use cases.

The methodology adopted for the use cases development is supported by a theoretical approach based upon the Action and Activity Theories, a research on use cases revealing the need of defining a problem-domain (i.e.. use cases context) and a model-domain (i.e., common terminology) as well as the UML diagrams to represent the use cases. Still, the main principle behind problem-domain and model-domain is that use cases themselves do not capture important information on the surrounding context. So, the problem-domain (i.e., the context, the environmental aspects) should be first analyzed and described. For this purpose, the Personas work run almost in parallel with the use cases work and was completed much before the finalization of the use cases, setting in this way a common reference and terminology for the use cases that are intended to support the AEGIS developments.

Thus, Personas actual target in AEGIS has been to address exactly this problem-domain aspect and this was achieved by interpreting the collected user needs info (emerging from the field trials and workshops) to fictitious archetypes of real users (featuring specific user characteristics, problems, needs and wishes, and not general ones representing the "average user"), constituting in this way the most efficient possible design and context of use capturing tool, considered very essential for the developers, and also very innovative in comparison to a theoretical consolidation of descriptive info that could be held instead. Personas are public and can be found in the project web site of AEGIS [2]. Table 1 presents the personas developed for each end-user group, targeted by the project. As in real people with disabilities, some of the personas (Emma, Jane, Peter and Wayne) have multiple impairments; thus, the names of these personas are mentioned in each relevant end-user group.

Each persona is introduced with a name, a picture and a short description of his personal situation. This includes age, marital status, education, job and a short description of the persona's impairment. In addition,

Table 1   AEGIS personas-user groups mapping.

AEGIS personas	
AEGIS targeted end-user group	Relevant personas
Visual impairments	Gert, Märta, Nitesh, Paulina
Motor impairments	Caroline, Jane, Mikel, Peter, Ramin
Cognitive impairments or learning difficulties	Adam, Peter, Wayne
Hearing impairments	Edward, Emma, Tomasa
Speech/communication impairments	Carlos, Emma, Jane, Wayne
Experts	Benoit
Developers	Clyde

each persona describes which technologies she/he uses in everyday life, and for which purposes. In the case of users with a limitation, the adaptive strategies for using a product are also described here, such as special tools or assistive technology (for example "uses screen reader software"), experience and skills with these tools or assistive technologies, and the frequency of use of the tools and technologies. Furthermore, a list of problems in using the technology in itself or in using the assistive technology is provided. Based on these problems, a section of each persona is dedicated to the overview of his/her needs and wants. The problems, needs and wants in using technology and special (assistive) tools are illustrated more concretely in a short description of a current scenario out of the life of the Persona. This section (titled "last month …") describes an everyday incident or event in which the persona was confronted with a particular problem or need. In this way, AEGIS has achieved to interpret all collected user needs in an absolutely meaningful and valuable format for further use, which is in parallel very easy to link with the project use cases.

The final step in this process has been the formulation of some condensed use scenarios, on the basis of the above use cases, which have constituted the basis for the detailed and more specific evaluation scenarios that will orient the evaluation activities of the project. Three major application scenarios have emerged, consisting of sub-scenarios, whereas the relevant user profile (linked to the relevant persona) is also described in each case.

Finally, as explained in the UCD plan of AEGIS, the creation of the conceptual models is a central step in the phase of specifying user requirements. A conceptual model represents a high-level structure for the system. The concepts and the entities that form the system are described in the conceptual design. Many possible formats for conceptual models are used, but these formats all have in common a description of the system from a user point-of-view. These models answer questions such as "which services and features does the system offer? how does the user interact with the services and features?", etc.

On the basis of the Phase 1 outcomes and taking into account the use cases, Personas and user scenarios developed, a conceptual model has been developed for each AEGIS identified prototype (priority is given to those expected to be evaluated in the first evaluation phase), reflecting, the functional requirements of the upcoming prototypes, after cross-checked with the user insights [3].

All above outcomes have been presented per test site in the context of focus groups and workshops and been showed that the end user and development community is keen on embracing AEGIS, under the condition it remains an "open project" and considers the needs of end users. This implies applying the UCD approach throughout the project as well as involving development communities and organisations that promote open software, offering access to source code and publishing information throughout the entire course.

4. Conclusions and Further Steps

This paper presents in short the UCD implementation plan defined and followed in AEGIS IP project, mostly focusing on its two first phases, which correspond to the "modelling the user" stage of the project, namely Phase 1: Gathering user needs and Phase 2: Specifying user requirements, providing in addition some indicative results emerging from each.

The major results of these two phases is the thorough

understanding of the targeted users, their needs and wants, which in turn have formulated the basis for the user requirements work of the project, which has been materialised in elaborate use cases and user scenarios, Personas and conceptual models, that will constitute the groundwork for the iterative design and prototyping phases of the project.

All above core elements are public and can be downloaded from the project web site (http://www.aegis-project.eu), while are all considered working documents that may undergo several updates and revisions, following the progress of the project as well as the evolution noticed in the open source accessibility community.

Above all, the UCD approach as being defined and adopted by AEGIS project may serve as a valuable practice for similar initiatives that need to be user-centric in order to achieve usable, useful and easy to penetrate products in the e-inclusion field and beyond.

Acknowledgments

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