A Harmonised Methodology towards Measuring Accessibility

Alexandros Mourouzis[1], Grammati-Eirini Kastori[2], Kostantinos Votis[2], Evangelos Bekiaris[1], and Dimitrios Tzovaras[2]

[1] Centre for Research and Technology Hellas (CERTH)
Hellenic Institute of Transport
Thermi, Thessaloniki, GR-57001, Greece
[2] Centre for Research and Technology Hellas (CERTH)
Informatics & Telematics Institute
Thermi, Thessaloniki, GR-57001, Greece
{mourouzi,abek}@certh.gr, {gkastori,kvotis,tzovaras}@iti.gr

Abstract. This paper introduces the *harmonized accessibility methodology (HAM)* that has been defined and deployed in the context of the ACCESSIBLE project. HAM is aimed to harmonize existing collections of related design knowledge, such as heuristics, guidelines, standards, etc., and thereby provide the grounds for defining ontology-based rules and, and thereby implementing, within ACCESSIBLE and beyond, automated accessibility assessment of ICT designs and developments. Ultimately, ordinary developers will be enabled to conduct rapid, yet specialized, accessibility assessments focused on any relevant disability types, assistive technologies, platforms, and contextual conditions.

Keywords: Accessibility, Disability, Evaluation, Assessment tools.

1 Introduction

Accessibility and ease of use for the elderly and the disabled has attracted a lot of attention during the last few years. This is strongly supported by the fact that an increasing number of governments are legislating towards promoting and enforcing equality of opportunity and of access for everyone within the economy and society (*Inclusion*), including in terms of access to ICT and the evolving Information Society (*eAccessibility*). Soon after the appearance and early developments of assistive technology, such as screen readers, special interaction devices, etc., researchers and practitioners realised that access to a computer-based system is often denied to large numbers of potential users as a result of the system's design. In the old days, it was widely believed that the interaction ability of an individual is simply subject to his/her functional characteristics. Yet, we now understand that it is the design of system in combination with the functional characteristics of the user that renders the person able or unable to interact with it.

However, the development of software requires specialised expertise and a strong effort from developers. With the additional encumbrance of taking into account different kinds of accessibility requirements, guidelines and best practices, and different

C. Stephanidis (Ed.): Universal Access in HCI, Part I, HCII 2009, LNCS 5614, pp. 578–587, 2009.
© Springer-Verlag Berlin Heidelberg 2009

implementation technologies (which by themselves might pose severe problems of delivering accessible applications), developers are faced with a daunting task. To this end, numerous sets of guidelines to help developers produce systems that are accessible and usable by elderly and disabled people have been recently proposed and put in practice. These range from very general guidelines to the very specific guidelines for Web user agents, authoring tools, and content developers. However, it is questionable whether providing guidelines is an effective method for ensuring usable and accessible designs, since their usage alone requires specialised skills and since the provided guidance might be differently interpreted among developers and designers. Moreover, designers and developers are often required to select among a number of similar guidelines sets without clear understanding of which set is more suitable for their specific task at hand. Ultimately, the highly specialised skills required for developing accessible software sets aside most developers. To mitigate such problems, developers should be guided in their development process about accessibility concerns within ICT development. Thus, developers need a conceptual framework in which to situate disability-related guidelines, which they often do not have due to lack of experience with disabled population and their technologies.

2 The ACCESSIBLE Project: Objectives and Rationale

Under the light of the above, and in response to the invitation to submit a proposal for 7th EU Framework Programme for Research and Technological Development (FP7), the ACCESSIBLE STREP Project[1] "Accessibility Assessment Simulation Environment for New Applications Design and Development" aims to define an overall European Assessment Simulation Environment making extensive use of the latest available IT technologies and concepts. This will constitute the base for a future generalised European Assessment Environment that will allow producers of ICT to assess the effectiveness of the various ICT tools, understand their caveats, and where to enhance their design to ensure full accessibility. The outcome will reflect a quality mark for users of assistive ICT, who will be assured that the acquired ICT will fully meet their needs. More specifically, the ACCESSIBLE project will implement specific methodologies and tools for ensuring accessibility for designers and software developers. To contribute for better accessibility for all citizens, to increase the use of standards, and to develop an assessment simulation environment (including a suite of accessibility analysing tools for Web services and applications, JavaFX Script applications as well as developer-aid tools) to access efficiently, easily and rapidly the accessibility and viability of software applications for all end user groups (with disabilities or not). Figure 1 depicts the rationale of ACCESSIBLE.

This paper presents the methodological approach (the ACCESSIBLE *harmonized accessibility methodology* - HAM) that has been determined for the structured assessment of software developments and the definition of accessibility assessment metrics for people with disability. The framework aims to formalize conceptual information about: (a) the characteristics of users with disabilities, assisted devices,

[1] Official Project website: http://www.accessible-eu.org/

applications, and other aspects that should be taken into account when describing an audience with disability; (b) accessibility standards and associated checkpoints and guidelines; and (c) semantic verification rules to help describing requirements and constraints of users, and associating them to accessibility checkpoints.

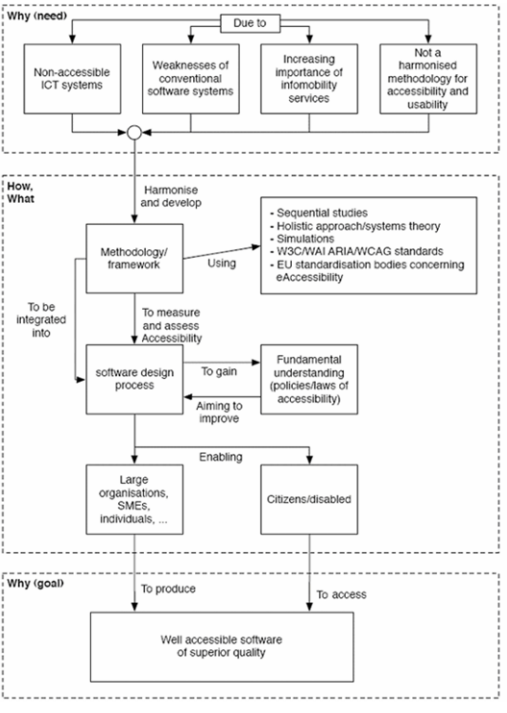

Fig. 1. Overview of the ACCESSIBLE project's rational and objectives

One of the many challenges of ACCESSIBLE is the integration of combinations of many possible disabilities, rather than on an individual basis. How do we design or assess for a person with both a hearing and sight loss, or a blind person with only one hand? This is particularly important as with ageing, everyone is likely to acquire multiple weaknesses, and although each one might be relatively minor their combined effects are often major. The proposed HAM is aimed to harmonize existing collections of related knowledge, such as heuristics, guidelines, standards, etc. and provide thereby the grounds for describing ontology-based rules and implementing, within ACCESSIBLE, automated assessment of ICT designs and developments (see [1]). Ultimately, designers, programmers, evaluators, etc. will be enabled to conduct specialized accessibility assessments focused on specific disability types, assistive technologies, platforms, and / or contextual conditions. Section 3 below serves as an introduction to the rationale of the HAM methodology described in the sections after.

3 Design and Accessibility Engineering: In Retrospect

Both practitioners and researchers have a strong interest in understanding why people may resist using computers, in order to develop better methods for designing technology, evaluating systems and predicting how users will respond to new technology. Previous research has identified a number of reasons why 'customers' use, or do not use, a computer-based system (see [4]). Utility and usability, for instance, have long been considered by the scientific community and practitioners as salient system adoption factors. The term usability (as ease of use), for example, was first introduced, and its importance recognised, long time before the appearance of computer systems and digital technologies. Back in 1842, De Quincey argued that "it is not the utility, but the usability of a thing which is in question". Nevertheless, it is nowadays commonly admitted that optimising utility and usability alone, although certainly a high priority, does not necessarily mean that take-up rates of a system will reach their full potential. Admittedly, the design and development of contemporary ICT applications and services that meet the needs and requirements of as many diverse users as possible is a difficult and demanding task. Computers, further enhanced by the Internet, serve nowadays as an unprecedented resource for knowledge, communication, and data and services acquisition, and play a key role in an increasing number of aspects of everyday life, including commerce, information, education and training, job searching and remote collaboration, entertainment, social participation, and interaction with public administrations. Information systems, thanks to their potential universality and the evolving usefulness (if not necessity) of the content, hold an unprecedented potential of reaching an enormous number of individuals; a population of potential users significantly characterised by diverse interaction skills, abilities, preferences, and access equipment (personal computers, mobile phones and other small display devices, kiosks, assistive technology, etc.).

Yet, the vast majority of developers today, by "tradition" (if not as a compromise), insist on designing their artefacts for the typical or so-called "average" users, trusting this as the best solution to cater the needs of the broadest possible population. These are most probably the leftovers of last century's anthropometry and the important role it played in industrial design, clothing design, ergonomics, and architecture, where statistical data about the distribution of body dimensions in the population were used to optimize products. Unfortunately, this approach when ported into the design of ICT, it eliminates our chances offered by the new medium (digital) to provide more flexible optimisations. In fact, this approach, typically employed in user interface design for quite some years, leads into excluding numerous "outliers", such as non-expert IT users, the very young or the elderly, people with disability, etc. [2]. As computers started to penetrate all aspects of our everyday lives, and becoming a critical asset for social inclusion, developers are eventually pushed by social or market needs towards broadening their user base, are often required to further "improve" their artefacts so that these adhere to generalised (i.e., average - again) usability and accessibility principles.

Over the years, accessibility has been addressed through various collaborative efforts. These fall into three main categories, which are distinctively characterised by their underlying focus and normative perspectives [1]:

- The first, which is also referred as reactive approach (or retrofit approach), aims to adapt products so as to build the required accessibility features. The qualification of this approach as reactive results precisely from the a posteriori adaptations that are delivered.
- The second and more recent approach aims to proactively account for accessibility by taking appropriate actions during the early phases of a product's life cycle. Proactively accounting for accessibility implies Design for All.
- Finally, the third perspective is that accessibility can be addressed by means of policy measures, such as legislation and standardisation.

As a result, there are now several on-going efforts to promote accessibility in national and international standardisation bodies and industrial consortia (e.g., the World Wide Web Consortium - W3C). The majority of these efforts aim to formulate accessibility guidelines, either general (e.g., HFES/ ANSI Draft, Section 5), platform specific (e.g., for Graphical User Interfaces or the Web), or domain-specific guidelines (e.g., for text editing, graphic manipulation). Such guidelines are typically documented on paper, and reflect previous experience gained and best practice available for designing accessible interactive software (also including content). The systematic collection, consolidation and interpretation of these guidelines is currently pursued in the context of international collaborative initiatives (e.g., W3C-WAI Initiative[2], ISO TC 159 / SC 4 / WG 5), as well as R&D projects, and international scientific fora. In this context, it is worth pointing out the efforts carried out in the area of Web accessibility guidelines by the W3C-WAI Initiative and by the US government in Section 508.

Clearly, there is now a vast amount of knowledge now available in the international literature concerning inclusive user interface design. Knowledge that is incarnated in guideline sets, standards, corporate guides, etc. Knowledge that is generic or specific, for example for the elderly, or for web or mobile interfaces, etc. As a result, developers are finding it difficult to locate and deploy effectively such knowledge in their development process. For instance, a web developer with no prior experience in web accessibility engineering would find it extremely difficult to identify the differences between the WCAG 1.0 and the Section 508 guidelines, would be uncertain about the actual types of users affected by each particular guideline, and would be confused, the least to say, by most of the checkpoints entailed. What happens if the developer would like to provide two alternative designs for the same task in order to cope with conflicting needs of two user types (e.g., see [3])? Not to mention that contemporary users increasingly desire and expect the delivery of interfaces that are highly tailored to their own needs, and hardly compromise on rigid designs for some imaginary "average" users. In such cases, how can an inexperienced developer identify which guidelines are most appropriate for each one of the alternative design? All these questions make clear the need for the envisioned methodology for harmonising design knowledge and rendering it easy to understand and apply for modern ICT designers and developers.

[2] World Wide Web Consortium - Web Accessibility Initiative (http://www.w3c.org/WAI/)

4 ICF: A Starting Point towards Harmonisation

As mentioned above, the main objective of this work is to provide a methodology for harmonising existing design knowledge and structuring it into a way (following an ontological approach) that will allow its automated exploitation. But, where can we start from to achieve this? Design knowledge is in numerous forms and often consolidated / generalized, thus difficult to directly relate items to specific disability types, assistive technology, or other contextual parameters. For instance, the generic W3C instruction "Ensure user control of time-sensitive content changes" cannot easily related to specific user types.

To this end, we decided to place the International Classification of Functioning, Disability and Health (ICF) approach at the core of our methodology. ICF is WHO's framework for health and disability[3]. It is the conceptual basis for the definition, measurement and policy formulations for health and disability. The list of domains in ICF becomes a classification when qualifiers are used. Qualifiers record the presence and severity of a problem in functioning at the body, person and societal levels. For the classifications of body function and structure, the primary qualifier indicates the presence of an impairment and, on a five point scale, the degree of the impairment of function or structure (no impairment, mild, moderate, severe and complete). In other words, ICF classifies *body functions* (see Table 1), as the physiological functions of body systems (including psychological functions) and thereupon, *impairments*, as problems in body function as a significant deviation or loss.

What is interesting about the ICF classification for our work in ACCESSIBLE is that the ICF *body structures* (BS) are not overlapping and are directly related to impairments and, thus can be directly linked to (a) disability / user types, (b) human-computer interaction limitations, (c) specialized design guidance (guidelines, standards, etc.), assistive technologies, etc. This is explained in section 5 below.

Table 1. Excerpt of the ICF List of Body Functions (some examples)

- ***MENTAL FUNCTIONS***
  - *Consciousness*
  - *Intellectual (incl. Retardation, dementia)*
  - *Attention*
  - *Perceptual functions*
  - …
- ***SENSORY FUNCTIONS AND PAIN***
  - *Seeing*
  - *Hearing*
- ***Touch function***
- ***VOICE AND SPEECH FUNCTIONS***
- ***NEUROMUSCULOSKELETAL AND MOVEMENT RELATED FUNCTIONS***
- …

[3] International Classification of Functioning, Disability and Health (ICF), ISBN 92 4 154542 9 – see http://www.who.int/en/

5 The ACCESSIBLE Harmonised Methodology

As mentioned above, ICF provides a concrete classification of impairments of the body structures, which ensures no overlaps. In this way, experts in ACCESSIBLE can work on linking user types (e.g., disability types) to certain ICF body structures and their related impairments (e.g., see Figure 2).

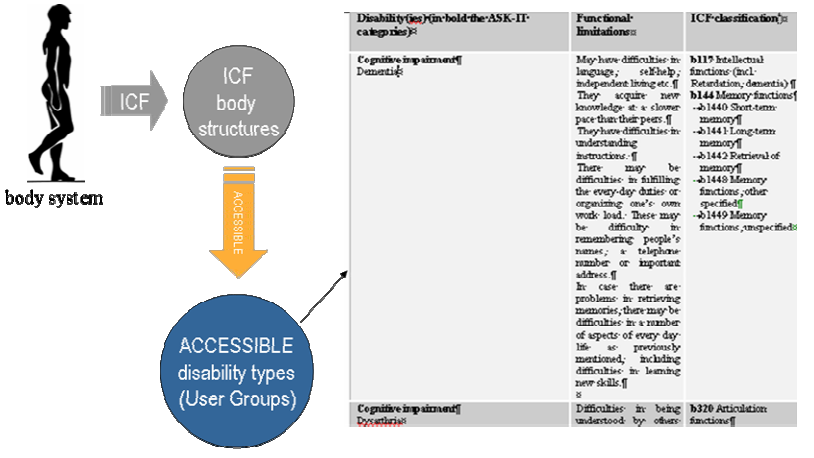

Fig. 2. Using the ICF classification as a base for harmonizing multiple user types

Then, experts in ACCESSIBLE have worked on deriving a classification of "interaction limitations" based on ICF. These are, in essence, a subset of the ICF functional limitations; we simply disregard body structures and functions that are not related to human-computer interaction, so that we can, for example, harmonise (i.e., link) assistive technologies indirectly to specific body structures (see Figure 3).

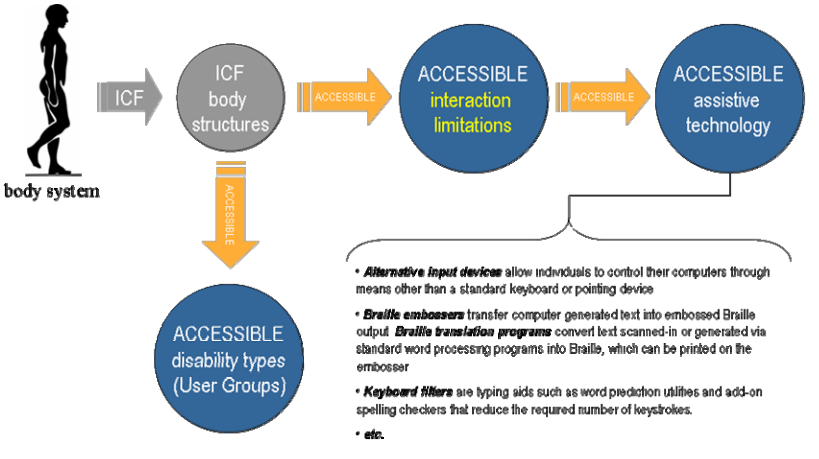

Fig. 3. Towards translating ICF body structures into interactions limitations and there upon relating individual assistive technologies to specific body structures and / or to disability types

In addition, the "translation" of the ICF body structure impairments into interaction limitations further facilities the linking of existing guidelines and heuristics from the literature to specific body structures and thereby to user types (see Figure 4). Although, it is often somehow hard to understand what type of user benefit the most from a given guideline (because it hard for inexperienced developers to understand a disability or it's the effects) it is much easier to correlate a guideline to an explicitly described interaction limitation. Such as the guideline for using specific colors ranges can be easily related to an interaction limitation "cannot see yellow, red or green' on a screen but to the user type with a certain color deficiency such as protanopia.

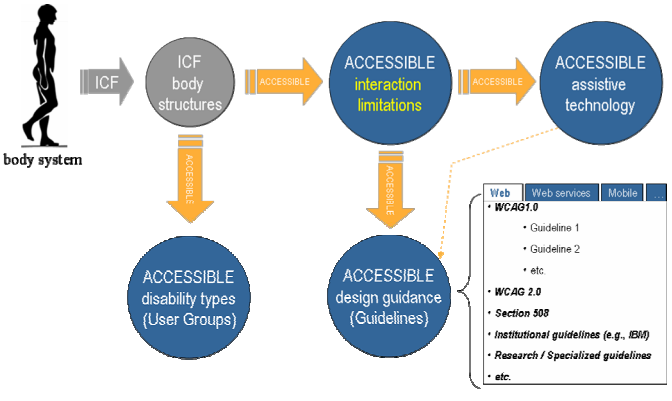

Fig. 4. Towards harmonizing design guidance with assistive technology and user types

At last, but not least, the above workplan, allows us to implement assessment rules that are derived from one ore more guidelines, and use the above classification (organised into an ontology) in order not to loose track of which user types do benefit and which assistive technologies are affected (see figure 5). Ultimately, in this way, a developer will be in the position to initiate an assessment by defining (alone) any one of the following: User Group(s), Guidelines collection(s), Assistive technology(ies), Assessment rule(s), or any other classification that can be integrated into this schema.

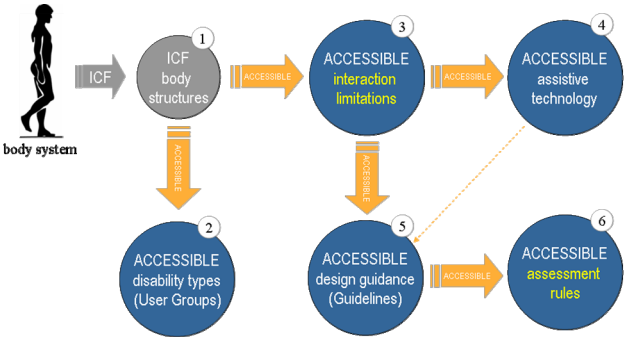

Fig. 4. Overview of the ACCESSIBLE harmonised methodology for measuring accessibility

Table 2 below shows an example (excerpt) of the relations established in the ACCESSIBLE ontology as part of the proposed harmonised methodology for measuring accessibility. The selection of the ICF categories was relevant to those that were directly linked to disabilities that will be addressed in ACCESSIBLE. Topics such as sleep functions, temperament and personality functions were considered as out of scope of the project.

Table 2. Excerpt of the ACCESSIBLE harmonised methodology for measuring accessibility

Disability(ies)	Interaction limitations	ICF classification	Checkpoints W3C/WCAG 1.0	Checkpoints W3C/WCAG 2.0	Section 508
Vision impairments Blindness	A total lack of vision represents the extreme end of the scale of a condition that we call blindness; Difficulties in reading, identifying symbols, identifying people, identifying graphics or reading signage; Difficulties in crossing streets, in seeing approaching traffic, in communicating with large groups of people difficulties in walking around, etc. It is difficult to perceive facial features and expressions, difficulties to recognise the edge of the pavement and the stairs, it may also cause difficulties in reading;	**b156** Perceptual functions b1561 Visual perception **b210** Seeing functions	1, 2, 3.3, 5.1, 5.3, 5.5, 6.1, 9.4, 12.1, 12.2, 14.2	1.1, 1.2, 1.3, 1.4 2.4, 3.1	1194.22 (a), (c) (d), (e), (i)

6 Current Status and Future Steps

At this stage most common user types / disability types (see #2 in Fig. 4) and the "ACCESSIBLE interaction limitations" (see #3) have been collected and inserted in the ACCESSIBLE ontology. A number of "assistive technology" (see #4) products have also been recorded along with their correlation to the "ACCESSIBLE interaction limitations". Regarding "design guidance" (see #5), most of the work has been done for WCAG 1.0, WCAG 2.0 and Section 508 guidelines, yet the processing of independent guidelines collections (including for platforms other than the Web) is still undergoing. Thereupon, a number of "assessment rules" (see #6) have been implemented and used in testing (see [1]) verifying the whole concept of the proposed harmonized approach. Within the following periods, our consortium focuses on making widely available the ACCESSIBLE taxonomy seeking feedback from external expert groups, for instance regarding the proposed correlation of interaction limitations to specific guidelines and assistive devices, while test are conducted in parallel with the ongoing development of the assessment rules and the assessment simulation modules of ACCESSIBLE.

7 Conclusions

Facing the background presented earlier, a holistic approach to accessibility is still missing. The work presented here goes beyond state of the art (see section 3) and provides the grounds for developing the ACCESSIBLE assessment simulation system for developers and designers; a type of adaptive environment that will enable them, on one side, to design accessible software applications and, on the other side, to understand about their problems, and analyse and test its accessibility. The ACCESSIBLE project integrates both new ICT driven concepts and disabled user oriented approaches with methodologies and tools regarding accessibility. Within this context, and by exploiting HAM, the ACCESSIBLE project aims at developing a new scalable, interoperable and integrated assessment simulation system as an accessible-driven solution with a user-centred approach. Partly as a consequence of the problems of relying only on guidelines to drive design for disabled people, and partly due to the need to develop practical methodologies that instantiate the universal design philosophy, ACCESSIBLE allows designers / developers to make an initial assessment of how usable a design might be for people with particular disabilities before conducting end user evaluations. By promoting accessibility and usability, the ACCESSIBLE project can act as a paradigm shifter. First, in the way it provides developers and designers a framework for gaining insight into the accessible software development process - the right disability and accessibility information, standard, tool or methodology. Instead of a simple developer and designer-aid framework, the designers/developers will have a user-centred interface to get access to the different piece of methodological approaches they need. At last but not least, it provides a "harmonised methodology" between different standard developing organisations, end user groups, expert groups, decision makers and policy makers.

References

1. Votis, K., Lopes, R., Tzovaras, D., Carrico, L., Likothanassis, S.: A Semantic Accessibility Assessment Environment for Design and Development for the Web. In: Stephanidis, C. (ed.) Proc. of 13th International Conference on Human-Computer Interaction (HCI International 2009), San Diego, USA, July 19-24. Springer, Berlin (2009)
2. Stephanidis, C., Salvendy, G., Akoumianakis, D., Bevan, N., Brewer, J., Emiliani, P.L., Galetsas, A., Haataja, S., Iakovidis, I., Jacko, J., Jenkins, P., Karshmer, A., Korn, P., Marcus, A., Murphy, H., Stary, C., Vanderheiden, G., Weber, G., Ziegler, J.: Toward an Information Society for All: An International RD Agenda. International Journal of Human-Computer Interaction 10(2), 107–134 (1998)
3. Doulgeraki, C., et al.: Adaptable Web-based user interfaces: methodology and practice. eMinds International Journal of Human Computer Interaction I(5), 1887–3022 (2009) ISSN: 1697-9613 (print) (online)
4. Antona, M., Mourouzis, A., Stephanidis, C.: Towards a Walkthrough Method for Universal Access Evaluation. In: Stephanidis, C. (ed.) HCI 2007. LNCS, vol. 4554, pp. 325–334. Springer, Heidelberg (2007)