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To cite this Article: Akoumianakis, Demosthenes and Stephanidis, Constantine , 'Blending scenarios of use and informal argumentation to facilitate universal access: experience with the Universal Access Assessment Workshop method', Behaviour & Information Technology, 22:4, 227 - 244

To link to this article: DOI: 10.1080/0144929031000120851

URL: http://dx.doi.org/10.1080/0144929031000120851
Blending scenarios of use and informal argumentation to facilitate universal access: experience with the *Universal Access Assessment Workshop* method

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Abstract. The accessibility of interactive computer-based products and services has long been an issue of concern to the Assistive Technology (AT) and Human-Computer Interaction (HCI) communities. In recent years, there have been several efforts aiming to document the consolidated wisdom in the form of general guidelines and examples of best practice. Despite their sound human factors content, these guidelines require substantial interpretation by designers, before they can generate practically useful and context-specific recommendations. In this paper, we examine how this task can be aided by blending *scenarios of use* and informal *argumentation* in the context of a structured technique referred to as *Universal Access Assessment Workshop* (UA²W). The paper provides a review of the technique and proposes two instruments, namely *scenario screening* and *growth scenarios*, which can be used to structure the conduct of UA²Ws. Finally, the paper summarises recent experiences in the use of these techniques in the context of a case study, which seeks to provide universal access insight to the design of a ward-based service to patient medical data.

1. Introduction

1.1. Design for all and HCI

The term *design for all* refers to the conscious effort to consider and take account of the widest possible range of end user requirements throughout the development lifecycle of a product or service. In many ways, universal design is not entirely new. Architects have been practising it for several years now and have developed a common understanding, which is summarised in the following definition:

‘Instead of responding only to the minimum demands of laws, which require a few special features for disabled people, it is possible to design most manufactured items and building elements to be usable by a broader range of human beings, including children, elderly people, people with disabilities, and people of different sizes.’ ([Encyclopaedia of Architecture, Design, Engineering and Construction](http://books.google.com/books?id=1989), 754)

In recent years, there have been several applications of universal design in interior and workplace design ([Mueller 1998](http://books.google.com/books?id=1998), housing ([Mace 1998](http://books.google.com/books?id=1998)), landscapes ([Mace et al. 1991](http://books.google.com/books?id=1991), etc. This is not to say, by any means, that the built environment we all live in has been designed for all, but merely points to the fact that *universal design* is not specific to the Information and Communications Technologies (ICT) sector of the industry. However, the distinction that should be made is that, whereas the existing knowledge may be considered sufficient to address accessibility of physical spaces (in our built environment), this is not yet the case with ICT, where *universal design* is still in its infancy and presents numerous challenges. In this paper, we will be concerned with the challenges of universal design in the context of Human-Computer Interaction and the design of interactive products and services.

Human Computer Interaction (HCI) and universal design have only recently established reciprocal openings, leading to the formulation of new concepts and
research agendas. In the mid-90s, the concept of *user interfaces for all* (Stephanidis 1995) was proposed as the first systematic effort to provide a methodological and an engineering base for the development of universally accessible user interfaces. *Unified user interface development* (Stephanidis 2001a, Stephanidis and Savidis 2003), was the methodology proposed to facilitate this effort, while a collection of dedicated user interface software tools (Savidis et al. 1997, Savidis and Stephanidis 2001) and design environments (Akoumianakis and Stephanidis 1997, 2001) comprised the engineering instruments for realizing user interfaces for all. With the progressive move towards an information society, the notions of *universal access* (Stephanidis et al. 1998b, 1999), *information society for all* (Stephanidis et al. 1998b) and *universal usability* (Shneiderman 2000, Shneiderman and Hochheiser 2001) became prominent research topics and acknowledged thematic areas of research and development activities within academic communities.

The common ground in all the above efforts is the realisation of the need to revisit some of the assumptions that have prevailed HCI research and development efforts in the past two decades. In Chapter 1 of Stephanidis (2001b), these assumptions are summarised as follows:

**The ‘average’ typical user**

In the context of the emerging distributed and communication-intensive information society, users are no longer only the computer-literate, skilled and able-bodied workers driven by performance-oriented motives. Nor do users constitute a homogeneous mass of information seeking actors with standard abilities, similar interests and common preferences with regards to information access and use. Designing modern Information Society applications and services for such broad and diverse client base, is clearly a multi-faceted challenge, constrained by several factors (Olsen 1999):

(i) target users of an application or service cannot be known in advance, other than by statistical generalities, and
(ii) users typically have only indirect influence on developers or service providers.

Thus, it becomes compelling that designers’ conception of users should (somehow) accommodate the requirements of as broad a range as possible, or ultimately all potential citizens, including the young and the elderly, residential users, as well as those with situational or permanent disability.

**The context of use**

Due to the unlimited business demand for information processing, the HCI community has progressively acquired a bias and habitual tendency towards outcomes (i.e., theories, methods and tools), which satisfy the business requirements and demonstrate performance improvements and productivity gains. However, since the early 1990s, analysts have been concerned with the increasing residential demand for information, which is now anticipated to be much higher than its business counterpart. The combination of the business and residential demand for information processing as well as the advent and penetration of the Internet, have motivated technological changes towards more intuitive computer-mediated human activities. In the 1990s, the need for intuitiveness in use was translated to increased demands for improved usability. More recently, the research agenda has expanded towards the realization of new concepts or metaphors such as *connected communities*, *inhabited information spaces*, and novel technological constructions to support *ambient intelligence* and *ubiquitous access*. A noticeable implication is that information processing is no longer bound to the physical boundaries of a working environment (such as the office) or conventional devices (such as the PC), but is distributed across the different contexts of use in which humans carry out their daily activities. Nevertheless, such novel contexts of use necessitate new patterns of use, which, in turn, are facilitated by novel devices. Consequently, designers should progressively adapt their thinking to facilitate a shift from designing tools for productivity improvement to designing computer-mediated environments offering interoperable services adapted to meet requirements of alternative contexts of use, as determined by parameters such as the user’s location, time, intensity of light, speed, noise, temperature, social surrounding or other context-oriented information which can be detected by sensors.

**Interaction devices and the ‘desktop’ embodiment of the computer**

The diffusion of the Internet as an information highway and the proliferation of advanced interactive technological platforms (e.g., mobile or wearable devices, network attachable equipment), signify that many of the tasks to be performed by humans in the information age will no longer be manifested through the visual desktop and its supporting interaction devices. New metaphors are likely to prevail as design catalysts of the emerging virtual spaces and the broader type and range of computer-mediated human activities. Arguably, these metaphors should encap-
sulate an inherently social and communication-oriented character in order to provide the guiding principles and underlying theories for designing more natural and intuitive computational embodiments of designated tasks. Consequently, the challenge lies within the scope of finding powerful themes and design patterns to shape the construction of novel communication spaces. At the same time, it is more than likely that no single design perspective, analogy or metaphor will suffice as a panacea for all potential users or computer-mediated human activities.

The trends described above constitute (part of) the rationale for striving towards new theoretical grounds, methodologies and engineering practices, which will make universal access to the information society a viable challenge rather than a utopia.

1.2. Universal access in HCI

Universal access in HCI, which is the strand motivating the present work, implies a conscious and systematic effort to advance a proactive approach (in terms of designated design processes, development tools, etc) towards interactive products and environments that can be accessible and usable by the broadest possible end-user population, anytime and from anywhere, without the need for additional adaptations or specialised (re-) design (Stephanidis et al. 1998b, 1999). It should be noted that the notion of universal access as defined above, extends the concept of universal design as defined by architects (see earlier definition), in so far as it adds at least two dimensions of consideration. Specifically, for a particular user task (e.g., reading a news article), universal access postulates explicit consideration (in the course of design), not only of the user carrying out the task, but also of the context of use in which the task is to be executed and the platform and/or access terminal that is to be used to provide the computational host for the corresponding system task (e.g. database retrieval) and the interactive manifestation of the task (in terms of object classes, dialogue patterns and input/output devices). It is claimed that these three clusters of design parameters (e.g., context of use, platform/terminal and the user) constitute predominant constituents of the global execution context of tasks that universal access should aim to cope with in the context of HCI. In other words, assuming a task \( T \) and designated sets of:

- Target user groups \( \Xi, \Xi_j \) is a set of enumerated user-specific parameters, such as 'eye-hand coordination', 'ability to reproduce movements on demand', 'tactile discrimination', etc,
- Envisioned contexts of use \( (\Psi, \Psi_j) \) is an enumerated set of context-oriented parameters, comprising both external context information detected by sensors such as current location, speed, intensity of light, noise, temperature, as well as other (internal to) computational environment specific context parameters such as presence or absence of other networked devices, and
- Technology platforms \( (\Sigma, \Sigma_j) \) is an enumerated set of platform-specific characteristics, such as range and attributes of interaction object classes, input/output devices, size of display unit), respectively,

then, the global execution context of task \( T \) is defined by the Cartesian Product \( \Xi \times \Psi \times \Sigma \), as opposed to any particular subset. Thus, universal access entails an effort towards understanding and designing to accommodate the global execution context of a task.

In this paper, we examine how the above research target can be aided by blending scenarios of use and informal argumentation in the context of a structured technique referred to as Universal Access Assessment Workshop (UA2W). The rest of the paper is structured as follows. The next section describes the theoretical links of the present work and reviews the process and instruments facilitating universal access insight into early design activities. To this effect, UA2W is described in terms of: (a) underlying process, (b) design materials used to facilitate structured argumentation, and (c) primary outcomes. Then, the paper presents a case study carried out in the context of EC-funded project work. Finally, lessons learnt and experiences resulting from the case study are discussed and the paper is concluded with a summary and future work.

2. Universal access design and engineering practice

Universal access requires a deep understanding of the global execution context of tasks. This involves the designer in a complex and iterative interplay between reflection on prevailing practices (which may be sub-optimal) and the envisionment of anticipated or intended use across a variety of contexts. The main departure from traditional design paradigms, especially those prevalent in HCI, amounts to the fact that whereas HCI designers are concerned with revising tentative designs within the realm of a specified design vocabulary (i.e., the visual embodiment of the desktop, interaction elements of some mobile devices such as PDAs), universal access designers increasingly need to articulate proposals which cross over the boundaries of
a particular design vocabulary or design language (Winograd 1996, Akoumianakis and Stephanidis 2003). In other words, universal access designers should seek to develop proposals to reflect how a particular task is (or can be) executed by different users, under various conditions of use and using a variety of platforms or access terminals, as appropriate for a specific scenario of use. The question that now becomes relevant concerns the reference frame appropriate to inform and guide designers in pursuing universal access in the context of HCI design. In what follows, we provide a critical review of the body of knowledge related to universal access as consolidated in various disciplines.

2.1. Accessibility guidelines and engineering perspectives

In the recent history of HCI, there have been various developments contributing to an understanding of universal access. However, these developments are not tightly linked together into a concise and consolidated frame of reference. In particular, prevalent HCI design frames of reference, such as human factors and cognitive theories, have had little impact on the field of universal access, other than formulations of general principles and design guidelines for accessibility (Nicolle and Abascal 2001). However, there are several factors impeding the use of such guidelines in the context of universal access. The first limitation is related to the scope of currently available guidelines. By scope, we imply the type and range of accessibility issues that can be adequately addressed by available knowledge and the kind of solutions that can be generated. The vast majority of the existing accessibility guidelines have been formulated on the basis of formative experimentation with people with disabilities. Thus, despite their sound human factors content, in the majority of cases they offer disability-oriented recommendations, which cannot be generalised to form a base towards universal access design. Furthermore, their context-independent formulation, which is inherited from the context-free research protocol of the human factors evaluation paradigm, necessitates substantial interpretation before they can provide practically useful insight. Lack of structured and organised methods to facilitate interpretation impedes their use even further.

Secondly, experience indicates that the engineering perspective adopted determines the outcome of guideline interpretation. There are two such engineering perspectives (Stephanidis and Emiliani 1999). The first roots to the reactive protocol, whereby adaptations are introduced a posteriori to provide an alternative access system to be used by specific user categories. In the context of universal access, such an approach is clearly inadequate due to the inherent complexity, which renders any short-term benefits quickly outweighed by software updates, versioning, the radical pace of technological change, but also the short life-cycles of present day products. The alternative is to formulate guidelines resulting into systems that are inherently and by design accessible. In contrast to the former, the latter alternative is more in line with universal access, since it entails proactive engineering practices to alleviate rather than remedy accessibility problems (Stephanidis 2001b). However, with only few exceptions, it is claimed that the prevalent state of knowledge cannot facilitate such proactive accounts.

New research is needed to re-address the accessibility challenge in a more generic manner (i.e., universal access), which accounts not only for diversity in human abilities, but also diversity in the technological environment and the emerging contexts of use. In this context, the challenge is two-fold. On the one hand, there is a compelling need for process-oriented guidance on universal access, while on the other hand, the field should invest to develop methods that provide insights to, and take account of, the global execution contexts of tasks. To this effect, recent advances regarding more analytical perspectives into HCI design seem to offer useful insights, but they have not been explored in the relevant literature.

2.2. Scenario-based design

Scenarios as a resource for deliberation and exploration have long been used in the humanities and the social sciences to study human behaviour (Carroll 2000). More recently, they have also been used to advance a new analytical perspective on systems design and development. The techniques used in scenario-based design vary to reflect alternative roles and uses of scenarios. In a recent article, Hertzum (2003) makes this point more explicitly by pointing out that scenarios are currently used in object-oriented design (Jacobson 1995), requirements engineering (e.g., Jarke 1998), participatory design (Kyng 1995), and evaluation (e.g., Nielsen 1995), and that, depending on the purpose, scenarios will differ in contents, form and life cycle (Hertzum 2003: 219). Indeed, some of the basic dimensions for differentiating the use of scenarios are the purpose for which they are employed (e.g., illustration of problems as in requirements engineering, or exploration of alternatives as in strategic management), the role assumed by end users (e.g., observers versus participants) and the stage of the development lifecycle.
in which scenarios are used (e.g., early design vs. evaluation of a system).

In this paper, we will review scenario-based design as practiced in HCI. In this context, the scenario-based approach is conceived as a branch of action research, which advocates the use of scenarios as minimal resources for design insight and evaluation (Carroll and Rosson 1992, Carroll 1995). Analysing and working with scenarios in HCI is a complex activity, which iterates between several predominant stages, such as constructing scenarios, studying prevailing use, envisioning anticipated use and building design rationales.

Scenario formulation is the first critical step, for which various techniques can be applied. For example, one way is to gather designers in one or more brainstorming sessions (Tognazzini 1995). Alternatively, scenarios may be generated using material from observations (Beyer and Holzblatt 1998), or traditional techniques such as user profiling, task analysis, protocol analysis and interviews (Suri and Marsh 2002) or more recent techniques such as SPES (Situated and Participative Enactment of Scenarios) sessions (Iacucci and Kuutti 2002). Studying prevailing use entails an understanding of how users make use of the scenario artefacts. This is the stage where psychological theories of users’ needs embodied in the scenario artefacts (Carroll and Cambell 1989) are made explicit. One popular method to achieve this is through claims analysis (Carroll and Rosson 1992). Typically, claims are made about the usability and usefulness of particular artefacts. The next stage is envisioning anticipated use. This is a creative stage where claims analysis is used to derive design improvements, which are progressively materialised through low-fidelity prototypes and/or system mock-ups of envisioned tasks. As part of this stage, the initial scenario may be retooled (Erskine et al., 1997) to depict how specified tasks can be carried out with the proposed (improved) design artefacts. At the end, the initial scenario together with the claims analysis and any accompanying prototypes comprise the design rationale.

2.3. (Semi-) formal argumentation

A particular track of scenario-based design techniques makes use of argumentation techniques to provide the basis for structuring the scenario analysis process. Argumentation as an approach to design is not new. In the context of software design, it amounts to the development of methodologies and notations to improve the reasoning of designers. Rittel originated this approach in the Issue-Based Information System (IBIS) framework for argumentation (Rittel 1984). IBIS was a method developed as a language, and a graphical representation of debate and negotiation, which is central to the process of tackling a particular class of problems that he called ‘wicked problems’. IBIS made use of issues as a means for structuring argumentation. Options in IBIS reflect alternative design solutions to particular issues. Finally, arguments are used to formulate the pros and cons of the proposed solutions for a given issue. In recent years, the argumentation perspective was advanced further in the area of HCI, which led to the development of additional frameworks and semi-formal notations (for a review see Carroll and Moran 1996) for structuring arguments, communicating alternatives, documenting design reasoning and recalling attention into HCI design deficiencies.

3. Blending scenarios and informal argumentation: The ingredients of the UA²W method

The IS4ALL project (see Acknowledgments) has pursued the above lines of research in the context of Health Telematics (Stephanidis and Akoumianakis 2002). Specifically, the project adopts a scenario-based perspective on systems development (Carroll 1995, 2001), and in particular on requirements engineering through scenarios (Jarke et al. 1998). Scenarios in the context of IS4ALL are perceived as narrative descriptions of computer-mediated human activities in a Health Telematics environment. The social setting of a Health Telematics environment may be bound to a clinic within the hospital, a ward within a clinic or even to an end-user’s business or residential environment. The scope of such scenarios is intended to be narrow and focused on a very specific issue.

3.1. The use of scenarios

Scenario analysis entails a process of extracting and developing scenarios for two primary purposes: firstly, to obtain a detailed insight into the universal access requirements relevant to Health Telematics, and secondly, to demonstrate the validity and applicability of a code of practice being developed by IS4ALL (Stephanidis and Akoumianakis 2002). These scenarios are being formulated around an agreed common theme, namely electronic health records, through an iterative process. Initially, narrative descriptions of tasks, as carried out by actual users, are developed, and subsequently peer reviewed by users and health telematics professionals. This peer review acts as validity check to ensure that the scenarios depict realistic and valid accounts of computer-mediated human activities in Health Telematics. In the course of this iterative phase,
any system mock-ups, prototypes or other artefacts, which reveal aspects of the scenario’s real execution context, are taken into account. Once an initial formulation is compiled and agreed upon, scenarios are articulated in a way as to unfold various perspectives relevant to universal access. Scenario articulation is primarily an argumentative process.

3.2. Argumentation instruments

Two primary argumentation instruments for scenario articulation are supported, namely scenario screening and growth scenarios. Both mechanisms serve the purpose of extrapolating (some of) the universal access design considerations relevant to a particular scenario. Specifically, since our baseline is that universal access entails two prime concerns, namely understanding the global execution context of tasks and managing the design of artefacts suitable for different execution contexts, scenario screening is introduced to facilitate the former target, while growth scenarios are compiled to assist in attending the latter. In what follows, we provide a more elaborate account of these two instruments (see figure 1) and explain how they may be used to serve the intended purpose.

3.2.1. Scenario screening: Scenario screening assumes the availability of artefacts for review and discussion. It entails a structured process whereby implicit or explicit assumptions embedded in an artefact and related to the intended users, the implementation platform and the context of use, are identified and documented. Typically, scenario screening is a group activity, which is initiated and guided by an analyst. Participants may include representatives of end user communities, project managers, developers, etc., taking part in a collaborative activity in which participants converge to obtain a common understanding of what is at stake, by identifying implicit or explicit assumptions in the reference scenario. Various instruments, depending on the intended purpose, may facilitate screening of a scenario. For instance, scenario screening may be conducted as a co-operative inspection of a product using an agreed set of heuristics. Alternatively, it may involve a few experts assessing the product’s compliance to standards or a designated guideline reference manual. Finally, it may take the form of retooling (Erskine et al., 1997) of the reference scenario. In any case, scenario screening is intended to provide an interdisciplinary forum for exchanging knowledge, perspectives and experiences.

When employed to provide insight to universal access, the screening process assumes an agreed set of criteria or design heuristics against which the product is assessed. Their content and scope may vary depending on the aims of the exercise. For the purposes of our work, we have made use of universal access filters as a mechanism to support argumentation about a tentative design. In many ways, universal access filters are similar to questions used by other analytical HCI design techniques, such as Question, Options and Criteria (QOC) (MacLean et al. 1991). The filters could be applied to screen an existing system, or a prototype version of a system under development. The fidelity of the prototype is not of critical importance, as long as it conveys the intended concept and provides a reference for discussing intended use. Nevertheless, irrespective of their type, range or scope, universal access filters are unlikely to generate design solutions. Rather, they should be conceived as mechanisms for reflecting upon the presence or absence of certain quality attributes, considered as critical to universal access. By implication, scenario screening is not a creative design stage, but a structured mechanism for identifying and recording potential problems or breakdowns, which can then be addressed in a subsequent phase, through growth scenarios. As a concluding remark, it should be noted that identifying a suitable set of filters to unfold universal access insights is far from trivial. This is partially due to the lack of consolidated knowledge on universal access, but also due to the misunderstanding that is usually associated with the term.
3.2. Growth scenarios: In a subsequent phase, the assumptions revealed through screening are relaxed to facilitate envisioning and generation of new artefacts through compiling growth scenarios. Compiling growth scenarios is different from scenario screening in the sense that growth scenarios are instruments for envisioning rather than reflecting. Growth scenarios are formulated as a result of argumentation based on the assumptions identified in the course of screening the reference scenario. Argumentation is facilitated by addressing critical design issues or questions, such as ‘what if . . . the task was to be used by another user?’, ‘what if . . . the task was to be carried out through an alternative device?’ etc. Through such argumentation, the group reaches consensus on the new relevant task execution contexts, which in turn, is documented as growth scenarios comprising narrative description of envisioned activities and corresponding artefacts in the form of mocks ups or low fidelity prototypes.

3.3. The Universal Access Assessment Workshop (UA²W)

Scenario articulation through scenario screening and growth scenarios takes place in the context of a structured session called the UA²W, organised by an analyst. The technique seeks to bring together as many stakeholders as possible to identify the type and scope of universal access requirements for a particular product or service. From this perspective, UA²W is essentially a participatory technique in which participants may be experts (e.g., usability engineering experts, technology developers), project managers, end users (either current or prospective), or representatives of end users who are invited by a coordinating analyst to take part in the workshops. A UA²W may be organised to facilitate either scenario screening or the development of growth scenarios. Depending on the purpose, the analyst may choose to invite individuals with specific expertise. Thus, for instance end user representatives may take part in the screening phase, while prospective users may be invited to participate during the compilation of growth scenarios. In all cases, participants should be briefed either in advance or in the course of the first workshop on the procedure to be followed, the reference scenario, the design materials to be used in the course of the workshops (e.g., any artefacts, forms, etc., see below), and the specific objectives to be attained in each stage (e.g., screening versus compiling growth scenarios).

The results of the UA²W are documented in the Universal Access Assessment Form (UA²F) depicted in figure 2. For each entry in the ‘Universal access issues’ section of the UA²F, the design team develops a corresponding ‘growth’ scenario. All growth scenarios are subsequently consolidated and documented in a more abstract template referred to as the Universal Access Quality Matrix (UAQM) illustrated in figure 3. It is important to mention that the UA²W need not be a one-off event. Instead, it may take place several times to provide the required materials and design insight. In such cases, where the resources are available, at least one UA²W should be devoted to scenario screening, followed by a separate UA²W to accumulate growth scenarios. From the above, it follows that planning and organising the UA²Ws needed for a particular project is important and may act as a catalyst for subsequent phases.

![Figure 2. UA²F.](Image)
To this effect, critical questions to be addressed include:

- Ensuring appropriate stakeholder participation and understanding of the process.
- Making design documentation materials self-explanatory and available to all participants.
- Setting appropriate targets (i.e., scenario screening, growth scenarios) and conducting the UA²W sessions in such a way so as to facilitate the designated targets.
- Making effective use of resources (time, participant competences, etc).

Schematically, the iterative character of UA²W together with the various outcomes involved in the process (i.e., several instances of the UA²F, screening criteria, growth scenarios and the UAQM), are depicted in the diagram of figure 4. In the following section, we will describe how the above concepts and techniques have been used in the context of a case study from the domain of Health Telematics.

4. Case Study: The WARD-IN-HAND prototype

4.1. Overview

This part of the paper describes how the design process and techniques described earlier have been applied in the context of a case study, based on an early prototype system developed in the context of the WARD-IN-HAND project (Virtuoso and Dodero 2001, see also Acknowledgements). The project seeks to develop an information technology tool to assist healthcare professionals in the course of their daily activities. The project’s baseline is that most often doctors and nurses do not have easy and timely access to the patient’s information when they work at the ‘bedside’. Information is often recorded on paper and subsequently transcribed on paper for further processing. The solution sought is to replace the current procedures, based on manual transcription and transmissions of data, through using wireless connectivity and natural human-computer interfaces (e.g., such as speech-based interfaces), as complement to conventional data entry. In a meeting between IS4ALL and WARD-IN-HAND representatives, it was agreed that the establishment of bi-lateral contacts between the two projects would bring mutual benefits. A technical agenda was set to achieve the following goals:

- IS4ALL would provide comments to WARD-IN-HAND regarding the usability of the prototype; the comments would be documented in a usability report to be delivered in a timely fashion so that WARD-IN-HAND could implement some of the recommendations; details of this activity are reported in (Karabelas et al., 2003)
- WARD-IN-HAND would provide the necessary materials for IS4ALL to compile a representative scenario of use of the system; the scenario would subsequently be refined and expanded to facilitate a broader understanding of the execution context of designated tasks, using universal access methods.

In the remaining part of this paper, we describe how the latter objective was addressed, using the approach highlighted in the previous sections. Specifically, we describe an extract of the initial scenario, and in particular the intended execution context of designated tasks, and then illustrate how this scenario was refined.
and expanded using the argumentation instruments in the context of the UA²W. It is important to clarify that the application of the UA²Ws as well as the design proposals compiled were independent of the development life cycle of WARD-IN-HAND⁴.

4.2. Methods

In an attempt to define a preliminary resource for design deliberations, a detailed scenario was compiled in such a way as to provide an accurate account of the system’s intended use in real practice. The scenario was developed in two stages. The first stage entailed observation (by the authors) of a demonstration of the system, which was carried out by a WARD-IN-HAND representative in the course of a joint meeting. In this demonstration all possible tasks supported by WARD-IN-HAND were reviewed and discussed. In the second stage, a draft scenario depicting the authors’ understanding of the system’s use was developed. This resulted in a fairly substantial design document, which was confirmed and agreed upon by the WARD-IN-HAND representative in a sequence of message exchanges.

4.2.1. Developing and refining the scenario: The scenario described in this section is an extract from the larger WARD-IN-HAND reference scenario and, depicts activities such as searching for patient records and reviewing patient data. These tasks turned out to be both frequently occurring and prone to user error, as revealed during the demonstration and confirmed by the usability study (Karabelas et al. 2003). Based on this, the scenario selected for investigation is depicted in Exhibit 1.

It should be noted that the tasks designated in Exhibit 1 depict actual use of the system during the demonstration session. To reduce the scope of the case study, we have chosen not to present the user interfaces of tasks such as login procedures, authorisation and security measures, choice of language, etc, even though they are fully supported by the prototype. Instead, we focus on frequently re-occurring tasks, such as searching and reviewing patient records (see figure 5a, b); especially the interaction with the dialogue of figure 5c may take place several times for each patient.

Exhibit 1: Access to the health record of a patient

Dr Fred is preparing for his morning visit to the patients in the ward of the hospital. To assist him, he makes use of his iPAQ to access the WARD-IN-HAND service, which was recently installed in the hospital. As part of the log-in procedure, Dr Fred selects the preferred language and then specifies the user name and password. For this purpose the system displays an on-screen keyboard which allows Dr Fred to type in text by selecting characters from a selection panel. Upon successful log-in, the system presents the user with the main applications menu (see figure 5a). By this time Dr Fred is at the bedside of the first patient and can review the list of patients registered in the ward (see figure 5b). The doctor finds out the patient’s name and selects the corresponding record using the styles of the iPAQ to select from the list. Once a particular patient record is selected then the

Figure 5. WARD-IN-HAND screens to accessing a patient record.
doctor can initiate a range of tasks from the menu of figure 5c, such as clinical overview, admission details, treatments assigned, examinations ordered, etc.

4.2.2. Preparing and conducting UA²Ws

4.2.2.1. Participants: As already pointed out, UA²W can be organised with the intention either to filter out aspects of the scenario that limit universal access (i.e., scenario screening) or to envision future use and to develop design proposals in the direction of universal access (i.e., growth scenarios). Typically, the development of growth scenarios follows and responds to a thorough phase of scenario screening. In each case, the coordinating analyst may choose to invite individual stakeholders so as to ensure the highest possible contribution to the objective of the workshop. In our case, both phases of screening and compilation of growth scenarios were carried out in sequence by a team comprising one coordinating analyst who was one of the co-authors of this paper, one expert in accessible design, being the other co-author of this paper, one representative of the WARD-IN-HAND design team and one end user representative of WARD-IN-HAND (a doctor). The coordinating analyst was responsible for moderating the workshops, providing clarifications on the use of the methods, guiding the group at certain stages, filling-in the forms and carrying out the prototyping efforts needed. The rest of the participants would contribute from their own perspectives to the screening phase, and later on to the compilation of growth scenarios.

4.2.2.2. Scenario screening: In the screening phase, the coordinating analyst introduced the scenario extract to the UA²W participants and briefly described the process to be followed. The WARD-IN-HAND representative was asked to present the use of the system and to provide clarifications, if needed. Following this short introductory phase, the coordinating analyst introduced the current context of use of the system, the target users and the prevalent access terminal/platform providing the computational embodiment of the corresponding tasks. Specifically, it was pointed out that the prototype was implemented on an iPAQ and it was to be used by authorised professional users (either doctors or nurses) while moving around a ward (see figure 6).

Then to motivate and qualify the objectives of the screening stage, the analyst presented the basic idea of screening and the notion of universal access filtering. Example filters (see table 1) were introduced to motivate the participants’ thinking towards identifying constraints in particular tasks due to the effect of one or more filters. As a result of the exercise, the group compiled a list (see table 2 for examples) of use cases or user tasks (underlined segments in the transcripts of table 2), which the current implementation could not facilitate.

Consolidating these deliberations results into an improved understanding of the universal access requirements pertaining to the WARD-IN-HAND prototype. This is depicted in figure 7, which is an extension of the current situation illustrated previously in figure 6. Specifically, figure 7 depicts alternative execution contexts to be addressed through specific and potentially distinct growth scenarios. It is important to note that each cube (or alternative execution context) in the matrix necessitates separate treatment and design consideration, which may give rise to further refinement. For instance, a Web version of the WARD-IN-HAND system may facilitate access to electronic patient records by authorised users at home (i.e., patients or professionals). This makes ‘individualisation’ or ‘adaptability’ to different users’ a predominant concern (since the user could be doctors, nurses or patients), which in turn, may necessitate further refinement of the designated execution context to facilitate access by different categories of authorised users (e.g., people with disabilities, elderly, novices, experts).

At the end of the screening phase, three key universal access objectives were agreed for all task considered, namely:

- (Relevant parts of) the system should be used from outside the ward (e.g., the office or the home).
- (Relevant parts of) the system should be made available as a service over another platform, such as the Web.
- (Relevant parts of) the system should be accessible by patients, including patient’s with motor-impairments.
These were recorded in the corresponding UA²Fs of the respective tasks (see figure 8 for an example).

4.2.2.3. Growth scenarios: In this phase, the group considered each one of the three objectives of figure 8 with the intention of compiling growth scenarios. To this end, the relevant assumptions (see table 2) should be relaxed to facilitate the designated execution contexts. During the deliberations, it was pointed out that ‘making relevant parts of the system accessible from outside the ward’ does not require the compilation of a growth scenario as the current implementation can support the task, assuming that the iPAQ could be used outside the physical boundaries of the ward or the hospital by authorised users, irrespective of whether they are in duty or not. However, ‘making the service available over another platform’ and ‘allowing patients to access the system’ require the compilation of growth scenarios (see figure 9), as they cannot be facilitated by the current implementation.

Participants were encouraged to generate design proposals for new artefacts to facilitate the designated execution contexts, by relaxing the relevant assumptions.
Moreover, in doing so, they were advised to focus on crafting creative design solutions without being concerned with constraints, such as implementation cost, time to market, availability of resources to realise the design, etc., or any other factor which may impede the development process. This relieves participants from the temptation to settle for obvious design solutions, or emulating existing poor design, when novel and more powerful ones may be within their grasp.

Table 2. Examples of envisioned tasks not facilitated by the current prototype.

<table>
<thead>
<tr>
<th>Transcript</th>
<th>Possible solution</th>
<th>Implicit/explicit assumptions (related to the initial scenario)</th>
</tr>
</thead>
</table>
| '... a doctor wishing to search for a patient’s record to review results of a medical examination from a location outside the hospital (e.g. home) before visiting the patient in the ward, can not do, unless in duty ...' | * WARD-IN-HAND re-engineered so as to be accessed from a conventional desktop using the WWW  
* WARD-IN-HAND re-engineered so as to be accessed using a WAP phone | The policy of the hospital’s ward restricts access to WARD-IN-HAND only for doctors in duty  
The doctor may wish to initiate / carry out (emergency) tasks from a residential environment  
The doctor cannot take the iPAQ outside the ward / hospital, unless in duty |
| '... the current implementation does not allow authorised patients with motor impairments to access the system from a remote location (e.g. their residential environment) in order to enter medical data ...' | * The Web style could be implemented in such a way as to facilitate switch-based access | Patients have the technical infrastructure required to access their medical record from their residential environment  
Patients are authorized to enter medical data  
The ward/hospital offers to authorised users secure access to their medical record |

Figure 7. The global execution context of WARD-IN-HAND.

Figure 8. Extract of the UA^2F for the task ‘Locating a patient record’.
The group managed to agree on three growth scenarios depicting ‘scalability to different platforms (e.g. Web and WAP)’ and ‘adaptability to different user groups’. These growth scenarios were first drafted on paper and, once agreed, were subsequently prototyped. Specifically, figure 10 depicts an example of how the Web-based system could realise the task of searching for a patient using a conventional browser. Moreover, figure 11 depicts a Web style augmented with scanning, which allows a patient with motor-impairment to enter medical data and to update the electronic patient record. For more details on the design and implementation of the scanning technique for browsing, the reader is referred to (Stephanidis et al. 1998a). Finally, figure 12 illustrates how a doctor can review some personal information about the patient using a WAP phone.

5. Discussion

The UA\textsuperscript{2}W is a method, which shares common grounds with some prevalent HCI design methods, particularly within the cluster of participatory action research and collaborative inquiry (Carr and Kemmis 1986). Links also exist with recent developments in the field of software engineering, especially requirements engineering (Jarke 1998) and the study of software quality attributes (Barbacci et al. 2002), as far as choosing and setting filters is concerned. Nevertheless, the specifics of the method, such as its strong orientation towards scenario-based design, the techniques used for articulating scenarios for both design reflection (through screening) and design creativity (through compiling growth scenarios), as well as the design instruments used for this purpose (e.g., filters, UA\textsuperscript{2}F) distinguish it from other similar approaches. On the other hand, as with other similar proposals, the UA\textsuperscript{2}W assumes a number of pre-requisites, including: (i) sufficient preparation on behalf of the organisers; (ii) availability of a working (reference) scenario; and (iii) agreement and commitment of participants towards using the techniques and the instruments of scenario screening or filtering and compilation of growth scenarios. As discussed below, the above, although necessary ingredients for a successful application of the method, rely on additional competencies when it comes to implementing design decisions.

5.1. Organizer’s preparation

The organizer(s) of a UA\textsuperscript{2}W need to plan and structure the activity. Critical decisions in this effort are the choice of participants, the choice of the working scenario and the sequence in which the scenario articulation instruments are to be employed. Regarding participants or stakeholders in the UA\textsuperscript{2}W, it is important to ensure sufficient representation of different categories of end users, including current and prospective users resulting from a future implementation of growth scenarios. This will guarantee clear statements on requirements and underlying rationale for building universal access features into the product or service. Moreover, participants need to be informed about the
Figure 10. Search task using a WWW style.

Figure 11. Patient’s medical entry using an augmented WWW style accessible via the AVANTI browser (Stephanidis et al. 1998a).
overall process, the success check points and the stages involved, in order to facilitate a seamless transition from scenario screening to the compilation of growth scenarios. Circulation of suitable documents and support materials is important. Such documentation may include the agenda of the UA2W, the reference scenario (if available), design documentation forms (i.e., UA2F, the UAQM). In addition, a whole range of issues appearing as prominent success factors in other participatory action research and collaborative inquiry efforts (e.g., democratic decision making, sympathy and appreciation of different perspectives, conflict resolution, time spent) need to be taken into account when planning and executing a UA2W.

5.2. Working (reference) scenario

The choice of the reference scenario turns out to be very important. A successful scenario must reflect the users’ experience with a realistic system, described in a manner that conveys actual rather than intended use. One important consideration relates to the nature and scope of the reference scenario, which should make it amenable by universal access considerations. For some systems and corresponding scenarios, universal access may not be a suitable cause of action. For instance, an application running on a conventional computer in an operating theatre and intended to be accessed by the surgeon in the course of an operation is less likely to be amenable by universal access considerations than a community service which by definition should be accessed by all authorised users, anytime and anywhere. It is, therefore, critical to choose a suitable reference scenario and to define the scope of the intended intervention. Our experience with the WARD-IN-HAND prototype shows that in order to eliminate such potential problems, but also to speed up the conduct of the UA2Ws, the reference scenario needs to be agreed upon and confirmed by end users. Ideally, this is an activity, which should take place prior to the UA2W since it may involve several iterations and in some cases it may be time consuming. If this is possible, then the draft reference scenario should be documented and circulated and presented to the UA2W participants.

5.3. Using the instruments

Familiarisation with the prime techniques and instruments used during UA2Ws, namely scenario screening (or filtering) and growth scenarios, is also important to yield useful results. As already pointed out, scenario screening should precede the compilation of growth scenarios, so that the latter build upon the outcomes of filtering. As a general guideline, designers should seek to work on argumentation filters covering all three relevant aspects, that determine the global execution context of a designated set of tasks, namely the target users, the platform and the context of use. One approach to deriving suitable and informative filters is starting with relevant non-functional quality attributes and incrementally deriving a set of argumentation filters. For example, a non-functional quality attribute is ‘scalability’ to another platform, which may lead to argumentation filters regarding the delivery medium of an application or a service. Another approach is to formulate argumentation filters by consulting assessment manuals or human performance criteria. Examples of such argumentation filters were listed in table 1, e.g., ‘How is the task performed by a user who possesses alternative reliable control acts, such as movement of one/both hands, directed eye-gaze, etc. (see table 1)?’

In a similar fashion, one can devise argumentation filters on the basis of terminal- or platform-specific issues. Representative examples include: locating and accessing the terminal, card systems, keypads, typefaces and legibility, touch screens, screens and instructions, external features, labels and instructions, operating instructions, etc. Nevertheless, irrespective of the type or source of the designated set of argumentation filters, growth scenarios need to be tightly linked to this set.
This does not imply that there should be a growth scenario for each respective argumentation filter. Rather, growth scenarios may relate to several filters. By implication, designers should aim for a few representative growth scenarios satisfying the conditions of usage set by the argumentation filters.

6. Summary and concluding remarks

The paper has described a participatory scenario-based method and two analytical design-oriented techniques, for gaining insight to universal access. The method, called Universal Access Assessment Workshop (UA²W), and the two techniques, namely scenario screening and growth scenarios, are being developed and validated in the context of the IS4ALL Thematic Network funded by the EU IST Programme (see Acknowledgements). Their prime intention is to facilitate an understanding of the global execution context of a designated set of tasks, and thereby contribute towards a design code for practicing universal access. We have used these instruments to guide design work in a few reference cases, and one of them, namely the WARD-IN-HAND case study, was presented in this paper. From the accumulated experiences, several conclusions can be drawn, which are summarised below.

First of all, at the level of conceptualising universal access, a prime concern is seeking to obtain an understanding of the global execution context of tasks. This entails an explicit effort to explore spaces of design options unfolding (plausible) alternatives for access to applications and services anytime, anywhere and by any authorised user. Consequently, understanding the global execution context of a task engages designers in a feedback loop between reflection of current experiences and envisionment of new virtualities. The latter typically occurs as a result of addressing different user requirements, alternative technology platforms or access terminals, variety in the context of use or any plausible combination thereof. It stands to argue therefore that universal access is not to be measured only with regards to the outcomes of design, but, perhaps more importantly, in terms of the design processes engaged and the extent to which these processes allow for incremental updates and refinements.

Secondly, at the level of the methods presented in this paper, it can be argued that the entire approach raises several demands upon the analyst. Some of these relate to preparatory steps, such as finding the appropriate peers to become engaged in screening and growth scenario compilation, while others relate to the conduct of the screening or filtering phase. Our conclusion is that screening is essentially an argumentative stage where all participants should put forward and justify their propositions. This can be greatly facilitated by an appropriate choice of suitable argumentation (or universal access) filters. Nevertheless, deriving general-purpose and reliable filters is far from trivial and demands substantial experience on behalf of the design team. In any case, it is important to underline that the objective of the filtering exercise should not be to exhaustively list all explicit or implicit assumptions underpinning a tentative design. Instead, the target should be to reveal a relevant sub-set, which determine and undermine the user’s actual and/or foreseen experiences with the system. A useful guideline to follow is to structure the screening process around three main lines of argumentation, seeking to unfold the assumptions underpinning the current design in relation to the users of the system, the target platform and the assumed context of use. Growth scenarios constitute primarily a remedial mechanism whereby new execution contexts, and thereby artefacts, are envisaged by relaxing the assumptions revealed through screening. In this manner, the process of generating growth scenarios is systematised and linked to specific objectives. It stands to argue therefore that screening and the compilation of growth scenarios, bridge across two prominent design perspectives that of design reflection generated through screening with design envisionment.

Notes

1. The term ‘community’ is used in the present context to reflect the fact that research programmes on universal access, information society for all and universal usability are scaling-up to obtain international recognition, having own research agendas, technical and scientific forums (i.e. International Scientific Forum towards ‘An Information Society for all’ – ISF-IS4ALL, http://ui4all.ics.forth.gr/isfis4all/; ERCIM Working Group on ‘User Interfaces for all’ – UI4ALL, http://ui4all.ics.forth.gr/), publication channels (i.e., http://hci2003.ics.forth.gr/html/tracks/uahci.html and http://www.acm.org/sigchi/cuu/) and archival journals (i.e., http://link.springer.de/link/service/journals/10209/).
2. This could be the case when end users cannot directly participate (e.g., some categories of people with disability).
3. Thus, the propositions derived as a result of the exercise are not intended to replace or affect in anyway the technical direction followed by the project. Instead, they are intended to provide input to subsequent versions of WARD-IN-HAND (i.e. revisions and/or re-engineering after the project ends).
4. Note that the combination between Web and the ward (i.e., Web-based access to the ward information system) was not considered as a meaningful or potentially relevant execution context since it can be facilitated by the current implementation of the system.

5. This illustrates that universal access may entail non-technological issues, such as forming appropriate organisational norms and providing the necessary infrastructure to all intended users.

6. Relevant assumptions in this context are those having technical (rather than organisational) implications.

7. As indicated in the figure, the virtual keyboard in automatic scanning mode is used to allow a user with a functional or situational motor-impairment to carry out text editing (i.e., to enter a value for the text edit fields of the user interface).

Acknowledgements

The work reported in this paper has been carried out in the framework of the European Commission funded Thematic Network (Working Group) ‘Information Society for All’ – IS4ALL (IST-1999-14101) http://is4all.ics.forth.gr/. The IS4ALL Consortium comprises one coordinating partner, the Institute of Computer Science, Foundation for Research and Technology – Hellas (ICS-FORTH), and the following member organizations: Microsoft Healthcare Users Group Europe (MS-HUGE), European Health Telematics Association (EHTEL), Consiglio Nazionale delle Ricerche – Institute for Applied Physics ‘Nello Carrara’ (CNR-IFAC), Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V.–Institut für Angewandte Informationstechnik (FhG-FIT), Institut National de Recherche en Informatique et Automatique – Laboratoire lorrain de recherche en informatique et ses applications (INRIA) and Fraunhofer-Gesellschaft zur Foerderung der angewandten Forschung e.V.–Institut für Arbeitswirtschaft und Organization (FhG-IAO). Several other cooperating organizations participate as subcontractors. Finally, the authors would also like to explicitly acknowledge the co-operation with Salvatore Viruoso (TXT eSolutions Spa, Italy) Project Manager of WARD-INHAND. WARD-IN-HAND stands for Mobile Workflow support and Information distribution in hospitals via voice-operated, wireless-Networked HANDheld PCs and comprises of the following partners: British Maritime Technology Ltd., Universita degli Studi di Genova, Relational Technology S.A., Stadische Kliniken Offenbach, Universita degli Studi di Genova and Corporacio Sanitaria Clinic.

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