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User Requirements Elicitation for Universal Access

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15.1 Introduction

User requirements elicitation is a fundamental phase of the development process of interactive product and services. This is evident in the principles of user-centered design (Norman and Draper, 1986), and has led to the development and practice of a wide variety of methods and techniques, mostly originating from the social sciences, psychology, organizational theory, creativity and arts, as well as from practical experience (Maguire and Bevan, 2002). Many of these techniques are based on the direct participation of users or user representatives in the process of formulating their own technological needs. However, the vast majority of available techniques has been developed with the "average" able-bodied user and the working environment in mind.

In universal access this precondition no longer holds, and, as pointed out in Chapter 1 of this handbook, the basic design principle of "knowing the user" becomes "knowing the diversity of users." In this context, the issue of gathering and specifying user requirements needs to be revisited. First, the consideration of accessibility becomes of foremost importance to avoid exclusion from design. This is a difficult obstacle to overcome, because of the limited current experience of designers and developers in identifying and addressing accessibility issues and applying accessibility knowledge and guidelines in a user-oriented fashion (Zimmermann and Vanderheiden, 2008). Part II of this handbook provides an overview of the main accessibility issues related to various target user groups with disabilities.

Second, the issue arises of which methods and techniques can be fruitfully employed to gather user requirements for diversity, and how such techniques need to be used, revised, and modified to optimally achieve this purpose, also taking into account the wide variety of technologies and contexts of use intrinsic in universal access.

Previous work in this area has mainly addressed the design of specific technologies for disabled users. For example, the UserFit methodology (Poulson et al., 1996) addresses the user-centered design of assistive technologies, and integrates a variety of requirements elicitation methods, identifying the problems that arise in their application. These include obtaining a representative sample of users with different types of impairments, gathering precise and comprehensive information from users who may have communication difficulties, or may be tired or confused, using combinations of techniques, obtaining specialist advice to correctly apply a method and ensure successful feedback, and following ethical procedures when the participants are not able to give their consent.

Under a universal access perspective, the collection of user requirements is further complicated by the fact that, following a design for all approach, more than one group of users with diverse characteristics and requirements need to be taken into account and involved.

This chapter aims at analyzing, based on a review of the related literature, the main issues arising in the context of user requirements elicitation for universal access, taking into account diverse target user groups, and in particular motor-impaired

people, blind and visually impaired people, deaf people, people with cognitive or learning disabilities or with communication impairments, children and older users. The selection of groups is not exhaustive, and is not intended to address all the dimensions of diversity affecting the study of user requirements for universal access. For example, cultural issues are also of fundamental importance, as well as context diversity. However, it provides an overview of the variety of methods and of the complexity of the issues involved. Section 15.2 introduces the addressed user groups with respect to requirements elicitation. Section 15.3 overviews some popular and emerging user requirements elicitation methods, outlining the main issues that arise when each method is applied involving nontraditional user groups. Finally, Section 15.4 discusses the emerging need for a more systematic approach to user requirements analysis in universal access.

15.2 Target User Groups

15.2.1 Motor-Impaired People

The nature and causes of physical impairments are various; however, the most common problems faced by individuals with physical impairments include poor muscle control, weakness, and fatigue; difficulty in walking; talking, seeing, speaking, sensing or grasping (due to pain or weakness); difficulty reaching things; and difficulty doing complex or compound manipulations (push and turn) (Vanderheiden, 1997; see also Chapter 5, "Motor Impairments and Universal Access"). Individuals with severe physical impairments usually must rely on assistive devices, and the most commonly used assistive devices include mobility aids, manipulation aids, communication aids, and computer-interface aids (Vanderheiden, 1997).

As a result, the involvement of motor-impaired users in the requirements elicitation process mainly presents practical and organizational problems, which may, however, hamper the results. For example, access to buildings, as well as user transportation issues, should be taken into account. Furthermore, the physical fatigue that might be provoked in testing or discussion sessions should be also taken into account. It is imperative that hardware and software accessibility requirements are included in the investigation, especially for users who have motor impairments of upper limbs.

15.2.2 Blind and Visually Impaired People

Blindness means anatomic and functional disturbances of the sense of vision of sufficient magnitude to cause total loss of light perception, while visual impairment refers to any deviation from the generally accepted norm (see Chapter 6, "Sensory Impairments," for a thorough discussion of blindness and visual impairments). Visual acuity of an individual may vary from very poor vision to awareness of light but not of shapes, to no perception of light at all (Vanderheiden, 1997). Low vision includes problems (after correction) such as dimness of vision, haziness, film over the eye, foggy vision, extreme near- or farsightedness, distortion of vision, spots before the eyes, color distortions, visual field defects, tunnel vision, no peripheral vision, abnormal sensitivity to light or glare, and night blindness.

Therefore, all the written material that may be used during requirements elicitation should be provided to blind and visually impaired users in the appropriate form. In more detail, blind users should be provided with such material either in Braille, if they are familiar with the Braille language, or in accessible electronic form, if they use computers and assistive hardware and software. Low-vision participants would benefit from printouts in large fonts and high text versus background contrast. When addressing color-blind participants, it should be ensured that semantic information is provided with the use of appropriate typography and not through color.

In addition, in group discussion techniques, the facilitator should make sure that all the material that is presented is explained to blind and visually impaired people orally.

15.2.3 Deaf People

Hearing impairment includes any degree and type of auditory disorder, on a scale from slight to extreme (see Chapter 6, "Sensory Impairments"). Familiar coping strategies for hearing-impaired people include the use of hearing aids, sign language, lip-reading, and telecommunication devices for the deaf (TDDs) (Vanderheiden, 1997). Furthermore, for individuals whose deafness occurred prelingually, it may also affect speech, as prelingually deaf persons can learn to speak, but their speech is usually difficult for most people to comprehend (Schein, 1981).

Consequently, to allow deaf participants to communicate effectively during a user requirements elicitation approach, sign language translators will be needed and the group participants should be instructed to speak at an appropriate pace, providing translators the needed time. In the methods in which only the deaf participant and the facilitator are involved, a sign language translator may not be necessary if the user is comfortable with lip reading. Finally, since many people with hearing disabilities from birth have problems with reading and writing (see also Chapter 38 of this handbook), any written material should be kept as simple as possible.

15.2.4 People with Cognitive or Learning Disabilities and People with Communication Impairments

Cognitive disability entails a substantial limitation in one's capacity to think, including conceptualizing, planning, and sequencing thoughts and actions, remembering, interpreting subtle social cues, and understanding numbers and symbols. Cognitive disabilities can also stem from brain injury, Alzheimer's disease and dementia, severe and persistent mental illness, and stroke (see also Chapter 7 of this handbook). Therefore, cognitive disabilities are many and diverse, individual differences are often very pronounced for this user group, and

it is particularly difficult to abstract and generalize the issues involved in researching user requirements for this part of the population.

An approach that has been found to be effective for addressing this lack of generalizability problem is to work with a small number of users initially, designing a system targeted to their needs, and subsequently evaluating the system with a broader group (Moffat et al., 2006).

The user requirements collection process may be very complex, given the communication difficulties between the design team and the involved participants. Multidisciplinary teams may be required for working with these users, involving psychologist, language therapist, and other rehabilitation specialists. Very often, design methods are preferred that do not require the direct involvement of users in requirements analysis. Alternatively, relatives and caretakers are also involved as proxies for design input (e.g., Fischer and Sullivan, 2002).

Newell et al. (2002) point out the serious ethical implications related to the involvement of people with cognitive disabilities in the design process (e.g., in obtaining informed content), suggesting that the standard user-centered design methodology is not appropriate for this target user group, and proposes user-sensitive inclusive design as an approach targeted to capturing individual differences related to disability, and in particular cognitive dysfunctions.

For some particular subgroups, the direct involvement in the user requirements elicitation process has been investigated thoroughly. For example, Francis et al. (2009) discuss the issue of involving users with autism and Asperger's in the design of assistive technologies. One of the main identified problems concerns the potential for misunderstandings and the difficulties in clarifying misconceptions. Limited communication and cognitive skills may render the process complex. Fear of failure and lack of motivation may also make it particularly difficult to engage people with autism or Asperger's syndrome in the design process.

The difficulties of conducting research with adult individuals with learning disabilities are discussed in Hall and Mallalieu (2003). This user group is considered in some aspects similar to children, in particular regarding limited awareness of software application potential, communications difficulties (including low literacy levels), high willingness to agree with the analyst, and potentially limited social and interaction abilities. Finally, Astell et al. (2008) discuss particular difficulties that arise in involving people with dementia in the design process. These include obtaining informed consent, determining their requirements, eliciting their views, and evaluating prototype systems. In addition, there are difficulties related to including both family caregivers and professional care staff in the development process.

15.2.5 Children

Nowadays, children are exposed from a very early age to a wide range of technologies, including multimedia systems, electronic toys and games, and communication devices. They are immersed in media from their first steps. A survey contacted by the Henry J. Kaiser Family Foundation showed that in the United States nearly half (48%) of all children 6 years old and under have used a computer, and more than one in four (30%) have played video games. By the time they are in the 4-to-6-year-old range, 7 out of 10 have used a computer (Rideout et al., 2003). The market of children's toys includes a plethora of computer programs and electronic games with complex interfaces and interaction systems that are designed and developed specifically for children. This high level of exposure to technologies from such early ages renders the assumption that today's children will become tomorrow's power users of every technological advancement safe and logical.

The emergence of children as an important new consumer group of technology dictates the importance of supporting them in a useful, effective, and meaningful way for their needs. Designing for all should take into account that children have their own likes, dislikes, curiosities, and needs that are different from adults. Therefore, children should be regarded as a different user population with its own culture and norms (Heller, 1998).

However, gathering user requirements from this group is not an easy task, and bringing them into the designing process is even more complicated. The difficulty in the process arises from several factors. Children go to school for most of their days; there are existing power structures, biases, and assumptions between adults and children that need to be overcome, and children often have difficulty expressing their opinions and thoughts, especially when it comes to abstract concepts and actions (Druin, 2002).

Since the 1990s, there has been a growth of literature about children and human-computer interaction (HCI) issues, and the active involvement of children in the technology development process has been investigated (Druin, 1999b). Apart from the traditional means of gathering user requirements, a few other novel approaches have been developed and used in projects involving children. Section 15.3.12 of this chapter describes two case studies that used such nontraditional techniques.

15.2.6 Older People

There is overwhelming evidence that the population of the developed world is aging. The European Commission has predicted that between 1995 and 2025 the United Kingdom alone will see a 44% rise in people over 60, while in the United States the baby boomer generation, which consists of about 76 million people and is the largest group ever in the United States, is heading toward retirement (Marquis-Faulkes et al., 2005; see also Chapter 8 of this handbook). This large and diverse in its physical, sensory, and cognitive capabilities user group can benefit from technological applications that can enable them to retain their independent living, and ultimately reduce healthcare expenditure.

However, gathering requirements from this group can be a complex and difficult process. On the one hand, age-related impairments are sensitive personal matters that users are

reluctant to discuss. Older adults also often exhibit a fundamental mistrust of technologies in general, which makes them reluctant to participate in design experiments (Newell et al., 2007). On the other hand, designers and developers of technology often have difficulty grasping the extent of the effects that age-related impairments have in the everyday activities of older people. To overcome these difficulties, researchers have been adapting and adjusting existing traditional design techniques so that they ease the process of involving this user group in the early stages of the design process. Section 15.3.11 describes examples of techniques that managed to successfully involve the users in the design process and proved to be a positive experience rich in lessons learned for everyone involved.

15.3 An Overview of User Requirements Elicitation Methods and Techniques

This section provides an overview of established as well as more recent approaches to user requirements elicitation. Based on a literature search, those aspects of each method and techniques that affect its application in the context of universal access are discussed.

In practice, more than one of these methods is usually employed in a design case. The choice can be dictated by several criteria, including the suitability of each method to be used with the involvement of users with specific characteristics, abilities, or limitations. Another relevant consideration is that in universal access many potential users of new technologies may be nonusers of current technologies, or may not even be familiar with technology at all. In this case, it is important that the selected methods do not require from the users previous experience with similar systems.

15.3.1 Brainstorming

Brainstorming, originated from early approaches to group creativity (Osborn, 1963), is a process where participants from different stakeholder groups engage in informal discussion to rapidly generate as many ideas as possible. All ideas are recorded, and criticism of ideas forbidden. This technique is often used in the early phases of design to set the preliminary goals for a project or target system. One of the advantages of using brainstorming is that it promotes freethinking and expression, also among involved users, and allows the discovery of new and innovative solutions to existing problems. Brainstorming can be supported by various technological means, the most common of which are video (Mackay, Ratzer, and Janecek, 2000) and group support systems (Davison, 2000).

Moffat et al. (2004) discuss the use of brainstorming techniques with users with aphasia. Discussion support through the use of images can be useful in some cases, depending on the expression abilities of the involved users. Brainstorming is also often used to gather initial design goals and ideas with the involvement of relatives and caretakers, leaving the direct involvement of users to subsequent design phases when some prototype can be shown to them.

Overall, brainstorming can be considered as appropriate when the users to be involved have good communication abilities and skills (not necessarily verbal), but can also be adapted to the needs of other groups. This may have implications in terms of the pace of the discussion and generation of ideas.

15.3.2 Direct Observation

Popular methods of exploring the user experience come from field research in anthropology, ethnography, and ethnomethodology (Beyer and Holtzblatt, 1997). Ethnographic methods are based on four basic principles (Blomberg et al., 2002):

- *Natural settings*: The foundation in ethnography is field work, where people are studied in their everyday activities.
- *Holism*: People's behaviors are understood in relation to how they are embedded in the social and historical fabric of everyday life.
- *Descriptive*: The ethnographers describe what people actually do, not what they should do. No judgment is involved.
- *Members' point of view*: The ethnographers create an understanding of the world from the point of view of those studied.

Direct observation is one of the hallmark methods of ethnographic approaches. It involves an investigator viewing users as they conduct some activity. The goal of field observation is to gain insight into the user experience as experienced and understood within the context(s) of use. Examining the users in context is claimed to produce a richer understanding of the relationships between preference, behavior, problems, and values.

Observation sessions are usually video-recorded, and the videos are subsequently analyzed. A less effective alternative is taking notes. This technique is often used in conjunction with others, such as interviews and diaries (see following subsections). Obtaining the cooperation of users is vital, so the interpersonal skills of the observer are important. The observer needs to be unobtrusive during the session, and only pose questions when clarification is necessary. The effectiveness of observation and other ethnographic techniques can vary, as users have a tendency to adjust the way they perform tasks when knowingly being watched. Davies et al. (2004) make a sound case for field studies and direct observation when designing with users with cognitive disabilities or aphasia, as this method does not rely on the participants' communication abilities. Similar observations may hold for people with autism. Ethnography, therefore, appears to be a valuable component of any user-centered or participative design activity with this group.

Shinohara (2006) reports on the use of observational studies with blind users to develop design insights for enhancing

interactions between a blind person and everyday technological artifacts found in their home such as wristwatches, cell phones, or software applications. Analyzing situations where workarounds compensate for task failures reveals important insights for future artifact design for the blind, such as, for example, tactile and audio feedback, and facilitation of user independence.

A difficulty with direct observation studies is that they may in some cases be perceived as a form of invasion of the users' space and privacy, and therefore may not be well accepted, for example, by disabled or older people who are not keen to reveal their problems in everyday activities.

15.3.3 Activity Diaries and Cultural Probes

Diary keeping is another ethnographically inspired method that provides a self-reported record of user behavior over a period of time (Whyte, 1984). The participants are required to record activities they are engaged in during a normal day. Diaries allow identifying patterns of behavior that would not be recognizable through short-term observation. However, they require careful design and prompting if they are to be employed properly by participants. Diaries can be textual, but also visual, employing pictures and videos.

Generalizing the concept of diaries, cultural probes, which originated in the traditions of artist-designers (Andreotti and Costa, 1996), are based on kits containing a camera, a voice recorder, a diary, postcards, and other items (Gaver et al., 1999). Cultural probes are claimed to allow the users great freedom and control over the self-reporting process, and have been successfully employed for user requirements elicitation in home settings with sensitive user groups, such as former psychiatric patients and the elderly (Crabtree et al., 2003).

Reading and writing a paper-based diary may be a difficult process for blind users and users with motor impairments. Therefore, diaries in electronic forms or audio-recorded diaries should be used in these cases. Lazar et al. (2007) report on a case study where electronic diaries were successfully used to investigate the causes of frustration of blind users when accessing the web through screen readers.

15.3.4 Surveys and Questionnaires

User surveys, originating from social science research (Alreck and Settle, 1995), involve administering a set of written questions to a sample population of users, and are usually targeted to obtaining statistically relevant results. Questionnaires are widely used in HCI, especially in the early design phases. Questionnaires need to be carefully designed to obtain meaningful results (Oppenheim, 2000). Questions may be closed with fixed responses and open where the respondents are free to answer as they wish. Various scales are used in questionnaires for the users to rate their responses. The simple and comprehensible formulation of questions is vital. Questions must also be focused to avoid gathering large amounts of irrelevant information.

Questionnaires can be administered in several ways, for example, by post, e-mail, or the web, and the effectiveness of mail versus web-based questionnaires has been largely discussed in the literature (Andrews et al., 2003).

Research shows that there are age differences in the way older and younger people respond to questionnaires. For example, older people tend to use the "Don't know" response more often than younger people. They also seem to use this answer when they are faced with questions that are complex in syntax. Their responses also seem to avoid the extreme ends of ranges. Researchers have found ways around this problem. For example, Eisma et al. (2004) found that having the researcher administer the questionnaire directly to the user helped to retrieve more useful and insightful information. Dickinson et al. (2002) found that in-home interviews were effective in producing a wealth of information from the user that could not have been obtained by answering a questionnaire alone.

Since questionnaires and surveys address a wide public, and it is not always possible to be aware of the exact user characteristics (i.e., if they use Braille or if they are familiar with computers and assistive hardware and software), they should be available either in alternative formats or in accessible electronic form. An example of an accessible questionnaire design process is described in a survey conducted to elicit the requirements of disabled users regarding e-Government services (Margetis et al., 2008).

15.3.5 Interviews

Interviews are another ethnographically inspired user requirements collection method (Gubrium and Holstein, 2002). In HCI, it is a commonly used technique where users, stakeholders, and domain experts are questioned to obtain information about their needs or requirements in relation to a system (Macaulay, 1996). Interviews can be unstructured (i.e., no specific sequence of questions is followed), structured (i.e., questions are prepared and ordered in advance), or semi-structured (i.e., based on a series of fixed questions with scope for the user to expand on their responses). The selection of representative users to be interviewed is important to obtain useful results. Interviews on a customer site by representatives from the system development team can be very informative. Seeing the environment also gives a vivid mental picture of how users work with existing systems and how a new system can support them (Mander and Smith, 2002).

In Smith-Jackson et al. (2003), a case study is reported involving blind and motor-impaired users in semistructured interviews. The objective of the study was to identify accessibility issues in mobile phones. In this study, the questions in the interview were associated to brief scenarios (see Section 15.3.9) illustrating features and functionalities of mobile phones to the users who were not familiar with them. Overall, the experience is reported to be positive.

With older people, interviews as a means for gathering user requirements have also proven to be an effective method, but

in-house interviews can be even more productive, because they tend to lead to spontaneous excursions into users' own experiences, and demonstrations of various personal devices used (Eisma et al., 2004). Careful sequencing and delivery of simple sentence structures that avoid the use of abstract concepts is recommended. Obviously, interviews present difficulties when deaf people are involved, and sign language translation may be necessary. Interviews are often avoided when the target user group is composed of cognitively and communication-impaired people.

Recently, a trend to conduct interviews online using chat tools has been emerging. Crichton and Kinash (2003) report on the application of this method with blind users. An obvious consideration in this respect is that the used chat tool must be accessible and compatible with screen readers.

15.3.6 Group Discussions

Focus groups are inspired from market research techniques (Greenbaum, 1998). They bring together a cross-section of stakeholders in a discussion group format. The general idea is that each participant can act to stimulate ideas, and that by a process of discussion, a collective view is established (Bruseberg and McDonagh-Philp, 2001). Focus groups typically involve 6 to 12 persons, guided by a facilitator. Several discussion sessions may be organized.

The main advantage of focus groups regarding requirements elicitation from users with disabilities is that it does not discriminate against people who cannot read or write and they can encourage participation from people reluctant to be interviewed on their own or who feel they have nothing to say (Kitzinger, 1995). During focus groups, various materials can be used for review, such as, for example, storyboards (see Section 15.3.9).

Organizing a group discussion that includes participants with disabilities requires a considerable amount of preparation and is dependent on each participant's communication skills (Poulson et al., 1996). This method should not be employed for requirements elicitation if the target user group has severe communication problems. Moreover, it is important that the discussion leader manages effectively and efficiently the discussion, allowing all users to actively participate in the process regardless of their disability.

Focus groups have been used for eliciting expectations and needs from the learning disabled, as it was felt that they would result in the maximum amount of quality data. They allow a range of perspectives to be gathered in a short time period in an encouraging and enjoyable way. This is important, as typically people with learning disabilities have a low attention span. The satisfaction of the participants is also an important factor to be taken into account (Hall and Mallalieu, 2003).

Concerning older people, related research has found that it is not easy to keep a group of older people focused on the subject being discussed. Participants tend to drift their discussions off the subject matter as for them the focus group meeting is a chance to socialize. Thus, it is important to provide a social gathering as part of the experience of working with IT researchers rather than to treat them simply as participants (Newell et al., 2007).

Kurniawan (2006) reports on a focus group study on the use of mobile phones by women aged 60 years and over. The study addresses usage patterns, problems, benefits, ideal phone design, and desired and unwanted features, as well as cooperative learning processes when encountering an unfamiliar mobile phone.

The findings of the focus groups were used for elaborating a survey questionnaire to obtain quantitative data.

15.3.7 Empathic Modeling

Empathic modeling is a technique intended to help designers and developers put themselves in the position of a disabled user, usually through disability simulation. This technique has been first applied to simulate age-related visual changes in a variety of everyday environmental tasks, with a view to eliciting the design requirements of the visually impaired in different architectural environments (Pastalan, 1982). Empathic modeling can be characterized as an informal technique, and there are no specific guidelines on how to use it.

A variety of modeling techniques for specific disabilities through simple equipment are available (Poulson et al., 1996; Nicolle and Maguire, 2003; Fulton et al., 2005). Visual impairment due to cataracts can be simulated with the use of an old pair of glasses with Vaseline, while total blindness is easier to simulate using a scarf or a bandage tied over the eyes. Total hearing loss, on the other hand, can be easily simulated using earplugs. Furthermore, software application simulating visual and hearing impairments have been developed to help designers understand the interaction difficulties experienced by users (Goodman et al., 2007).

Some upper limb mobility impairments can be simulated with the use of elastic bands and splints, while others, such as lack of motor control, are quite difficult to simulate. Cognitive disabilities are also particularly difficult to simulate (Svensk, 1997). Simulators can also only communicate certain aspects of what it is like to have a disability, failing, for example, to account for context, support, and coping strategies (Goodman et al., 2006). A set of flexible and graded simulators for vision, dexterity, and reach and stretch is discussed in Cardoso and Clarkson (2006).

15.3.8 User Trials

In user trials, a product is tested by "real users" trying it out in a relatively controlled or experimental setting, following a standardized set of tasks to perform. User trials are performed for usability evaluation purposes (see Chapter 20, "The Evaluation of Accessibility, Usability, and User Experience"). However, the evaluation of existing or competitive systems, or of early designs or prototypes, is also a way to gather user requirements (Maguire and Bevan, 2002). While there are wide variations in where and how a user trial is conducted, every user trial shares some characteristics (Dumas and Redish, 1993). The primary goal is to

improve the usability of a product having participants who are representative of real users to use the product carrying out real tasks while being observed, and the data that are collected are later analyzed. In field studies, the product or service is tested in a "real-life" setting.

Most of the related concerns regarding users with disabilities have already been mentioned in other requirements elicitation methods, such as user observation and focus groups. In user trials, however, an appropriately equipped room needs to be available for each session. When planning the test, it should be taken into account that trials with older users and users with disabilities may require more time than usual to complete the test without anxiety and frustration.

Research on the use of the most popular methods has indicated that modifications to well-established user trial methods are necessary when users with disabilities are involved. For example, two studies (Chandrashekar et al., 2006; Roberts and Fels, 2006) explore the required adaptations to the think-aloud protocol that have to be applied when carrying out user trials with deaf users and blind users respectively.

Furthermore, it is very important to explicitly emphasize during the instructions that it is the product that is being tested and not the user (Poulson et al., 1996), since a trial may reveal serious problems with the product, to the extent that some tasks may not be possible to carry out. Therefore, it is important that the users do not feel uncomfortable or attribute the product failure to their disability.

Finally, when the user trial participants are users with upper limb motor impairments and poor muscle control, it should be ensured that testing sessions are short, so as to prevent excessive fatigue.

15.3.9 Scenario, Storyboards, and Personas

Scenarios are widely used in requirements elicitation and, as the name suggests, are narrative descriptions of interactive processes, including user and system actions and dialogue. Scenarios give detailed realistic examples of how users may carry out their tasks in a specified context with the future system (Carroll, 1995, 2000). The primary aim of scenario building is to provide examples of future use as an aid to understanding and clarifying user requirements and to provide a basis for later usability testing. Scenarios can help identify usability targets and likely task completion times.

Storyboards are graphical depictions of scenarios, presenting sequences of images that show the relationship between user actions or inputs and system outputs. Storyboarding originated in the film, television, and animation industry (Hart, 1998). A typical storyboard contains a number of images depicting features such as menus, dialogue boxes, and windows. Storyboards may vary regarding the level of detail, the inclusion of text, the representation of people and emotions, the number of frames, and the way time-passing is indicated (Truong et al., 2006). Storyboards can be developed using various tools (e.g., Microsoft PowerPoint and similar software).

Another scenario-related method is called personas (Cooper, 1999), where a model of the user is created with a name, personality, and picture, to represent each of the most important user groups. The persona model is an archetypal representation of real or potential users. It is not a description of a real user or an average user. The persona represents patterns of users' goals and behavior, compiled in a fictional description of a single individual. Potential design solutions can then be evaluated against the needs of a particular persona and the tasks users are expected to perform.

The scenario approach was used in Antona et al. (2007) as a vehicle to discuss potential benefits and challenges of ambient intelligence (AmI) for disabled people. In this case study, generic AmI scenarios were re-elaborated by considering modifications occurring in the case that the principal character in each scenario has some disability.

Zimmermann and Vanderheiden (2008) propose a methodology based on the use of scenarios and personas to capture the accessibility requirements of older people and people with disabilities and structure accessibility design guidelines. The underlying rationale is that the use of these methods has great potential to make this type of requirement more concrete and comprehensible for designers and developers who are not familiar with accessibility issues.

According to Goodman et al. (2006), however, really reliable and representative personas can take a long time to create. Additionally, personas may not be well suited to presenting detailed technical information, for example, about disability, and their focus on representative individuals can make it more complex to capture the range of abilities in a population (see also Chapter 19, "Tools for Inclusive Design").

The use of storyboarding with disabled or older users does not appear to be common. However, it is self-evident that storyboarding is not optimal for blind users, while it requires particular care for users with limited vision or color-blindness. On the contrary, it would appear to be a promising method for deaf or hearing-impaired users.

15.3.10 Prototyping

A prototype is a concrete representation of part or all of an interactive system. It is a tangible artifact, does not require much interpretation, and can be used by end-users and other stakeholders to envision and reflect upon the final system (Beaudouin-Lafon and Mackay, 2002). Prototypes serve different purposes and thus take different forms. Off-line prototypes (also called paper prototypes) include paper sketches, illustrated storyboards, cardboard mockups, and videos. They are created quickly, usually in the early stages of design, and are usually thrown away when they have served their purpose. Online prototypes, on the other hand, include computer animations, interactive video presentations, and applications developed with interface builders. Prototypes also vary regarding their level of precision, interactivity, and evolution. With respect to the latter, rapid prototypes are created for a specific purpose and then thrown away, iterative

prototypes evolve, either to work out some details (increasing their precision) or to explore various alternatives, and evolutionary prototypes are designed to become part of the final system.

Collaborating on prototype design is an effective way to involve users in design (see Section 15.3.11). Prototypes help users articulate their needs and reflect on the efficacy of design solutions proposed by designers.

Research has indicated the use of prototypes is more effective than classic methods for user requirements elicitation, such as interviews and focus groups, when designing innovative systems for people with disabilities, since potential users may have difficulty imagining how they might undertake familiar tasks in new contexts (Petrie et al., 1998). Using prototypes can be a useful starting point for speculative discussions, enabling users to provide rich information on details and preferred solutions (Engelbrektsson et al., 2004).

Prototypes are usually reviewed through user trials (see Section 15.3.8), and therefore all considerations related to user trials and evaluation are pertinent. An obvious corollary is that prototypes must be accessible to be tested with disabled people. This may be easier to achieve with online prototypes, closely resembling the final system, than with paper prototypes.

15.3.11 Cooperative and Participatory Design

Cooperative inquiry is a partnership design process that has its roots in the Scandinavian projects of the 1970s (Bodker et al., 1988). Since its introduction, cooperative inquiry as a method has been adapted and expanded, and examples of its practices can be found throughout the literature of the human-computer interaction field.

Likewise, the participatory design approach has its roots in the Scandinavian workplace democracy movement and is a set of theories, practices, and studies related to end-users as full participants in activities that lead to the development and design of technology (Muller, 2002). Participatory design may adopt a wide variety of techniques, including brainstorming, scenario building, interviews, sketching, storyboarding, and prototyping, with the full involvement of users.

Traditionally, partnership design techniques have been used for gathering user requirements from adult users. However, in the past few years a number of research projects have shown ways to adapt these techniques to benefit the design of technology process for nontraditional user groups, such as children and the elderly.

Cooperative inquiry has been widely used to enable young children to have a voice throughout the technology development process (Druin, 1999a, 1999b, 2002), based on the observation that although children are emerging as frequent and experienced users of technology, they were rarely involved in the development process. In these efforts, alterations were made to the traditional user requirement gathering techniques used in the process to meet the children's needs. For example, the adult researchers used note-taking forms, whereas the kids used drawings with small amounts of text to create cartoonlike flow charts. Overall, involving children in the design process as equal partners was found to be a very rewarding experience and one that produced exciting results in the development of new technologies (Druin, 1999a).

Designing technology applications to support older people in their homes has also shown an increase in necessity as the developed world is aging. However, designing for this group of users is not an easy process as developers and designers often fail to fully grasp the problems that this user group faces when using technologies that affect their everyday lives. HCI research methods need to be adjusted when used on this user group. They have to take into consideration that older adults experience a wide range of age-related impairments, including loss of vision, hearing, memory, and mobility, which ultimately also contribute to a loss of confidence and difficulty in orientation and absorption of information (Zajicek, 2006; see also Chapter 8 of this handbook). Participatory design techniques can help designers reduce the intergenerational gap between them and older people, and help them better understand the needs of this group of users (Demirbileka and Demirkan, 2004). When older people participate in the design process from the start, their general fear toward using technology decreases, because they feel more in control and confident that the end result of the design process has truly taken their needs into consideration.

Wu et al. (2004) discuss the adoption of participatory design to involve users with amnesia. A set of reviewing techniques for reducing the demands made on explicit memory during the design process were developed and applied. Overall, the investigation conducted has allowed for identifying assumptions of participatory design that have been established with normal cognitively functioning populations, and to devise more flexible and supporting ways of conducting participatory design.

15.3.12 Recent and Emerging Approaches

In recent years, specific approaches and techniques targeted to nontraditional user groups have emerged, often reported through design case studies. The main goal of these techniques is to immerse the user group inside the technology design process from its early stages as an active member and not just as an informant, or a tester. This section overviews some of them.

The KidReporter method (Bekker et al., 2003) aims mainly at enabling children to contribute their opinion to a design problem through a choice of activities that finally results in a newspaper with the children's ideas about a topic. KidReporter was used in the context of a project whose aim was to design an electronic educational interactive game for a zoo. Two classes of children ages 9 and 10 participated in making a newspaper about a zoo. The researchers gathered information from children about their interests in the zoo, through activities such as making photos and descriptions of the photos, holding interviews, writing articles, and filling in questionnaires. Some teachers and parents assisted in supervising the various tasks that the children participated in.

The outcome of the implementation of the KidReporter method indicated that even though it requires a lot of planning, it brings benefits that definitely outweigh the difficulties. Its main strengths are that it is appealing and fun for children, and that the submethods for gathering information make it possible to make stronger inferences about children's opinions.

Mission from Mars (Dindler et al., 2005) is another novel approach targeted to children, which has been applied in the early phases of the development process of an electronic school bag. The method's main goal is to provide a framework for questioning specific user requirements according to elements in children's practices. The design process emphasizes fun and playfulness, facilitated by the notion that children are talking to a Martian. Seven children ages 10 and 11 and five members of the design team participated in a 3-hour session. The children were divided into three groups, which took turns presenting their material through cameras to Martians who were interested in the way schools function on earth and especially how pupils spend their time during the day. According to the researchers involved in this project, the Mission from Mars method offered an opportunity to the technical team to engage with the children, establish the necessary level of confidentiality through role-play, and get to the actual requirement for making a design that was meaningful to its users in context. The main strengths of the method are that it is another playful and motivating framework for both children and designers and the shared narrative space makes it possible to ask questions that would be impossible to raise in a conventional setting.

The use of drama has also emerged as a user requirements elicitation technique, mainly oriented to older adult users. In Marquis-Faulkes et al. (2005) the application of drama in the design of a system that provides fall detection and movement monitoring to support older people living at home is reported. To gather user requirements for the design of the system, a theater group was hired to develop and perform four scenarios based on material from focus groups and anecdotal evidence. The scenarios featured older people falling at home with different outcomes, and caretakers discussing an older person's needs. The scenarios were filmed and shown to three different groups of older people and a group of sheltered housing wardens to provoke discussions. The research team found that the outcome of discussions following the video scenarios explored effectively the user requirements early in the design cycle. They felt that drama was an extremely useful method of provoking discussion at the pre-prototyping stage and provided many insights that they believed would not have been obtained without such techniques being utilized.

Pastiche techniques (Blythe and Dearden, 2008) employ fictional characters and settings borrowed from literary and popular culture to create a space for the discussion of new technological developments and user experience. Both pastiche scenarios and pastiche personae can be used. The scenarios developed by the designers of the project are then used as discussion documents with the users. This practice creates a common and safe ground on which to discuss highly personal matters that older people may be experiencing in their everyday lives. In the case study reported in Blythe and Dearden (2008), this technique was used in a project supporting a befriending and shopping scheme for older people. The scenarios were written in the style of Dickens' *Christmas Carol* and had as their main character Ebeneezer Scrooge. Changes in how the shopping service is run are envisaged as consequences of the events that occur in the chain of scenarios. The research team found the use of pastiche techniques a low-cost, high-speed alternative to established approaches to personae and scenarios. Pastiche can provide a common ground among design stakeholders and an engaging and stimulating basis for discussion. Its main limitation lies in the difficulty of finding suitable characters that are familiar to all the members of the design team.

Finally, an emerging approach to user requirements elicitation based on arts is reported in Vickers et al. (2008). A project is described that sought to get a group of older people to think creatively about their needs and desires for technological support through the medium of paint. The approach was found to show promise, as it allowed information to be gathered in an environment that is comfortable and familiar using methods already known by the participants and that they find enjoyable. It provides a complement (or possible alternative) to standard protocols and has the potential benefit of extracting even richer information as the primary task for participants is enjoyable in its own right, and is not associated with an interrogative process.

15.4 Challenges under a Universal Access Perspective

The previous section provided an overview of established as well as emerging user requirements elicitation methods, discussing their application for the target user groups taken into consideration in Section 15.2.

Table 15.1 summarizes the results of this study, suggesting an indicative path toward method selection for the considered groups.

The following general considerations also emerge from the previous analysis:

- Practical and organizational aspects of the elicitation process play an important role when nontraditional user groups are involved, and are mentioned by many of the reviewed literature as critical to the success of the entire effort. Their importance should not be underestimated.
- Very few methods can be used as they stand when addressing diverse user groups. One of the main issues is therefore how to appropriately adapt and fine-tune methods to the characteristics of the involved people. Much of the literature reviewed in this chapter moves along these lines and proposes potential solutions for some target user groups.
- User requirements elicitation is mostly based on communication between users and other stakeholders in the design process. Therefore, the communication abilities of the involved users should be a primary concern. It is

TABLE 15.1 Summary of User Requirements Elicitation Methods

User Requirements Elicitation Methods and Techniques	Disability				Age	
	Motion	Vision	Hearing	Cognitive/ Communication	Children	Elderly
1. Brainstorming	✓	✓	■	■	■	■
2. Direct observation	✓	✓	✓	✓	✓	✓
3. Activity diaries and cultural probes	■	■	✓	■	■	✓
4. Survey and questionnaires	■	■	■	☒	■	■
5. Interviews	✓	✓	■	☒	■	■
6. Group discussions	✓	✓	■	☒	■	■
7. Empathic modeling	✓	✓	✓	☒	☒	☒
8. User trials	■	■	■	■	■	■
9. Scenarios and personas	✓	✓	✓	✓	✓	✓
10. Prototyping	✓	✓	✓	✓	✓	✓
11. Cooperative and participatory design	✓	✓	✓	■	■	■
12. Art-based approaches					✓	✓

✓ Appropriate.
■ Needs modifications and adjustments.
☒ Not recommended.

important to remove potential communication obstacles and provide support to the users. Communication forms alternative to interviews and questionnaires (such as, e.g., pictures, drama, and art) can be taken into consideration when appropriate to enhance users' expressive means and encourage free expression.

- Some methods, such as, for example, empathic modeling and scenarios (see Sections 15.3.7 and 15.3.9, respectively) do not necessarily require user involvement, although they are often elaborated with the users' participation or reviewed by representative users. In any case, they should be accurate enough in rendering the users' potential problems and needs, and therefore should be based on in depth-knowledge of the users' characteristics and abilities.
- Requirements elicitation is progressively becoming an online rather than a face-to-face activity. Many of the reported methods can be supported by appropriate technology. In this case, every care should be taken that the hardware and software used are accessible to the involved users and compatible with their preferred assistive technologies. Requirements elicitation can also take place virtually through the web. This is a potentially interesting direction to investigate, as it can contribute to reducing time and costs, address users' and researchers' moving, as well as facilitate less stressful communication. On the other hand, however, face-to-face communication can allow better reciprocal understanding.
- Traditional HCI debates regarding in-laboratory versus in-field methods, group-based versus individual-based methods, short-term versus long-term, and structured versus unstructured methods, maintain and increase their timeliness in the context of universal access. There is no available cookbook or even guide through the possible combinations of choices. Omnipresence and interweaving of technology in the social fabric of life would provide an argument in favor of longer-term, in-field, and group-based approaches. On the other hand, the difficulty of following and monitoring users in their own social environments would argue for the opposite. Along with the evolution of universal access toward AmI, large-scale research infrastructures are emerging as full-immersion environments where users can be brought into contact with new technologies, thus offering direct experience for diverse user groups (Stephanidis et al., 2007). The main advantage is offered by the possibility of combining contextual and laboratory-based methods, simulating and validating scenarios, and obtaining precious data from the continuous monitoring of user activities in various environments.

Overall, the considerations put forward in this chapter clearly point to the need for rethinking methodologically user requirements elicitation in universal access, and developing an articulated framework to orient and guide researchers and practitioners among the many dimensions of diversity that may play a role in the adoption, application, and modification of existing approaches, as well as toward the elaboration of new methods.

15.5 Summary and Conclusions

This chapter has discussed user requirements elicitation under a universal access perspective, based on the (arbitrary) selection of a number of target user groups and a literature review of existing approaches and methods that are reported to have been used

for such groups. The considered user groups are motor-impaired people, people with different sensory disabilities, people with cognitive, learning, or communication disabilities, children, and older people. The addressed methods include brainstorming, direct observation, activity diaries and cultural probes, surveys and questionnaires, interviews, group discussions, emphatic modeling, user trials, scenarios, storyboards and personas, prototyping, cooperative and participative methods, as well as emerging approaches based on playing, arts, drama, and literature.

This investigation is by no means complete, both in terms of addressed groups and included methods, and does not propose any practical way out of the dilemma faced in each universal access design project: how to know users' and contexts' diversity. However, it provides a clear indication, through case review, of the complexity of the issues involved in requirements elicitation in universal access, and raises the need for further work in this area to systematically address the subject, thus resulting in additional guidelines and more concrete solutions.

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Requirements Elicitation Techniques. Gregor v. Bochmann, University of Ottawa. Based on Poserpoint slides by Gunter Mussbacher (2009) with material fromÂ â€¢ Must access to the system or information be controlled? â€¢ Should each user's data be isolated from data of other users? â€¢ Should user programs be isolated from other programs and from the.Â â€¢ Facilitated and directed group sessions to get common understanding and universal buy-in. â€¢ Use of visual aids. â€¢ To enhance understanding, e.g., props, prepared diagrams.