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Designing for Dynamic Diversity - interfaces for older people

Peter Gregor & Alan F Newell, MBE, FRSE
University of Dundee
Department of Applied Computing
Dundee DD1 4HN Scotland
+44 1382 344152
pgregor@computing.dundee.ac.uk

Mary Zajicek
Oxford Brookes University
School of Computing & Mathematical Sciences
Oxford OX33 1HX
+44 1865 484579
mzajicek@brookes.ac.uk

ABSTRACT

In this paper, we describe why designers need to look beyond the twin aims of designing for the 'typical' user and designing "prostheses". Making accessible interfaces for older people is a unique but many-faceted challenge. Effective applications and interface design needs to address the dynamic diversity of the human species. We introduce a new design paradigm, Design for Dynamic Diversity, and a methodology to assist its achievement, User Sensitive Inclusive Design.

To support our argument for a new form of design we report experimentation, which indicates that older people have significantly different and dynamically changing needs. We also put forward initial solutions for Designing for Dynamic Diversity, where memory, vision and confidence provide the parameters for discussion, and illustrate the importance of User Sensitive Inclusive Design in establishing a framework for the operation of Design for Dynamic Diversity.

Keywords

Universal accessibility, design for all, HCI, Usability Engineering, Design for Dynamic Diversity, User Sensitive Inclusive Design

1. INTRODUCTION

The human interfaces to most computer systems for general use have been designed, either deliberately or by default, for a "typical", younger user [8,9,11]. In a similar way, most research and development in the field of communication and information technology to support older people and people with disabilities has concentrated on the development of special systems, and on accessibility features focused on younger disabled people. The knowledge from these fields, therefore, does not necessarily easily transfer to the challenges encompassed in universal design [3,5,16,17,18] and in particular the changing functionality that accompanies the ageing process.

This paper discusses the particular issues for the design process which accompany ageing and suggests a paradigm and methodology to support the process of designing software which is as near to the universal accessibility ideal as is possible, or at least reasonable. These are, ***Design for Dynamic Diversity*** (D^3); and a necessary change in the focus of methodology to accommodate D^3, ***User Sensitive Inclusive Design*** (USID) [12].

We put forward an example of Design for Dynamic Diversity within the context of Web browsing for visually impaired users, together with experimental results which provide pointers for supporting dynamic diversity in memory and confidence.

Through these examples we hope to illustrate the way in which the process of User Centred Design, by seeking to homogenise subject user groups in order to more clearly evaluate design decisions, tends at best ignore, and at worst suppress, diversity in design. We argue that User Sensitive Inclusive Design will provide the initial impetus for a large-scale investigation of user diversity and establish a framework within which Design for Dynamic Diversity can take place.

2. OLDER PEOPLE ARE DIFFERENT

It is important to review the methodology of design for older people, as there are important characteristics that occur much more widely in groups of older people than in younger ones. In crude terms, older people can be divided into three groups:

- Fit older people, who do not appear – nor would consider themselves - disabled, but whose functionality, needs and wants are different to those they had when they were younger
- Frail older people, who would be considered to have one or more "disabilities", often severe ones, but in addition, will have a general reduction in many of their other functionalities
- Disabled people who grow older, whose long-term disabilities have affected the ageing process, and whose ability to function can be critically dependent on their other faculties, which may also be declining.

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Other major characteristics of older people, when compared with their younger counterparts, include:

- The individual variability of physical, sensory, and cognitive functionality of people increases with increasing age
- The rate of decline in that functionality (that begins to occur at a surprising early age) can increase significantly as people move into the "older" category
- There are different, and more widely appearing problems with cognition, e.g. dementia, memory dysfunction, the ability to learn new techniques
- Many older users of computer systems can be affected by multiple disabilities. Such multiple minor (and sometimes major) impairments can interact, at a human computer interface level to produce a handicap that is greater than the effects of the individual impairments. Thus research into accessibility focused on single impairments may not always provide appropriate solutions.
- Older people may have significantly different needs and wants due to the stage of their lives they have reached
- The environments in which older people live and work can significantly change their usable functionality – e.g. the need to use a walking frame, to avoid long periods of standing, or the need to wear warm gloves.
- On a more positive note, older people can have access to a much wider experiences and knowledge of the world than younger people, and a more mature approach to problem solving.

The taxonomy and list of characteristics given above is important, because they illustrate the fact that capability and disability are not opposites. The implication of this, however, is often not apparent to software developers who have a tendency to develop systems "for disabled people" or for "normal people". When doing this they fail to recognise that a whole range of capability levels can exist which, while declining, do not yet represent a disability as such, and also that a range of reduced capabilities may constitute a handicap only when taken together and when the user is interacting with computer systems. Also older people may bring experiences and knowledge to an interaction which would not be expected from a younger user.

3. DESIGNING FOR DYNAMIC DIVERSITY – A NEW PARADIGM

As people grow older their abilities change. This process of change includes a decline over time in the cognitive, physical and sensory functions, and each of these will decline at different rates relative to one another for each individual. This pattern of capabilities varies widely between individuals, and as people grow older, this variability increases. In addition, any given individual's capabilities vary in the short term due, for example, to temporary decrease in, or loss of, function due to a variety of causes including illness, blood sugar levels and state of arousal.

This collection of phenomena present a fundamental problem for the designers of computing systems, whether they be generic systems for use by all ages, or specific systems to compensate for loss of function. In contrast the young, fit, maless ´typical user` is assumed to have abilities which are broadly similar for everybody and crucially these abilities are perceived to remain static over time. . Not only is this view wrong, in that is does not take account of the wide diversity of abilities among traditional users, but it also ignores the fact that for all users abilities are dynamic over time. Both the abilities and the rate at which they change also vary between individuals and between cultures, and these variations can be very much more pronounced for older users.

Current software design typically produces an artefact which is static and which has no, or very limited, means of adapting to the changing needs of users as their abilities change. Even the user-centred paradigm [e.g. 6,13,14,15] looks typically at concerns such as representative user groups, without regard for the fact that the user is not a static entity

Metaphors and processes in use at present are ineffective in meeting the needs of many user groups or addressing the dynamic nature of diversity. There is an urgent need to address the issues of Designing for this Dynamic Diversity. New processes and practices are needed which address the design issues; awareness raising among the design, economic and political communities has to start; research is needed to find methods to pin down this moving target.

4. USER SENSITIVE INCLUSIVE DESIGN – A SUPPORTING METHODOLOGY

Particularly as older people can have very different characteristics to most designers, User Centred Design principles need to be employed in the development of appropriate technology for this user group [4]. UCD methodologies, however, have been developed for user groups with relatively homogonous characteristics. "Older people" encompass an incredibly diverse group of users, and, even small subsets of this group, tend to have a greater diversity of functionality than is found in groups of younger people.

An additional complication is that there can be serious ethical issues related to the use of such people as "subjects". Some of these are medically related, but also include, for example, the ability to obtain informed consent. It is thus suggested that the standard methodology of User Centred Design is not appropriate for designing for this user group. It is proposed that the techniques of UCD need to be modified to be appropriate to older people as the user group.

A methodology, which could be called User Sensitive Inclusive Design, is required. This would need to address the issues of coping with:

- Much greater variety of user characteristics and functionality
- Finding and recruiting "representative users" [7]
- Conflicts of interest between user groups (including "temporarily able-bodied")
- The need to specify exactly the characteristics and functionality of the user group
- Tailored, personalisable and adaptive interfaces
- Provision for accessibility using additional components (hardware and software)

"Inclusive" is a more achievable objective than "for all" or "universal". "Sensitive", rather than "centred" reflects:

- The lack of a truly representative user group,
- Difficulties of communication with users,
- Ethical issues [1,2],
- That different paradigms are needed to standard UCD paradigms [e.g. 16],
- That there must be a different attitude of mind of the designer

An appropriate experimental methodology is needed as well as for new forms of communication of results of such research and development. This should be a major strand in a research agenda within the field provision of "universal accessibility" for older people.

5. DESIGNING FOR DYNAMIC DIVERSITY

User Sensitive Inclusive Design will bring into focus not only the substantial variability which exists in user characteristics, but also the changing nature of the functionality they have, over both short and long time scales. This will lead naturally to the need for interface designs which are appropriate for a much wider range of functionality than is currently the case, and to the dynamic nature of users' functionality. We thus believe that the concept of Design for Dynamic Diversity provides an important step not only towards the development of more effective interfaces for older people, but also for the more general problem of "universal" interface design.

6 VISION DIVERSITY

As a concrete example of the advantages of designing for dynamic diversity and the need for a paradigm such as User Sensitive Inclusive Design, we have included a case study of the design of a web browser for visually impaired users developed at the Speech Project at Oxford Brookes University.

The design of this web browser shows how support for dynamic diversity in vision, memory and, importantly, confidence in users, can be supported by interface design. However, a relatively standard User Centred Design Methodology was used in this development, and the case study illustrates the weaknesses of this approach, and illustrates how a user sensitive inclusive design methodology would have been a more efficient design methodology and would have produced a more effective product.

The BrooksTalk Web browser for visually impaired users was designed to support visual diversity, by providing an interface in three different parts:

1. A set of function keys, which drive the speech output browser, thus enabling its use by totally blind people.

2. A text banner, which provides a large text version of the spoken output, which enables people with some residual vision to read what is being spoken as they hear it. Users can adjust the size of text, and the number of lines of text shown.

3. A standard graphical rendering of the page, so that, if visually impaired people are working alongside sighted, colleagues they can pool resources and have access to both forms of input.

Figure 1 shows the configuration of the interface. Users can adjust the proportion of screen used for the text banner or standard graphical interface depending on their level of visual impairment and working conditions for example if a fully sighted person is present.

Figure 1.

In this interface, dynamic diversity in vision can be accommodated by adjusting the settings for the screen layout. This is accomplished by using function key F7 and stepping through a relatively long list of different settings to change the font size and the number of lines displayed in the text banner. This provides a less than transparent adjustment to the parameters of screen parameters

7. DIVERSITY IN OLDER ADULTS

BrooksTalk was evaluated in a large-scale exercise among visually impaired users. This was, designed to investigate how people use its special features, such as the abstracting feature or different views of the Web page. One of the most important outcomes of the evaluation, which the researchers had not anticipated, however, was that 82% of older adults were unable to even get started with BrookesTalk.

During observation of their interaction, it was noted that older adults appeared to lack confidence in building conceptual models of the interface, and the application. At the interaction level difficulties can be attributed to two main factors which interfere with conceptual model development, these being age associated memory impairment and visual impairment, both of which reduce the user's ability to benefit from visual clues and contexts.

7.1 A design solution

To help these users with memory loss and visual impairment, a speaking front end called Voice Help was built onto BrookesTalk. This would support the user in their construction of conceptual models by 'talking' them through their interaction. For each possible state of BrookesTalk an optional spoken output was provided, where the user was informed as to where they were in the interaction and which actions were possible at that point. Optional further details were also available to describe the consequences of each action. After listening to the message the user chooses an option, presses the appropriate function key and receives another message describing the new state of the system and the options available.

For example, the spoken output for those who have just started up BrookesTalk would be:

> 'Welcome to BrookesTalk your speaking web browser. There is currently no page loaded. Would you like to:
> Enter the URL of a page, press F1
> Start an Internet search, press F2
> Change the settings of the browser, press F7
> Hear more details about options available to you, press F3
> Repeat the options, press return

With such messages reinforcing the users' knowledge of the state of the system and explaining to them what they can do next, it was hoped that the development of conceptual models would be accelerated, and that the user would no longer need to rely on memory to know which set of actions were needed at each point. For example, with Voice Help, the user can function at the beginning of their interaction, with virtually no conceptual models at all, by using the system like a telephone answering system, simply responding to questions, and then hopefully in time begin to 'see' what to do next without waiting for the message.

7.2 Diversity of confidence levels

In addition to vision and memory problems, many older people lack confidence in using IT systems, and it is important that take this into account in the design process. An experiment was thus carried out using BrookesTalk with Voice Help, whereby older adults were provided with extra confidence in the form of a personal helper, who provided support by answering yes or no to user's questions as they interacted with the software. Users could therefore confirm decisions they were making at the interface, and talk through strategies as they developed. It was assumed, that this would increase the user's confidence in the conceptual models they were developing. Further support than simple yes or no answers, was not given as it would have been too difficult to monitor for consistency.

Those users who were provided with personal support were more able to get up and running with BrookesTalk with Voice Help than those who worked without support. [20] The confidence created by the reinforcement that they were doing the right thing built the user's confidence in their creation of conceptual models. Even within this user group, however, considerable diversity in the levels of confidence they displayed was found, and this could change very rapidly apparently solely due to the users' experience experience with the system. . Each user's personal confidence increased markedly following a particularly successful interaction, and decreased following a disaster.(

These findings are in line with other work [19] and [23], where Bed and Breakfast operators of all ages, who were unable to use computers unaided, found off-line support to be essential when getting started. Here we see users' confidence in their actions at the interface as an important parameter of interaction, which spans all ages.

7.3 Diversity of interface support

In trials set up to establish whether the design innovation of Voice Help was useful [20], we found that older adults who used BrookesTalk with Voice Help were able to sucessfully use the Web where they had been unable to with the standard BrookesTalk. Thus 'talking the user through' approach provided by Voice Help enabled users to achieve interaction where it had previously been impossible.

Diversity among users was seen in the amount of time they needed with Voice Help before moving on to standard BrookesTalk. This diversity was supported within the design since users could decide for themselves, when they no longer needed Voice Help, and could be confident that they were ready to use standard BrookesTalk.

8. MEMORY DIVERSITY

The research on diversity in memory levels was carried out user testing at Age Concern Day Centres in Oxfordshire. The work was prompted by problems observed with older adults as they struggled to recall the long synthetic speech messages in the BrookesTalk Voice Help. Many people appeared to require simpler and shorter messages for instruction, as they could not absorb or remember large amounts of information.

The Day Centre subjects formed a relatively homogeneous group, with an average age 84 years who were at a similar stage in life. They were able to look after themselves, but benefited from attendance at the centre for meals, companionship and activities. They were not ill and showed normal age related sensory impairment. None of them had used a computer before and they had rather sketchy ideas of what the World Wide Web might be about.

An experiment was carried out [22], to determine whether long speech output messages were actually causing older adults to remember less. The results from the experiment showed that memory retention at the interface works differently for older adults compared to younger ones [21]. While younger adults are able to accommodate differences of length of output message and retain the same amount of information from the message, older adults were confused by the extra information in long message and actually remembered less. These results indicate that there are important memory related factors playing their part in interface design for older adults, which do not affect younger people. The amount of output at any time should be monitored, with ways designed to reduce the amount of output, and make it more digestible.

8.1 Diversity of functional requirement

The results above indicated that the message length in Voice Help should be reduced for older adults. Shorter messages, however, mean fewer options being presented, and this implies that functionality should be reduced. In addition it is known that low functionality systems are easier to learn and understand. Other research into interfaces for older adults also point to the need for low functionality systems, with the possibility of adding in extra facilities when a few simple actions have been mastered. For example Czaja et al [24] found that older adults were happy to add extra facilities once they had mastered a low functionality email system. To test this hypothesis a low functionality version of BrookesTalk is currently under construction.

9 TOWARDS DESIGNING FOR DYNAMIC DIVERSITY

Visual impairment, memory loss, lack of confidence, and inability to remember instructions are not confined to the type of older users in the group above. This case study of BrooksTalk thus illustrates the value of a design approach which could support far more diverse range of users . Not only older people, but also those with cognitive impairment and many others who, when they are tired, anxious or ill, experience similar difficulties in varying degrees.

Oxford Brookes University are prototyping a Design for Dynamic Diversity in a multi function-level version of BrookesTalk with Voice Help. A wide diversity of memory impairment, visual impairment and confidence levels will be supported using a set of different levels of functionality. Those who experience high levels of memory impairment, visual impairment and low confidence, will be provided with minimal functionality and therefore shorter messages. The lowest level of functionality will involve simply: load a page, read a page and follow a link. When users become familiar with these functions and can use them successfully, they can move on to learn new functions such as search, hear an abstract of the page and change settings.

Progression will be structured with users passing some form of assessment, possibly self-assessment, before moving to a higher functionality level, and that a sense of achievement in reaching particular points should be reinforced. Recognising and reaching goals will contribute to user confidence.

10 USER SENSITIVE INCLUSIVE DESIGN PROVIDES A FRAMEWORK

Although the developers of BrookesTalk were aware of the potential diversity in their user group, they initially tended to follow a traditional User Centred Design methodology. For example, in the experiments described above every effort was made to ensure that the experimental user group was homogenous so that other factors would not confound the changes being monitoring in particular parameters, such as the amount remembered in shorter and longer messages. The researchers even performed a memory test to ensure similar memory levels, as would be standard practice in User Centred Design. Despite these precautions, they were particularly struck by the difference in ways of memorising, and what was remembered across the group. The diversity in this supposedly homogeneous group of older people was found to be substantial , even though the group did not represent the range of groups of older adults described in Section 2. It is even more significant, in retrospect, that the standard User Centred Design approach with the initial version of BrookesTalk was based on the assumption that that the group of two hundred users world-wide was homogeneous and would all use BrookesTalk in more or less the same way. At the time the researchers were genuinely surprised that older users were not able to use BrookesTalk, although five minutes spent observing a visually impaired older adult trying to get going with the software would have made this clear. Significantly, as the researchers were not looking for diversity, they did not see it. Thus, even when researchers were sensitive to potential diversity in the use group, traditional User Centre Design proved to be a less effective design methodology than was hoped. In contrast User Sensitive Inclusive Design represents a radically different approach, which encourages designers to seek out diversity. We recommend a systematic research program incorporating the core elements of User Sensitive Inclusive Design to uncover the key areas where dynamic diversity plays an important part. This is an unexplored and new approach where expertise should be developed within an experimental framework, in order to uncover the characteristics of dynamic diversity, which will feed into this new design process.

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