Designing a Portal for Older Users: A Case Study of an Industrial/ Academic Collaboration

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A multi-disciplinary team from industry, government and academia developed prototype email and web search & navigation systems for users over 60 years old who were inexperienced in using computers and had never used the Internet. The academics encountered problems in persuading other team members of the specific challenges of designing for and working with older people. A number of ways of overcoming such challenges were implemented, and the final "radically simple" systems evaluated by a team of older people. The collaboration highlighted the conflicting pressures of the commercial world and the time and patience needed to design for older users.

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1. INTRODUCTION

This paper describes a case study of a multi-disciplinary team who developed a Proof of Concept Internet system for people over 60 who were uninitiated and unconfident in the use of computers. The team consisted of academic researchers and commercial developers. The academics approached the system development from a perspective focussed on the needs and wants of older people, whereas the industry representatives were influenced by their extensive experience of commercial development for 'typical' computer users. Although the final implementation was received very positively by user groups, there were significant differences of opinion within the design team throughout the development phase. This paper address these issues and how they were resolved.

2. COLLABORATIVE PROJECTS AND USABILITY

Collaborative research between industry and academia can involve a clash of cultures, centring on the perception of what the purpose of 'research' is and how to communicate results effectively. Jones and Phillips [2003] comment that universities commonly conduct in depth exploration of issues, whereas industry typically uses research to provide short-term guidance for decisions, and is often focused on the rapid development of commercial software. Industry-based developers can find academic writing "literally unreadable" [Robey and Markus 1998 p.8]; so, while there may be a lot of relevant research, it is often difficult to transfer this successfully into an industrial setting.

There have been well-documented problems of introducing usability considerations into the software development industry [Knight and Jefsioutine 2002; Siegel and Dray 2003]. This is partly because of developers' attitudes, some developers having complained about "rewarding inexperienced unskilful thick people" and that "stupid people skew results" [Knight and Jefsioutine 2002]. The lack of uptake of usability recommendations is also attributed to communication failures between usability experts and designers [Blyth 2002], and there is a danger that a focus on the user to the exclusion of technical and time constraints can make usability specialists' advice appear "naïve and ill informed" [Rosenzweig and Ziff 2003 p.22].

The above challenges are significantly exacerbated when the development concerns systems designed for non-typical computer users, such as older people.

3. THE CYBRARIAN PROJECT

As society becomes increasingly digital, it becomes more important to ensure that electronic resources are accessible to everyone, and digital provision of government services should support the broadest possible participation by constituents. User

interfaces for Digital Government thus require specialised attention both in government and the HCI community [Marchionini and Levi 2003]. There is clear evidence that resources the Internet currently provides are not accessed by the majority of the population: Table 1 shows that 56% of the UK population have not used the Internet and these non-users are likely to be both older and less well-educated than Internet users. In the UK, 92% of the over 60s do not use the Internet – a total of 9 million people. The data also show that this is not simply a cohort effect, the divide is unlikely to disappear with time as only 12% of the 3 million people aged 40-60 with no qualifications use the Internet.

Table 1: Digital Divide Statistics, Cybrarian Proof of Concept Invitation to Tender

Population	**15-60**	**Over 15**	**Over 60**	**15-30**	**40-60**	**Over 60**
Education	**All**	**All**	**All**	**Post 16 qual**	**No qual**	**No qual**
Total	35.71	45.52	9.82	5.20	3.36	3.36
Non-users	16.41	25.57	9.17	0.80	2.96	3.23
Percentage users	54%	44%	8%	85%	12%	4%

The UK Department for Education and Skills (DfES) instigated a wide ranging examination of this problem, and, as part of this project, a consortium of a commercial consultancy company and two universities were commissioned to design a "Proof of Concept" (PoC) Internet portal entitled the "Cybrarian Project". The Proof of Concept focused a major digitally excluded group - older people. The portal was intended to be:

"attractive to older users (over 60 years of age) who were uninitiated and unconfident in the use of computers and for whom the Internet was an alien territory".

As Morrell et al. [2004] note, the internet is potentially an "invaluable resource" for people over 60 as it allows access to information and communication without leaving the house. It also seems probable that computer use is associated with improvements in psychosocial wellbeing among older people (see [Morrell 2004] for a summary of the research), although to date the evidence is equivocal: it is difficult to properly control such studies, and investigations of wellbeing improvements suggest that it is the incidental increase in person-to-person contact through training and mutual support that is primarily responsible for the psychosocial effects, and not the use of computers *per se* [Billipp 2001].

In addition to the advantages of a specially designed portal for this group of people, it has been argued by Newell [1993], that designing for "extremes" in the population can produce better designs for everyone. There is significant evidence that systems designed for older and disabled people can provide much more usable systems for everyone. Historic examples include the cassette tape recorder having been designed by a company producing "talking books" for blind people, and the original typewriter having been designed for a blind Italian Countess [Newell & Gregor, 1997]. Thus, in addition to providing a gateway which was attractive to the specific client group, it was thought that if such a system was designed for "older people for whom the internet was an alien territory", it may well become popular with a much wider section of the population.

For this PoC project, the representatives of the *Clients* (the U.K. Dept for Education and Skills) included a usability engineer, the *Developers* (Fujitsu) were very experienced engineers, who had significant user centred design experience, and were fully aware of the accessibility guidelines of the W3C consortium, but had not previously designed systems for older people. The Developers thus approached Dundee University, (*the Academics*) which had substantial experience of designing systems for older and disabled people over many years, primarily within a research context, and asked them to join the project team. Staff from the University for Industry advised on learning and progression aspects of the study.

The challenge of this collaborative project was intensified by older people being the target user group. In addition to the usual cultural and communication difficulties between academia and industry, mainstream developers rarely develop systems specifically for older people, and communication about the problems that older people face using computers was especially difficult.

3.1 The Proof of Concept Project Remit

The specially designed internet applications were to be evaluated to discover whether they would (a) attract older people to use the Internet and (b) provide a pathway for them to learn and progress to more advanced usage. This study would thus indicate whether and how the target users can be converted from Non-Users into Users of the Internet.

3.2 Older People and the Internet

'Older people' are not a homogenous group; the characteristics and experiences of a fit 62 year old are very different to those of a frail person in their 80s. There is more variability in the over-60s than in any other age group, and, in addition, a high percentage, approximately 50%, of people over 65, have a serious disability.

Older people differ from 'typical' computer users in two essential ways. They are less likely to have experience of computers and the Internet than younger people [Fox 2004], and the physical, sensory and cognitive characteristics of ageing can be significant barriers to the use of the Internet and other computer systems in their present form.

Research demonstrates that a significant proportion of older people will encounter barriers to computer use. Older adults are likely to encounter more difficulties learning to use computers, to make more errors, to take longer and to perform more poorly on post-tests [Czaja and Lee 2003]. Web usability is also significantly poorer for older users [Coyne and Nielsen 2002] The reasons for these differences are likely to be found mainly in age-related cognitive change, including reduction in processing speed [Salthouse 1996] and working memory [Salthouse and Babcock 1991], and a decreased ability to ignore irrelevant or distracting information [Lustig, Hasher & Tonev 2001; May, Hasher et al. 1999]. Ageing is also associated with changes in vision, including visual acuity, contrast discrimination and reduction in the efficacy of parafoveal vision [Carmichael 1999; Hawthorn 2000]; in addition, severe visual impairments become more likely with advancing age. Finally, changes in muscle strength and manual dexterity, as well as musculo-skeletal disorders [Ranganathan 2001] mean that using a mouse is more difficult: older adults consistently perform poorly on tasks using a pointing device [Chaparro 1999; Worden 1997], and as the tasks become more difficult, e.g. double-clicking, the difference between older and younger adults increases [Czaja and Lee 2003]. Despite these barriers, there is little evidence that older people are particularly technophobic [Morell 2004].

Older people are, therefore, a group which differs from the "typical" computer user. Although these differences make effective communication between developers and older users especially desirable, obtaining requirements and evaluation data from older people therefore is not straightforward [Zajicek, 2004; Eisma et al. 2004].

The characteristics of many older people make it difficult to communicate easily; for example, people with hearing difficulties often find it hard to contribute to group discussions, and the large majority of older people have little knowledge of 'computer' language, complicating the communication process between such groups and technology specialists. In addition, when asked to evaluate software systems, older people tend to blame themselves, and their own incompetence, rather than poor design. They tend to be very positive about the prototypes which are presented to them – wishing to praise the developers rather than give an objective view. Their confidence in their ability to use technology can also be very fragile, and it is important from an ethical perspective not to put them in a position which any confidence they have is under threat.

Developers are rarely required to consider the implications of age-related changes for interface design and, although they are usually aware of the legal requirements for accessibility, may assume that "non typical" users need special accessibility provisions, which are normally provided as part of the operating system or as a special feature rather than an integral part of the software [Newell and Gregor 1997]. There are clear legal and ethical issues in ensuring that any design is accessible by disabled people. Many guidelines have been produced on "inclusive design" and "accessible design" [see World Wide Web Consortium, 1999; Office of the e-Envoy, 2002a and 2002b] and detailed analyses of the characteristics of older people have been published [Carmichael 1999; Fisk 2004; Hawthorn 2000]. Many "accessibility" features found in commercial software, however, require significant knowledge of computers to find and install them – skills not often found in older people, and many accessibility options have very poor usability.

The solid distinction between 'able' and 'disabled' is artificial: within any real population there is a continuum of functionality, which is also age related. Vision, for example, ranges from 20/20 vision, through age related reductions in focal range (which can be corrected by spectacles), to legal and finally total blindness. As we mentioned above, all older people have minor age related visual impairments and although most will not consider themselves visually impaired, they will find the use of standard screens much more difficult than they did when they were younger. "Non-disabled older people" tend to be overlooked as being neither "able-bodied", nor "disabled" enough to need "accessibility" features.

3.3 User Centred Design and Older People

The Cybrarian Project should have benefited from User Centred Design, but historical marginalisation of older and disabled people in mainstream usability engineering means that traditional UCD provided little or no guidance about how to design for the Cybrarian user group [Newell 1993; Newell and Gregor 1997]. The Cybrarian Developers were an excellent team, with significant User Centred Design experience and knowledge of W3C accessibility guidelines, but were unfamiliar with the challenges and constraints of working with a user group of older people. Ironically their commitment to traditional UCD made it difficult for the academics to persuade them that a traditional and standard User Centred Design process was likely to be less than adequate in designing for older people.

3.3.1 User Sensitive Inclusive Design

The heterogeneity of older people makes it difficult to recruit 'representative' users [Gregor and Newell, 2001], and to produce universal guidelines. Thatcher [2003] has also pointed out that written accessibility guidelines and standards, used without knowledge of the context, are often applied to the considerable detriment of usability for the disabled computer user. This effect can be more extreme when older people, with their very wide ranging and interacting disabilities, are the user group.

Gregor and Newell [2001] suggested that a new design paradigm should be developed which they described as User Sensitive Inclusive Design. They believed that "Inclusive" was a more achievable objective than "for all" or "universal", and "Sensitive", rather than "centred" reflects the lack of a truly representative user group. Above all, however, they recommended that it is necessary to develop a different attitude of mind among designers. They suggested that this change of mindset required different novel forms of presenting information to designers for whom older people are an unfamiliar user group.

In order to design successfully for older people, it is not appropriate for designers to simply follow guidelines. They need to be made aware of the huge cultural and functionality differences between themselves and older users: they cannot design for themselves and expect the users to find the system appropriate or usable. Although there is a lot of academic research on older people, this has not filtered through to the design community and different strategies need to be sought to change the mindset of designers effectively.

4. CHANGING THE MINDSET OF THE CLIENTS AND DEVELOPERS

The Academics in the Cybrarian Study were concerned that neither the Developers, nor the Clients fully appreciated the specific needs of older people and would rely too heavily on their extensive experience of developing web applications for 'ordinary' users, and published accessibility guidelines. This became clear during the early project meetings where the Clients, and to some extent the Developers, pressed for the development of a system which was far more complex and had much greater functionality than the Academics thought appropriate for the proposed client group. The Academics, therefore, began to explore ways in which the Developers and the Clients could be exposed to the user interface needs of the elderly, and thus bring about a change in this mind-set. The UCD literature underlines the importance of developers meeting with users, but the characteristics of older people, as described above, means that this has to done with some care, with both developers and older people sensitised to what is required of them. The University had developed a cohort of over 200 older people who had worked with them in the past, in the UTOPIA (Usable technology for older people:

inclusive and appropriate) Project (www.computing.dundee.ac.uk/projects/UTOPIA). This group had a range of physical and sensory characteristics, and, more importantly for the Cybrarian project, a range of familiarity with information technology. The Academics were thus able to chose appropriate older people for the messages they wished to convey to the Clients and Developers.

A training session had been planned where the Academics would give a number of presentations to the Client and Developers about the needs, and wants of older users. As part of the training day, four older women (with an age range of 74-88 and a mean age of 79.8) from a small, well-established, Internet café group took part in an informal discussion with representatives of the Developers and the Clients. The central consideration in the selection of the older people for this session was to ensure that they were unlikely to be intimidated or discouraged by the Clients and Developers. This was not only of ethical importance, but also vital to ensure that useful dialogue could take place. The participants were therefore invited from a pre-existing group, with extensive experience of mutual support. These older people were led by a lady who had, on her own initiative, started a cyber café in her kitchen in a rural village in Scotland. This café had expanded significantly and was now held in the local village hall, having gained funding for equipment. She was accompanied by three friends who were users of the café. These ladies were very articulate, and, typically of older users of information technology, were familiar only with a very limited range of software. For example, they all used email, but had never "surfed the web". The discussion lasted approximately two hours, and consisted of a free flowing question and answer session. The meeting provided the first example of changes to the mind sets of the Developers and Clients. Although the Clients and Developers were trying hard to communicate with the older people, they used language and concepts which were not familiar to them, and expressed surprise by what they regarded as the "extremes" which the older women represented in comparison to what they thought of as more typical user groups. Although the Academics had made many of these points previously, the Developers and Clients were very surprised by these users':

- Lack of any real understanding of the technology, what the Internet was (for example, some did not realise that sending an email involved using the Internet), and what was within their own computers and what was elsewhere in the "internet".
- Inability to be able to move onto the next step (e.g. from word processing to email) despite many months' experience because of the complexity of the technology.

- Recourse to aids that they found essential to enable them to cope with poor memory and understanding (for example, one woman had a note book in which she kept detailed instructions for using the system – which was widely used by the group members).

Although the women from the Internet café only illustrated information which had already been presented as part of the conventional training day, the face to face meeting made a great impression on the Clients and Developers. Their combination of enthusiasm to use the Internet, with a substantial lack of understanding of what it was, and an inability to find out how to use it, was particularly thought provoking. Setting such a meeting within a more traditional training day placed the comments of the women within a more general context to the mutual benefit both of the discussions and the formal presentations.

5. ATTRACTORS AND PROGRESSION FOR USE OF THE INTERNET BY OLDER PEOPLE

Following the training day, a number of formal meetings with the Academics, Clients and the Developers determined that applications had to be developed which would attract potential users to the Internet, and provide some progression mechanism to allow users to move from the "attractor" to more complex use of the Internet for obtaining information.

Research from a number of different sources has shown that communication, normally embodied or perceived as email, is a powerful attractor to Internet use for everyone, including older people [SeniorNet 1996, 2002a, 2002b; Age Concern 2002; Digital Glasgow 2002; Nielsen and Coyne 2002]. Ongoing research at Dundee University has also shown that communication is the computer task that most older people who do not use computers would most like to carry out [Arnott et al. 2004]. Not only is this seen as a way of keeping in touch with children and grandchildren, but also, as social isolation is prevalent in older people, especially those with mobility dysfunction, a communication system is perceived as particularly valuable for them. Many older people, however find existing email systems very difficult to use, which is one possible explanation for the failure of older people to 'take the next step' and use the Internet.

Although enough research on email systems for older people has been done to indicate that they can be used fairly autonomously [Czaja et al. 1993] and that design alterations make significant differences to ease of use for this group [Hawthorn 2003], there has been no comparative research with other systems, or recent, formally tested design direction.

It was thus decided to build and evaluate two systems, an email system and a search and navigation system, with a similar look and feel capability, both being specifically designed for "uninitiated and unconfident older people for whom the Internet was an alien territory". Due to the inevitable time and resource pressures of a commercial development, the number of design iterations with users had to be kept to a minimum.

The development followed the Dynamic Systems Development Method (DSDM). It utilized a process whereby a brain storming session initially produced a comprehensive list of possible features. This list was refined using the MoSCoW priorities, with each feature was designated into the groups: Must have, Should have, Could have, Would like. A series of interactive workshops enabled the Academics, Clients and Developers to establish a common understanding of what needed to be developed and evaluated in each study. These workshops generated of a number of working documents that progressively defined the studies and prototype requirements for these studies.

The initial process was successful, the Developers and Academics collaborated well, and the formal development process, introduced by the Developers, provided a structure and discipline which greatly benefited the project. When the design process began to tackle user interface issues at a level of specifics, however, it became clear that there were still some significant communication difficulties. Because the email system was designed first, most of the design conflict took place during its development, the later development of the search and navigation system benefiting greatly from the lessons learned from the development of the email system.

6. OUTLINE OF THE BASELINE REQUIREMENTS AND BASIC ASSUMPTIONS

6.1 Older Users

In order to sensitise the design team to the sensory, physical and cognitive characteristics of the client group, as well as their attitudes to computers, the Academics provided a working paper which suggested that current email systems included:

- Substantially too much functionality, increasing the risk of getting lost in the system, and the fear of not knowing what to do
- Complex conventions which were not understood by the users, including issues such as when to double-click
- The use of impenetrable terminology and jargon
- Very cluttered screens which confused older people
- Icons, fonts and colour contrasts which were inadequate for those with age related sensory loss

- Memory needs that demanded far too much from people with age related memory loss, which included information being hidden within poorly titled menu systems.

Bearing in mind the heterogeneous nature of user group, and comments from specialists that prescriptive guidelines are not sufficient and compliance with such guidelines is rarely adequate [Knight and Jefsioutine, 2002], the Academics believed that the guidelines which this process produced should be qualitative and intended to guide rather than direct. The design principles which emerged from the discussions between the Academics and the Developers included:

Level of functionality:

- Only essential functionality for a working email system to be included, any advanced functionality being provided by a layered interface. (Software development seems to contain an almost inevitable "functionality drift" which compromises usability – the Academics were determined that this would not occur in this project)
- Each screen to have a very clear primary function
- The number of actions / buttons per screen kept to a minimum (below 10)

User interface paradigms

- Simple and very consistent select and operate paradigms
- Clear conventions for the positions of buttons and information
- No new or poorly established interface paradigms which were unlikely to be understood by the user group
- Scroll bars to be avoided if at all possible,
- Never provide nested scroll bars

Accessibility

- Larger than average clickable targets (32 and 26 pt size was used)
- Larger than average fonts (14 point as a minimum)
- High contrast choice colours for text and background
- Accessibility features compatible with the W3C guidelines

Terminology

- Terminology which was understandable by the user group

Personalisation

- Some simple personalization to allow for people with poor eye sight or dexterity in addition to "accessibility features"

There was, however, pressure from the Developers for firmer more quantitative guidelines, and the font and target sizes mentioned above are examples of where qualitative guidelines were rephrased to become quantitative. It was also sensed that guidance provided by the Academics was perceived as "extreme", being presented as negotiating points rather than absolute requirements. This misunderstanding was caused largely by the Developers not being fully aware of the needs of the target user group. For example: one early design was produced with buttons where the text was white on a pale grey background, as shown in Figure 1.

Fig. 1 Early Button Design

From the designer's perspective of developing systems for himself, and people like him, the button was high contrast. The button in fact was still insufficiently clear for most older people, but communicating this to the designer proved to be a challenge.

6.2 Design Issues

The above was an example of 'tensions' between Developers (including the Client) and Academics, where the Developers were trying to maintain visual 'appeal' and the Academics were striving for simplicity and trying to effectively communicate their knowledge of the elderly. This tension was manifest in a numbers of areas, as illustrated in Table 2 below.

Table 2: Researcher and Designer Perspectives

Issue	Developer perspective	Researcher perspective
Large buttons	Seemingly consumed a disproportionate amount of screen real estate in relation to content areas. Accentuated difficulties in maintaining screen layouts given that the Personalise capability could also change the text size of button labels.	Essential to cater for the poorer motor skills and mild visual impairments that are typical of the elderly.
Use of colour	Commonly used and desired to enhance the visual appeal of an application	The need for strong contrast to cater for the mild visual impairments that are typical of the elderly.
Use of background designs	Commonly used and desired to enhance the visual appeal of an application	Introduced unnecessary clutter in the interface and hence potential for confusion.

Use of icons associated with buttons and pages	Established and demonstrable value in the learnability of user interfaces if employed effectively to create associations. Added to the visual appeal of the page.	Introduced unnecessary clutter in the interface and hence potential for confusion. Icons had no prior meaning to the target audience.
Scroll bars	Both sides agreed that scroll bars were problematic	
	Their use, appearance and functionality were largely outside of the Developer's control, and were intrinsic features of either Windows or Internet Explorer. Sizing of display panes was particularly difficult given the chunkier buttons and that the Personalise capability could change the size of any text.	Scroll bars were known to cause problems with elderly users. Repeatedly suggested the use of 'spin' buttons and other alternative designs.
Terminology	Use of established terminology from the Internet world. The desire to use one word or very short phrases for labels on buttons in order to ease the layout problems.	The knowledge that the target users were not at all familiar with the Internet world, and hence the established terminology had no meaning to them.

It was clear that, over many issues, the Clients and Developers believed that the Academics were exaggerating the difficulties of the potential user group. This impasse was solved by re-organising a focus group with older people. The Academics had planned this focus group to occur in the middle of the design and development phase of the email system, and the Academics would use it to gain early feedback on the designs. In an ideal world several such focus groups would have been useful in the design of each system, enabling real users to be consulted on a much wider range of design issues, but this was not possible within the constraints of this study.

Nine older people were selected from the Academics' database of volunteers to attend a two hour focus group. These were five women, and four men with an age range of 65-84 with a mean of 76.4. Five participants had some basic experience of using computers (defined as ten or fewer sessions at a computer class) but no experience of using the Internet, and the other four had no computer experience. The participants were divided into groups of three. They took part in a structured walkthrough using paper prototypes

of the system during the first part of the session, and this was followed by a general group discussion about possible improvements of the system. The tasks used during the walkthrough were fundamental email tasks such as "Please show me what you would do to send an email". During the focus group, responses to the system were elicited through open-ended questions and encouragement from the facilitator for the participants to discuss their experiences during the walkthrough.

In addition, specific design issues were raised with the group, including appropriate language to use on the interface and which of three button designs was preferred.

There had been an ongoing debate within the development team about the appropriate appearance for buttons. The research team emphasized clearly visible text as a priority above aesthetics and were uncertain about the usefulness of icons on the buttons, since the icons did not appear intuitive.

Figure 1: Three button designs presented to the workshop

1 2 3

Standard button Button with text in bold Button with icon

The older participants found the non-bold text on the standard button (1) very difficult to read, justifying the researchers' anxiety about the indistinct text, and liked a combination of two of the designs (2&3), justifying the designers' use of icons. However, the group expressed a preference for different text/ background colours; one of the participants commented: "it would be better if it was a white background and black, black text?... much easier to see, *much* easier to see…".

The workshop produced useful information about the system design, both from the participants' comments and from observations of them using the system. Three illustrative examples of the design-related workshop outcomes are provided below, as well as an indication of how they impacted on the design.

Table 3: Example workshop outcomes

Comments and observations from workshop	**Effect on design**
Participants commented on the language used, which included terms like "recipient" and "compose". Although efforts had been made to avoid technical language, the language used remained too	Language was carefully evaluated and the design team tried to keep language "everyday".

formal.	
The position of globally-available buttons was observed to interfere with screen specific actions. Users would read through the screen from the top left, meaning that any action buttons were better placed at the left and towards the top of the screen where they would be encountered first.	Screen specific buttons were placed in a column at the left of the screen, while general buttons (e.g. "my preferences") were placed at the bottom of the screen.
Participants commented that they would like instructions from the system about what they could do.	A panel at the top of the screen was devoted to page specific instructions.

The breakthrough in communication between the researchers and the clients occurred because, rather than the structured walkthroughs being conducted by the Academics, one of the Developers, with a background in user-centred design, was asked to facilitate one of the structured walkthrough sessions. It was during this process that the Developer "saw with his own eyes", rather than had related to him, the problems users encountered. Although he was well aware of the issues from a theoretical standpoint, the users' lack of understanding of many "basic" points came as a great surprise to the Developer, who, to his great credit, accepted that his earlier inclination to regard the Academics' position as exaggerated had been mistaken. Selected extracts from the notes of the Developer having just returned from the Focus Group event are given below.

…

Back to basics

The first overwhelming observation is that some of our users start right back at the very basics. That is absolutely NO prior knowledge whatsoever!

In the first 5 minutes they were literally just beginning to make sense of what the screen might be about.

We have a ready-made framework for interpreting what's on a screen. Our users don't have this. They have to construct it as they go.

We take for granted all kinds of metaphors and conventions in user interface design. The lesson for me was that absolutely NOTHING can be assumed.

Scroll bars

It was not obvious to our users what scroll bars were and what their purpose was!

One set of scroll bars was hard enough but two was incomprehensible!

The idea of content going off the bottom (edge) of the screen was comprehensible, after a little thought.

The idea of content going behind other visible content was hard to comprehend.

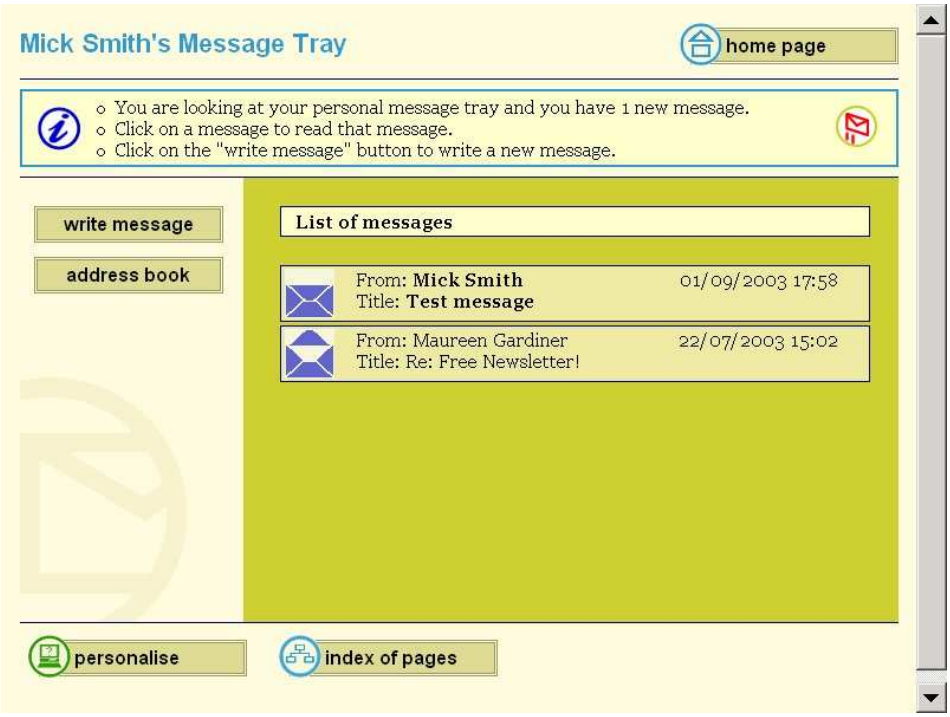
He, and other members of the Development team, were subsequently much more amenable to design suggestions from the Academics, and this significantly facilitated the interface changes which had been proposed on the basis of the results from this focus group.

7. WORKING PROTOTYPES

This change to the mind set focussed the developers on producing a prototype email system with a radically simple interface. Each screen in the system had a number of generic features, such as a page title in the top left hand corner and a Home Page button on the top right hand corner. On all pages an Information box below the title and navigation buttons gave instructions on what the user could do on the page. A globally available "Personalise" button in the bottom left hand corner allowed the user to change font, font size, colour scheme and character/line spacing. A fuller discussion of the development and evaluation of the email system can be found in (Dickinson et al, forthcoming).

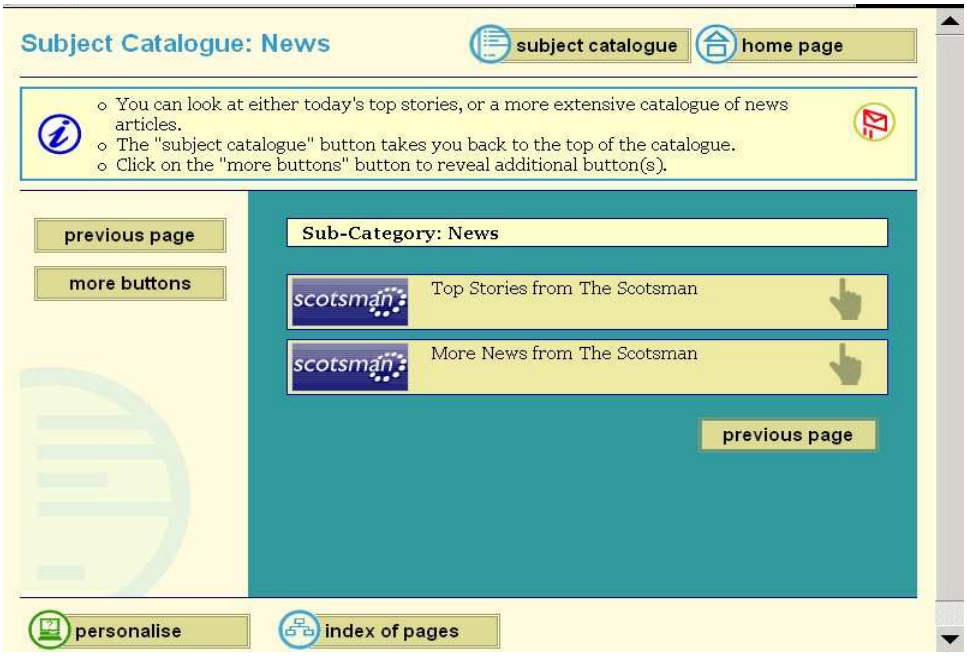
The message tray interface is shown in Figure 2.

Fig. 2: Message Tray



A similar look and feel was used for a web search and navigation system, so that there would be a familiar context for the user to 'progress' to. Figure 2 shows that a panel at the top of the screen contains instructions for what users could do on the page, and the page name is clearly visible on the top left hand side. The search and navigation facility (Figure 3) was 'layered' so that the initial interface was very simple, but allowed the user to progress to a more complicated system if they chose to.

Fig. 3: Subject Catalogue:
News



8. EVALUATION

It was decided to evaluate the two applications in separate studies with users.

1. A user engagement study, which concentrated on the use of the email system as an attractor to the Internet, and
2. A learning and progression study, which examined whether users could progress through the web searching and navigation tool with minimal external intervention.

8.1 Evaluation Studies

Eight days were allowed for each evaluation, with the evaluation of the email system taking place quickly to allow the results to feed into the development of the search and navigation system.

The evaluation of the systems proved to be another area of conflict within the team, and here once more, essential differences of opinion and knowledge transferred from other areas caused disagreements. The clients had two major points of concern - the number of participants, and appropriate questions to be asked during the evaluations.

8.1.1 Participants

The selection of participants was complicated by the short time period available for the evaluations. The research team were keen to evaluate system use over more than one visit and this meant that participant numbers had to be kept relatively small. The very wide range of capabilities of older and disabled people also complicate the evaluation of systems. In commercial contexts, only a small number of participants are commonly used. Nielsen, for example, recommends three to four users as the optimal number for "most usability studies", and to allow five for no-shows [Barnum et al. 2003]. This small number of participants is often an effect of the usability specialist trying to get answers in time to influence the development process, and it has been reported that Microsoft will make changes after evaluation by one or two participants to ensure that the results of usability testing affect the development process [Medlock et al. 2002]. Wixon [2003 pp.29-34] also suggests that "a more relevant criterion than, for example, the number of errors found is… "what is the best way of deploying the usability resources we have available .... in order to maximize our beneficial impact on the product".

The methodology recommended by Newell & Gregor [1997] is to ensure that the experimental group is representative of those characteristics of older people which are crucial to the particular evaluation, rather than that they be representative of the whole population of potential users. The Academics thus carefully selected twenty users from their panel of volunteers who had age related multiple minor impairments and were unconfident in the use of computers and had never used the internet. The sample also did not represent older people who had a major disability. The challenges of older people with major disabilities were addressed separately by a formal usability and accessibility audit of the systems, which included formal assessments of the system by disabled people.

Table 4: Study participants by age and gender

	Female	Male	All
60-64	4	2	6
65-74	4	3	7
75-84	3	2	5
85+	1	1	2
All	12	8	20

All the participants had corrected vision, four had hearing aids, two had had strokes which left some minor motor control impairment and some concentration and memory difficulties, and another three participants had minor fine motor control impairment. Five people had other self-reported medical conditions.

8.1.2 Procedure

In order to ensure that the comments the participants made were within the context of currently commercially available systems, and to give them a basis for comparison, each evaluation study compared the experimental system with a commercial equivalent. In the email study Microsoft Outlook Express, a system commonly provided by Internet Service Providers in the United Kingdom, was selected as the comparison system. The comparison system selected in the web search and navigation study was Yahoo (http://uk.yahoo.com), selected to provide a portal and search facility.

Fifteen participants evaluated the email system, and 11 evaluated the search and navigation system. 6 participants were involved in the evaluation of both systems in order to gain data on the extent to which use of the email system aided the progression to web search and navigation.

For each evaluation, every participant attended twice, their visits being roughly a week apart and, on each visit, they used both the experimental system and the commercial system. The order of presentation was controlled to prevent order effects. The participants carried out several tasks using each system, intended to reflect increasingly advanced use of the system. The tasks carried out on the first visit were mainly basic tasks, on the second visit tasks were more advanced. In the email study, participants were initially asked to read and reply to emails and, in later tasks, to use the address book and forward a message. The early search and navigation study tasks took place within the "walled garden" of the Cybrarian search and navigation system: for example, participants were asked to find details on entry to Glamis Castle when one of Cybrarian's navigation options was "Places to Visit". Later tasks involved entering search terms and further exploration of the web, for example, finding the times of a specific theatrical production and ways of travelling to the venue. In these tasks, specific websites were suggested to support users.

Participants were supported by a facilitator, an Academic who asked them to carry out the tasks, and offered help if they were stuck or distressed. Responses to systems were elicited after each system was used. The participants were also asked a series of questions by the facilitator about their experience of using each system following a semi-structured interview procedure at the end of each session. Participants were asked which system they preferred, and the reasons for this preference. Based on their responses, facilitators followed up areas of interest. An example list of questions can be found appended to this paper.

Notes were taken by a note-takers, who were members of the Client or Developer's team, and who tried to be an unobtrusive as possible. In order to provide an informal

ambience it had been decided that both facilitator and note taker should be in the same room as the user, rather than utilise the more usual two-way mirror system for observing users. Each visit involved two sessions with a coffee break in the middle, where informal chat between the user and the evaluation team was encouraged – mainly to provide time for social interaction between the team and the user

There were basic conflicts between the Academics and Clients about the questions it was appropriate to ask participants. Clients believed that the Academics were not planning to ask participants questions of sufficient technical depth. For example, the Academics proposed to ask participants to compare "two email systems": the Clients thought that these questions were too simplistic and did not include reference to the differences between a "proof of concept simulator", and an email system. They were concerned these simple questions would not produce the depth of information that they needed, but were unaware than the user group would not be likely to understand the technical differences between an actual email system and a simulator, even if they were carefully articulated. The Academics also made the point that most of the older users in the study were unaware even that there could be more than one way of doing a task on a computer, and were certainly unaware of what an 'interface' was. More importantly, attempting to communicate such an unfamiliar distinction would have discouraged and intimidated the participants.

This conflict again reflected the interest of the participants:

1. The Clients wanted as much testing as possible, and were influenced by previous experience of user testing with more typical user groups.
2. The Developers were concerned about the available time for testing and the resources that were necessary in terms of both person time and costs.
3. The Academics were most concerned with carrying out a scientifically useful evaluation whilst ensuring that the participants were not distressed by either the technical detail or their "failures".

A pilot run of the evaluation with real users, where the Clients acted as note-takers, finally persuaded the Clients of the real extent of the participants' lack of knowledge of computers. Sharing these different, but valid, perspectives, and ensuring all parties were fully conversant with what could be expected from the users, facilitated reaching agreement on points of concern.

8.2 Results of Evaluations

The data from the studies clearly showed that the specially developed systems were superior to the commercially available systems both in terms of providing an unthreatening introduction to email and to web searching and navigation.

Results from the structured interviews showed a very clear preference for the specially designed systems, with such comments about the Cybrarian email system such as “it is so easy it’s unbelievable”, “it is non-threatening”, “if I had something as simple as this I would use it” compared with “this may well have put me off (computers)” or “oh this one is scary, difficult and unhelpful” for Outlook Express.

These qualitative findings were confirmed by quantitative measures. Participants in the email study were able to use the Cybrarian system more autonomously and successfully than the control system, and learned to use it more quickly than they learned to use the control system. Results for the Search and Navigation system were more equivocal but also indicated that Cybrarian was initially easier to use than the control system.

8.2.1 Email system

An important measure of the usability of the email system was the number of tasks that a user managed to complete without any intervention from the facilitator. As the tasks were designed to be progressive in both complexity and the level of system familiarity required, comparisons will focus on success rates across the different tasks.

Table 5: Email tasks completed without intervention
(max score in each cell = 15)

	Visit 1		Visit 2	
	Cybrarian	Control	Cybrarian	Control
Task 1	14	8	13	9
Task 2	13	7	14	9
Task 3	14	7	14	8
Task 4	10	7	11	8
Task 5	10	7	8	6
Task 6	7	6	12	8
Task 7	-	-	12	3
Mean	11.33	7.00	10.14	7.29

Table 5 shows the number of email tasks that participants completed without help from the facilitator during both visits. A 2 (System) x 2 (Visit) Analysis of Variance was conducted on the data to determine any difference in performance between using the Cybrarian system and using the control system. The tasks set for the first visit, although comparable, did differ from those presented during the second visit, and hence Visit will be treated as a between-factor in the ANOVA.

A main effect of System [$F(1,11) = 9.366$, $p < 0.05$] indicates that more participants successfully completed the range of different tasks using the Cybrarian software (each task averaging a success rate of 10.69) rather than the Control (only 7.15; a little under half the participants on average). Performance did not alter significantly between visits [$F(1,11) = 0.162$, $p > 0.5$] and the lack of any interaction [$F(1,11) = 0.395$, $p > 0.5$] between the two variables confirms that the benefit of using the Cybrarian software was not restricted to either the first or second visit in particular.

8.2.2 Search and navigation system

The Search and Navigation evaluation was intended to show whether progression was made between visits; that is, whether by introducing the participant to the Web using the Cybrarian system they showed indications of progression and learning.

Table 6: Search and Navigation tasks completed without intervention
(max score in each cell = 11)

	Visit 1		Visit 2	
	Cybrarian	Control	Cybrarian	Control
Task 1	10	7	10	7
Task 2	10	9	8	5
Task 3	8	4	7	4
Task 4	11	4	3	3
Task 5	11	7	6	9
Task 6	11	4	9	8
Task 7	11	3	5	5
Task 8	5	2	1	1
Task 9	10	1	5	3

Task 10	7	5	-	-
Task 11	5	1	-	-
Task 12	1	-	-	-
Mean	8.33	3.92	4.5	3.75

T-tests carried out on the data indicated that while users of the Cybrarian search and navigation system completed significantly more tasks unaided in the first visit than did users of the control system [$t(11)=5.641$, $p<0.001$] there was no difference in task completion between systems in the second visit [$t(11)=1.472$, $p=0.169$].

These quantitative results reflect the qualitative results where strong preference for the Cybrarian system in the first visit is qualified in the second by increased preference for the control system (although Cybrarian is still preferred). Attributing cause to the results is more complicated: while they could be used to support the argument that users *did* progress in web use between the first and second visits, they may also reflect the increased difficulty of the tasks on the second visit. Fewer participants successfully completed tasks on the second visit in either condition and this may have concealed differences between the systems.

These results demonstrate that while both systems were preferred and used more autonomously the first time they were encountered, these benefits were subsequently less apparent for the search and navigation system.

8.2.3 Difficulties encountered with control systems

The higher rate of tasks completed under both Cybrarian systems reflects the barriers that users encountered using the control systems (Outlook Express and Yahoo). There is a fairly extensive body of literature on design for older adults [Fisk et al 2004; Hawthorn 2000], much of which was used in the design of the systems. Perhaps unsurprisingly, many of the difficulties that users experienced with the control systems reflected this literature. It is not the intention of the authors to repeat it here, but some findings are presented:

Table 6: Problems encountered with control systems

Problem encountered	**Details**	**Notes**
Difficulty making sense of screen contents.	Participants repeatedly scanned complicated screens for targets; long hesitation in finding target on complicated screens.	This difficulty may be associated with cognitive ageing which brings about a reduction in visuospatial ability. Both Newell et al. [2003] and Fisk et al. [2004] warn that older users will take longer to process visual displays.

		Chadwick et al. [2004] found that extremely complicated displays can act as an insurmountable barrier for older users.
Comprehension of interface conventions. Knowledge that is assumed by conventional interfaces acts as a significant barrier to use.	Difficulty understanding scrollbars; not knowing when to double-click; failure to understand menus and multiple windows; mode errors like repeatedly clicking on "inbox" when they were already there.	The effects of a lack of contextual knowledge are reported in the research [Fisk et al. 2004]. Dix [1998] has pointed out the illogical behaviour of the scrollbar.
Difficulty with mouse use; considerable investment of time moving mouse over smaller targets.	Difficulty moving mouse over targets and clicking; clicking motion can move mouse off target; double clicking especially difficult: participants often left too long between clicks. Some participants moved attention to mouse, away from screen, and did not see the result of their actions.	Manual dexterity difficulties are well-reported, particularly for more complicated and time-dependent actions like double-clicking [Czaja and Lee 2003].
Technical and inappropriate language constituted a continual and powerful discouraging factor.	Participants did not recognise terms like "Contacts" and "Properties"	Difficulty with computer jargon is a recognised barrier [Janicki 2002].
Difficulty encoding information in complicated contexts	During tasks they found difficult, participants repeatedly forgot small details about the computer, e.g. how to get a new line or a capital letter; such tasks were poorly remembered.	Hawthorn [2000] presents research suggesting that concentration on a difficult task will degrade performance on related, simultaneous tasks.

8.3.1. Formal Audits for Accessibility

A formal accessibility audit on both systems was performed by Dundee University's Digital Media Access Group. This review involved a variety of evaluation techniques, and included a detailed inspection of the systems for potential accessibility and usability problem based on a methodology developed by Sloan et al [2000]**.** The systems were evaluated under a variety of browsing conditions and with a variety of browsing and assistive technologies. Manual and automatic evaluation was performed against the W3C Web Content Accessibility Guidelines and HTML standards. Informal usability evaluations, involving both able bodied people and disabled participants were also carried out. A high level of accessibility was noted and clear evidence found that accessible

design guidelines had been closely followed during development. Some potentially significant accessibility barriers were however found, including confusing presentation of internal page navigation links, inappropriate and inconsistent text alternatives for icons, and inappropriate use of technical jargon.

Overall, the most significant issue noted was 'usability' of the system via the accessibility options, rather than accessibility per se. The complex relationship between usability for disabled people and accessibility, and the apparent limitations of a strict focus on accessibility guidelines have been noted by several authors [DRC 2004; Kelly et al. 2005]

In the Cybrarian case, these included the usability problems of a text-to-speech device reading out data, which was easily understandable in the visual format, but, when reduced to linear spoken text, became in some places virtually incomprehensible. It seemed clear that the designers had been aware of, and attempted to follow, best practice by ensuring that all text should be accessible to a screen reading device, and that graphics should be provided with text alternatives. Yet, the evidence suggested that their testing process did not include listening to the text read out by a speech synthesiser to judge the quality and logic of the text, including text alternatives for images, when spoken out. This would seem to imply that these particular designers had had little actual interaction with disabled people, particularly those who needed to use alternative display methods.

8.4 Success of the Experimental Designs

The evaluation with users showed that the radically simple experimental designs had been successful in providing an easy to use email and search and navigation system for older people for whom the internet was an alien territory. An additional advantage of the studies was the effect on the participants. In general, the experience of using the specially designed system increased the confidence of those who had taken part in the study, and the authors believe that it is more likely that they will use the Internet in the future. They do not believe this would have happened had the study only exposed these users to commercially available applications.

The effect of the studies on the Clients and the Developers was dramatic: their views of the characteristics of older users changed substantially, and they came to understand the very low level of Information Technology knowledge of many members of the group. All members of the Development team are convinced that this would not have happened if the results of the studies conducted by the Academics had only been fed back to the Clients and Developers as experimental results. Having Clients and Developers as note takers might have resulted in the notes being less professional than if trained note-takers

had been used. The great advantage which overweighed this consideration, however, was that the Clients and Developers were fully engaged in the complete evaluation process. They not only spent time as formal note-takers in the same room as the users, but also had the opportunity to meet the users and talk to them outwith the formal experiment. This facilitated an empathy with the users, which may not have been so strong had they been viewing the users through a two way mirror.

Wixon [2003] comments that “it is no accident that most usability testing involves encouraging entire design teams to watch the test, and it is well known that much of the effectiveness of the test comes from this active participation”. He makes the point, however, that “this important element in making methods effective is by and large ignored in the formal literature”. This project has taken Wixon’s suggestion one stage further by involving Developers as participants in the conduct of usability studies rather than simply as observers.

The authors believe that this experience will have a long term effect on the Clients and Developers in terms of their approach to user-centred design in the future.

9. CONCLUSIONS

This paper provides a case study approach to the development of a radically simple Internet system for older people, with a team of developers from academia and industry. It is a single instance, but the authors believe that the project was not un-representative of commercial software design. Wixon describes such case studies as “both the only practical way to produce a body of knowledge for applied usability and the most effective." [Wixon 2003]. Although, in this particular project, the group with experience of working with older users was an academic group, the authors believe that many of the perspectives found in this case study would apply equally to a wholly industrial based group with the same spread of experience.

In the early stages of the project, both developers and clients felt that the academics were exaggerating the difficulties older people had in using computers. It was not until they had the opportunity to interact with older people themselves, that their views changed, and changed significantly. The academics, on their part, obtained useful insights into the stresses and time pressure that the developers were under. This process of developing mutual understanding throughout the project was an important experience for everyone involved. The system that resulted was very appropriate for the user group, and was produced to a very high standard within severe time constraints.

Substantial preference was indicated by the users for these radically simple designs. The project thus showed that it is possible to design Internet applications which are

"attractive to older users (over 60 years of age) who are uninitiated and unconfident in the use of computers and for whom the Internet is an alien territory."

The studies underlined the importance of having requirements gathering and evaluation methodologies which are carefully designed to be appropriate to the particular characteristics of older people, and having access to a group of older people who are appropriate for such tasks. More importantly they confirmed the importance of "changing the attitudes of mind of designers", by providing them with information in a form which made maximum impact. A great deal of data about the characteristics of older people had been available to the Clients and Developers both as academic research, and also through formal and informal discussion between the Academics and the Clients and Developers. The Clients and Developers had also talked with some older users. This exposure, however, seemed to have little effect. It was not until older participants were actually personally observed trying to use the system that the Developers and the Clients fully realised the technological ignorance and fear of the users. Ensuring that the Developers met and interacted with older people developed a level of empathy which would not have occurred if the focus groups and evaluations had been conducted solely by usability professionals who reported their findings to the development team. In addition, the accessibility audits showed that following guidelines alone may produce applications which conform to these guidelines, but may in practice be un-usable by disabled people.

We believe that this development underlined the need for including within the design process a method whereby the clients and developers are exposed to user needs in a way which has the maximum impact on their designs. Although this should include standards and guidelines and research results, it is not clear that these always have sufficient impact. The work reported here showed the impact of designers actually observing older users interacting with their systems – as opposed to simply reading the results of such evaluations. It is important, however, to control the introduction of inexperienced developers to older users with little computer experience. Older users meeting such developers should be given every opportunity to create a situation in which they feel comfortable, including inviting pre-existing groups, situating the first meeting somewhere familiar to the volunteers and making it clear that their comments are valuable. We would suggest that similar strategies might be considered for the first design evaluation, especially if this takes place very early in the development process (desirable for optimal impact on the developers and the subsequent design). Small groups of people evaluating paper prototypes can create a more mutually supportive environment

than individuals faced with an unfamiliar design. An additional advantage of using small groups at early stages is that the process of "thinking aloud" is considerably less artificial as a discursive exploration of an interface with others, rather than a process of laying one's uncertainties open to an "expert". We emphasise again that these precautions are important not only for ethical reasons but to enable genuinely useful information to be elicited and exchanged.

The authors, however, appreciate that the approach adopted in this project of ensuring that clients and developers worked with carefully chosen older people is not always feasible. They are thus examining other ways of "changing the attitudes of minds" of software developers concerning the real characteristics of older users and non-users of information technology. A promising approach is the use of theatrical techniques using professional script writers and actors to present the characteristics of this user group of which it is particularly important for developers to be aware [McKenna et al. 2003]. A video, the "Utopia Trilogy" which addresses the issues of older people's interaction with technology has been developed by the authors and others, in conjunction with the Foxtrot Theatre Company. This has been shown to make a significant impact on the attitudes of both student and professional designers [Carmichael et al. 2005], and is recommended viewing as part of the training of designers, particularly those who have not had experience of this user group. Copies of a CDRom of the Utopia Trilogy can be obtained from Newell (email: afn@computing.dundee.ac.uk).

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Table ?
Outline of the Design Process.

The design process consisted of a number of formal workshops including academics, clients and developers which controlled the development of the software.

1) "Stakeholder and Assumptions Workshop"

This discussed the high level project principles, and was followed by a series of Project Initiation Workshops.

2) Project Initiation Workshops

These were concerned with identifying the characteristics of the software to be developed and the primary and secondary hypotheses which the evaluations would address. These workshops considered

i) The User Space – the characteristics and requirements of the user group
ii) The Technology Space – what could be achieved within the timescale
iii) The Interaction Space – the user interface and interaction metaphors and methodologies

During these workshops that the academics were concerned with the over ambitious nature of some of the proposals, and they proposed a Training Workshop.

3. Training Workshop

This full day workshop was provided by the academics and included:

i) Relevant research
ii) Diversity of older people's characteristics
iii) Accessibility Auditing, and
iv) Group discussions with older people from local cyber café

4. Workshops to determine the applications to be developed.

These were decided as

i) email, and
ii) search and navigation

[The developers suggested a greater range of functionality than the academics thought appropriate, and thus the academics produced a working paper underlining the

sensory, physical and cognitive characteristics of the client group, as well as their attitudes to computers with specific reference to an email system. The tensions between the views of the academics and the developers and clients, who thought that the academics were exaggerating the characteristics of older people, however, remained and are shown in table 2.]

7. Focus group

The timing of this was brought forward by the academics, on the basis of the current mind-set of the clients and developers, and re-designed to include an evaluation of paper prototypes by older people. Representatives of both clients and developers took part in this study, which proved to be the turning point in their understanding of the real characteristics of the users. See section 6.2

5. Accessibility Workshop

i) Accessibility features to be included within the system
ii) Accessibly features to be available via "personalisation"
iii) Formal methods for evaluation of accessibility

6. Working prototypes produced by developers

[An iterative process with academics commenting at various stages in the development. Unfortunately, but typically of a commercial project, there were no resources available for discussions with users during this process].

7. Workshops to develop the formal evaluation methodology.

This included
i) An engagement study (with email)
ii) A search and navigation study

[Tensions arose between the clients and the academics in terms of what could be achieved in terms of results within such a study. The clients specifying a level of complexity and depth of technical understanding which the academics did not think appropriate for an evaluation study with the particular user group].

8. Pilot run of a formal evaluation study with email

[This convinced the clients that they were in fact being over optimistic and the evaluation methodology was significantly altered]

8. Formal evaluations

[Again representatives of the client and developers participated in these evaluations]

9. Formal accessibility audit

None of the users in the studies were severely disabled, and thus a formal accessibility audit was conducted on the software by an independent group

End of Session Questionnaire - facilitator script

Thank you very much, I just have a few more questions for you.

You have tried two email systems, system A and system B, to remind you what they were like here are two pictures of them.

Now we would like you to answer some questions about them:

1. Which email system did you prefer?

Why?

2. Which email system did you find easiest to use?

Why?

3. Do you think one of the systems is easier to remember than the other?

4. Would you use either of the systems again? If so, would you use one rather than the other? Which one?

Why?

I noticed you had difficulty with ….. [noted during the session] … can you tell me about that?

You seemed to like …. [noted during session] … what did you like about it?