CHI 2003 Tutorial:

Designing for Users with Special Needs

Alan Edwards, Alistair D.N. Edwards and Elizabeth D. Mynatt

Instructor Biographies

Alan Edwards

Alan is an HCI consultant specializing in accommodation for users with special needs. He also, is an adjunct professor in the College of Information Science and Technology at Drexel University. Previously he provided technology accommodation within Unisys.

Alistair Edwards

Alistair is a senior lecturer in the Department of Computer Science at the University of York, England, and a member of the Human-Computer Interaction Research Group. His principal research interest is in the use of multiple modalities of interaction to make computers accessible to people with disabilities. He is the author of one book, *Speech Synthesis: Technology for Disabled People*, and editor of the book, *Extra-Ordinary Human-Computer Interaction* He has taught a longer version of this material in his course, *IT as an Enabling Technology*.

Elizabeth Mynatt

Beth is an Associate Professor in the College of Computing at the Georgia Institute of Technology. Previously, as a research scientist and doctoral student, she directed the Mercator Project. The Mercator Environment provides access to GUIs for people who are blind through the use of synthesized speech, non-speech audio, and spatialized sound. She has also worked in the Enabling Technology Group at Sun Microsystems. Prior to joining the faculty at Georgia Tech, she spent three years at Xerox PARC working on ubiquitous computing and novel human-computer interfaces that leverage sensing the physical environment. Most recently, she has started the *Aging in Place* project that focuses on helping elderly individuals continue to live in their own homes longer instead of moving to an institutional care setting through the use of novel sensing technology and human-computer-human interfaces.

Agenda

9:00	Introduction
	Motor impairment
10:30	Coffee Break
11:00	Visual impairment
	Speech impairment
12:00	Exercises
12:30	Lunch
2:00	Hearing impairment
	Cognitive impairment
	Language impairment
	Focus on elderly
3:30	Coffee Break
4:00	Design guidelines
	Design exercises
5:15	Wrap-up
5:30	End

Objectives of the course

- To raise the awareness of the needs of the diverse population of computer users, including those classed as having disabilities.
- To provide information on the effects of common disabilities and guidance as to how these may be accommodated.
- To inform regarding the legal obligations to meet the needs of disabled users.
- To provide support and motivation for companies to meet their obligations with regard to access.
- To give a taste of practical experience of solving accessibility problems.
- To provide information on the current state of the art in commercial and developmental assistive technology.

Introduction

In this tutorial we provide the motivation for pulling together HCI research and Enabling Technology. First, there is no real distinction between disabled and non-disabled users. We are all disabled at different times due to accidents, disease, aging, simple daily strain, environment, or poor technology. Second, research in assistive technology has led to many technological advances for all people. Third U.S. law requires that employers provide accessible equipment. We discuss what these laws mean to the computer hardware and software industries as well as to employers. And finally, we propose that taking possible physical and mental disabilities into account is simply part of good HCI design practice. We include lessons learned from involving disabled users in the design and evaluation of various products. When HCI design includes all users then we create **enabling technology** – technology that enables all users. We will look at two main types of enabling technology: technology which ensures access for all users and technology which makes use of the computer to perform traditionally non-computer tasks.

Foreword

There is an increasing realization that computers and other information technology have become an intrinsic part of everyday life and that most people must be able to use the technology – including people who have differing abilities. While the level of awareness is high, the knowledge of how to achieve access for people with disabilities is not always as readily available. It is the objective of this tutorial to fill as much of that gap as possible.

The tutorial has a long history. Versions of it have been presented as follows:

Date	*Institution*	*Presentation*	*Presenters*
1993	InterChi '93	Tutorial	Alan Edwards , Alistair Edwards, and Beth Mynatt
1994	Chi '94	Tutorial	Alan Edwards , Alistair Edwards, and Beth Mynatt
1995	Chi '95	Tutorial	Alan Edwards , Alistair Edwards, and Beth Mynatt
1997-2002	University of York	*IT as an enabling technology,* third-year option	Alistair Edwards
2000	Chi 2000	Tutorial	Alistair Edwards & Beth Mynatt
2000	HCI 2000	Tutorial	Alistair Edwards
2001	Chi 2001	Tutorial	Alistair Edwards & Beth Mynatt
2002	HCI 2002	Tutorial	Alistair Edwards

Section 1
Introduction

This tutorial
Everybody uses computers, whether it is directly such as writing on a word processor, accessing a database, withdrawing cash, or indirectly in a washing machine or car. A proportion of the population differs from the "average" in terms of their physical, sensory or cognitive abilities – to the extent that they are identified as "disabled." That section of the population requires the same access to computers as everyone else. There is an increasing realization within the industry of the need to ensure that such access is attainable. There is often less of an understanding of how to achieve that access. That is the topic of this tutorial.

Language and definitions
Before we can get into any discussion it is necessary to be clear about the language we are going to use. In any discussion of people who are different from the average, the language can be highly value-laden and so we must set out our rules and meanings to ensure clarity and to avoid giving offence.

"What's in a name? that which we call a rose By any other name would smell as sweet." Did Shakespeare really mean to suggest that the language which he used to such effect was really so powerless? Perhaps 'rose' is a relatively value-free name, but many of the names and descriptions used in this tutorial are not. The subject of this tutorial is the design of interfaces for particular people and the terms we use to identify those clients are far from being value-free; they can be laden with emotive references.

The terminology used is subject to fashion. At one time 'cretin' and 'idiot' were precise medical terms but they became terms of abuse and were dropped from their former use. Current 'politically correct' language attempts to replace the negative associations of traditional language by positive references. The motivation of the proponents of such language is to be applauded, but there are two problems. One is that language is subject to fashion and fashion changes rapidly, so that there is a danger that anyone not 'on the inside' will not understand the language. Secondly such artificial language can be imprecise. For instance, some people prefer to talk of people with 'physical limitations' rather than disabilities – but everyone has limitations, so whom does the term not include? As soon as you attempt to define the term, you must resort to exactly the terms you were trying to avoid.

As David Lunney has observed (on the Internet), the use of euphemisms is potentially an infinite cycle; as soon as people understand your euphemism you

have to think of a new one. Ultimately the aim should surely be to eliminate the negative associations of the words we use.

The World Health Organization makes the following useful distinctions (UN, 1981).

Impairment
: Any loss or abnormality of psychological, physiological or anatomical structure or function.

Disability
: Any restriction or lack (resulting from an impairment) of ability to perform an activity in the manner or within the range considered normal for a human being.

Handicap
: A disadvantage for a given individual, resulting from an impairment or disability, that limits or prevents the fulfillment of a role (depending on age, sex and social and cultural factors) for that individual.

Example are:

Impairment		*Disability*		*Handicap*
Vision	→	Seeing	→	Orientation
Skeletal	→	Walking	→	Mobility
Cardio-respiratory	→	Walking	→	Mobility

Within this tutorial we have attempted to use language which is understandable, precise and not offensive. The Americans with Disabilities Act refers to 'people with disabilities' and we will tend towards that usage. Should the language we use cause anyone offence, we apologize and hope you realize that this was totally unintentional.

At a personal level, disability is related to loss of independence. We are all dependent to a greater or lesser extent on others. For instance, most of us are dependent on farmers to grow the food we eat. For the most part, however, we have some choice as to the level of dependence. People with disabilities tend to become more dependent on others. One of the things that technology can do is give back some of that independence.

HCI and users with special needs

Until the advent of interactive computers in the 1970s, the human-computer interface consisted of punched card readers and line printers and any interaction was at a distance in time and space, so the study of human-computer interaction is a relatively young discipline. Until now it has largely been concerned with the design and development of interfaces which will be usable by the 'average' person. But what is average? Lacking any theoretical base, interface designers have tended to rely a great deal on instinct and introspection. In other words, the implicit assumption

is often that the user resembles the designer. This has led to interfaces which have been designed for users who are 25-year-old males with a Ph.D. in Computer Science who are besotted with the technology (Newell, 1995). How else is it that conferences such as CHI for years regularly included papers which proved what a bad interface Unix has, and yet Unix kept on selling and growing? Surely this was because for long enough most Unix users were 25-year-old male PhDs.

Designing for exceptional users has much broader significance than is often assumed. Again it is fallacious to think in terms of disabled people and 'normal' people as if they are two clearly distinct groups. We all have a collection of abilities and weakness, we can all be handicapped by our environment and statistically we will all at some time in our lives (as we live longer) become disabled in some way. At the risk of slipping into politically correct euphemism, a better term instead of 'normal' might be 'temporarily able-bodied'.

The accommodation of users with special needs is part of the discipline of human-computer interaction because that is where it ought to be. At the same time, though, there is a powerful argument that it is also important because much of the research and development has a much broader significance. Great strides have been made in research by addressing difficult problems. This is a model that has long been followed in medicine which we can emulate.

For instance, there is currently significant interest in the development of multimodal (or multimedia) human-computer interfaces. That often involves adding sounds so the interface. There is considerable scope for further work to be done to ascertain what kinds of sounds can and should be used, but if one is designing an interface for blind users – in which sounds replace visual information rather than just supplementing it – one is likely to come up with some efficient communicative sounds.

Large-scale research projects are often justified in terms of the benefits which spin-off into other areas. Many of the devices described in this tutorial have components which arose in this manner – not the least the microprocessor. However, there is an argument that runs in the opposite direction: if resources were concentrated in these specialist areas, what benefits might accrue to other areas of research and development?

What do the telephone, the ballpoint pen and the cassette tape have in common? It is often not realized that many everyday products originated as inventions to aid people with disabilities. Alexander Graham Bell was interested in hearing aids for people with hearing losses, when he developed the telephone. The cassette tape was originally intended as a format suitable for blind people. The ballpoint pen was designed for people who lacked the dexterity to use a fountain pen.

The best contemporary example of this approach in practice is the IPSNI project at Dundee University, Scotland (Newell, Arnott *et al.*, 1995). The aim of this project is to develop a rich, multimedia human-computer interface designed to maximize the communication ability of an operator with severe physical impairments. But the project is proceeding in collaboration with an avionics company. The company is tracing all developments in order to see what it can learn which will be of use to

pilots, who may be operating within a handicapping environment (such as blacked out, upside down with limbs weighing three times as much as they normally do).

Access versus assistance

It is important to distinguish two areas of application of information technology as used by people with special needs. As we are all aware, computers are becoming an increasingly vital part of daily life in work, education and leisure. More people require access to them in daily life and that includes people who have impairments which affect their ability to access standard technology. There is, therefore, a need to adapt human-computer interfaces so as to make them accessible to such people.

The second area of application is what can be referred to as *assistive* use of computers. That is to say, using the technology to attempt to alleviate some of the limitations caused by disability. In such a role, a disabled person would use a computer (or computer-based technology) for tasks for which most people would not use the computer.

The dividing line is not distinct, though. For instance a blind person may use a word processor in a secretarial job which previously used a typewriter. Also, in many cases, the task of the human-computer interface designer is the same: to adapt the interface to meet the particular needs of the individual user. However, the emphasis may be slightly different. In one case the designer is essentially given the standard interface to 'remold' to fit the user, whereas the design of a assistive device can be built from the ground up with the interface requirements in mind. Since the ultimate design objectives are almost identical, this tutorial covers both uses of the technology, and most of what will be said will be equally applicable to both areas.

It is important to sound a caveat at this stage. Information technology can be a mixed blessing. While some barriers fall new ones can be erected. The newspapers like to publish stories of the wonders that computers have done for individuals to help them overcome their limitations. This is quite correctly worthy of note. However, it should be borne in mind that there is (potentially) another side to the technology, that its adoption could exclude some people. Blind people have already been through several stages. When computers were first introduced they were largely unusable by blind people. Then, with the development of personal computers and speech synthesizers, suddenly they became enfranchised. Now they were able to do jobs from which they had previously been excluded. They achieved a degree of equality of job opportunities in some areas of clerical and secretarial work and computer programming. However, that situation was not to last, with the advent of graphical user interfaces computers started to become inaccessible once more.

The same may happen for people with hearing impairments. Currently computers make minimal use of sounds and so such people are not significantly disadvantaged in using them. However, as multimedia interfaces become more prevalent they may become excluded if the interfaces are design in such a way as to rely on the perception of sounds. Of course part of the motivation for a tutorial such as this is to prevent such situations from reoccurring. It is to be hoped that in the future new technology will not be introduced which disadvantages users with special needs and that this tutorial makes a contribution to the development of interfaces designed with those needs in mind.