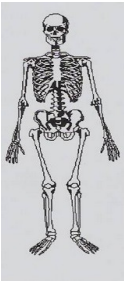
HCI-4- HUMAN CAPABILITIES AND LIMITATIONS (OTHER ISSUES)

Aims and Objectives: this is the last of the three lectures on understanding human limitations and capabilities and their implications for HCI. The first lecture looked at the five senses and the second at mental capabilities, especially memory. This lecture concludes the series by looking firstly at health and safety issues, then at ergonomics (study of work and work conditions) and finally at the need to design to accommodate the range of human diversity.

Lecture Notes

Health and Safety

Health hazards result from poorly designed computer equipment and tasks. There are international and national standards (e.g. ISO, CEN, BSI) and national legislation in many countries. *It is important that system designers are aware of the legislation that applies in their own country.* For example, member countries of the European Union are covered by a number of EC directives. *In many countries compliance with standards is monitored by a body with wide ranging powers.* For example the monitoring body may be able to close a workplace that does not conform to the standards.



As well as having a legal responsibility in many countries to safeguard their employee's health and safety most people would also agree that employers also have a moral (right standards of behaviour) responsibility to do so.

Some Health and Safety Issues

1. Postural Fatigue

Postural fatigue is mainly caused by *static effort.* Static effort is where muscles may be contracted for long periods without any opportunity to relax. Using a computerised system static effort may be required to sit with ones head and shoulders in a fixed position looking at a screen. Even moderate amounts of *static effort* can lead to pain and even damage to *joints*, *tendons-tissue joining muscle to bones* and *ligaments-tough flexible tissue that connects bones in a person's body,* if it is carried out for too long a period and is frequently repeated. ***Pain and damage*** occurs because static effort reduces *blood supply* to muscles and joints leading to a *build up of waste products* that in turn lead to *pain* and possible permanent damage.

The problem is reduced by:

- good equipment design and adjustment
- rest pauses – 5 to15 minutes per hour of VDU use
- jobs designed to require varied activity

2. Repetitive Strain Injury (RSI)

RSI is caused by repeated movement of a particular *joint*. VDU operators are at risk from RSI of wrist. Other professions are at risk of RSI of other joints' (tennis players' *elbows* and house maids' *knees*). The risk increases as typing speed increases so that data entry clerks typing at over 10,000 keystrokes per hour (not an uncommon rate) are at more risk than ordinary typists who are unlikely to exceed 7000 key strokes per hour.

The problem is reduced by:

- lower typing speeds
- regular breaks
- use of ergonomic keyboards – for example split keyboards

Quick Quiz Question 1

a) What is it about *static effort* that is likely to cause pain and possibly damage?
Reduced blood supply to tissues prevents removal of waste products

b) Why do you think it has been reported that smokers are less at risk from RSI that non-smokers? ***Motivated to take breaks***

3. Eye Strain and headaches

One of the most common problems experienced by VDU operator is eyestrain. This includes blurring-not appearing clear/distinct, soreness, dryness, watering, redness and double vision. One particular problem with VDU work is that the eyes tend to be focused at a fixed distance for long periods of time. This causes problems for the eye muscles that are similar to those of static effort described earlier.

The problems of eyestrain are worsened by

- difficult to read screens (e.g. poor contrast, too small a font)/ good contrast
- room lighting too low or too high / adequate lighting systems
- screen glare/window and table covers
- screen flicker (possibly from adjacent screens)/eye tests

Screen flicker has particularly been blamed *for headaches*. Screen flicker is more noticeable at the *peripheral areas* of vision so that people *using large screens* are more at risk.

In many countries (including those of the EU) employers are required to provide safe workstations and provide eye checks for VDU users.

4. Other Health Problems which have sometimes been blamed on VDUs.

A number of other health problems possible caused by VDUs have been investigated at various times. These include cataracts-*condition affecting part of the eye cause gradual loss of sight*, epilepsy-*disease of nervous system*, reproductive problems and rashes. At present evidence about the all of these is inconclusive.

Ergonomics

A definition of ergonomics:

'ergonomics aims to design appliances, technical systems and tasks in such a way as to improve human safety (not to be a hazard), health (should not cause health problems), comfort (enjoy) and performance (enhance the human effort)' (Dul and Wearmeester 1993).

Ergonomics pre-dates HCI. It came about through collaboration between scientists and engineers during World War 2. One of the early projects was to improve aircraft design. Ergonomics is wider than HCI in that it considers the whole of the working environment (lighting, furniture, equipment etc) and not just computerised systems. One important input to ergonomics is the study of anthropometry, which is the study of the shape and size of the human body. Human bodies obviously vary considerable in shape and size. The measurements of thousands of people of both **sexes,** and different **ages** and **races** have been collected and collated (combined) to provide basic data that can be used by designers.

Over the years there have many ergonomic studies that have resulted in sets of guidelines about workplace design. These cover factors such as (***see EEC 90/270 Regulations***):

- desk height
- seat height relative to desk height
- desktop depth
- distance from seat to back wall
- Height of VDU screens relative eye level
- Height of keyboards relative to seat height
- Design of backrest for seats
- Use of foot rest etc

Designing for human diversity

So far these lectures on human capabilities and limitations we have mainly discussed these in general terms. Occasionally we have acknowledged the fact that there are individual differences (e.g. some people are colour-blind) but in the main we have talked as if most people have the same capabilities and limitations. Whereas it is true that as human beings we share many characteristics in common and limitations. Whereas it is true as human beings we share many characteristics in capabilities (e.g. less well developed senses of smell than possessed by most dogs) there are of course significant differences from person to person. This means that a system designed for a particular person, or even for the ‘’average’’ person, will not be ideal for many of its users. There is no easy answer to this problem of designing to accommodate human diversity. This section firstly reviews some of the significant ways in which we differ and then outlines some general approaches to designing systems to cope with this diversity.

1. Differences of body size and shape

We are all aware that body size and shape differs dramatically from person to person. It is possible to work out statistical norms for people of different ages (e.g. children tend to be smaller than adults), sexes and races, but even within these norms there is considerable variety.

How can these differences be accommodated in the design of computer equipment e.g. screens and keyboards? Where possible it makes sense to make the ***devices adjustable***. For example screen height and angle should ideally be adjustable. Other things are more difficult to adjust (e.g. the space between keys on a keyboard). Here the usual approach is to ***design for the average person*** in the target user group (e.g. keyboards specifically designed for children may be smaller) and possibly accommodate extremes by providing alternative versions (e.g. a large keyboard for people with particularly large hands – or perhaps people who need to type when wearing gloves!).

2. Personality differences

People vary greatly in their personalities and attitudes. One particularly significant difference in this context is in ***people’s attitude*** to computers and computerised systems. Some people are ***attracted*** to computer systems and are keen to explore the facilities that have to offer. Others are ***suspicious*** or disapproving of computers, and may be frankly scared of them. These groups are likely to have very different reactions when put in a situation where are required to use a system that is new to them e.g. buy a travel ticket. Most people who design systems tend to be of the first type and so may unconsciously tend to design systems that appeal to similar technophiles and are thus particularly off-putting to members of the second group.

Another fact about people who design computerised systems is that ***majority of them are male***. There is some evidence from the study of computer games that particular styles of

software appeal more to males than females and vice-versa. Could this be a problem in the design of software? Imagine the design of some educational software where the reward for completing a piece of work is the opportunity to pay an arcade-style "shoot-em-up" game. Do you think this is more generally likely to appeal to girls or boys?

Personality differences are much more difficult to identify and classify than physical differences and for that reason are more likely to be ignored in system design. Some of the ways that people differ are listed below:

- risk taking versus risk avoiding
- extrovert versus introvert
- feeling versus thinking
- assertive versus passive
- reflective versus impulse

At present such differences are rarely considered or catered for in system design. May be this will change as computing devises and applications play a large role in many people's everyday life.

3. Cultural Differences

The most obvious way that people from different cultural backgrounds may differ is in terms of language. Converting a system for users from a different country may mean more than just converting textual messages that appear on the screen. For the direction that people scan the screen in (right-to-left or left-to-right etc) will also differ depending on language.

Designing systems that can readily be adapted for the international market is termed **internationalisation.** Actually adapting a given system for a particular country is called **localisation**. The international market is so important now that many software development languages and tools now support ***internationalisation and localisation***. One important example of this is the java programming language, which has built-in support for localising software written using it. The basic approach is to keep all the items that may need to be changed. (e.g. message text) separate from the software itself, so that removing those for one country and replacing them with those for another requires the minimum of disruption of the actual software code.

The issue that need to be considered when localising systems include:

- all text (obviously!)
- date and time formats
- number and currency formats
- addresses and telephone numbers
- personal names and titles
- punctuation
- collating (combining) sequences
- use of colour to mean something (e.g. red for danger)
- etiquette and use of metaphors
- screen layout (e.g. first item for input at top left or top right

Quick Quiz Question 3

What is anthropometry? ***Human body size and shape***

4. Disabilities

What are often called disabilities can be seen as a continuations of the normal range of human differences e.g. is colour blindness a disability, is being a short sighted a disability? Different cultures and individuals may choose to define disability in different ways. However it seems clear that the flexibility and power of computerised systems should be used to reduce the negative consequences of difference or disability rather than reinforce or exacerbate them.

Systems can be designed specifically to assist people with disabilities. Some examples given below:

- Enlarged text for people with poor sight
- Braille or voice output (e.g. to convert email for blind users)
- Speech recognition for people with mobility problems
- Head-mounted optical mice for people with mobility problems

It is recognised that it is easier to design systems in the first place which consider the needs to disable people than to change them complete after they have been built.

People with mental disabilities can also be helped by appropriately designed systems. Children with learning problems can benefit from educational programmes designed to give them a feeling of control and satisfaction. Computer systems have infinite patience and are non-judgemental in a way that can be difficult for a human being.

The World Wide Web consortium (W3C) is the body responsible for which important internet standards as HTML. They place such great importance of catering for the full range of human diversity including those with disabilities that they have an initiative called '' The Web Accessibility Initiative'' with the specific remit to improve the '' accessibility of the Web through five primary areas of work: technology, guidelines, tools, education and outreach and research and development.

5. Age Differences

We have all been children and most of us will grow to be old! Clearly people of different ages have different needs, capabilities and Limitations. There is growing market for education and entertainment software aimed at children. This section briefly considers the needs of people at the other end of the age range, namely the elderly.

As we age we undergo may physical and mental changes. Unfortunately most of them are not particularly pleasant sounding. For example:

- powers of vision and hearing decline
- some memory loss is common
- learning new things slows down
- flexibility of joints and strength of muscles decline

Many of these problems can easily be accommodated by sensible systems design e.g. the use of large fonts, greater contrast, simpler interfaces, easier to use mice, louder sounds. In many cases these aspects of the system can be made user configurable, and this configuration itself need to be made easy (e.g. how easy is it to configure the double – click speed of the mouse?

Demographic forces mean that many countries (including the US) have an ageing population. This alone probably ensures that the needs of elderly users are likely to be well catered for the future.

General Approaches of Dealing with diversity

Pulling together some of the points made above it can be seen that there are a number of general approaches to dealing with diversity. These are summarised below:

1. Find out your target user group and design for the ''average'' person in that group

2. Design the system so that it can be configured and adjusted

3. Provide multiple versions of the system by use for individual with different needs

These approaches can be combined. Whatever approach is taken it is important that the systems should be thoroughly tested and evaluated preferably by members of the target user group. Testing and evaluation techniques are covered in a later lecture.

Summary

This lecture has discussed health and safety issues in HCI, ergonomics and approaches to catering for the diversity of human beings.

Having completed it you should:

- Be aware of the system designer's responsibility to create a system that takes account of health and safety issues.
- Be able to explain the main types of health and safety issues associated with computerised systems.
- Be able to explain the role of ergonomics
- Be able to describe the range of ways that human beings differ and outline strategies for taking account of these differences in system design.

Tutorial Exercise

1. Consider a computer system with which you are familiar e.g. using the system at An Internet Cafe to access email. List the features of the hardware and software that you think may be different for an elderly person to use.

2. Find out what health and safety legislation and/or standards relevant to computerised systems apply in your country. How is compliance with these standards monitored?

3. Think about a software system that you are familiar with. List the things about it that would need to be changed if it were to be used by people from a different cultural background. Do you have any direct experience of using software that has been localised? Was it done well?

4. Visit the W3C's (http:/www.w3.org/WAI) and read about its '' We Accessibility Initiation''.

ANSWERS TO THE QUICK QUIZ QUESTIONS

1. a) The fact that blood supply to the tissues is reduced which prevents **w**aste products being removed.

   b) Smoker tend to be more motivated to take breaks (i.e. to go and have a cigarette) than non-smokers. This breaks reduce the danger of RSI.

2 People tend to more sensitive to screen flicker at the periphery of their vision

3. Anthropometry is the study of human body size and shape.