Introduction to Human Factors

Human Anatomy
& Biomechanics

CSiT

The University of Nottingham

Lecture Overview

- Use of Anthropometry in Human Factors
  - Stages and design principles that can be adopted
- Use of Biomechanics in Human Factors - how to minimise:
  - Back pain (due to manual handling; seated work)
  - Upper limb pain (relating to use of computers)

CSiT

The University of Nottingham

What is anthropometry?

- The comparative study of sizes and proportions of the human body
- *Traditionally*, used to design equipment, tools etc. for use when user is constrained in posture (e.g. chairs/seats, workstations)
- *More recently*, being applied to design of computers that are worn (wearables) or carried (portables)

CSiT

The University of Nottingham

Stages involved in using anthropometric data

- 1. What are the important/relevant body dimensions?
- 2. What is the relevant population?
- 3. What principle should be followed?
  - Design for extremes
  - Design for adjustable range
  - Design for average

CSiT

The University of Nottingham

Stage 3: Design for extremes

- Either design for *maximum* value of design feature, e.g. height of doors, size of buttons
- Or design for *minimum* value of design feature, e.g. distance from control
- Traditionally, designers have used limits of 5th % female---> 95th % male
- This strategy can 'design out' large sections of a user population
- Recently, push for *Inclusive Design* - increase limits in design

CSiT

The University of Nottingham

Stage 3: Design for adjustable ranges

- Provide range of adjustments when there are health and safety issues involved (e.g. driving a car, working in office)
- As before, danger of designing out sections of user population, particularly if design is multi-dimensional
- Inclusive design argues that full range of adjustments are needed

CSiT

The University of Nottingham

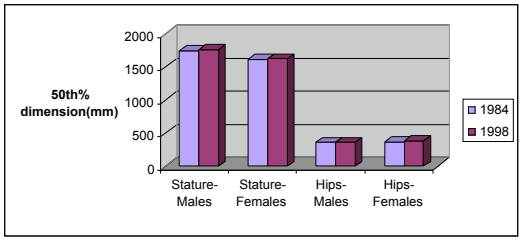
Stage 3: Design for averages

- For population of interest, use 50th percentile figures for relevant dimensions
- There is no such thing as the 'average person', due to poor correlations between different body dimensions
- This strategy is only acceptable when
  - primarily concerned with one dimension, and….
  - ….health and safety is not a significant issue (e.g. lecture room chairs)

Stages involved in using anthropometric data(2)

- 4. What percentage of population can be accommodated?
- 5. Locate anthropometrical data of interest (either in tables, or using computer-aided design packages)…….
- 6. Account for 'real-world' use (clothing, postures, movements, etc.)
- 7. Build mock-ups and test

Population growth in UK 1984-1998



Is Gary average?

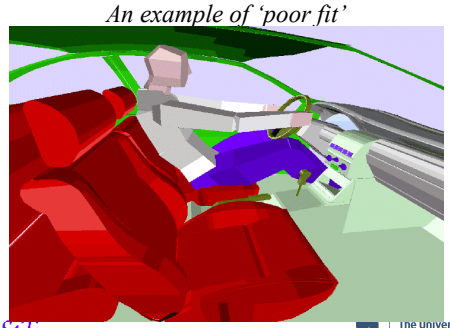
Come to the lecture to find out!!!

Is Tim big?

Come to the lecture to find out!!!

Computer-aided design

An example of 'poor fit'



Biomechanics

- Biomechanics concerns the physical movements of the human body
- Forces can be calculated using the basic laws of mechanics
- Human-machine system factors can lead to injury of musculoskeletal system, primarily:
  - Lower back
  - Upper limb

Back pain

- About 60% of adults experience back pain at some point in their working lives
- Lower back is vulnerable to injury through:
  - Manual handling (lifting, moving, etc.)
  - Long periods spent in constrained posture (particularly sitting)

Back pain - Manual handling

- Various factors increase risk of injury:
  - Weight of object/s to handle
  - Horizontal/vertical distance away of object/s
  - Distance to move object/s
  - Need for torso twisting
  - Frequency of handling
- Manual handling regulations aim to reduce workplace risk

Back pain - Sitting

- Sitting posture places greater pressure on inter-vertebral discs of spine than does standing
- Slumped (arched back) and unsupported postures lead to greatest problems
- Reduce risk by good chair and job/task design

Work-related upper limb disorders *(WRULD)*

- Effects fingers, hands and wrists, lower arms, elbow and shoulders
- In relation to the use of computers, the most common problems relate to the hands & wrists:
  - Compression of nerves within wrist (Carpal Tunnel Syndrome)
  - Inflammation of tendons (Tendonitis)
  - Inflammation of sheaths that surround tendons (Tenosynovitis)

WRULD: *Physical factors*

- *Repetition* - same movement and body part
- *Posture* - away from neutral positions
- *Static exertion* - maintaining position
- *Contact stress* - resting body part against hard/sharp surface
- *Force* - excessive muscular exertions

WRULD:

Examples of design implications

- Consider alternative *input devices* (split keyboards, speech recognition, pointing devices, etc.)
- Careful design of the *workstation* (placement of computer, chairs, desk, etc.)
- Change aspects of a person's *job/tasks* (work breaks, mental pressures, autonomy, etc.)

Summary

- Introduced important design-related issues concerning the physical characteristics of people:
  - Anthropometry
  - Biomechanics
- *Today's reading:*
  - Wickens - Chapters 10 and 11
  - Sanders and McCormick - Chapter 13
- Next lecture: Displays and controls