Overview

- Define human factors (HF).
- Identify differences in terminology within HF.
- Understand the basic philosophy of HF.
- Discuss some central concepts underlying HF.
- Understand the multidisciplinary nature of HF.
- Explore a conceptual framework for HF.
Defining Human Factors

‘that branch of science and technology that includes what is known and theorized about human behavioural and biological characteristics that can be validly applied to the specification, design, evaluation, operation, and maintenance of products and systems to enhance safe, effective, and satisfying use by individuals, groups, and organisations’

(Christensen, et al, 1988)
Defining Human Factors

In other words…

Understanding:

• why humans behave the way they do, and
• what influences this behaviour,
• to aid in improvements in behaviour (safety, efficiency, health).
Defining Human Factors

Put simply...

Designing for human use

or

Fitting the task to the human

Also known as **ERGONOMICS**.
“environmental, organisational and job factors, and human and individual characteristics, which influence behaviour at work in a way which can affect health and safety”

(U.K. Health and Safety Executive, 1999)
Other Terminology

• **Ergonomics**
  – (Greek: ‘ergon’, ‘nomos’) Literally means “laws of work”
  – The traditional term used in Europe
  – Synonymous with “human factors”, a US-derived term
  – Also called *Human Engineering* and *Human Factors Engineering*

• **Cognitive Ergonomics** or **Engineering Psychology**
  – Branch of ergonomics or psychology
  – Emphasises the study of cognitive or mental aspects of work

• **Human-Machine Interaction** or **Human-Computer Interaction**
  – Applied study of how people interact with machines or computers
Human Factor Examples

What do you see?

What is good?

What behaviour, other than the primary could be performed while driving?

How does this behaviour/s impact on safety, efficiency, & health?

Are all motorists in the same mental state while driving?

What external influences could be present?

How does personal factors influence driving (age, gender, etc)?
Human Factor Examples

What do you see?

What is good?

How is this apparatus used?

How does this behaviour impact on safety, efficiency, & health?

What factors influence the appropriate (safe, efficient, & health) use of this apparatus?

What about age, gender, mental state, IQ, fatigue levels, etc, how does these affect behaviour?
Human Factor Examples

Which control turns on the fan?

What do you see?

What is good?

How does this behaviour impact on safety, efficiency, & health?

Under what conditions is this item used (Mental state, fatigue, influence of substances, etc.)
Human Factors Examples
Human Factors Examples

- What do you see?
- What is good?
- How is this equipment used?
- Under what conditions is this equipment used (time pressure, soiled hands, etc)?
- Who uses this equipment (various IQ levels)?
- How does this behaviour impact on safety, efficiency, & health?
What do you see?

What is good?

How is this equipment used?

Under what conditions is this equipment used (time pressure, soiled hands, etc)?

Who uses this equipment (various IQ levels)?

How does this behaviour impact on safety, efficiency, & health?
Artefacts and systems are there to serve humans, and must be designed with the user in mind.

Individual differences matter in design – systems and artefacts should accommodate for them.

Design can affect human behaviour and well-being. Good design should not be noticeable. We become very aware of bad design.

Empiricism and evaluation are essential.

An objective scientific approach is necessary - hypothesis testing, validity, generalisable results, etc.

Systems approach - people, machines, environment, etc., are part of the system.

(Sanders & McCormick, 1992)
A Conceptual Framework
Person-Environment Fit

Characteristics of Person
- Physical characteristics eg: age, height, weight, etc
- Limitations of information processing
- Behavioural style/personality eg: social skills, leadership etc

Characteristics of Environment
- Physical environment, eg: lighting, noise etc
- Nature of task/job, eg: pace, type, complexity
- Organisation of task/work, eg: hours of work, breaks etc

OUTCOME
- Productivity
- Health
- Safety

Moderating factors
- Fatigue, stress, motivation
Discuss other Human Factors examples.

1. Procedures
2. Automation, etc.
Think of context
Utensils holder

What do you see?
What is good?
How is this item/s used?
Who uses this item?
Under what conditions is this equipment used (time pressure, soiled hands, etc)?
How does this behaviour impact on safety, efficiency, & health?
It is not all bad – but…..

Good designs can be misused?

Lead Pencil with eraser.
Good Design = Intuitive
Poor Design = ↑ errors
Some Key Concepts

Human Capabilities

Human Limitations

Human Needs and Values
Summary

• HF = Designing for human use
• Focus on Safety, Efficiency, and Health
• Remember,
• Humans vary
• Influences that affect humans vary
• Same influences can affect same person different depending on many factors
• Understanding this the first step in improving performance.
Information Processing
Human Information Processing Framework

(Wickens, 1992)
Overview

• Framework for human information processing
• Identify different types of information input
• Describe the signal detection framework
• Distinguish between absolute and relative judgement
• Describe the fundamental principles of coding and compatibility
• Determine when to use visual or auditory displays
• Discuss factors that affect perception in aviation
Human Information Processing Framework

(Sensory Processing)

Receptors → Perception → Decision and response selection → Response execution

- Attention resources
- Working memory
- Long-term memory
- Memory

Feedback

(Wickens, 1992)
Perception
“The term perception refers to the means by which information acquired by the sense organs is transformed into experiences of objects, events, sounds, tastes, etc.” Roth (1986)

- Detection - determining whether a stimulus is present
- Identification - classification as one thing or another
- Recognition - recognise from prior experience/memory
717
Recognise

Letters  Numbers  Alphanumeric
Identification

Car

Aircraft

Dept Office
Perception

- Perception is forward looking and predicting
- Fast ball games not possible without anticipation
- When prediction is not possible, response suffers
- Coping mechanism to overcome new and novel tasks - based on theory and comparisons
Information Acquisition

Within both high hazard and high risk industries, information is generally acquired through four of our five senses:

1. Tactile
2. Audio
3. Visual
4. Smell

Most crucial of these four senses is visual, while our fifth sense, taste, rarely plays a part in information acquisition.
• The Pupil is the opening in the center of the Iris.

• Iris is a muscle that controls the amount of light entering the pupil.

• The cornea is the transparent, dome-shaped window covering the front of the eye.

• Light passes through the lens, and the cornea and focuses light on the back of the eye - retina. Image projected on the retina is inverted and reversed.

• The Optic Nerve transmits electrical impulses from the retina to the brain.
Visual Perception involves:
1. The eye
2. Balancing mechanism of the ear, and
3. The brain

It is also strongly influenced by past experiences

Consider taking-off in an aeroplane
Visual Perception

• Often the interpretation of what we see differs from what is actually presented.

• Visual illusions are present in everyday life, but unless they lead to a noticeable event, they will often pass undetected.

• Number of theories relating to visual illusion, some more plausible than others, but irrespective of an individual theoretical preference, the impact of visual illusions on human performance are real and need to be catered for.
Can you guess this woman's age? Keep looking at the picture and see it change.
Shade Illusions

Same shade of grey?
Cover the join.
No spirals just circles.
by Akiyoshi Kitaoka
Shade Illusions

No blue spirals just green.
by Akiyoshi Kitaoka
Visual Illusion

John Tyndall, L. Hermann (1870)
Visual Illusion

- Hering Illusion
Visual Illusion

(Kitaoka, 2003)
Visual Illusion – Sexy or not?

Males what do you see?
Females what do you see?
Visual Illusion – Sexy or not?

Males what do you see?
Females what do you see?
Visual Illusions in Aviation

5 Steps to reducing the effect of visual illusions
1. Recognising that visual illusions are normal phenomena
2. Understand the nature and situation where visual illusions are present
3. Supplement visual cues with information from other sources
4. Alert people where visual illusions occur (i.e., geographic locations depict on charts)
5. Incorporate HF design principles in products
Information Input
Information Input

• Information processing depends on the sensory reception of relevant external stimuli
  – Direct (see and avoid, tower ATC, …) or Indirect (TCAS, radar, …)
  – Coded (auditory warning) or Reproduced (RT)

(Sanders & McCormick, 1992)

• Display = any indirect method of presenting information
Information can be:
- Quantitative
  - Static (tables)
  - Dynamic (speedometers)
- Qualitative (display info that reflects change)
- Status (off/on)
- Warning and signal (flashing lights, etc)
- Representational (pictorial or graphical)
- Identification (display used to identify static condition)
- Alphanumeric and symbolic (place cards)
- Time-phased (morse code)

Examples?

Sanders and McCormick (1992) p. 52
Information Input

Map the examples to the categories

- Runway markings
- Signs
- Conflicting object or aircraft
- Maps or charts
- Procedures
- Speed
- Direction of turn
- Morse-code
- Stop-caution-go lights
- Temperature

- Static (4)
- Dynamic (6,7)
- Quantitative (6)
- Qualitative (4,5)
- Status (9)
- Warning and signal (3)
- Representational (4)
- Identification (1)
- Alphanumeric and symbolic (2)
- Time-phased (8)
Inattentional Blindness

- [http://www.youtube.com/watch?v=ubNF9QNEQLA](http://www.youtube.com/watch?v=ubNF9QNEQLA)

- [http://viscog.beckman.uiuc.edu/grafs/demos/15.html](http://viscog.beckman.uiuc.edu/grafs/demos/15.html)
Signal Detection Theory

• Signal detection theory - two states of the world (signal and noise) that cannot be easily discriminated
  – 1. Sensory evidence concerning absence / presence of signal
  – 2. Decision - Yes (I detect a signal) or No (I do not detect a signal)
  – Response criterion
  – Sensitivity

<table>
<thead>
<tr>
<th>State of the world</th>
<th>Signal</th>
<th>Noise</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Hit</td>
<td>False Alarm</td>
</tr>
<tr>
<td>No</td>
<td>Miss</td>
<td>Correct Rejection</td>
</tr>
</tbody>
</table>

Response
Signal Detection Theory

- Decision-making = Two main components
  - Information acquisition gathering knowledge to make an informed decision
  - Criterion is the subjective component to decision-making (own judgment)

Figure 1: Internal response probability of occurrence curves for noise-alone and for signal-plus-noise trials.
What are some aviation applications of Signal Detection Theory in Aviation?
Absolute and Relative Judgment

• Coding - An original stimulus is converted to a symbol
  – Codes vary according to ‘stimulus dimensions’
  – Multiple codes
• Absolute versus relative judgements
• Relative discrimination 1800 tones based on pitch (Mowbray & Gebhard, 1961)
• Absolute basis 5 tones (Mowbray & Gebhard, 1961)
• The magical number “7 ± 2” (Miller, 1956)

Listen to the sounds and determine if they are similar or different
Detectable codes - Yellow on charts

Discriminable codes - A vs A

Meaningful codes -

Standardised codes

Multidimensional codes

Sanders and McCormick (1992)
Compatibility

• Relationship of stimuli and responses to human expectations

• Aim is to reduce information transformation or recoding
  – Optimise learning, response times, errors, mental workload

• Compatibility relationships may be intrinsic to the task or culture
Compatibility

Conceptual compatibility >>>

Movement compatibility <<<

Spatial compatibility >>>

Modality compatibility <<<
## Display Modalities

<table>
<thead>
<tr>
<th><strong>Auditory Presentation</strong></th>
<th><strong>Visual Presentation</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Short message</td>
<td>- Complex message</td>
</tr>
<tr>
<td>- Simple Message</td>
<td>- Long Message</td>
</tr>
<tr>
<td>- Message not referred to later</td>
<td>- Message referred to later</td>
</tr>
<tr>
<td>- Message deals with events in time</td>
<td>- Message deals with location in space</td>
</tr>
<tr>
<td>- Message calls for immediate action</td>
<td>- Message does not call for immediate action</td>
</tr>
<tr>
<td>- Visual system is overburdened</td>
<td>- Auditory system is overburdened</td>
</tr>
<tr>
<td>- Very bright or dark environment</td>
<td>- Noise environment</td>
</tr>
<tr>
<td>- Job required continual movement</td>
<td>- Job allows person to remain in one position</td>
</tr>
</tbody>
</table>

(Deatheridge, 1972; cited in Sanders and McCormick, p 53)
Factors Affecting Perception

- Display properties
- Visual and auditory capabilities
- Experience
- Expectation or Mental Set
- Distraction and Preoccupation
- Fixation
- Fatigue
- Hypoxia / Smoking
- Illusions
- Many others
Summary

- What we see, is not always accurate
- Visual illusions are real
- Our vision can also affect what we hear
- Avoid leap of faiths, use scientific methods when coding
- Better still, avoid coding where possible
- Good design = minimal confusion = reduced errors