Chapter 2
The Human Factor
Term Project Stage 1

• Complete the 6 steps necessary for Needfinding:
  1. Choose a specific design or goal – pick from topics 'Change', 'Glance', 'Time' or a blend of two
  2. Select an activity to observe – should be computer based (example: making sure there is enough space for a bike on the train)
  3. Select 3 individuals to observe – should not be like you
  4. Observe – watch them perform the activity you chose (example: commuter train to San Francisco)
  5. Identify user needs – generate at least 15 opportunities for improvement (example: better prediction of availability at a certain station)
  6. Sources of inspiration – list anything you saw in other application domains that inspire you (example: airline reservation)
Instructions

• Please make sure you pick something you feel excited about – you will have to deal with it for the entire semester.

• You can do the sequence of stages in teams of two or by yourself – bigger accomplishments are expected when you work as a team. You will then do all stages in that team.

• Submission deadline is September 16.
  – Submission site will be announced. It will NOT be Blackboard.
Models of the Human

• Descriptive models are tools for thinking (see Chapter 7)
• It would be useful to have a descriptive model for the human
• In fact, there are many (e.g., Model Human Processor, Chapter 1)
• We begin with two useful models for the human…
Newell’s Time Scale of Human Action

<table>
<thead>
<tr>
<th>Scale (sec)</th>
<th>Time Units</th>
<th>System</th>
<th>World (theory)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^7$</td>
<td>Months</td>
<td></td>
<td>SOCIAL BAND</td>
</tr>
<tr>
<td>$10^7$</td>
<td>Weeks</td>
<td>Task</td>
<td>ex: social networking</td>
</tr>
<tr>
<td>$10^6$</td>
<td>Days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$10^5$</td>
<td>Hours</td>
<td>Task</td>
<td>RATIONAL BAND</td>
</tr>
<tr>
<td>$10^3$</td>
<td>10 min</td>
<td>Task</td>
<td>ex: web navigation</td>
</tr>
<tr>
<td>$10^2$</td>
<td>Minutes</td>
<td>Task</td>
<td></td>
</tr>
<tr>
<td>$10^1$</td>
<td>10 sec</td>
<td>Unit task</td>
<td>COGNITIVE BAND</td>
</tr>
<tr>
<td>$10^0$</td>
<td>1 sec</td>
<td>Operations</td>
<td>ex: menus, gestures</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>100 ms</td>
<td>Deliberate act</td>
<td></td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>10 ms</td>
<td>Neural circuit</td>
<td>BIOLOGICAL BAND</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>1 ms</td>
<td>Neuron</td>
<td>ex: lines, points, shapes</td>
</tr>
<tr>
<td>$10^{-4}$</td>
<td>100 μs</td>
<td>Organelle</td>
<td></td>
</tr>
</tbody>
</table>

Human Factors Model\textsuperscript{1}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{human-factors-model.png}
\caption{Human Factors Model}
\end{figure}

Human Factors Model

Human Senses

Rosa: You deny everything except what you want to believe. That’s the sort of man you are.
Bjartur: I have my five senses, and don’t see what need there is for more.

(Halldór Laxness, Independent People)

• The five senses:
  – Vision (sight)
  – Hearing (audition)
  – Touch (tactition)
  – Smell
  – Taste
Vision (The Eye)

• People obtain about 80% of their information through vision (the eye)
Fovea Image

• Sharp central vision
• 1% of retina, 50% of visual cortex
• Fovea image is $\approx 1^\circ$ of visual angle:
Visual Stimulus

• Physical properties of light…
  – Frequency
  – Intensity (luminance)

• Create subjective properties of vision…
  – Colour (next slide)
  – Brightness
Colour Spectrum

Frequency (Hz)

- AC circuits
- Radio waves
- Radar
- Infrared
- Ultra-violet rays
- X-rays
- Gamma rays

Visible Light

Wavelength (nanometers)

- 400
- 500
- 600
- 700
Fixations and Saccades

• Fixation
  – Eyes are stationary (dwell)
  – Take in visual detail from the environment
  – Long or short, but typically at least 200 ms

• Saccade
  – Rapid repositioning of the eye to fixate on a new location
  – Quick: ≈120 ms
Yarbus’ Eye Tracking Research (1965)

“Remember the position of people and objects in the room”

“Estimate the ages of the people”

Scan Paths

- Visual depiction of saccades and fixations
- Saccades $\rightarrow$ straight lines
- Fixations $\rightarrow$ circles
  - Diameter of circle $\propto$ duration of fixation
- Applications
  - User behaviour research (e.g., reading patterns)
  - Marketing research (e.g., ad placement)
Scan Path Example
Eye Tracking Technology

- Has come a long way
- Now on the consumer level using corneal reflection
Eye Tracking Technology

- Now available for any devices

- Can even use standard web came and mobile phone cameras

[Video links]
Hearing (Audition)

- Sound $\rightarrow$ cyclic fluctuations of pressure in a medium, such as air
- Created when physical objects are moved or vibrated
- Examples
  - Slamming a door, plucking a guitar string, shuffling cards, speaking (via larynx)
Auditory Stimulus

• Physical properties of sound…
  – Frequency
  – Intensity

• Create subjective properties of hearing…
  – Pitch
  – Loudness
Properties of Sounds

• Loudness
• Pitch
• Timbre (next slide)
• Attack (after next slide)
Timbre

• Aka *richness, brightness*

• Results from harmonic structure of sound

• E.g., a musical note of 200 Hz, has harmonics at 400 Hz, 600 Hz, 800 Hz, etc.

• Notes of the same frequency from different instruments are distinguished, in part, due to timbre
Attack

- Aka *envelope*
- Results from the way a note and its harmonics build up and transition in time – from silent, to audible, to silent
- Considerable information in the onset envelope
- Assists in distinguishing notes of the same pitch coming from different instruments
- Onset envelop created through articulation (e.g., legato, staccato)

![Staccato](image)

![Legato](image)
Touch (Tactition)

- Part of somatosensory system, with...
- Receptors in skin, muscles, joints, bones
  - Sense of touch, pain, temperature, position, shape, texture, resistance, etc.
- Tactile feedback examples:
Smell and Taste

• Smell (olfaction)
  – Ability to perceive odours
  – Occurs through sensory cells in nasal cavity

• Taste (gustation)
  – Chemical reception of sweet, salty, bitter, and sour sensations

• Flavour
  – A perceptual process that combines smell and taste

• Only a few examples in HCI (e.g., Brewster et al., 2006; Bodnar et al., 2004)
Human Factors Model

Human Factors Model

Human

Interface

Computer

Brain

Sensors

Displays

Machine State

Responders

Controls
Responders

• Humans control their environment through responders, for example…
  – A finger to text or point
  – Feet to walk or run
  – Eyebrow to frown
  – Vocal chords to speak
  – Torso to lean

• Penfield’s (1990) motor homunculus
  – Shows human responders and the relative area of motor cortex dedicated to each (next slide)
Motor Homunculus

Area of motor cortex

Responder Examples
Handedness

- Some users are left handed, others right handed

- Handedness exists by degree
- Edinburgh Handedness Inventory used to measure handedness (next slide)
Edinburgh Inventory for Handedness

<table>
<thead>
<tr>
<th></th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Writing</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>2. Drawing</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>3. Throwing</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>4. Scissors</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>5. Toothbrush</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>6. Knife (without fork)</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>7. Spoon</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>8. Broom (upper hand)</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>9. Striking a match</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>10. Opening box (lid)</td>
<td>☐ ☐ ☐ ☐</td>
<td></td>
</tr>
<tr>
<td>Total (count checks)</td>
<td>☐ ☐</td>
<td></td>
</tr>
</tbody>
</table>

**Instructions**
- Mark boxes as follows:
  - x preference
  - xx strong preference
  - blank no preference

**Scoring**
- Add up the number of checks in the “Left” and “Right” columns and enter in the “Total” row for each column. Add the left total and the right total and enter in the “Cumulative Total” cell.
- Subtract the left total from the right total and enter in the “Difference” cell. Divide the “Difference” cell by the “Cumulative Total” cell (round to 2 digits if necessary) and multiply by 100. Enter the result in the “RESULT” cell.

**Interpretation of RESULT**
- -100 to -40 left-handed
- -40 to +40 ambidextrous
- +40 to 100 right-handed

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Human Voice

• Human vocal chords are responders
• Sounds created through combination of...
  – Movement in the larynx
  – Pulmonary pressure in the lungs
• Two kinds of vocalized sounds:
  1. Speech
  2. Non-speech
• Both with potential for computer control
  – Speech + speech recognition
  – Non-speech + signal detection (e.g., frequency, loudness, duration, change direction, etc.)
Non-speech Example

- NVVI = non-verbal voice interaction

<table>
<thead>
<tr>
<th></th>
<th>Key 1</th>
<th>Key 2</th>
<th>Key 3</th>
<th>Key 4</th>
<th>BACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>SET 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SET 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SET 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SET 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example: user might say: “volume up, aaah.” In response, the system increases the volume of the television set for as long as the user sustains “aaah”

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The Eye as a Responder

• As a controller, the eye is called upon to do “double duty”
  1. Sense and perceive the environment/computer
  2. Act as a controller via saccades and fixations
• This suggests a modification to the human factors model presented earlier (next slide)
Modified Human Factors Model

Example - Eye Typing

Human Factors Model

Human

Interface

Computer

Brain

Sensors

Displays

Responders

Controls

Machine State
The Brain

• Most complex biological structure known
• Billions of neurons
• Enables human capacity for…
  – Pondering, remembering, recalling, reasoning, deciding, communicating, etc.
• Sensors (human inputs) and responders (human outputs) are nicely mirrored, but it is the brain that connects them
Human Uniqueness

• With associations and meaning attached to sensory input, humans are vastly superior to the machines they interact with:

People excel at perception, at creativity, at the ability to go beyond the information given, making sense of otherwise chaotic events. We often have to interpret events far beyond the information available, and our ability to do this efficiently and effortlessly, usually without even being aware that we are doing so, greatly adds to our ability to function.¹

Perception

• 1\textsuperscript{st} stage of processing for sensory input
• Associations formed…
  – Auditory stimulus $\rightarrow$ harmonious, discordant
  – Visual stimulus $\rightarrow$ familiar, strange
  – Tactile stimulus $\rightarrow$ warm, hot
  – Smell stimulus $\rightarrow$ pleasurable, abhorrent
  – Taste stimulus $\rightarrow$ sweet, sour
Psychophysics

- Branch of experimental psychology
- Studied since the 19th century
- Relationship between human perception and physical phenomena
- Experimental method:
  - Present subject with two stimuli, one after the other
  - Stimuli differ in a physical property (e.g., frequency)
  - Randomly vary the difference
  - Determine threshold below which the subject deems the two stimuli “the same”
  - This threshold is the *just noticeable different* (JND)
Ambiguity

Necker cube

Which surface is at the front?

Rubin vase

Wine goblet or two faces?
Illusion

**Ponzo lines**

Which black line is longer?

**Müller-Lyer arrows**

Which horizontal line is longer?
Illusion – Other Senses

• If illusion is possible for the visual sense, the same should be true for the other senses
• Tactile/haptic illusion: phantom limb
• Auditory illusion: Sheppard-Risset glissando
  – video

Competing impression:
1. tone stays the same because the perceived frequency is the distance among harmonics
2. tone is rising because the frequencies are shifting right
Cognition

• Cognition is the human process of conscious intellectual activity
  – E.g., thinking, reasoning, deciding

• Spans many fields
  – E.g., neurology, linguistics, anthropology

• Sensory phenomena → easy to study because they exist in the physical world

• Cognitive phenomena → hard to study because they exist within the human brain
“Making a Decision”

- Not possible to directly measure the time for a human to “make a decision”
- When does the measurement begin and end?
- Where is it measured?
- On what input is the human deciding?
- Through what output is the decision conveyed?
- There is a sensory stimulus and motor response that bracket the decision (next slide)
Making a Decision – in Parts

<table>
<thead>
<tr>
<th>Operation</th>
<th>Typical time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensory reception</td>
<td>1 – 38</td>
</tr>
<tr>
<td>Neural transmission to brain</td>
<td>2 – 100</td>
</tr>
<tr>
<td>Cognitive processing</td>
<td>70 – 300</td>
</tr>
<tr>
<td>Neural transmission to muscle</td>
<td>10 – 20</td>
</tr>
<tr>
<td>Muscle latency and activation</td>
<td>30 – 70</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td><strong>113 - 528</strong></td>
</tr>
</tbody>
</table>

Large variation!
Examples of Simple Decisions

- Driving a car $\rightarrow$ decision to depress the brake pedal in response to a changing signal light

- Using a mobile phone $\rightarrow$ decision to press REJECT-CALL in response to an incoming call

- Reading news online $\rightarrow$ decision to click the CLOSE button on a popup ad

- These are reaction time tasks (discussed shortly)
A More Involved Decision

Black Jack hand:

Another card? (dealer has 17)
Memory

• Vast repository

• Long-term memory
  – Declarative/explicit area → information about events in time and objects in the external world
  – Implicit/procedural area → information about how to use objects and how to do things

• Short-term memory
  – Aka working memory
  – Information is active and readily available for access
  – Amount of working memory is small, about 7 (±2) units or chunks

Short Term Memory Experiment

- Random sequences of digits recited to subjects
- Sequences vary from 4 to 13 digits
- After recitation, subjects copy sequence from memory to a sheet of paper
- Transcriptions on sheets scored (correct/incorrect)
- Results ($n \approx 60$):

![Graph showing the percentage of correct responses as a function of sequence length.](image-url)
Chunking

• Units in short term memory may be recoded as a chunk
• Expands capacity of short term memory
• E.g., Commit to memory and recall…

• Phone numbers 4-7-1-1-3-2-4 chunk into 471-1324
Language

- The mental faculty that allows humans to communicate
- As speech, available to (almost) all humans without effort
- As writing, only available with considerable effort
- HCI interest: primarily in writing, creation of text

Humankind is defined by language; but civilization is defined by writing.¹

One way to characterise written text is a corpus

Large collection of representative text samples

A corpus may be reduced to a word-frequency list:

<table>
<thead>
<tr>
<th>Word Rank</th>
<th>English</th>
<th>French</th>
<th>German</th>
<th>Finnish</th>
<th>SMS English</th>
<th>SMS Pinyin</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>the</td>
<td>de</td>
<td>der</td>
<td>ja</td>
<td>u</td>
<td>wo (我)</td>
</tr>
<tr>
<td>2</td>
<td>of</td>
<td>la</td>
<td>die</td>
<td>on</td>
<td>i</td>
<td>ni (你)</td>
</tr>
<tr>
<td>3</td>
<td>and</td>
<td>et</td>
<td>und</td>
<td>ei</td>
<td>to</td>
<td>le (了)</td>
</tr>
<tr>
<td>4</td>
<td>a</td>
<td>le</td>
<td>in</td>
<td>että</td>
<td>me</td>
<td>de (的)</td>
</tr>
<tr>
<td>5</td>
<td>in</td>
<td>à</td>
<td>den</td>
<td>oli</td>
<td>at</td>
<td>bu (不)</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>1000</td>
<td>top</td>
<td>ceci</td>
<td>konkurrenz</td>
<td>muista</td>
<td>ps</td>
<td>jiu (舅)</td>
</tr>
<tr>
<td>1001</td>
<td>truth</td>
<td>mari</td>
<td>stieg</td>
<td>paikalla</td>
<td>quit</td>
<td>tie (贴)</td>
</tr>
<tr>
<td>1002</td>
<td>balance</td>
<td>solution</td>
<td>notwendig</td>
<td>varaa</td>
<td>rice</td>
<td>ji (即)</td>
</tr>
<tr>
<td>1003</td>
<td>heard</td>
<td>expliquer</td>
<td>sogenannte</td>
<td>vie</td>
<td>sailing</td>
<td>jiao (角)</td>
</tr>
<tr>
<td>1004</td>
<td>speech</td>
<td>pluie</td>
<td>fahren</td>
<td>seuran</td>
<td>sale</td>
<td>ku (裤)</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
Part-of-speech Tagging

• Some corpora include part-of-speech (POS) tagging
• Each word is tagged by its category (e.g., noun, verb, adjective)
• Used in word prediction to narrow search space
• Example:

  The *paint* is dry. (noun)

  Children *paint* with passion. (verb)

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Statistics and Language

• Native speakers intuitively understand the statistical nature of their language

• We...
  – Insert words that are omitted or obscured:
    Ham and ______ sandwich.
  – Anticipate words:
    A picture is worth a thousand ______.
  – Anticipate letters:
    Questio_
  – Anticipate entire phrases:
    To be or __ __ __.
Redundancy and Language

• Since humans can fill in missing parts, perhaps the missing parts can be eliminated
• This shortens the text (efficient)
• Example: 243 characters of text with vowels removed

Th std ws flld wth th rch dr f rss, nd whn th lght smmr wnd strrd mdst th trs f th grdn, thr cm thrgh th pn dr th hvy scnt f th llc, r th mr dlct prfm f th pnk-flwrng thrn.

• 71 vowels removed
• Text shortened by 29.2%

Meaning of the text?

Summr → summer, thrgh → through, etc.
Redundancy and Language (2)

• Vowels at beginning of words intact:

Th std ws flld wth th rch odr of rss, 
and whn th lght smmr wnd strrd amdst th 
trs of th grdn, thr cm thrgh th opn 
dr th hvy scnt of th llc, or th mr 
dlct prfm of th pnk-flwrng thrn.

Easier to understand.

• Original:

The studio was filled with the rich odour of roses, 
and when the light summer wind stirred amidst the 
trees of the garden, there came through the open 

doors the heavy scent of the lilac, or the more 
delicate perfume of the pink-flowering thorn.

Oscar Wilde: The Picture of Dorian Gray
Recoding

• Other ways to shorten text
• Recoding: replacing words/characters with shortened tags using linguistic tricks\(^1\)

• Examples
  – Sound:
    
    th@s → that’s
    gr8 → great

  – Invented acronyms:
    
    w → with
    gf → girlfriend
    x → times

SMS Shorthand

• The final frontier!
• A 13-year-old student’s essay (excerpt)¹

My smmr hols wr CWOT. B4, we used 2go2 NY 2C my bro, his GF & thr 3 :- kids FTF. ILNY, it's a gr8 plc.

• 102 characters

• Original (for the teacher to deduce)

My summer holidays were a complete waste of time. Before, we used to go to New York to see my brother, his girlfriend and their three screaming kids face to face. I love New York. It's a great place.

• 199 characters

¹ http://news.bbc.co.uk/2/hi/uk_news/2814235.stm
Human Factors Model

Human

| Brain |

Interface

| Sensors | Displays | Controls |

Computer

| Machine State |

Human Performance
Skilled Behaviour
Attention
Human Error
Human Performance

- Humans use their sensors, brain, and responders to do things
- When the three work together to achieve a goal, human performance arises
- Examples:
  - Tying shoelaces
  - Folding clothes
  - Searching the web
  - Entering a text message on a mobile phone
Speed-accuracy Trade-off

- Fundamental property of human performance
- Go faster and errors increase
- Slow down and accuracy improves
- HCI research on a new interface or interaction technique must consider both the speed in doing tasks (achieving the goal!) and the accompanying accuracy
Human Diversity

• Human performance is highly complex:
  – Humans differ (age, gender, skill, motivation, etc.)
  – Environmental conditions affect performance
  – Secondary tasks often present

• Human diversity and human performance often shown in a distribution (next slide)
Human Diversity and Performance

Where are you on this chart?
Where is your mother?
Where is an 8-year old, just learning to use a computer?
Where is someone with a physical disability?
Where are you while using your mobile phone on a crowded bus (standing)?
Reaction Time

• One of the most primitive manifestations of human performance is *simple reaction time*

• Definition: The delay between the occurrence of a single fixed stimulus and the initiation of a response assigned to it

• Example: pressing a button in response to the onset of a stimulus light

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Sensory Stimuli and Reaction Time

• Delay time varies by type of sensory stimuli
• Approximate values\(^1\)
  – Auditory \(\rightarrow\) 150 ms
  – Visual \(\rightarrow\) 200 ms
  – Smell \(\rightarrow\) 300 ms
  – Pain \(\rightarrow\) 700 ms

Visual Search

- A variation on simple reaction time
- User scans a collection of items looking for desired item
- Time increases with the number of items to scan
- Included in the demo software with $N = 1, 2, 4, 8, 16, \text{ or } 32$ items
Experiment Results (1)

\[ y = 40.952x + 497.58 \]

\[ R^2 = 0.9929 \]
Skilled Behaviour

- For many tasks, human performance improves considerably and continuously with practice
- (Note: Very little improvement with practice in the simple reaction time tasks)
- In these tasks, there is interest in studying the progression of learning and the performance achieved according to the amount of practice
- Categories of skilled behavior:
  1. Sensory-motor skill (e.g., darts, gaming)
  2. Mental skill (e.g., chess, programming)
     - Some tasks required a lot of both (next slide)
Laparoscopic Surgery\(^1\)

1 Photos courtesy of The Centre of Excellence for Simulation Education and Innovation at Vancouver General Hospital.
Attention

• Texting while driving!

• Attention is complex:
  – Divided attention, secondary tasks
  – Which tasks require attention?
    • Can’t talk and type
  – Which tasks do not require attention?
    • Can talk and walk
  – What are the human limits? What is attention?

• Two categories of attention
  – Divided attention (attending to more than one task)
  – Selected attention (attending to one task to the exclusion of others)
Human Error

• Human error can be studied from many levels
• Simple view: An error is a discrete event where the outcome deviated from the desired outcome
• But, tasks that are performed in error are often at least partly correct (next slide)
## Variability and Error

What went wrong and why?

<table>
<thead>
<tr>
<th>Target Selection</th>
<th>Text Entry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct</td>
<td>quickly</td>
</tr>
<tr>
<td>Incorrect</td>
<td>qucehkly</td>
</tr>
</tbody>
</table>

What went wrong and why?
Accidents

• A broader perspective is often necessary
• Serious accidents causing significant damage or loss of life are often attributed to *human error*
• But the fault may be a *design induced error*
  – were the keyboard keys too small or too close together?
  – were the gestures ambiguous or too similar?
  – was the input too awkwardly positioned?
• Interaction errors (e.g., an operator pressing the wrong button or entering a wrong value) are not only possible, they are, in time, likely and must be anticipated in the design
Thank You