Human Error

General

- People make errors routinely
  - we’ve already seen some of this
    - attention lesson
    - decision making lessons
    - display, control lessons
- Fundamental categories (“first cut”)
  - slips - result from automatic behavior
  - mistakes - result from conscious deliberation
Slips

- Most everyday errors are slips.
  - go home instead of to a meeting after class
  - putting the cereal in the refrigerator and the milk in the cupboard
  - calling a well-known friend by another name
  - etc.

- Intend to do one thing and end up doing another.
- Associated with skilled behavior.

Types of slips

- **Capture errors**: a frequently done activity takes charge instead of (captures) the one intended.
  - Occurs when 2 action sequences have initial stages in common, but one is more familiar than the other.
  
  You go to your room to change clothes for dinner, but find yourself ready for bed instead.

- **Description errors**: the intended action has much in common with other possible actions
  - Internal description of intent is not sufficiently precise. Perform the correct action on the wrong object.

  A person intends to put a lid on the sugar bowl, but instead puts it on a coffee cup (w/ same size opening.)

- Different actions having similar descriptions leads to problems, especially with skilled operators not paying full attention.
Types of slips (cont.)

- **Data driven errors**: automatic actions are triggered by sensory data and can intrude on other actions.

  I intend to tell someone my phone number, but I'm looking at my VISA bill and start to give my account number.

- **Associative activation errors**: internal thoughts and associations trigger response.

  My older brother answered the phone at the end of dinner and politely said, "May I be excused please?"
  I have been thinking about an old friend when I pass a student I know well - I call the student by the name of my friend.

- "Freudian slips"

Types of slips (cont.)

- **Loss-of-activation errors**: forgetting
  - Activation of goals has decayed.

  You go to the kitchen and open the refrigerator door, only to stand and stare at the contents, trying to remember what you came in to get.

- **Mode errors**: Actions have meanings that depend on the mode of operation of the device.
  - errors occur when the mode is not the one that is intended.

  stopwatch
  computer applications
  automatic pilots
  microwave ovens
Design lessons from slips

• **PREVENT**
  - Minimize problems by increasing “distance” between possible actions.

  **CAR FLUIDS**: oil, transmission, brakes, windshield, radiator, battery. Designers minimize errors through different shapes, sizes, and colors of fluids, indicators, and containers.

  • Confirmation.

  **COMPUTER**: Are you sure you want to delete the file "my most important work"?

  • Problem: the user is confirming the action, not the file name. Confirmation alone cannot detect and prevent all slips.

• **DETECT AND CORRECT**
  - Eliminate irreversible actions (e.g., automatic backups, “undo” functions.)

Examples

• *Commentary: Human Error and the Design of Computer Systems*  
  (http://www.jnd.org/dn.mss/error_design.html)

• *Study: Human Error Causes Most Security Breaches*  
  (http://www.cioupdate.com/trends/article.php/2120371)

• *Human Error and Clinical Systems (HECS'99)*  
  (http://www.dcs.gla.ac.uk/~johnson/papers/HECS_99/)

• etc …
Mistakes

- A “planning failure”
  - actions go as planned, but the plan was bad
- Errors of judgment, inference, etc.
  - Result in
    - incorrect intention
    - incorrect choice of criterion
    - incorrect value judgment.
- Examples
  -
  -
  -

Error Classification: Rouse

<table>
<thead>
<tr>
<th>Stage</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Observation of system state</td>
<td>Improper rechecking of correct readings</td>
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<tr>
<td></td>
<td>Erroneous interpretation of correct readings</td>
</tr>
<tr>
<td></td>
<td>Incorrect readings of appropriate state variables</td>
</tr>
<tr>
<td></td>
<td>Failure to observe sufficient number of variables</td>
</tr>
<tr>
<td></td>
<td>Observation of inappropriate state variables</td>
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<tr>
<td>2. Choice of hypothesis</td>
<td>Hypothesis could not cause the values of the state variables observed</td>
</tr>
<tr>
<td></td>
<td>Much more likely causes should be considered first</td>
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<tr>
<td></td>
<td>Very costly place to start</td>
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<tr>
<td></td>
<td>Hypothesis does not functionally relate to the variables observed</td>
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<tr>
<td>3. Testing of hypothesis</td>
<td>Stopped before reaching a conclusion</td>
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<tr>
<td></td>
<td>Reached wrong conclusion</td>
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<tr>
<td></td>
<td>Considered and discarded correct conclusion</td>
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<tr>
<td></td>
<td>Hypothesis not tested</td>
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</table>
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<table>
<thead>
<tr>
<th>Stage</th>
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<tbody>
<tr>
<td>4. Choice of goal</td>
<td>- Insufficient specification of goal</td>
</tr>
<tr>
<td></td>
<td>- Choice of counterproductive or nonproductive goal</td>
</tr>
<tr>
<td></td>
<td>- Goal not chosen</td>
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<tr>
<td>5. Choice of procedure</td>
<td>- Choice would not fully achieve goal</td>
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<tr>
<td></td>
<td>- Choice would achieve incorrect goal</td>
</tr>
<tr>
<td></td>
<td>- Choice unnecessary for achieving goal</td>
</tr>
<tr>
<td></td>
<td>- Procedure not chosen</td>
</tr>
<tr>
<td>6. Execution of procedure</td>
<td>- Required stop omitted</td>
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<tr>
<td></td>
<td>- Unnecessary repetition of required step</td>
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<tr>
<td></td>
<td>- Unnecessary step added</td>
</tr>
<tr>
<td></td>
<td>- Steps executed in wrong order</td>
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<tr>
<td></td>
<td>- Step executed too early or too late</td>
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<tr>
<td></td>
<td>- Control in wrong position or range</td>
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<tr>
<td></td>
<td>- Stopped before procedure complete</td>
</tr>
<tr>
<td></td>
<td>- Unrelated inappropriate step executed</td>
</tr>
</tbody>
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### Error Classification: Rasmussen

**Manual variability**

- The situation deviates from normal routine. Does operator respond to this change?
  - Operator realizes and responds to changes.
  - Is the situation covered by normal work know-how or planned procedures?
    - Yes
    - No

**Topographic misorientation**

- Does other highly skilled act or activity interfere with task?
  - Yes
  - No

**Stereotype takeover**

- Does the operator realize this?
  - Yes
  - No

**Stereotype fixation**

- Does operator respond to proper task-defining information?
  - Yes
  - No

**Other slip of memory**

- Mistakes, alternatives forgets isolated act
  - Yes, but fails during execution
  - No

**Unique situation**

- The situation is unique, unknown, and calls for operators functional analysis and planning.
  - Does operator realize this?
    - Operator responds to familiar cue which is incomplete part of available information
    - No

**Familiar association shortcut**

- Does the operator correctly collect the information available for his or her analysis?
  - Information not seen or sought
  - Information assumed not observed
  - Information misinterpreted
  - Are functional analysis and deduction properly performed?
    - Side effects or conditions not adequately considered
    - Other, specify
Examples to classify

- A person intends to put a lid on the sugar bowl, but instead puts it on a coffee cup (w/ same size opening.)
  - Rouse classification: 
  - Rasmussen classification: 

- The stock clerk entered 11,000,000 into the shares field instead of the dollars field, resulting in the sale of $50,000,000 of stock and a brief but memorable run on the stock market.
  - Rouse classification: 
  - Rasmussen classification: 

Examples to classify

- In the absence of explicit information, the power system operator assumed the feeder line from the north was still providing power to the grid.
  - Rouse classification: 
  - Rasmussen classification: 

- During an airshow demonstration, the Airbus A320 crashed during low-level maneuvers because the pilot had left the autopilot in a mode that did not allow manual correction of airspeed.
  - Rouse classification: 
  - Rasmussen classification: 
Design lessons from mistakes

- **PREVENT**
  - Situation awareness.

  **GPS systems use maps to display navigation information so users can understand where they are in the world and make decisions accordingly.**

  - Training.

  **RECALL Klein's work on naturalistic decision making.**

  - Aiding.

  **EXPERT SYSTEMS based decision aids give decision makers the benefits of years of experience gained by others in the field.**

- **DETECT AND CORRECT**
  - Provide feedback on the real or expected results of decisions.

  **PREDICTOR DISPLAYS in aircraft show the predicted result of planned control actions.**

Systems View to Prevent Errors

- **From your book**
  - Environmental factors
    - spills, obstructions, etc.
    - glare, noise, temperature, etc.
  - Job factors
    - workload, shift rotation, fatigue, etc.
    - ergonomics, procedures, etc.
  - Social/cultural factors
    - managerial practices, incentives, etc.
    - social norms, morale, etc.
    - training, reminders, visibility
  - **Hazard analysis**
    - Recall ISE 311, Fault Tree Analysis