The Human Factors Analysis and Classification System: An Alternative to Root Cause Analysis in Healthcare

Awatef O. Ergai, PhD
Post-Doctoral Research Associate
Healthcare Systems Engineering Institute
Northeastern University, Boston MA
www.HSyE.org
Presentation Outline

• Introduction
• Human Error
• Human Error Approaches
• Human Error Models
  – Swiss Cheese Model
  – HFACS
    • Validation of HFACS
    • Application of HFACS
• HFACS vs. RCA
• Conclusion & Future Work
Introduction

- The number of deaths from medical preventable errors are increasing

![Bar chart showing number of deaths from preventable medical errors from 1999 to 2013](chart.png)

(James, John 2013)

- Currently, medical preventable errors is the third leading cause of death in America
Human Error

• Rasmussen (1982)
  – An occurrence of a misfit within the total man-task system, and error is only identified based on the outcome
  – Categorized error based on cognition

Skill-based
Rule-based
Knowledge-based
### Human Error Approaches

<table>
<thead>
<tr>
<th></th>
<th>Persons</th>
<th>Systems</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>System</strong></td>
<td>Safe</td>
<td>Unsafe</td>
</tr>
<tr>
<td><strong>People</strong></td>
<td>Unreliable</td>
<td>Reliable and central to creating safety</td>
</tr>
<tr>
<td><strong>Cause of accident</strong></td>
<td>Operator at the front end (Human error)</td>
<td>Operator errors are indications of deeper failures in the system farther up-stream</td>
</tr>
</tbody>
</table>

*(Woods, Dekker, Cook, Johannesen, & Sarter, 2010; Reason, 2000)*
Human Error Models Systems Approach

- Accident/incident investigation models
  - Incorporate multiple levels of causal factors
    - ‘SHEL’ Model (software, hardware, environment, liveware)
      - (Edwards 1972)
    - ‘Swiss-cheese model’
      - (Reason 1990)
    - Wheel of Misfortune
      - (O’Hare 2000)
    - Incident Cause Analysis Method (ICAM)
      - (Gibbs, Haywards et al. 2001)
    - Human Factors Analysis and Classification System (HFACS)
      - (Wiegmann and Shappell 2003)
Reason’s “Swiss Cheese Model” (SCM)

- Latent Conditions
- Organizational Influences
- Unsafe Supervision
- Preconditions for Unsafe Acts
- Unsafe Acts
- Failed or absent defenses

Accident
HFACS Framework

- Organizational Influences
  - Resource Management
  - Organizational Climate
  - Organizational Process

- Unsafe Supervision
  - Inadequate Supervision
  - Planned Inappropriate Operations
  - Failed to Correct a Known Problem
  - Supervisory Violations

- Preconditions for Unsafe Acts
  - Environmental Factors
    - Physical Environment
    - Technological Environment
  - Conditions of Operators
    - Adverse Mental States
    - Adverse Physiological States
    - Physical/Mental Limitation
  - Personal Factors
    - Communication Coordination and Planning
    - Fitness for duty

- Unsafe Acts
  - Errors
    - Skill-based Errors
    - Decision Errors
    - Perceptual Errors
  - Violations
    - Routine Violations
    - Exceptional Violations
UNSAFE ACTS

Errors
- Skill-based Errors
- Decision Errors
- Perceptual Errors

Violations
- Routine Violations
- Exceptional Violations
Preconditions for Unsafe Acts

Environmental Factors
- Physical Environment
- Technological Environment

Conditions of Operators
- Adverse Mental States
- Adverse Physiological States
- Physical/Mental Limitation

Personal Factors
- Communication Coordination and Planning
- Fitness for Duty
Northeastern University © 2014

Organizational Influences

- Resource Management
- Organizational Climate
- Organizational Process

Unsafe Supervision

- Inadequate Supervision
- Planned Inappropriate Operations
- Failed to Correct a Known Problem
- Supervisory Violations
Validation of HFACS

• Validity refers to the extent to which a taxonomy is well-grounded and corresponds accurately to the real world
  – (Fleishman, Quaintance, & Broedling, 1984)
• The criteria used to validate the HFACS framework:
  – Comprehensiveness: Is the framework’s ability to define and/or identify all significant information relating to an incident/accident
  – Diagnosticity: Is the framework’s ability to show the relationships among errors and their trends and causes
  – Reliability: Is the extent to which an instrument gives results that are consistent
    • Adequate overall intra-rater reliability
    • Reasonable overall inter-rater reliability
Validation of HFACS

- **Usability**: Is the framework’s ability to be applied for practical use in industry
  - Adopted by the U.S. Navy/Marine and the U.S. Army
  - HFACS has seen successful applications in diverse industries:
    - Air traffic control (Broach & Dollar, 2002)
    - Civil aviation (Inglis & McRandle, 2007; Lenne, Ashby, & Fitzharris, 2008; Li, Harris, & Yu, 2008; Shappell et al., 2007; Ting & Dai, 2011; Wiegmann et al., 2005; Wiegmann & Shappell, 2001a)
    - Aviation maintenance (Krulak, 2004; Rashid, Place, & Braithwaite, 2010)
    - Mining (Lenne, Salmon, Liu, & Trotter, 2012; Patterson & Shappell, 2010)
    - Construction (Garrett & Teizer, 2009)
    - Railroads (Baysari, McIntosh, & Wilson, 2008; Baysari, Caponecchia, McIntosh, & Wilson, 2009; Reinach & Viale, 2006)
    - Oil and gas (Aas, 2008; Wang, Faghih Roohi, Hu, & Xie, 2011)
    - Marine (Celik & Cebi, 2009; Schröder-Hinrichs, Baldauf, & Ghirxi, 2011)
    - Security (Wertheim, 2010)
    - Healthcare (ElBardissi, Wiegmann, Dearani, Daly, & Sundt, 2007, Diller, et al., 2014)
HFACS Application Areas in the Human Error Loop
Percentage of Nonfatal US GA Accidents Associated with Unsafe Acts

(Wiegemann & Shappell, 2003)
Failure Paths between HFACS Categories *(Li & Harris, 2008)*
## HFACS vs. RCA

<table>
<thead>
<tr>
<th>HFACS</th>
<th>RCA</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Standard framework</td>
<td>• Lacks standardization</td>
</tr>
<tr>
<td>• Consistent identification of systematic errors</td>
<td>• Inconsistent identification of systematic errors</td>
</tr>
<tr>
<td>• Focuses on “what” happened (unsafe act) then “why” it happened at 3 levels</td>
<td>• Focuses on “what” and “why” happened and “who” was responsible <em>(Diller, et al., 2014)</em></td>
</tr>
<tr>
<td>• Reasonable Reliability</td>
<td>• Reliability ?</td>
</tr>
<tr>
<td>• Aggregation; each root cause of the adverse event is compiled in HFACS database and a corrective action plan is developed with respect to the aggregate</td>
<td>• No aggregation; each root cause of the adverse event is addressed with its own unique corrective action plan</td>
</tr>
<tr>
<td>• Outcomes are specific and actionable</td>
<td>• Outcomes are often vague and not actionable <em>(Diller, et al., 2014)</em></td>
</tr>
<tr>
<td>• Effective, proven to reduce adverse events (e.g. aviation)</td>
<td>• Concerns regarding its effectiveness <em>(Classen, et al., 2011)</em></td>
</tr>
</tbody>
</table>
Conclusion & Future Work

• HFACS is a promising tool for investigating adverse events and close calls in healthcare.
• HFACS has the potential to be effective in reducing adverse events in healthcare, a concern as the number of deaths from preventable medical errors are increasing.

Future Work

• Further research is needed to:
  – investigate the feasibility of this tool for use in healthcare.
  – customize and tailor this taxonomy to address the unique characteristics of the healthcare industry.
Thank You