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
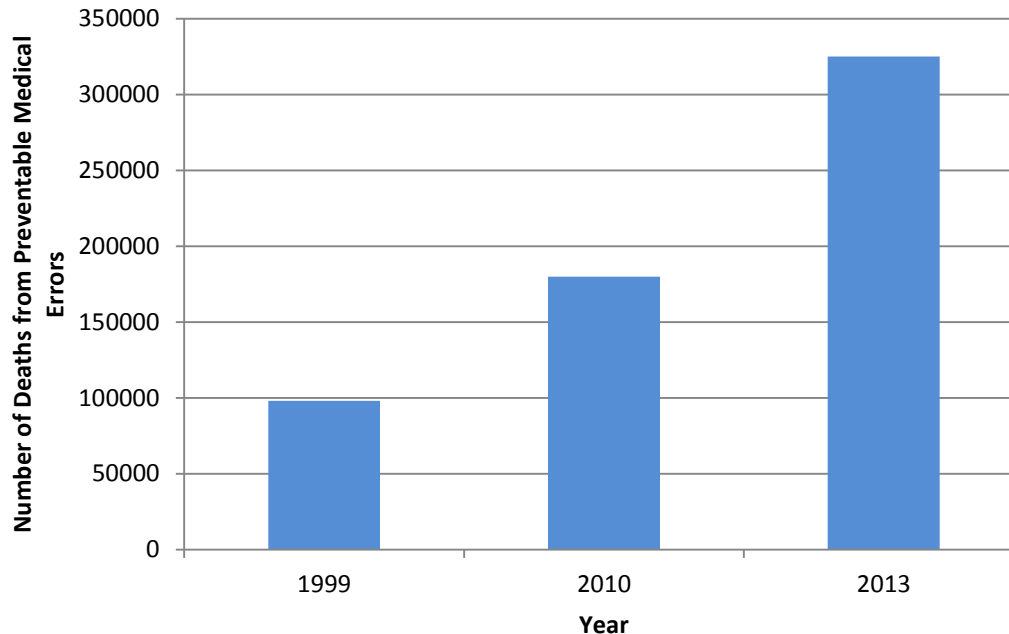
www.HSyE.org

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
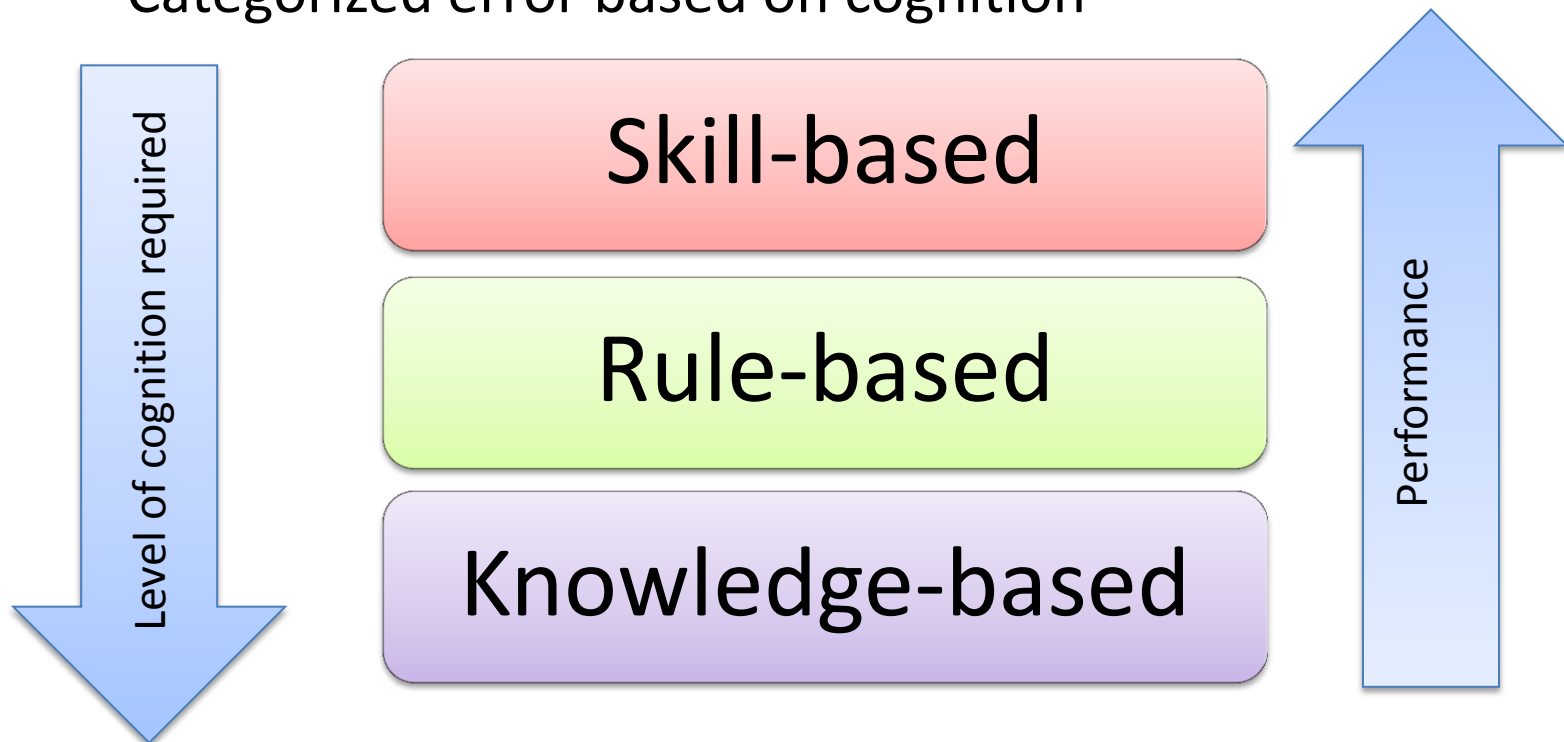

(James, John 2013)

- 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

Level of cognition required →
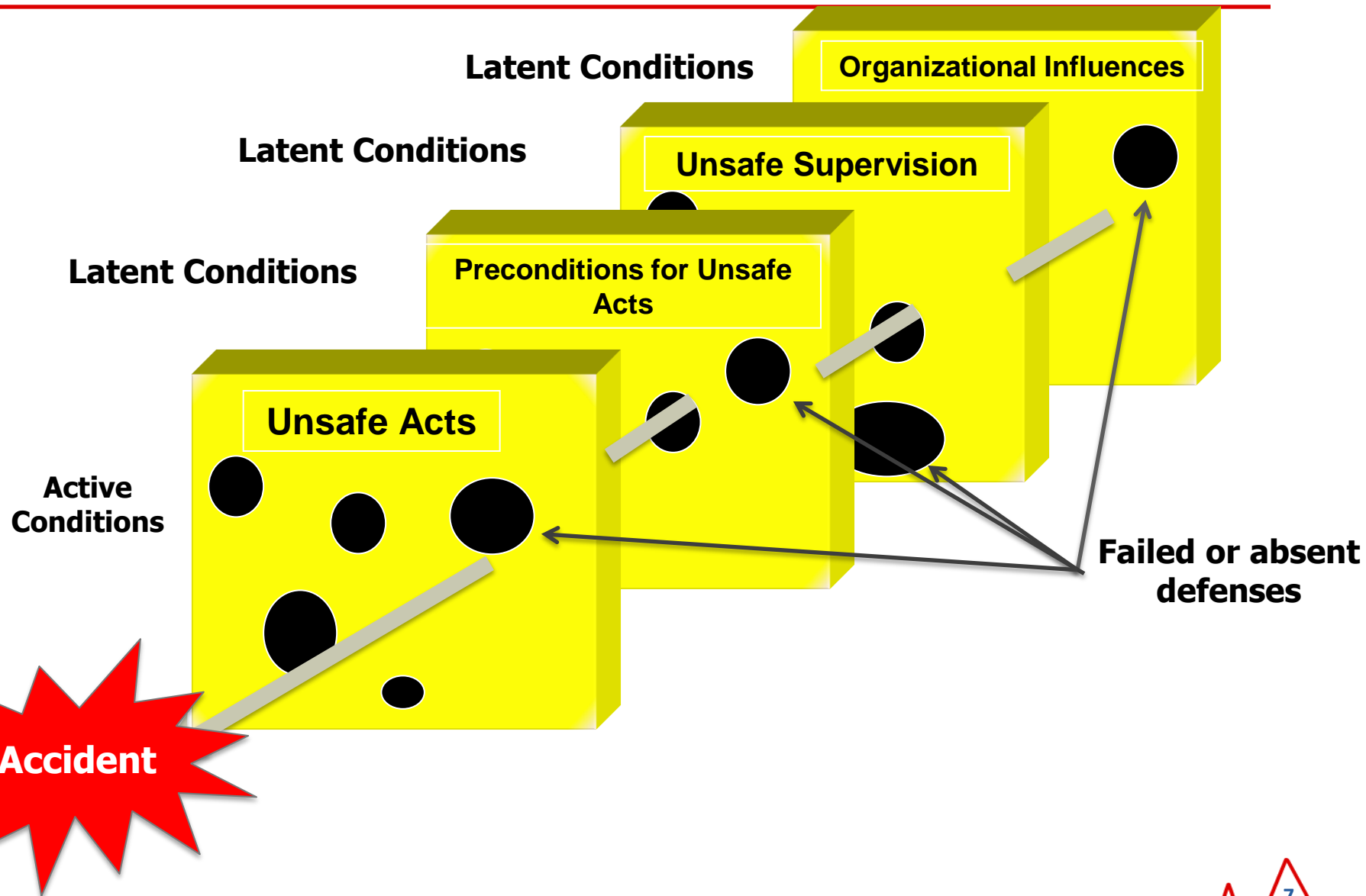
Skill-based

Rule-based

Knowledge-based

Performance →

Human Error Approaches

	Persons	Systems
System	Safe	Unsafe
People	Unreliable	Reliable and central to creating safety
Cause of accident	Operator at the front end (Human error)	Operator errors are indications of deeper failures in the system farther up-stream

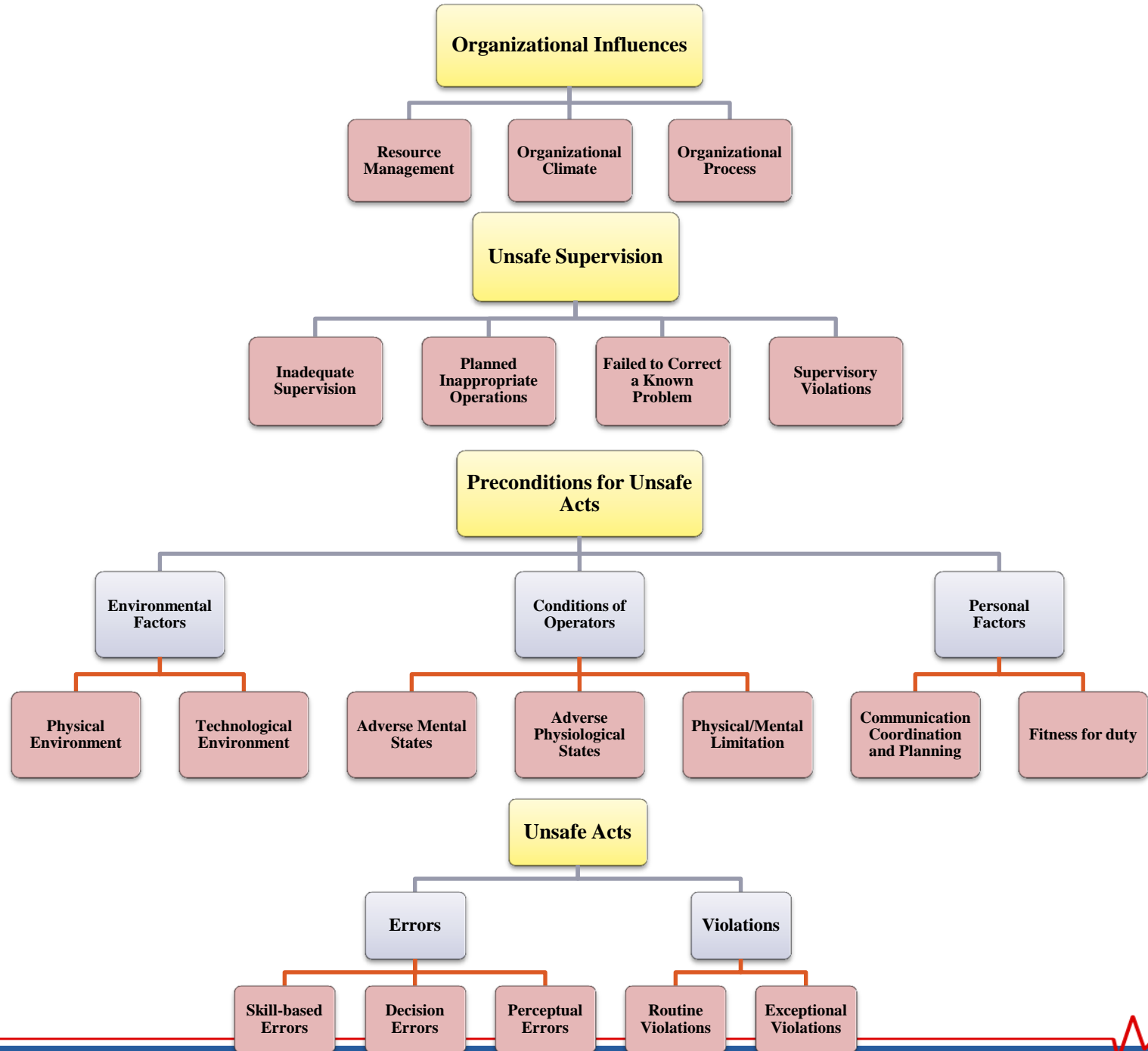*(Woods, Dekker, Cook, Johannesen, & Sarter, 2010; Reason, 2000)*
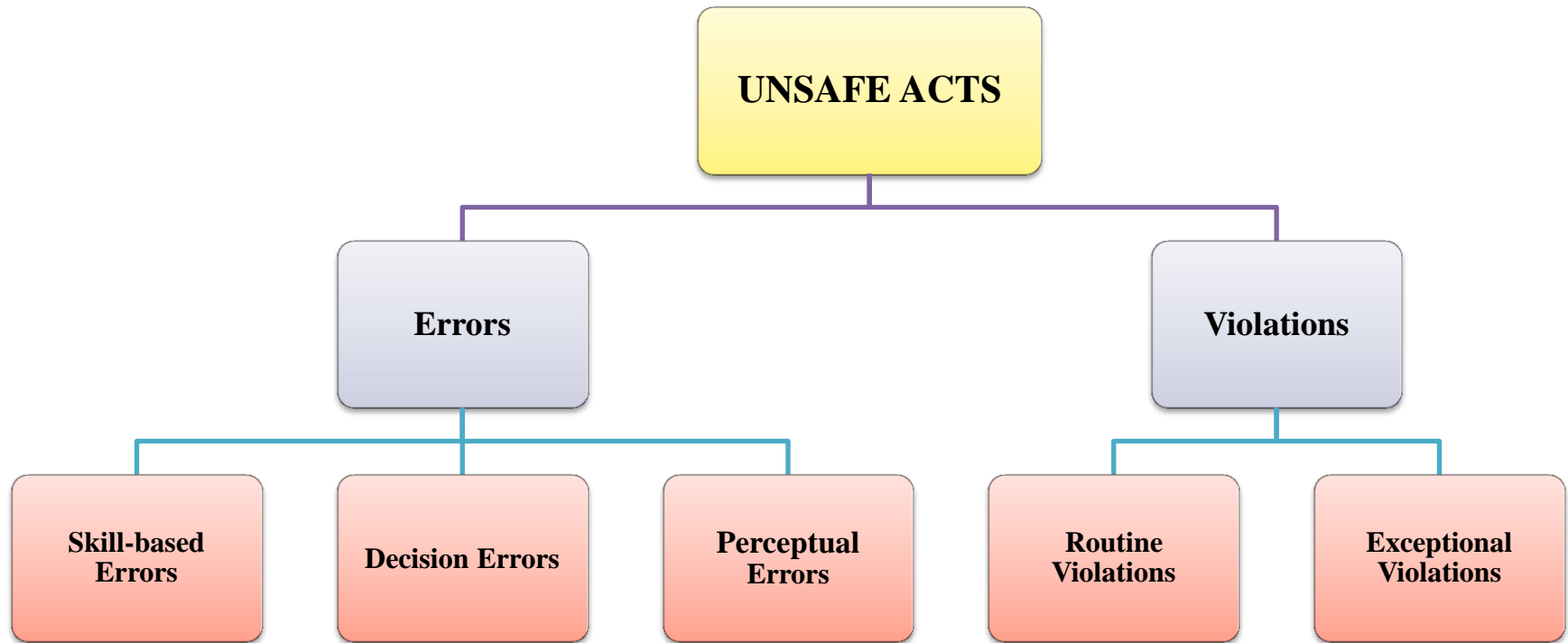
Human Error Models Systems Approach

- 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

Latent Conditions — Unsafe Supervision

Latent Conditions — Preconditions for Unsafe Acts

Active Conditions — 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
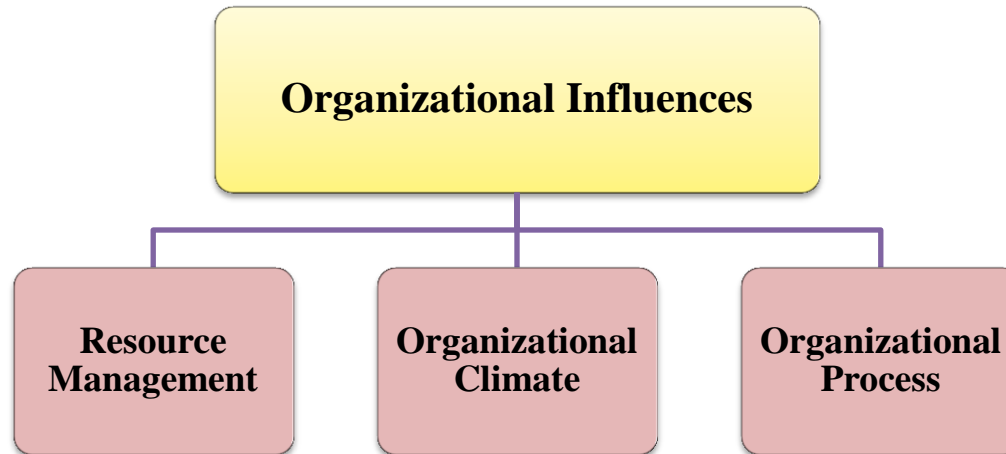 - Adverse Mental States
  - Adverse Physiological States
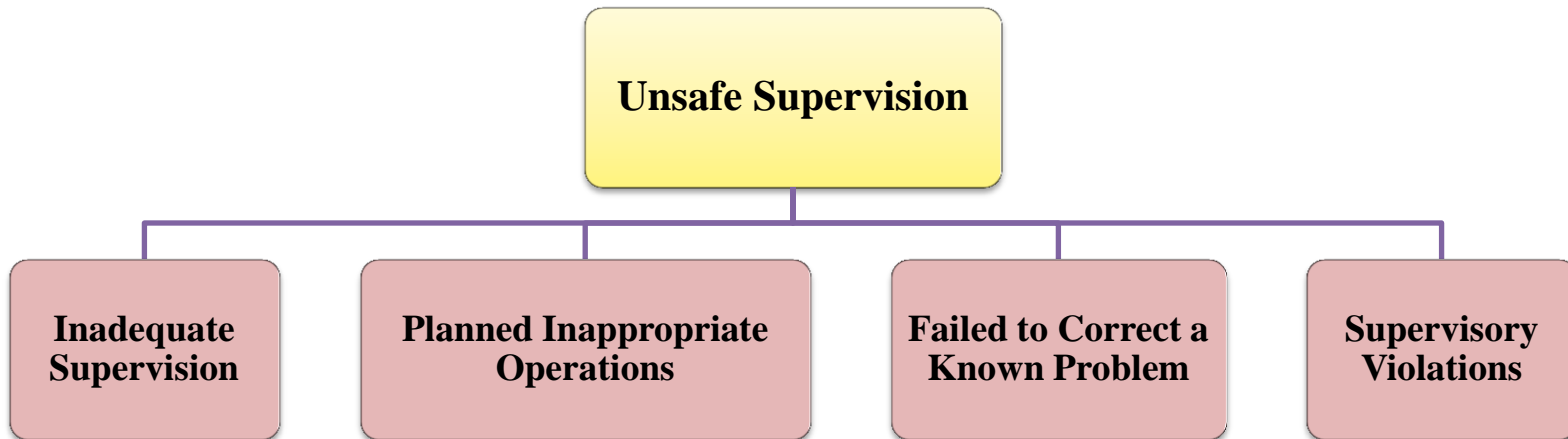 - Physical/Mental Limitation
- Personal Factors
  - Communication Coordination and Planning
  - Fitness for duty

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

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
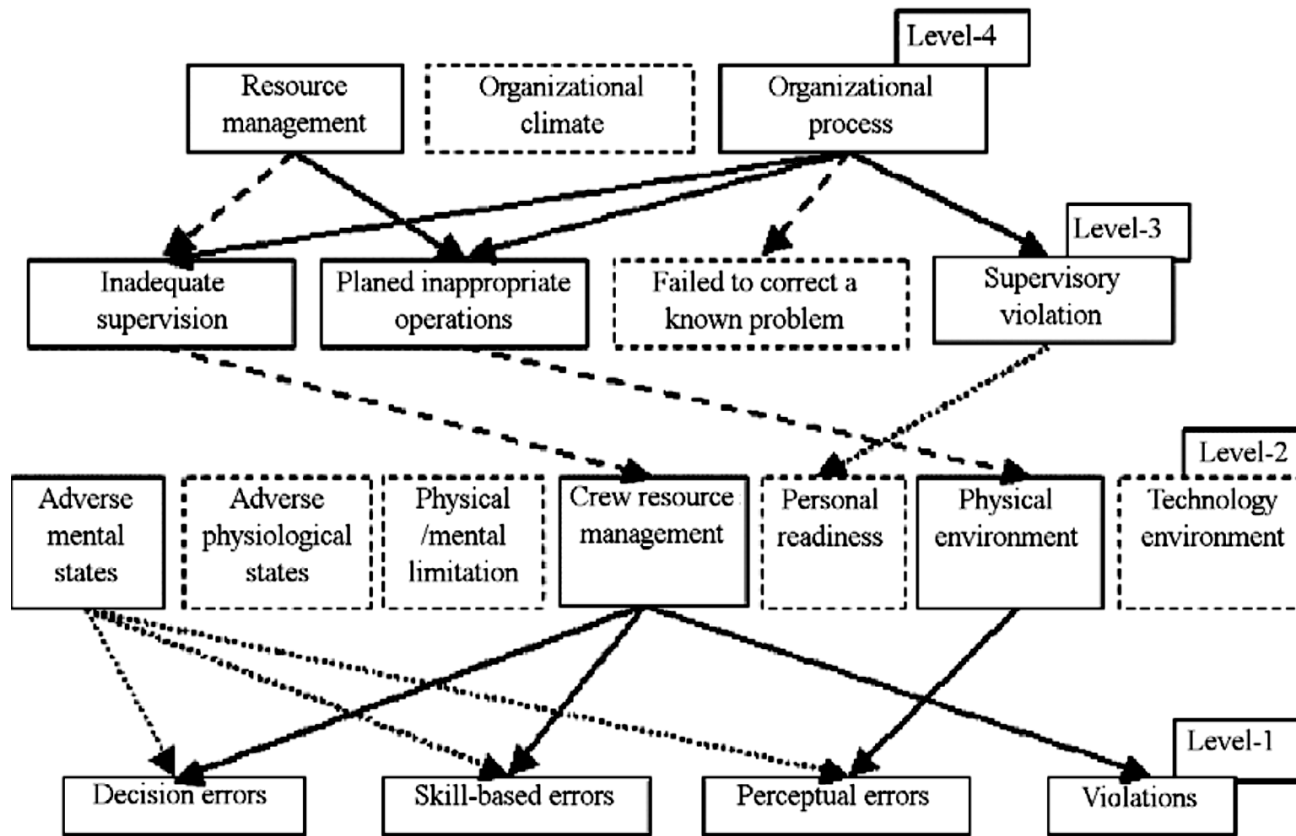
Validation of HFACS

- 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)
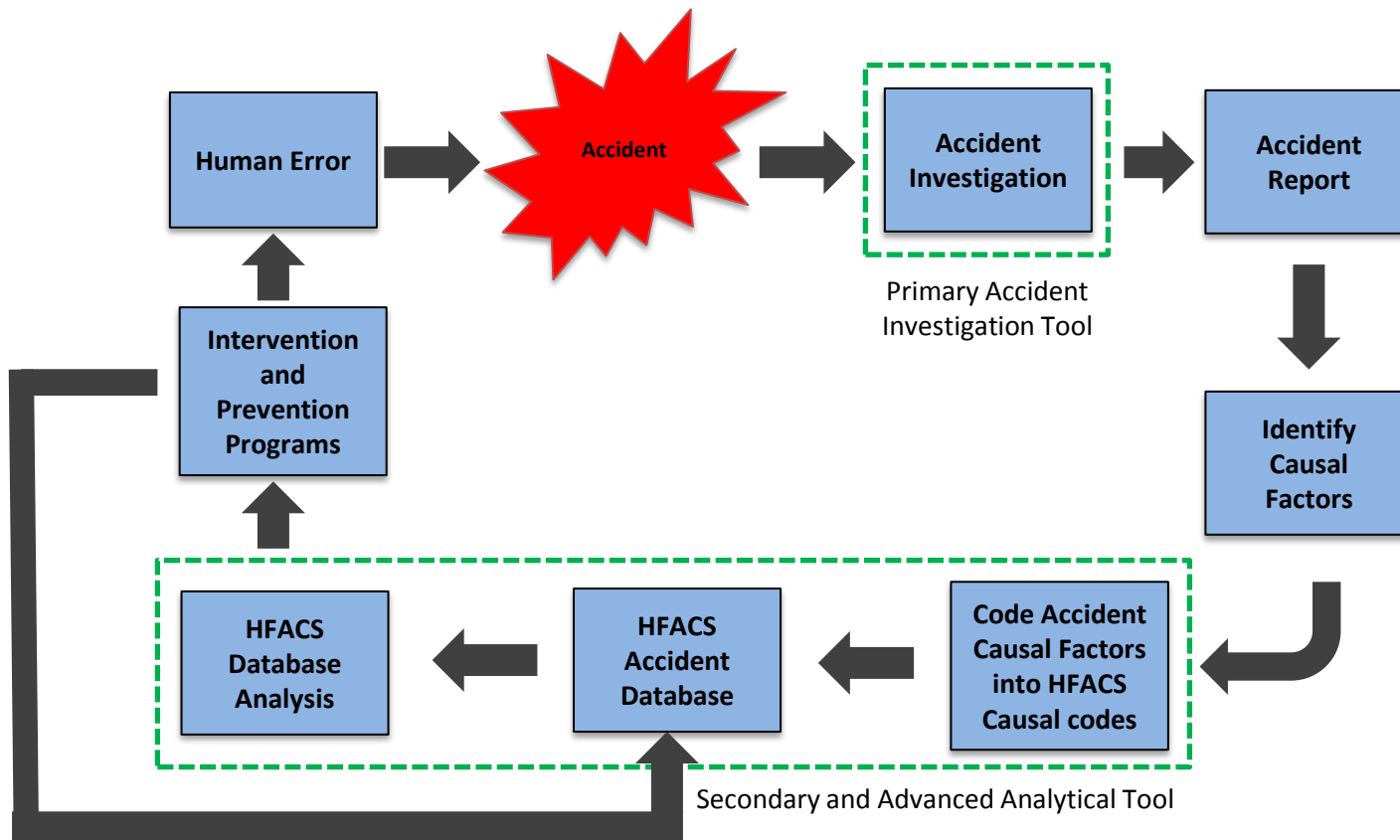
HFACS Application Areas in the Human Error Loop
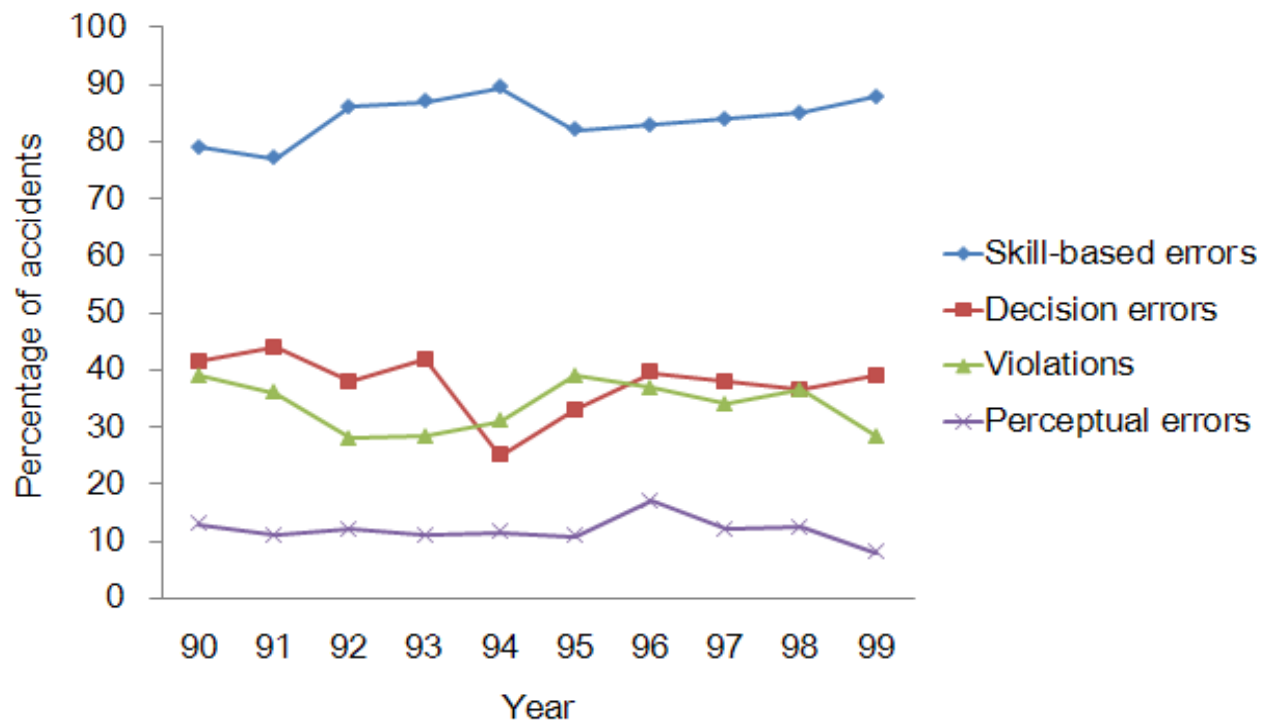
Percentage of Nonfatal US GA Accidents Associated with Unsafe Acts
(Wiegmann & Shappell, 2003)

Failure Paths between HFACS Categories *(Li & Harris, 2008)*

HFACS vs. RCA

HFACS	RCA
• Standard framework • Consistent identification of systematic errors	• Lacks standardization • Inconsistent identification of systematic errors
• Focuses on "what" happened (unsafe act) then "why" it happened at 3 levels	• Focuses on "what" and "why" happened and "who" was responsible *(Diller, et al., 2014)*
• Reasonable Reliability	• Reliability ?
• 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	• No aggregation; each root cause of the adverse event is addressed with its own unique corrective action plan
• Outcomes are specific and actionable	• Outcomes are often vague and not actionable *(Diller, et al., 2014)*
• Effective, proven to reduce adverse events (e.g. aviation)	• Concerns regarding its effectiveness *(Classen, et al., 2011)*

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