Human Error and Human Error Identification Techniques

adapted from an IE 545 presentation by Katarina Morowsky

December 1, 2015

What is human error?

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What is human error?

- "The making of an error as an inevitable or natural result of being human; the making of an error by a person, esp. (in later use) as contrasted with a mechanical or electronic malfunction" (OED)

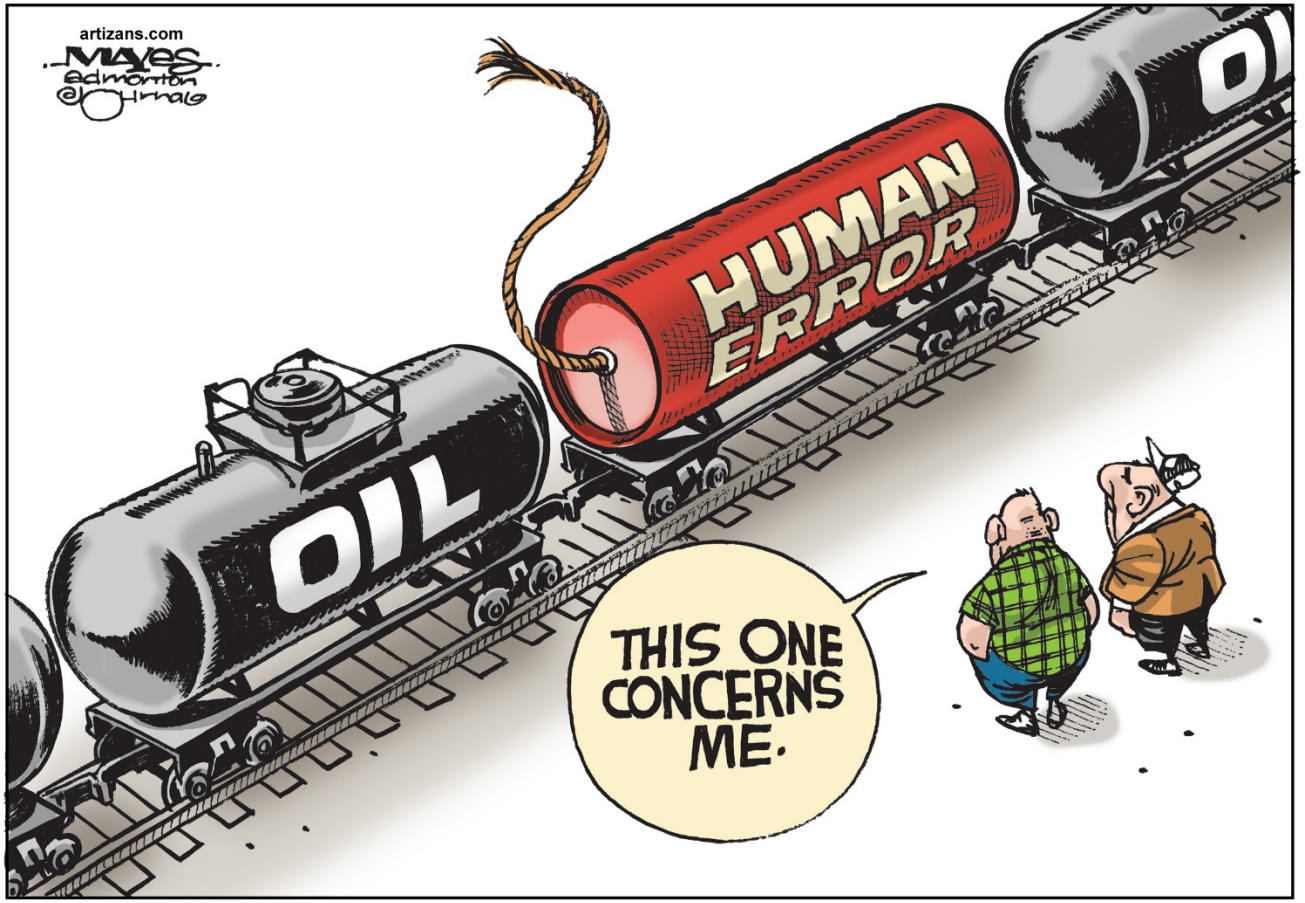
- "All those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency" (Reason, 1990: 9)

What is human error?

- An event or action that results in a degradation of performance that is committed by a person who would be expected to be interacting with the system. (Hollnagel, 1998)

- Deviations from stated performance or the normative sequence of events in which a human has some influence over the occurrence of the deviation (Leveson, 2004)

Why study human error?



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Why study human error?

- Regularly identified as a contributing factor in a high number of incidents and accidents that occur within complex and dynamic environments (Stanton et al., 2013:145)

Human Error → 80% accidents

Asiana Airlines Admits Pilot Error to Blame for San Francisco Crash

Noah Rayman @noahrayman | March 31, 2014

Asiana Airlines says last year's Boeing 777 crash, which killed three and injured scores, was likely due to slow flying and failure to abort landing. A report to the National Transportation Safety Board also cites failure in speed-control features

Asiana Airlines said for the first time that pilot error was the "probable cause" of the deadly crash in San Francisco last year, according to newly released documents provided

The wrecked fuselage of Asiana Airlines flight 214 sits in a storage area at San Francisco International Airport on July 12, 2013 in San Francisco, Ca.

Left: http://www.boeing.com/commercial/aeromagazine/articles/qtr_2_07/article_03_2.html
Right: http://loyaltylobby.com/2014/04/01/asiana-airlines-admits-to-pilots-error-on-san-francisco-crash/

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“Pilot Judgement & Action” → 84% of accidents

http://www.huffingtonpost.ca/2013/07/05/helicopter-crash-sturgeon-county_n_3552803.html

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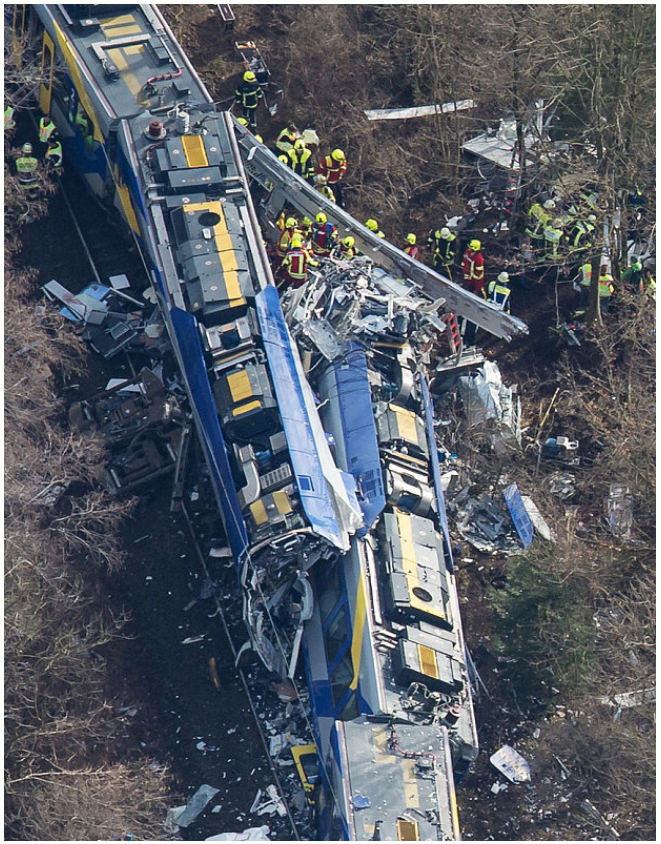
“Staff Error” → 46% of accidents



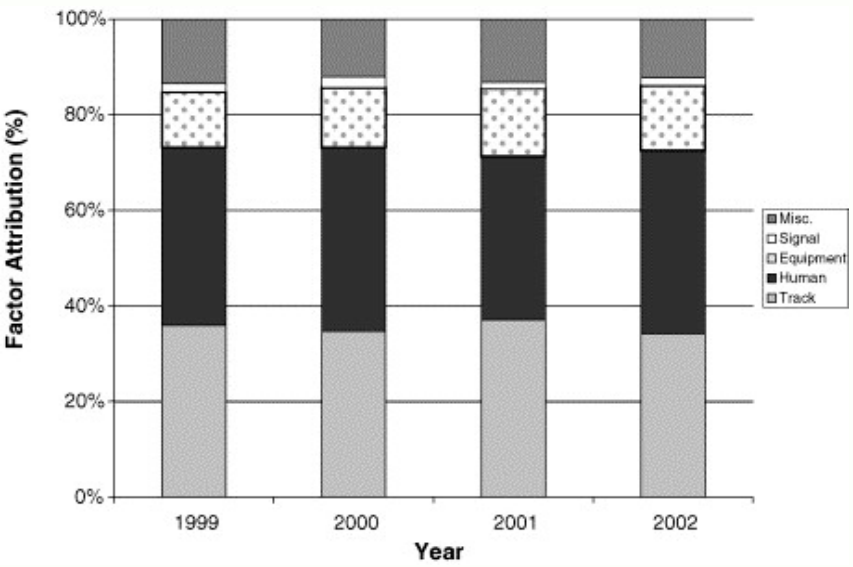


Fig. 1. Relative assignments of factor types for U.S. train crashes expressed as a percentage of the annual number of crashes with a cited factor (Lawton & Ward, 2005; FRA, 2002).

http://www.telegraph.co.uk/news/worldnews/europe/germany/12147601/German-train-crash-Several-killed-and-100-injured-in-Bad-Aibling-Bavaria-live.html

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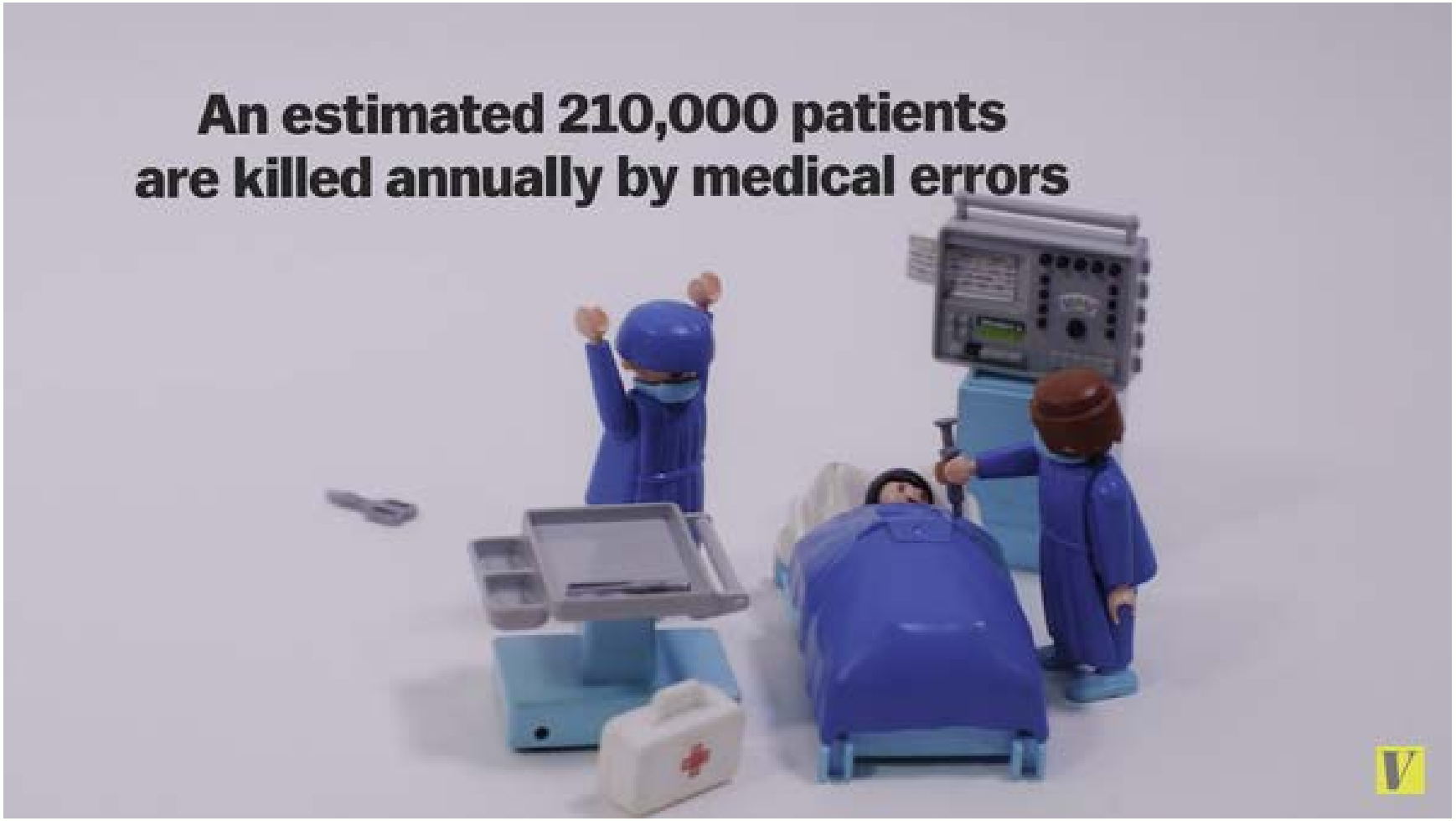
“Human Error” → ~ 75% of accidents

http://www.icebike.org/real-time-traffic-accident-statistics/



http://www.vox.com/2014/9/2/6089693/health-care-facts-whats-wrong-american-insurance

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http://www.fastcoexist.com/1680167/is-new-nuclear-energy-the-way-forward

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Some Notable Adverse Events – and Classes of Adverse Events – Attributable to Human Error

RMS Titanic

Tenerife

Air France 447: aircraft, wreckage

Other aircraft accidents

Bhopal chemical plant disaster

Three-Mile Island Nuclear Accident

Chernobyl Nuclear Disaster

Deepwater Horizon oil spill

Therac-25 radiation overdoses

Trocar injuries

Medical error

Distracted Driving

Motor vehicle accidents

Power tool accidents

etc.

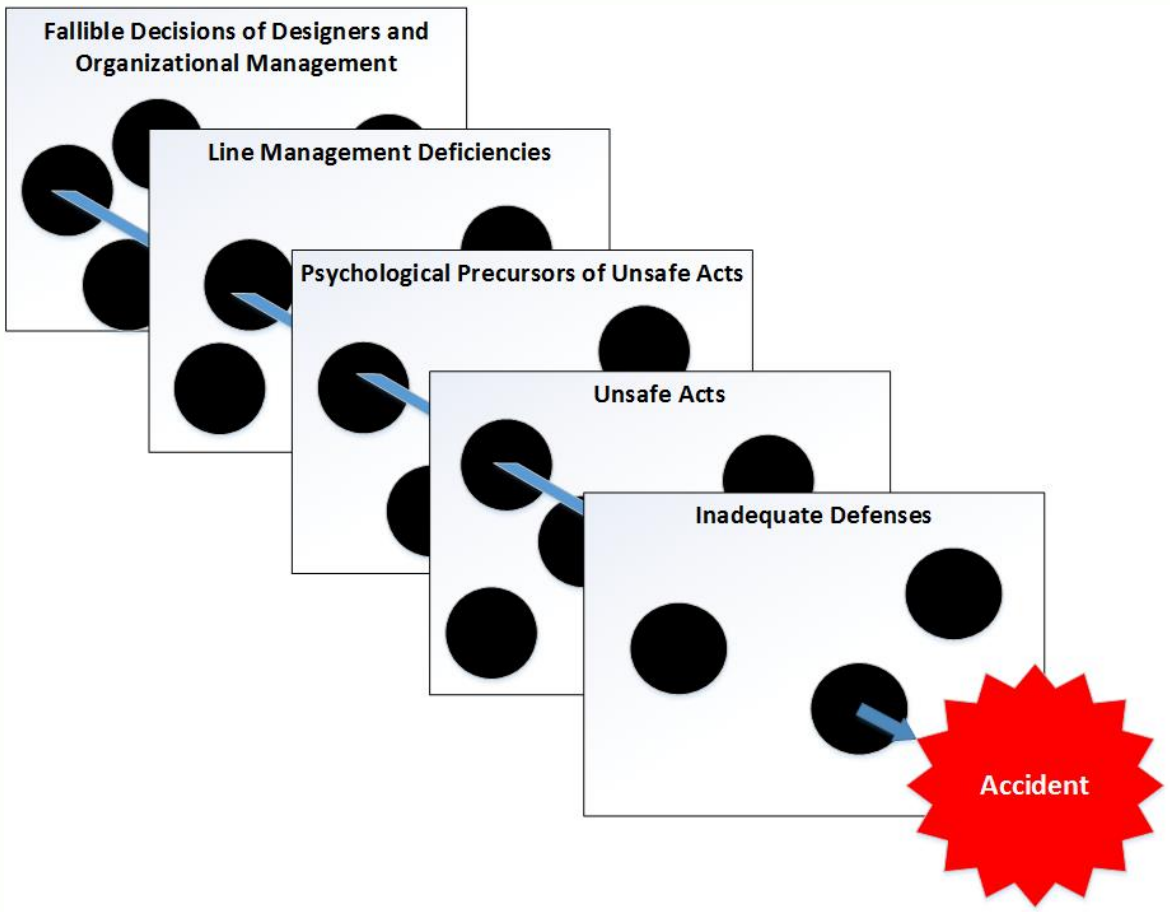
Is human error the sole cause of an accident?

Types of errors

- **Active Error** → "Errors whose effects are felt almost immediately" (Reason, 1990, p. 173)

- **Latent Error** → "Errors whose adverse consequences may lie dormant within the system for a long time, that only become evident when they combine with other factors to breach the system's defenses" (Reason, 1990, p. 173)

Human error is rarely the sole cause of an accident



The Swiss Cheese Model
Adapted from Reason (1990)

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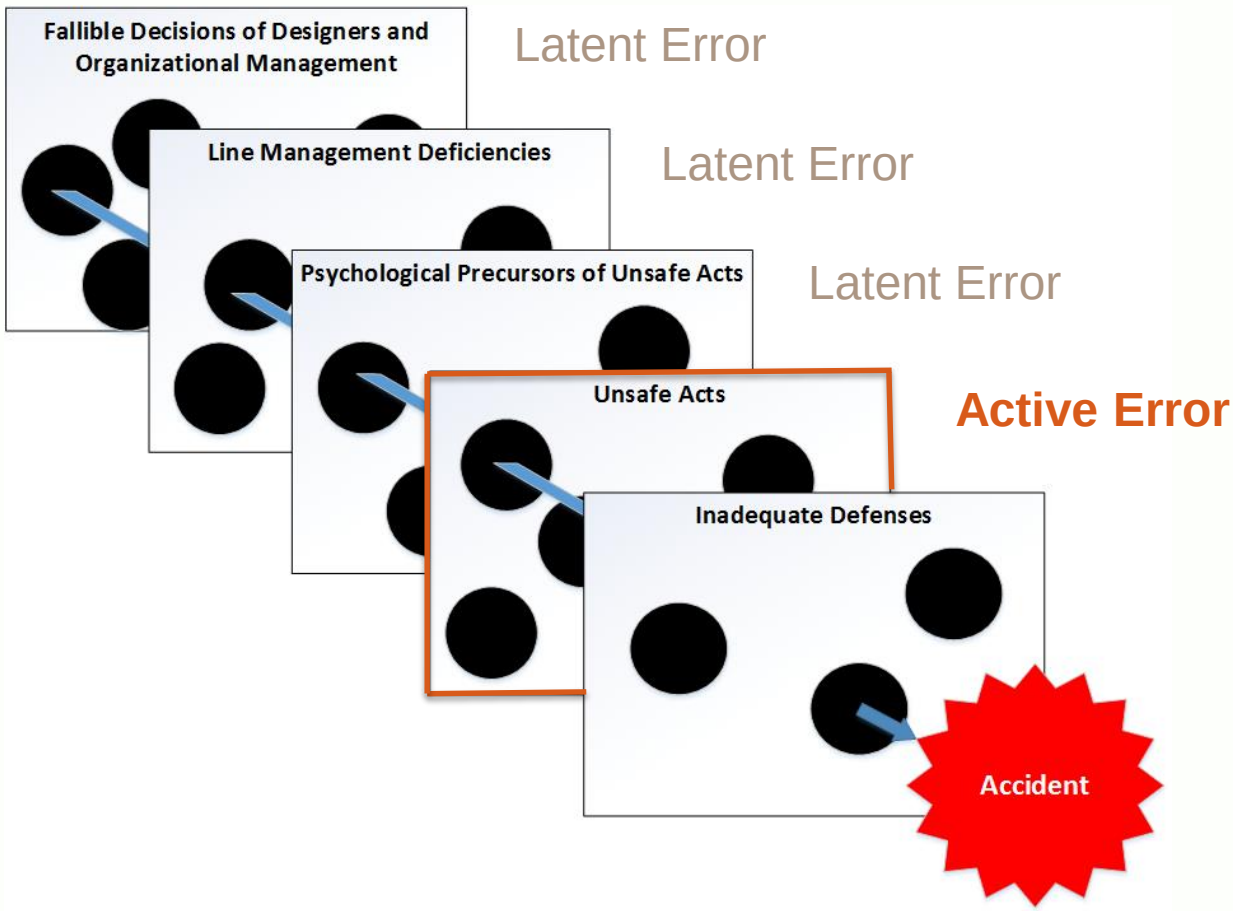

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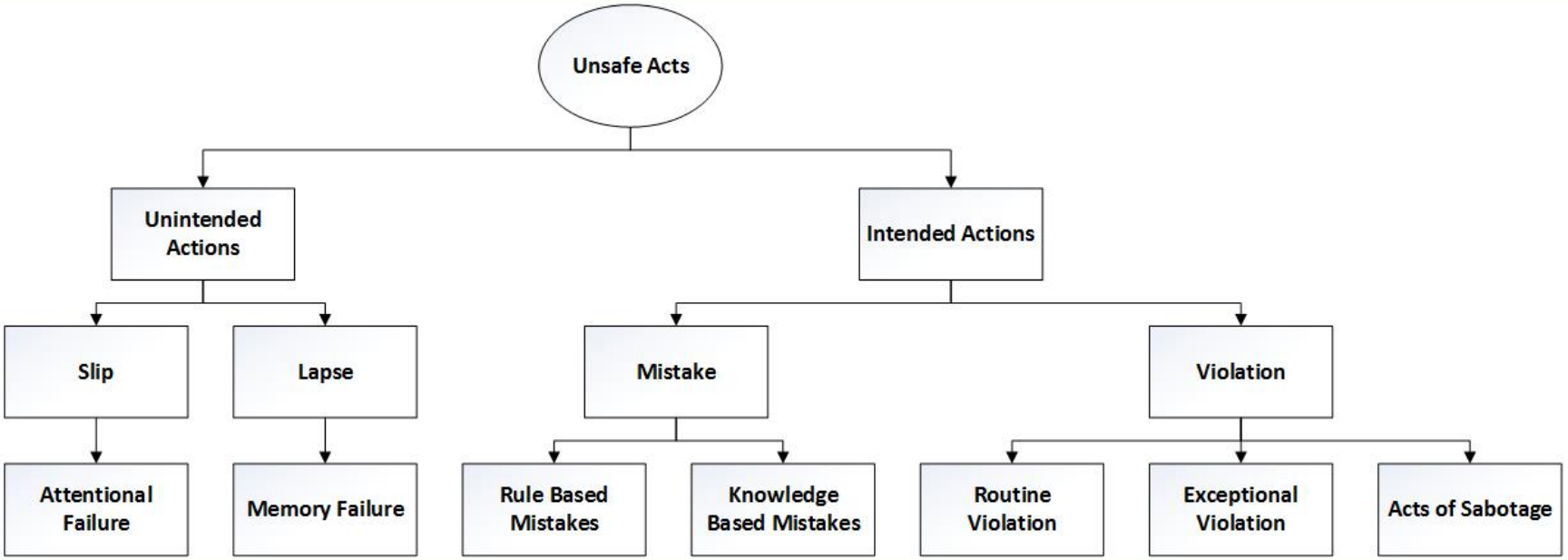
The Swiss Cheese Model



Adapted from Reason (1990)

What are Human Error Identification (HEI) techniques?

- Tools used to assist in identifying potential errors that could potentially occur within a complex human-machine system
- Seek to identify the nature of potential causal factors, including human errors
- Some go further to identify consequences of causal factors, probability of occurrence, and potential recovery strategies.

(Stanton et al., 2013: 143)

Characteristics of HEI Techniques

- Qualitative vs. Quantitative
- Proactive vs. Retroactive
- Types of HEI Techniques?

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- Qualitative vs. Quantitative
- Proactive vs. Retroactive
- Types of HEI Techniques
  - Taxonomy-based techniques
  - Error identifier techniques
  - Error quantification techniques

What are the benefits of using HEI techniques?

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- Systematic / methodic approach to analyzing a system or set of accident reports
- Ability to reference external error mode taxonomies or frameworks that are used / accepted(?) by the industry
- Ability to compare and contrast findings with other reports using the same HEI technique
- Identify trends across an industry or system

What are the problems with HEI techniques?

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- Validation
- Resource usage: money and time
- Access to systems under analysis
- Lack of representation of the external environment (Stanton, 2002)
- Do not consider the conditions, context, and environment in which the activity occurs
- Subjectivity of analysis (Stanton, 2002)

(Stanton et al., 2013: 148)

What are the problems with retrospective HEI techniques?

- Hindsight bias of analysts and the source of accident reports when using retrospective HEI techniques (Woods, Dekker, Johannesan, & Cook, 2010)
- Second or third-hand accounts of events
- Incomplete information within accident reports (European Helicopter Safety Team, 2010)

(Stanton et al., 2013: 148)

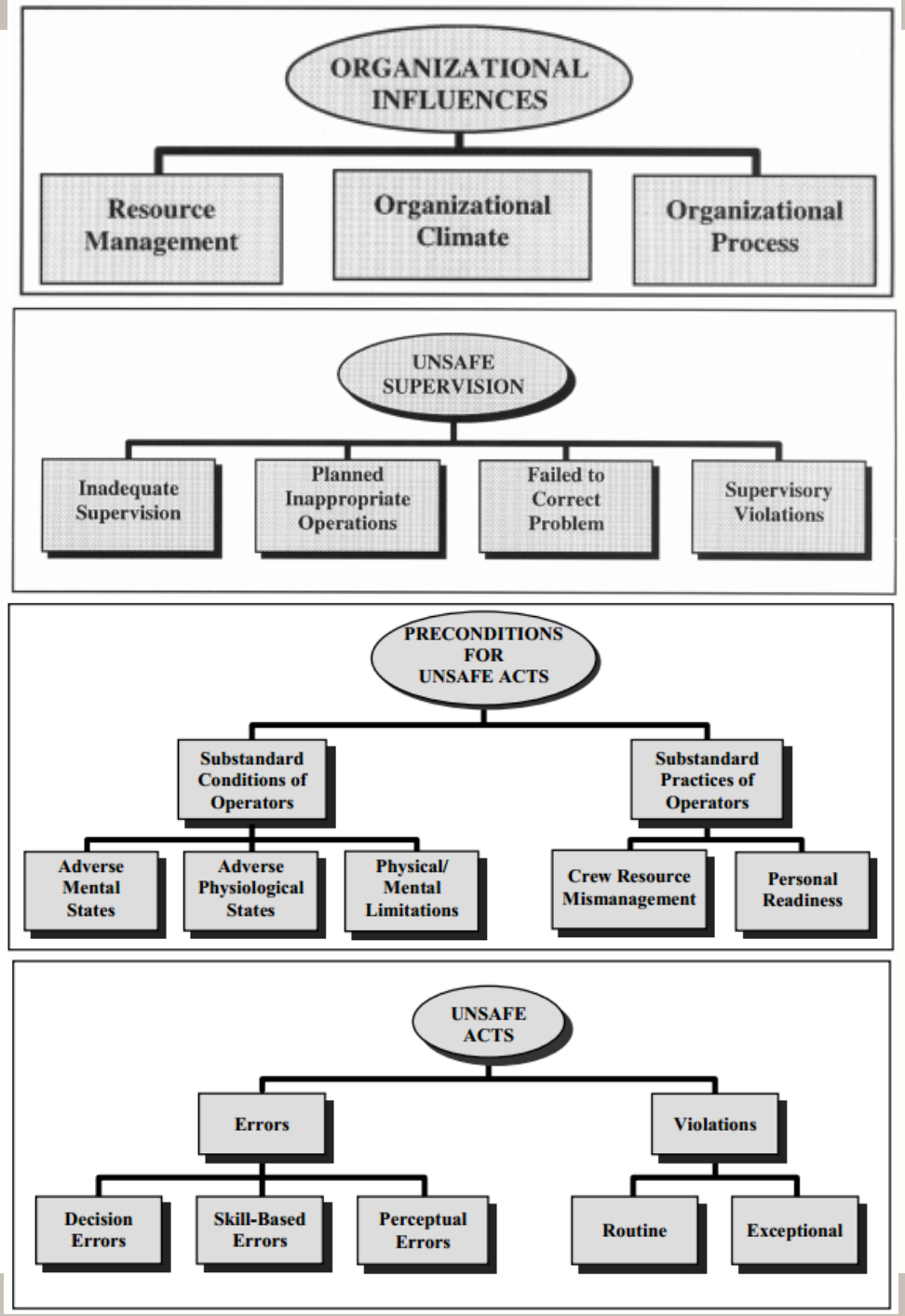
Human Factors Analysis & Classification System (HFACS)

Human Factors Analysis & Classification System (HFACS)

- Author: Shappell & Wiegmann (2000)
- Original Domain: Aviation
  - Modified for use within:
    - Air Traffic Control (HFACS-ATC; Scarborough and Pounds, 2001)
    - Maintenance (HFACS-ME)
    - Healthcare (Milligan, 2007) and surgery (El Bardissi et al., 2007)
    - Rail (HFACS RR; Reinach and Viale, 2006)
    - Defense (DOD HFACS)

HFACS

Taken from (Wiegmann & Shappell, 2001)



HFACS

Procedure

1. Define the task under analysis
2. Data collection
3. Identification of Unsafe Acts
4. Identify failures at the Pre-conditions for Unsafe Acts Level
5. Identify failures at the Unsafe Supervision Level
6. Identify failures at the Organizational Influence Level
7. Produce a short narrative discussing each error for an individual accident report
8. Iterate analysis (review & refine) – Have all contributing factors been identified?
9. Analyze data from across reports
10. Analyze associations between the failures that occur within different HFACS levels

Output

- Descriptive statistics for individual errors
- Associations of errors – Fischer's exact test and odds ratios (ORs)
- Inter-rater reliability (Cohen's Kappa)

HFACS

Strengths:

- Comprehensive in the aviation domain (Li & Harris, 2006; Liu et al., 2013; Wiegmann & Shappell, 2001; Salmon, Regan, and Johnston, 2005)
- Inclusion of organizational influences (Baysari et al., 2009)
- A taxonomy is offered for each level of failure (Salmon et al., 2005)
- Simple to use (Baysari et al., 2009)
- Consistent structure across accident reports (Stanton et al., 2013: 220)
- Based on Reason's model of human error that is well-regarded within the academic and research community (Stanton et al., 2013: 220)
- Most developed error taxonomy (Baker and Krokos, 2007)
- Most widely used error taxonomy (Chin Li, Harris, and San You, 2008)
- Low training time (Stanton et al., 2013: 220)
- Relatively low application time (Stanton et al., 2013: 220)

HFACS

Weaknesses:

- Too course for pinpointed mitigation strategies (Beaubien & Baker, 2002)
- Does not capture chain of events (Beaubien & Baker, 2002)
- Classifications can be confusing (Baysari et al., 2009)
- Low analyst confidence (Baysari et al., 2009)
- Poor levels of inter-rater reliability (Baysari et al., 2009)

Questions?