ECPS6005: COGNITION IN ACTION

HUMAN ERROR AND COGNITIVE FAILURES

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Human Error

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To Err is human

- Human errors occur often but do not always lead to accidents
- Errors contribute up to 90% of incidents and accidents
- Is error fault of individual or systems and organisational culture they operate?

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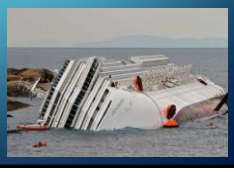
What is an error?

- Failure of planned actions to achieve intended outcome.
- Deviation between what was actually done and what should have been done.

Costa Concordia



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Three basic error types

ERRORS

- Skill-based slips and lapses
- Rule-based mistakes
- Knowledge-based mistakes

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Slips & lapses: 3 main types

- Recognition failures
- Memory failures
- Attention failures

- Each linked to specific cognitive function
  - Perception,
  - Divided Attention,
  - Prospective memory,
  - Automatic processing

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Rule-based mistakes

- Misapply a good rule
  - Inappropriate circumstance
- Apply a bad rule
  - Unwanted consequences
- Fail to apply a good rule
  - violation/non-compliance

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Causes of Violations

- Lack of safety culture
- Incorrect knowledge of consequences
- Poor morale
- Violation-condoning norms
- Inappropriate/ambiguous rules/instructions
- Macho attitudes
- Pressure:
  - Workload
  - Perceived management expectations
  - Time
  - Output

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Types of Violation

- **Routine**
  - we never wear hard hats here
- **Situational**
  - I normally wear a hard hat but it would make access to this area difficult
- **Exceptional**
  - I should get my hard hat but I need to reach this panel quickly and it will only take a moment
- **Optimising**
  - Hard hats are not necessary for this task and I can get it done quickly this way

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Knowledge-based errors

- Ocur when people need to improvise in novel situations.
- Influence of various cognitive biases:
  - –Confirmation bias
  - –Over-confidence
  - –Out-of-sight-out-of-mind
  - –Halo effects: impression created in one area to influence opinion in another area
- Dealing with novel situation in dangerous setting is highly error-provoking

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What factors may lead to human error?

- Safety Culture
- Organisational systems (automation)
- Lack of training/competence
- Workload
- Fatigue

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- Fatigue implicated in 20% of accidents on major roads.
- Incidence of accidents & injuries higher:
  - On night shifts,
  - After a succession of shifts,
  - When shifts are long
  - When there are inadequate breaks.
- Health and Safety Executive: Fatigue

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Causes of fatigue

- Workload
- Working environment
- Shiftwork
- Overtime
- On call working
- Travel time
- Recovery time

Increased risk of incidents

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Fatigued people are..

… **more** prone to:

- Error, poor decisions, memory lapses
- Work more slowly and less effectively
- Drowsiness (e.g. can include micro-sleeps)

And are **less……**

- Alert, receptive, responsive
- Able to detect change e.g., monitoring
- Able to sustain concentration

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Fatigue at work

- **Acute fatigue**
  - Sleep loss previous night
  - Tiredness after work (e.g. demanding day)
  - Can be compensated for and quickly overcome
- **Cumulative fatigue**
  - Longer term sleep loss
  - Inadequate quality & quantity of sleep
  - Overcome by extended sleep
  - 2-night recovery period

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Impact of fatigue on performance

- Varies with info processing demands of task
- Sleep deprivation can lead to loss of attentional resources (cognitive architecture)
- Internal circadian rhythms affect performance
- Person's knowledge of task environment is key
- Variation in effort-regulation

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Development of HSE Fatigue Index

- Based on analysis of accidents and shift work patterns
- Higher score = higher probability of a person feeling extremely fatigued
- Validated with Karolinska Sleepiness Scale

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Development of HSE Fatigue Index

Fatigue Index Calculations based upon:

- cumulative fatigue
- time of day shift length
- the effect of breaks
- recovery from a sequence of shifts.

BUT: No thresholds/cut-offs for "unsafe" levels of fatigue

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Shift work & Health (HSE view)

- Fatigue is key established health effect
- Fatigue can itself create other adverse consequences – e.g., accidents, injuries and other H&S failures
- Also leads to detrimental health/social issues

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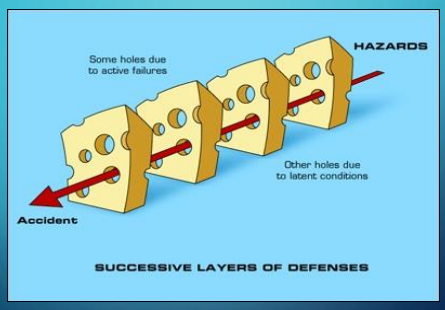
Reason's Swiss Cheese Model



Reason, J. (1990) Human Error. Cambridge: University Press, Cambridge.

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How can we reduce human error?

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Organisational Culture

- Effective training/re-training
- Effective recruitment/selection strategies
- Good working practices (hours etc.)
- Good leadership
- Enhancing motivation, commitment, morale

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Systems Design

- Design systems to minimise chance of error resulting in serious consequences
- Particularly in automated industries e.g., Nuclear industry.

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Safety Culture

- Effective leadership on H&S
- Employee involvement in H&S
- Investigations of near misses (not just incidents/accidents)
- Team responsibility for error reporting
- Not disciplining staff for reporting errors (promoting reporting culture)

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General HSE view

- Law requires duty holders to eliminate risk if possible (e.g. is shift work necessary?)
- Employers should:
  - consider risks of shift work & benefits of effective management;
  - establish systems to manage risks of shift work
  - assess risks associated with shift work;
  - take action to reduce risks;
  - check & review shift-work arrangements often

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Legal Duty

- General duties under Health & Safety at Work Act and the…
- Management of Health and Safety at Work Regulations.
- Specific duties under the Working Time Regulations (WTR).

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Guidelines for using Napping to Prevent Commercial Vehicle Driver Fatigue (2007)

National Transport Commission, Australia

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Napping

- Timing of nap is important
  - Preventative napping more effective than recuperative naps
  - Naps between 2-4 pm most effective
  - Naps are easiest to take between 2 and 4pm and between midnight and 6am
  - Naps in early hours of morning more likely to result in grogginess – sleep inertia
  - Duration of nap: 15, 30, 60, 120 mins
- Napping environment

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Bright light exposure

- To aid adaptation to night shifts by shifting sleep-wake schedule
  - Exposure in first half of night
  - Linked to body temperature cycle for timing
- Direct alerting effect leading to improved performance, reduced sleepiness and increased vigilance
- Use of morning goggles to counteract melatonin suppressing of bright light exposure

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Pharmacological interventions

- Modafinil for shift work sleep disturbance
- Caffeine
  - Effective dosages vary (50-300mg)
  - Timing important
- Hypnotics for insomnia
- Melatonin (natural hormone produced by pineal gland – inactive during day)
  - Unpredictability in effective dosage & formulation
  - Can directly promote daytime sleep

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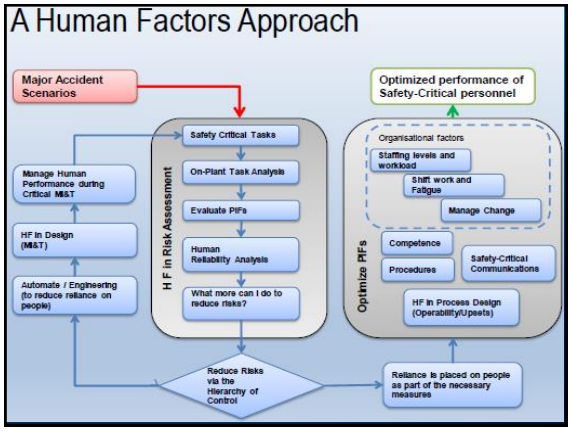

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Human Reliability Assessment

- First step in carrying out HRA
  - Work out what can go wrong
  - To do this, must understand task
- Role of task analysis:
  - Understanding, in advance of errors, how people really do tasks…
  - and hopefully pre-empt such errors

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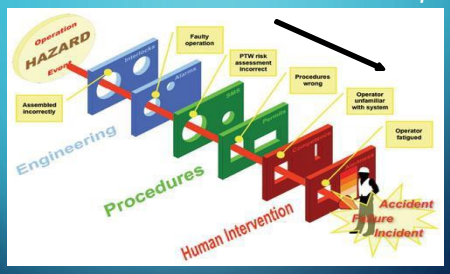
Control measures/barriers

Defence in depth



Some holes due to latent conditions
Some holes due to active failures

After James Reason 1997

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Interactive Activity

Work in pairs (or three's)

Walk around the SA1 campus

Complete the Human Error Report Worksheet provided to explain where and how a potential human error could occur.

Report your findings back to the class

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Individual differences in human error

- "Error Proneness" or "Accident Proneness"
  - Some people consistently make more errors
- General "cognitive failure"?
- Correlations between individual differences and human error/accidents rarely above .40 (moderate)

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Individual differences in human error

- Personality and Air Pilot Crashes (Lardent, 1991)
- Compared personality constructs with the Sixteen Personality Factor Questionnaire (16PF) of
  - 47 F-4 Phantom fighter pilots who had experienced Class-A accidents and 44 who had not.
- Differences in 5 significant personality factors: conscientious, suspicious, shrewd, self-sufficient, tense, discriminated the safe from the crashed F-4 pilots.
- 27% of variance in crashing explained by personality differences, and over 70% of the pilots correctly classified.

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- Data did not provide evidence for "grand theory" or generic personality profile for accident prone fighter pilots
  - But suggested support for concept of "limited domain" theories of accident proneness.
- Research is challenging
- Real life investigations often necessitate retrospective designs
  - Limits causal explanations

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Individual differences in human error

- Personality factors and mood as predictors of detection accuracy (Schell et al., 2005)
- Experimental study involving simulated pharmacy checking task
- Undergraduate student population
- Trait measures collected included:
  - Avoidant motivational tendencies
  - Trait Anxiety
  - Extraversion
  - Neuroticism
  - Type A Behaviour
  - Social Anxiety

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Individual differences in human error

- Personality factors and mood as predictors of detection accuracy (Schell et al., 2005)
- Measures of mood collected
  - Task-related mood
- Perceived workload
  - Mental demand
  - Physical demand
  - Effort
  - Frustration

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Individual differences in human error

- Personality factors and mood as predictors of detection accuracy (Schell et al., 2005)
  - Social anxiety, Type A and Locus of control (high internal) all predictive of accuracy
  - Data suggested traits were more predictive of hit rates in quality control task than state measures such as mood and workload