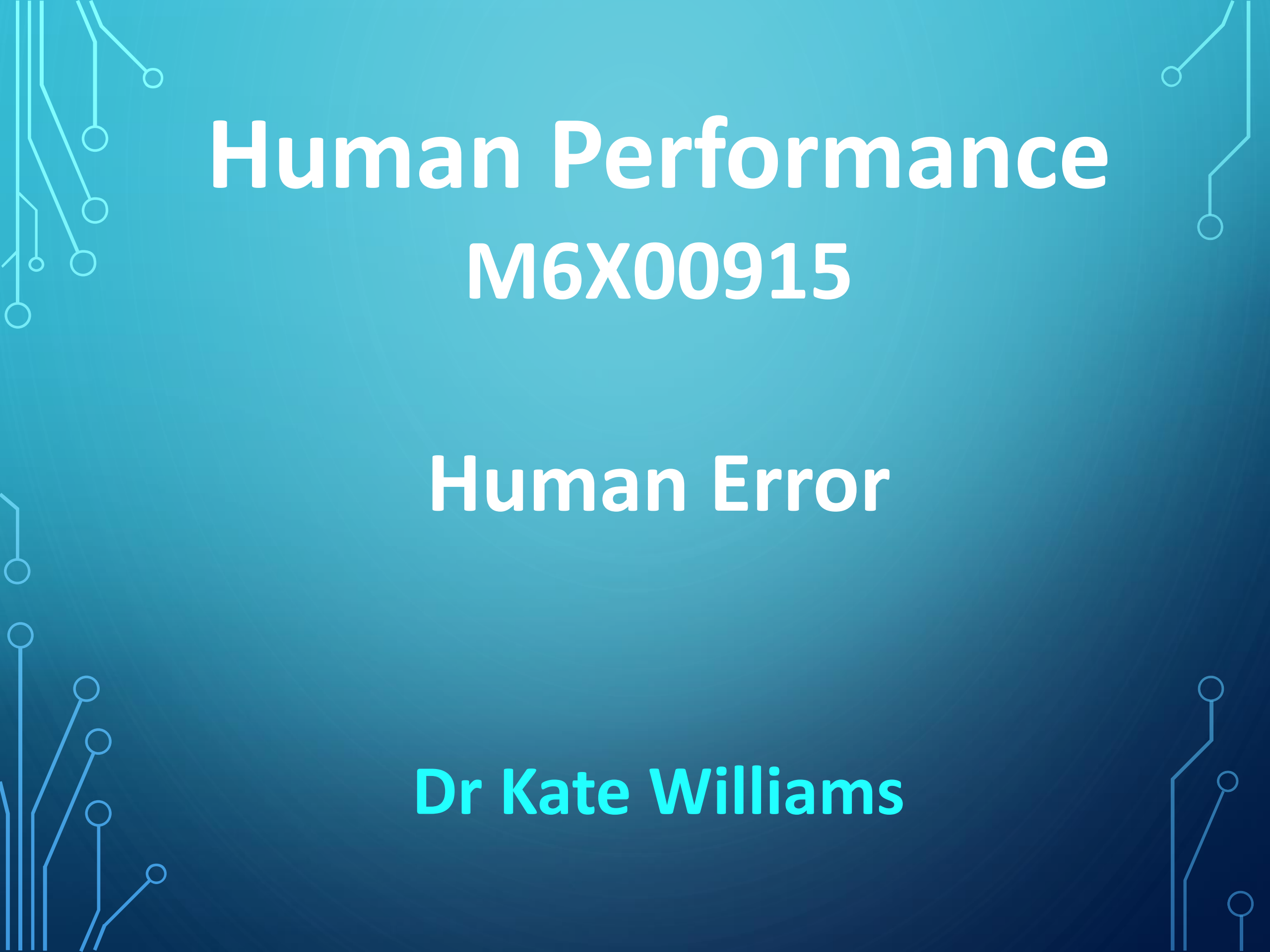


The background is a solid blue gradient. In the corners, there are decorative white line art elements resembling circuit boards or neural networks, with lines and small circles connecting them.

Human Performance

M6X00915

Human Error

Dr Kate Williams

Human Error



To Err is human

- Human errors occur often but don't always lead to accidents
- Human Errors contribute up to 90% of incidents and accidents
 - Paddington Rail Crash + Southall Rail Crash
 - Herald of Free Enterprise Disaster
- Is human error the fault of the individual or the systems and organisational culture in which they operate?

What is an error?

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

Costa Concordia



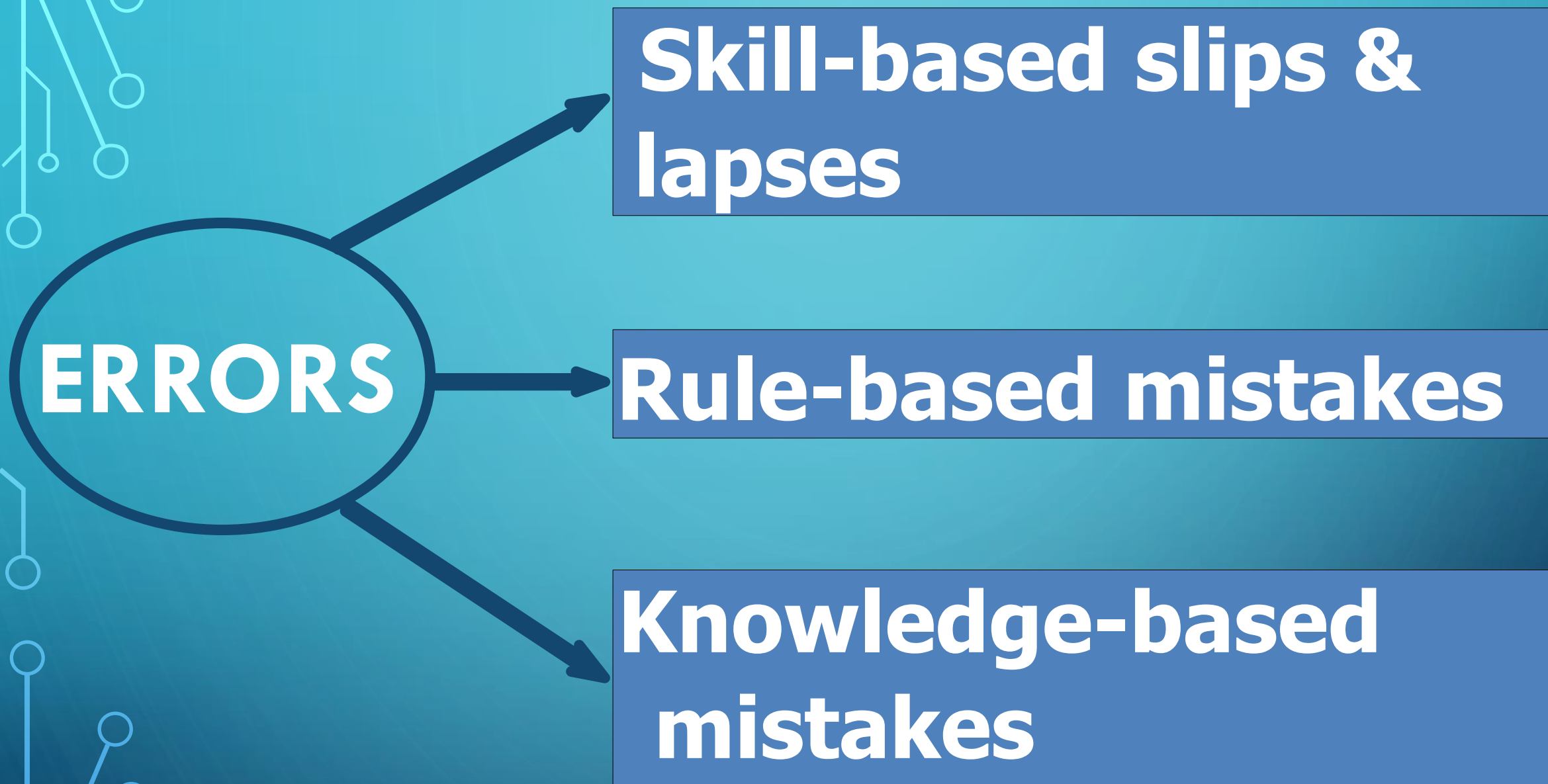
Costa Concordia Disaster

- Captain Francesco Schettino deviated from ship's computer-programmed route to treat people on a nearby Island to the spectacle of a close sail-past.
- Ship's officers first told passengers that the problem was a reparable "electrical fault" and told inquiring maritime officials that the event was merely a "black out".
- Captain delayed preparations to abandon ship, and the ship developed a hole, both of which hindered eventual evacuation attempts.
- The captain left the ship during the evacuation and did not reboard despite orders by maritime officials.

Costa Concordia Disaster

- Captain arrested on preliminary charges of multiple manslaughter in connection with:
 - Causing a shipwreck,
 - Failing to assist 300 passengers, and
 - Failing to be the last to leave the wreck.
- Also charged with failing to describe to maritime authorities the scope of the disaster
 - For which 7 other officers/managers of Costa Cruises were investigated for abandoning incapacitated passengers.

Three basic error types



Slips & lapses: 3 main types

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

Rule-based mistakes

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

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**

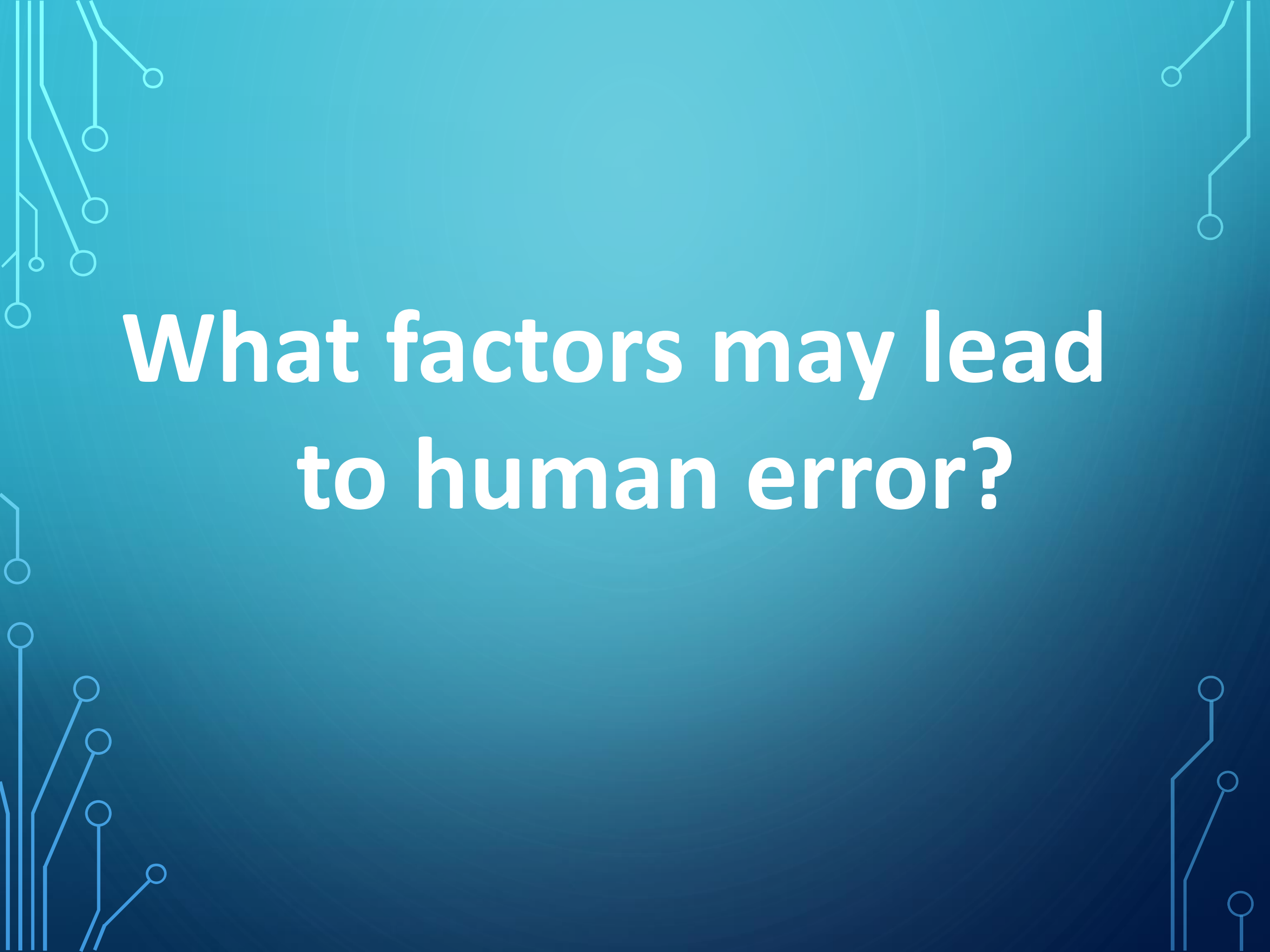
- I should get my hard hat but I need to reach this panel quickly and it will only take a moment

- **Optimising**

- Hard hats are not really necessary for this task and I can get it done more quickly this way

Knowledge-based errors

- Ocur when people have 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

The background is a solid blue gradient. In the corners, there are white, stylized circuit-like lines with small circles at the ends, resembling a network or data flow diagram.

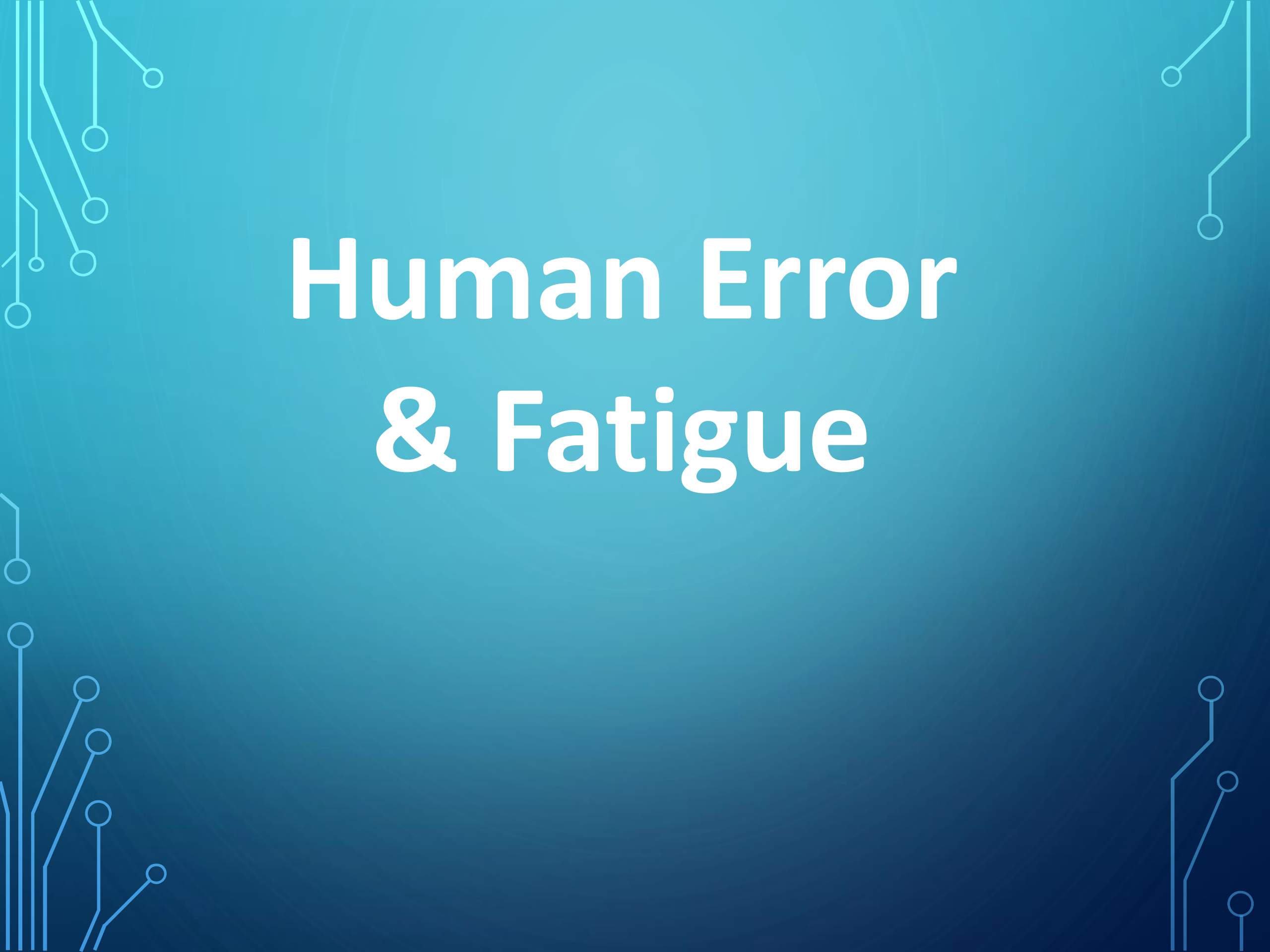
**What factors may lead
to human error?**

What factors may lead to human error?

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

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

The background is a blue gradient with decorative white circuit-like lines in the corners. These lines consist of straight segments and small circles, resembling a stylized electronic circuit or data network.

Human Error & Fatigue

- Fatigue implicated in 20% of accidents on major roads.
- Costs UK £115 - £240 million p/y in work accidents alone.
- Incidence of accidents & injuries higher:
 - On night shifts,
 - After a succession of shifts,
 - When shifts are long
 - When there are inadequate breaks.
- <http://www.hse.gov.uk/humanfactors/topics/fatigue.htm>

Causes of fatigue

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

Increased risk of incidents

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

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

Can you recognise fatigue warning signs?

Most common effects associated with fatigue are:

- desire to sleep
- lack of concentration
- impaired recollection of timing and events
- irritability
- poor judgement
- reduced capacity for effective interpersonal communication
- reduced hand-eye coordination
- reduced visual perception
- reduced vigilance
- Slower reaction times

Fatigue management Guide 2005
Workplace Health & Safety Queensland

Folkard & Lombardi (2006)

“Estimated risk of injury/accident associated with any given number of weekly work hours varies substantially depending on how work hours are comprised. Risk depends on length and type of shift, as well as frequency of rest breaks.”

"Placing limit on risk associated with a particular work schedule is likely more effective than setting daily, weekly or monthly work hour regulations in keeping workplace safety within acceptable limits."

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 can affect performance
- Person's knowledge of task environment is key
- Variation in effort-regulation

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

Development of HSE Fatigue Index

Fatigue Index Calculations based upon:

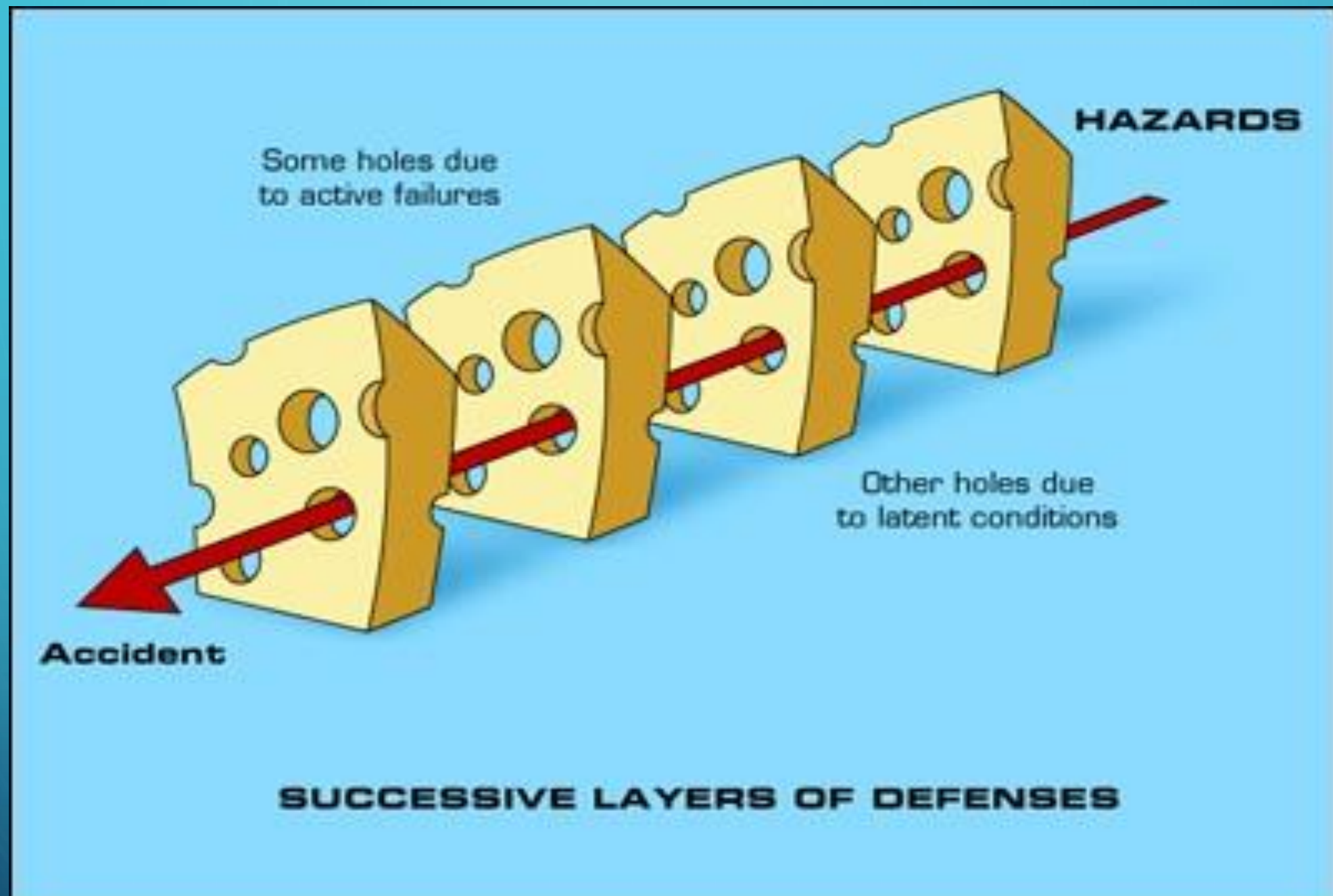
- cumulative fatigue
- time of day shift length
- the effect of breaks
- recovery from a sequence of shifts.

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

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 effects/social issues

Reason's Swiss Cheese Model



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

Reason's Swiss Cheese Model of System Failure

- Every step has potential for failure, to varying degrees.
- Holes are opportunities for process to fail & each slice is “defensive layers” in process.
- Error may allow a problem to pass through a hole in one layer, but in next layer holes are in different places, and the problem should be caught.
- Each layer is a defence against potential error impacting the outcome.
- For a catastrophic error to occur, the holes need to align for each step in the process allowing all defences to be defeated and resulting in an error.

Individual differences in human error

- “Error Proneness” or “Accident Proneness”
 - Some people consistently make more errors
 - See link to Visser et al. paper on Moodle
- General “cognitive failure”?
- Correlations between individual differences and human error/accidents rarely above .40 (moderate)

Individual differences in human error

Personality & 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 the variance in crashing was explained by personality differences, and over 70% of the pilots were correctly classified.

- Data did not provide evidence for a "grand theory" or generic personality profile for accident prone fighter pilots
 - But suggested support for concept of "limited domain" theories of accident proneness.

Researching individual differences in human error and accident liability

- Real life investigations often necessitate retrospective designs
 - Limits causal explanations



Individual differences in human error

**Personality factors & mood as
predictors of detection accuracy
(Schell et al., 2005).**

- Experimental study involving simulated pharmacy checking task
 - Undergraduate student population
- 
- 

Individual differences in human error

Personality factors & mood as predictors of detection accuracy (Schell et al., 2005).

Trait measures collected included:

- Avoidant motivational tendencies
- Trait Anxiety
- Extraversion
- Neuroticism
- Type A Behaviour
- Social Anxiety



Individual differences in human error

Personality factors & 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
- 

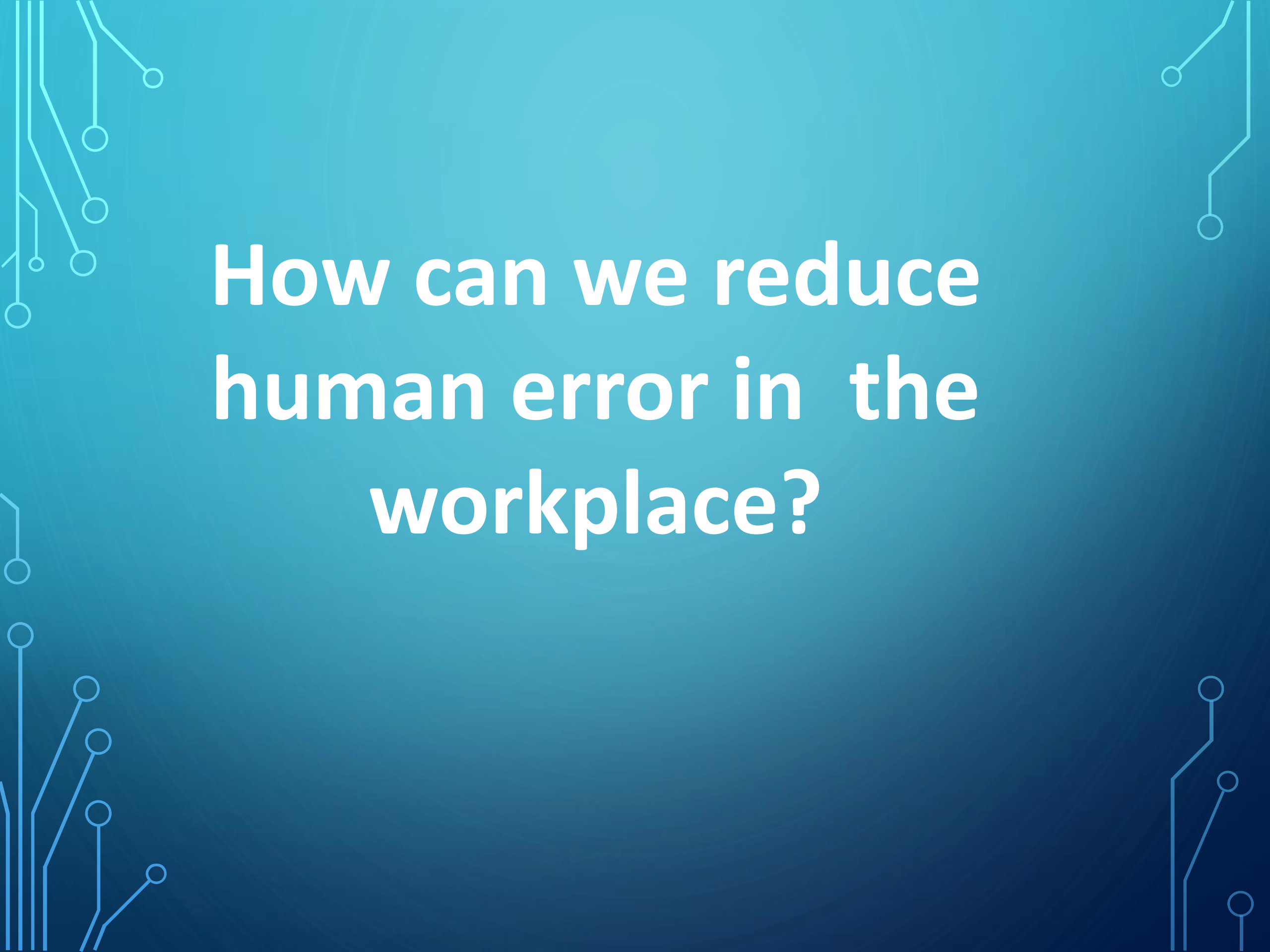
- Individual differences in human error
- **Personality factors & mood as predictors of detection accuracy (Schell et al., 2005).**

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 & workload

- Visser et al's (2007) Meta Analysis paper
- Schell et al. (2005) Simulated quality control task paper

**Critical discussion of research methods
used to understand the link between
human error and performance at work**

The background is a solid blue gradient. In the corners, there are white, stylized circuit-like lines with small circles at the ends, resembling a network or data flow diagram.

**How can we reduce
human error in the
workplace?**

Organisational Culture

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

Systems Design

- Importance of designing systems that minimise the chance of an employee's error resulting in serious consequences
- Particularly in automated industries e.g., Nuclear industry.

Organisational 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)

- Fatigue management policies
- Sleep contracts

<http://www.hse.gov.uk/humanfactors/topics/fatigue.htm>

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 in their workplace;
 - take action to reduce these risks;
 - check & review shift-work arrangements often

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).

Reducing the impact of fatigue

- Strategic napping
 - Bright light exposure
 - Pharmacological interventions
 - Psychostimulants
 - Caffeine
 - Hypnotics:
<https://www.nice.org.uk/advice/ktt6/chapter/evidence-context>
 - Melatonin (But not regulated)
 - Exercise
-
- Boivin., Tremblay., & James. (2007). Sleep Medicine, 8, 578 – 589.
 - Caldwell et al. (2009). Aviation, Space and Environmental Medicine, 80.

Sleep Contracts: A definition

“a negotiated and agreed framework for managing fatigue on a day-to-day basis that is integrated into an organisation’s existing safety management system. The framework is formally documented and makes it clear that employees and management are jointly responsible for the management of fatigue risk and states the responsibilities/accountabilities of each party.”

<https://www.energyinst.org/site-search?keywords=fatigue&submit=SEARCH>

Dr Alexandra Holmes Petroleum Review

July 2006

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



National Transport
Commission, Australia

Napping

- Timing of nap is important
 - Preventative napping more effective than recuperative naps
 - Naps between 2 and 4 pm are 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 (up to about 30 mins after waking)
- Duration of nap
 - 15, 30, 60, 120 mins
- Napping environment

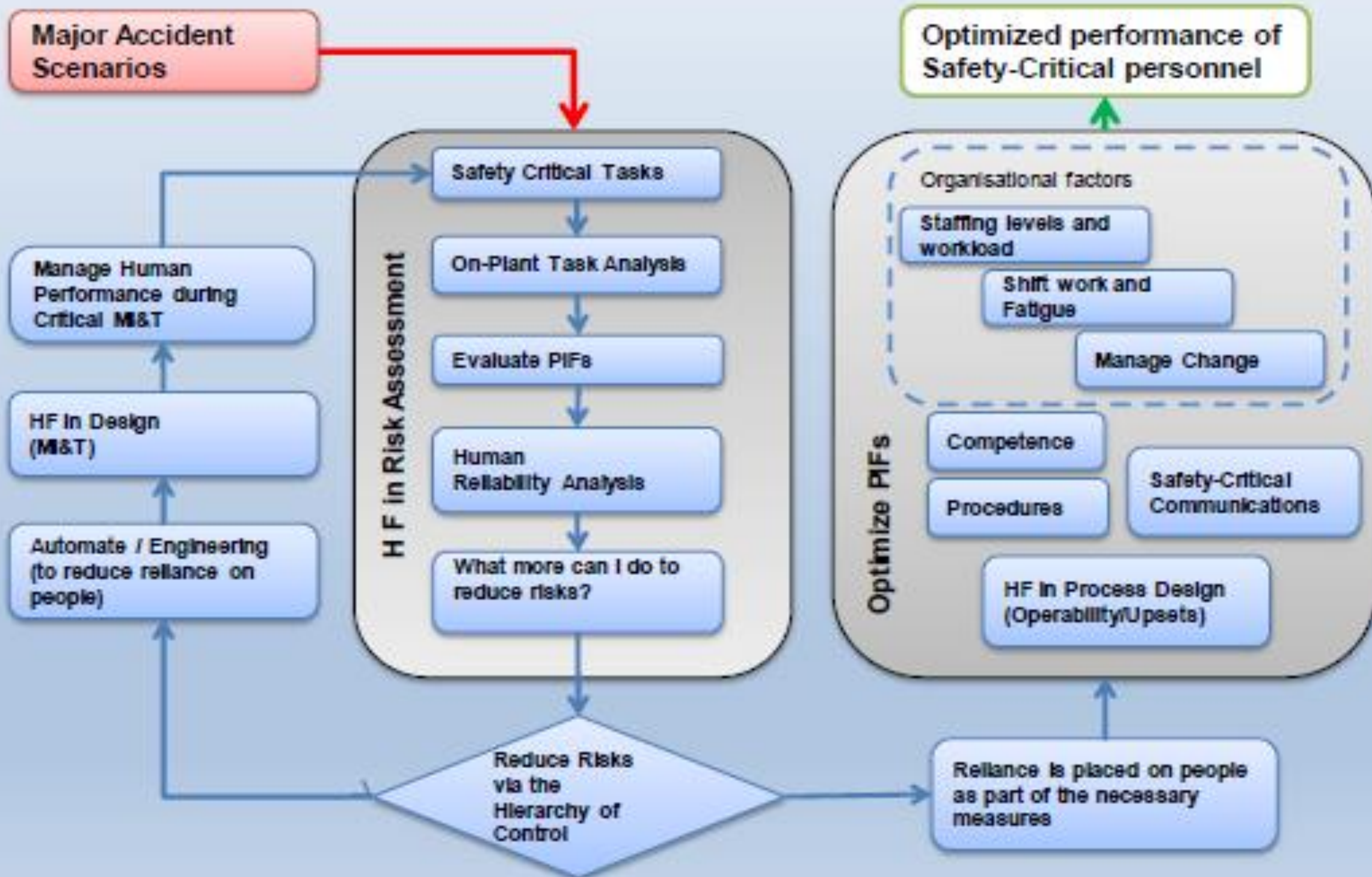
Bright light exposure

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

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

A Human Factors Approach

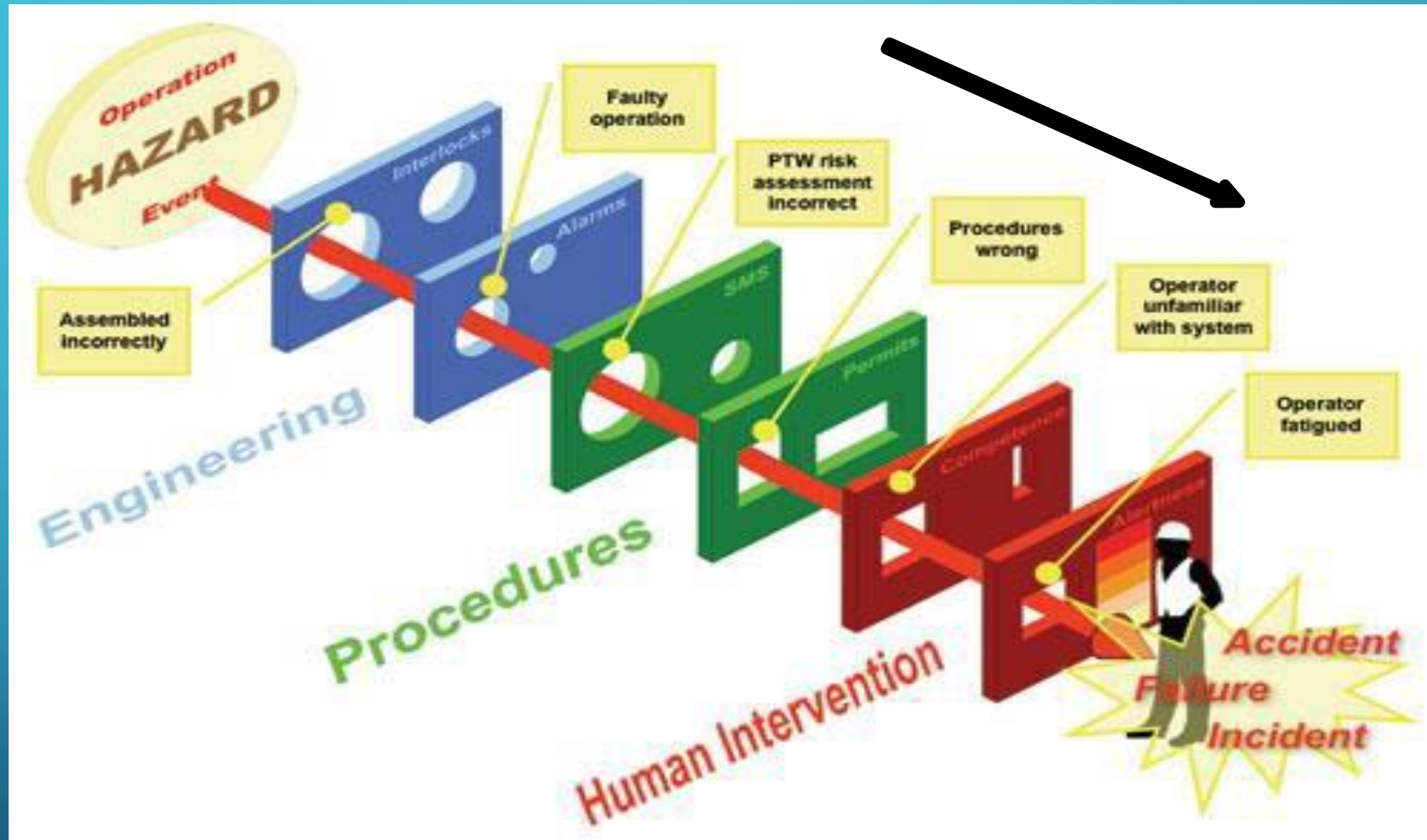


Human Reliability Assessment

- First step in carrying out a HRA
 - Work out what can go wrong
 - To work out what can go wrong, you have to understand the task
- The role of task analysis:
 - Understanding, in advance of errors, how people really do tasks...
 - and hopefully pre-empt such errors

Control measures/barriers

Defence in depth



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

After James Reason 1997

Reason's Swiss Cheese Model

Very useful source for understanding human error and the Swiss Cheese model

- http://patientsafetyed.duhs.duke.edu/module_e/swiss_cheese.html