

Human Factors and Human Error

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What are Human Factors?



Human Factors / Ergonomics

- Human Factors (also known as Ergonomics) is a field concerned with the integration of the human-machine interface in the workplace
 - Involves consideration of design and, specifically, in researching and designing machines that fit human requirements
- Studying factors that make it easier to do work **in the right way**
 - Applies to wherever humans work!
 - Importance of human factors has been recognised for a long time, particularly in aviation and nuclear power

The goals of Human Factors / Ergonomics

- Attempting to make human interaction with systems one that:
 - Enhances performance
 - Increases health and safety
 - Increases user satisfaction
- It is NOT:
 - Common sense
 - Introducing checklists / guidelines
 - Limited to correctly labelling or designing a device
 - Introducing solutions based **ONLY** on what users say they need

Human Factors / Ergonomics

- Human factors integration can be physical or cognitive (or both)

Physical

- Concerned with human anatomy and how we work best
- Could include;
 - Working postures
 - Repetitive movements
 - Workplace layout
 - Occupational related health issues (back pain, carpal tunnel syndrome, etc)

Cognitive

- Concerned with our mental processes
- e.g.,
 - Perception;
 - Memory; Reasoning;
 - Decision making;
 - Motor skills

Cognitive Ergonomics

- Human cognition is highly prone to mistakes
 - Mistakes in reasoning, in decision-making, in perception, in memory recall, etc

- A (very basic!) example

If I ask you to repeat the word **SILK** ten times, and then ask the question “what do cows drink?”

Most people will say **MILK** – even though cows **PRODUCE** milk, not drink it

Our brains are wired to make that link between silk and milk, and understanding where we're prone to make mistakes allows us to

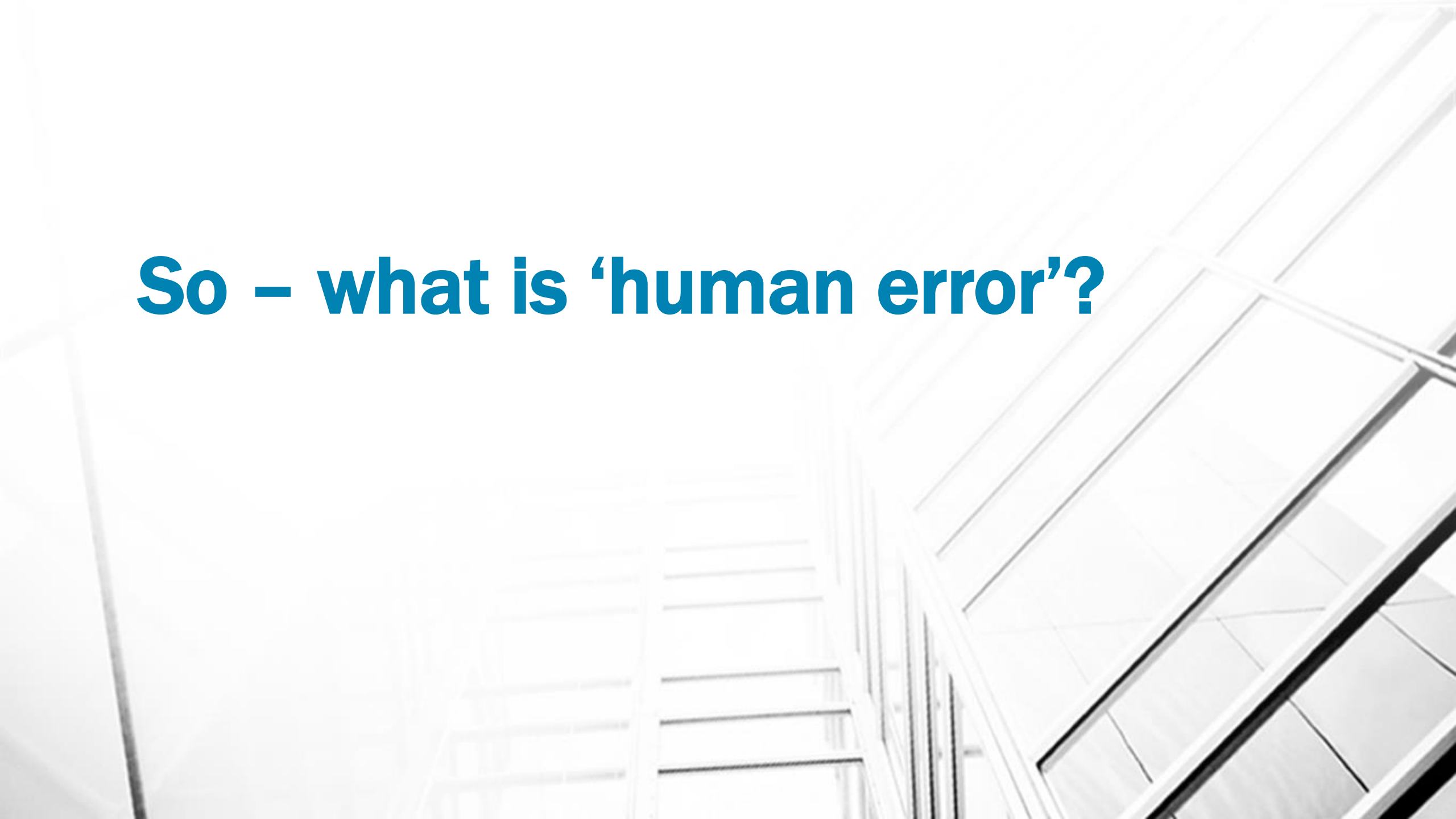
1. defend against them and
2. potentially predict where future errors will occur

Human Error

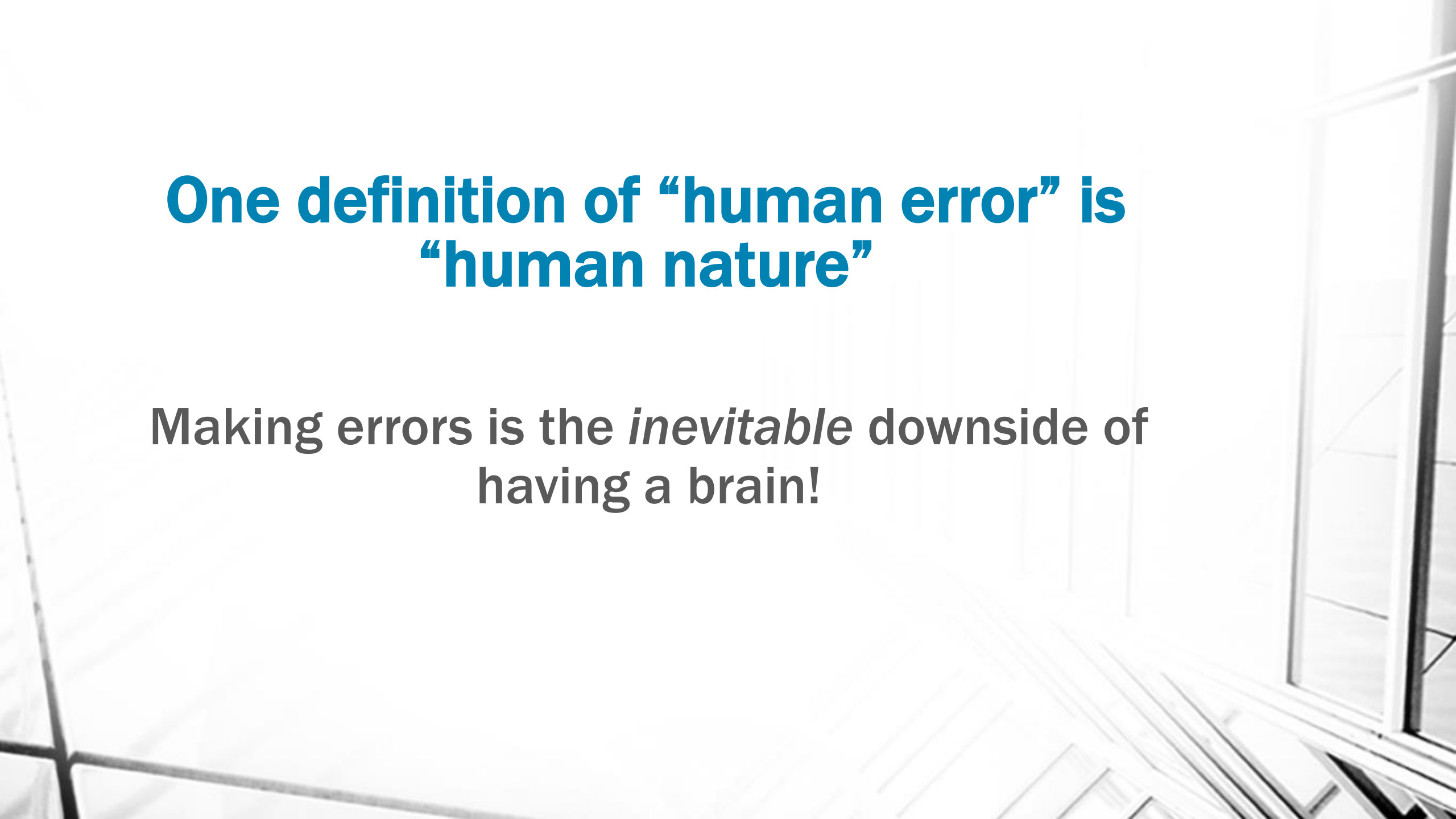
- But – to err is human...
- Human errors occur all the time, but they don't always lead to accidents
- Human error is **assumed** to contribute to up to 90% of incidents and accidents (Yeow et al., 2014)
 - Paddington Rail Crash
 - Southall Rail Crash
 - Herald of Free Enterprise Disaster

Human Error

- The study of human factors acknowledges:
 - The universal nature of human fallibility
 - The inevitability of error
- Assumption is that errors **will** occur
 - Aim, therefore, is to design things at work to try to minimise the likelihood of error or its consequences



So – what is ‘human error’?



**One definition of “human error” is
“human nature”**

**Making errors is the *inevitable* downside of
having a brain!**

What is an error?

- The failure of planned actions to achieve their intended outcome
 - Or an unintended action, or an undesirable one
- A deviation between what was actually done and what should have been done
- Not random events – usually caused by a combination of events and/or multiple variables

Situations associated with increased risk of errors

- Unfamiliarity with the task*
- Lack of time
- Inadequate checking
- Poor procedural guidance
- Poor human-equipment interface
- Inexperience*

**particularly if combined with lack of supervision*

The occurrence of errors

- “doing the wrong thing when meaning to do the right thing”
- Do errors only occur for inexperienced staff?

NO!

- Errors can happen whenever demands (of the job, of the situation, etc) exceed capabilities of the worker

The occurrence of errors: Person Approach

- Blame the person for inattention, forgetfulness, making an incorrect decision, moral weakness
 - Very often focused on procedural violations of people at the 'sharp' end: nurses, surgeons, anaesthetists etc
- Consequences?
 - Disciplinary measures, threat of litigation, retraining, blaming, shaming
- An outdated approach! Problems do not get solved, errors still likely to reoccur

The occurrence of errors: Person Approach

- Errors = moral issues
- Blaming individuals is emotionally more satisfying than blaming an institution / organisation
- Effective risk management depends critically on establishing a reporting culture

The occurrence of errors: System Approach

- Multiple faults that occur together in an unanticipated interaction create a chain of events in which faults can grow and evolve into (sometimes catastrophic) errors
- Recognising that hazards will (always) be present
- Based on assumption that we cannot change the human condition, but we can change the conditions under which humans work

System Approach

- Two overarching principles:
 1. Same set of circumstances can provoke similar errors, regardless of the people involved.
 2. Safety is seriously impeded if an organization does not seek out and remove the error provoking properties within the system at large.

Understanding Human Error

Three types of human error

Types of Human Error

- There are three types of human error (i.e., unintentional);

- Slips
- Lapses



Skill-based errors

- Mistakes



Rule- or knowledge-based

- These types of HE can happen to even the most experienced and well-trained of workers

Slips and Lapses

- Slips and lapses are related to skill-based errors
- Very often occur in the most familiar tasks which we carry out without much conscious attention

Slip = slip of action
or failure of response
execution

Lapse = failure of
memory

Slips and Lapses

- Three main failures:

- Recognition failures → e.g., not recognising the fault
- Memory failures → e.g., a fault with technique used
- Attention failures → e.g., being distracted

- Each can be linked to specific cognitive function

- Perception, divided attention, prospective memory, automatic processing

Examples

Slips

- **Not doing what you're meant to do**
- Performing an action too soon or leaving it too late
- Omitting a step from a task
- Carrying out the wrong check but on the right item

Lapses

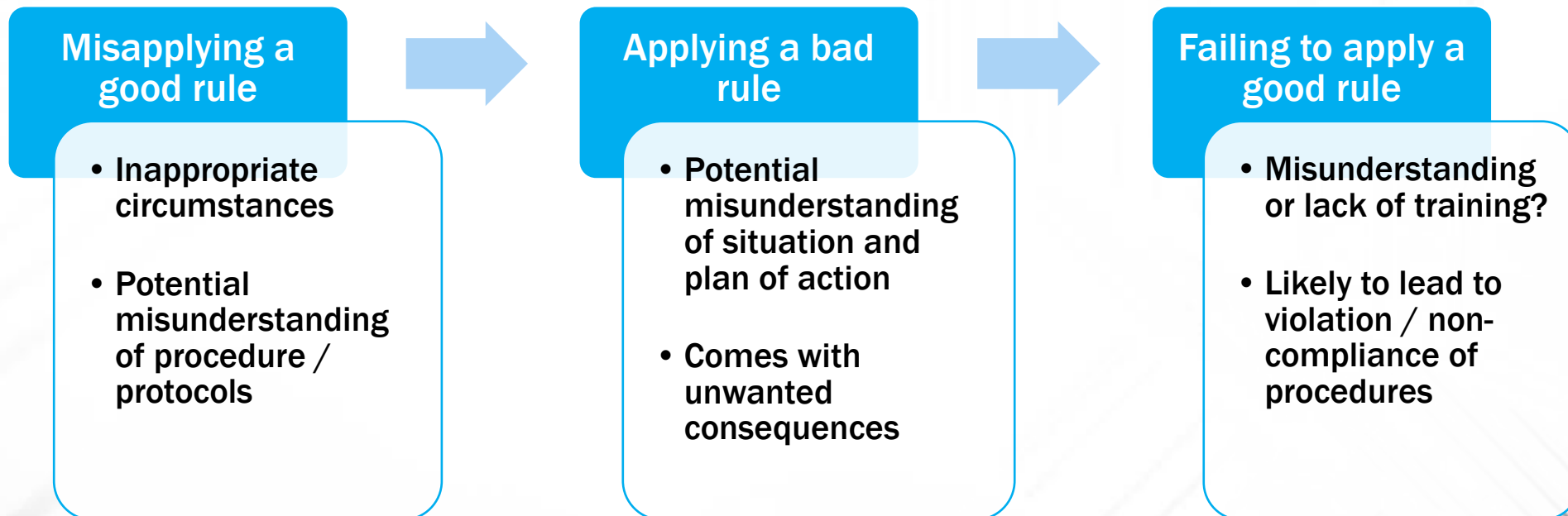
- **Forgetting to do something, or losing your place midway through a task**
- Taking off a mask while talking to a colleague and forgetting to put it back on
- Failing to secure scaffolding because of an interruption

Mistakes

- Decision-making failures
- Two main types:
 - Rule-based mistakes
 - Knowledge-based mistakes
- Occur, overall, when we do the wrong thing but believe it to be right

Rule-based mistakes

- Rule-based behaviour is guided by rules and procedures that are either stored in memory or made available through explicit instructions/protocols
- Can occur in many circumstances:



Rule-based mistakes

- Often decisions determined to be wrong **after the fact**, even though the individual may have believed them to be correct at the time
- Mistakes can also occur when a worker is doing too many complex tasks at the same time, or is under time pressure
 - E.g., if a driver is attempting to overtake and misjudges the time and space needed to complete the manoeuvre

Knowledge-based mistakes

- Occur when workers have to improvise in novel situations
- Deliberate deviations from rules, potentially for safe operation of equipment
- Although seen as deliberate, KBM's tend to stem from a desire to perform work satisfactorily given particular constraints and expectations

Knowledge-based mistakes

- Often demonstrate the influence of various decision-making biases:

1. CONFIRMATION BIAS

- Represents the gathering of information that supports our initial conclusions
- Our early hypotheses/views are resistance to change, even when contradictory evidence is available.

Knowledge-based mistakes

- Often demonstrate the influence of various decision-making biases:

2. REPRESENTATIVE BIAS

- When a decision maker wrongly compares two situations because of a perceived similarity

Knowledge-based mistakes

- Often demonstrate the influence of various decision-making biases:

2. OVERCONFIDENCE BIAS

- People generally tend to be overconfident in evaluating the correctness of their knowledge
- Tendency to justify a violation by focusing on evidence that favours the choice made, and disregarding contradictory signs

What about Violations?

i.e., intentional failures

Violations

- Intentional failures – deliberately doing the wrong thing
- The violation of H&S rules or procedures is one of the biggest causes of accidents and injuries at work.
 - ‘I felt I had no choice’ – intentional due to the situation or rules
 - ‘I didn’t care about the consequences’ – intentional violations

When are violations likely to occur?

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

Factors contributing to human error - violations

- **Job**

- Distractions; lack of time; inadequate procedures; poor lighting; extremes of temperature

- **Human**

- Physical ability; competency; fatigue; stress; substance misuse; hunger; cultural factors; hazardous attitudes

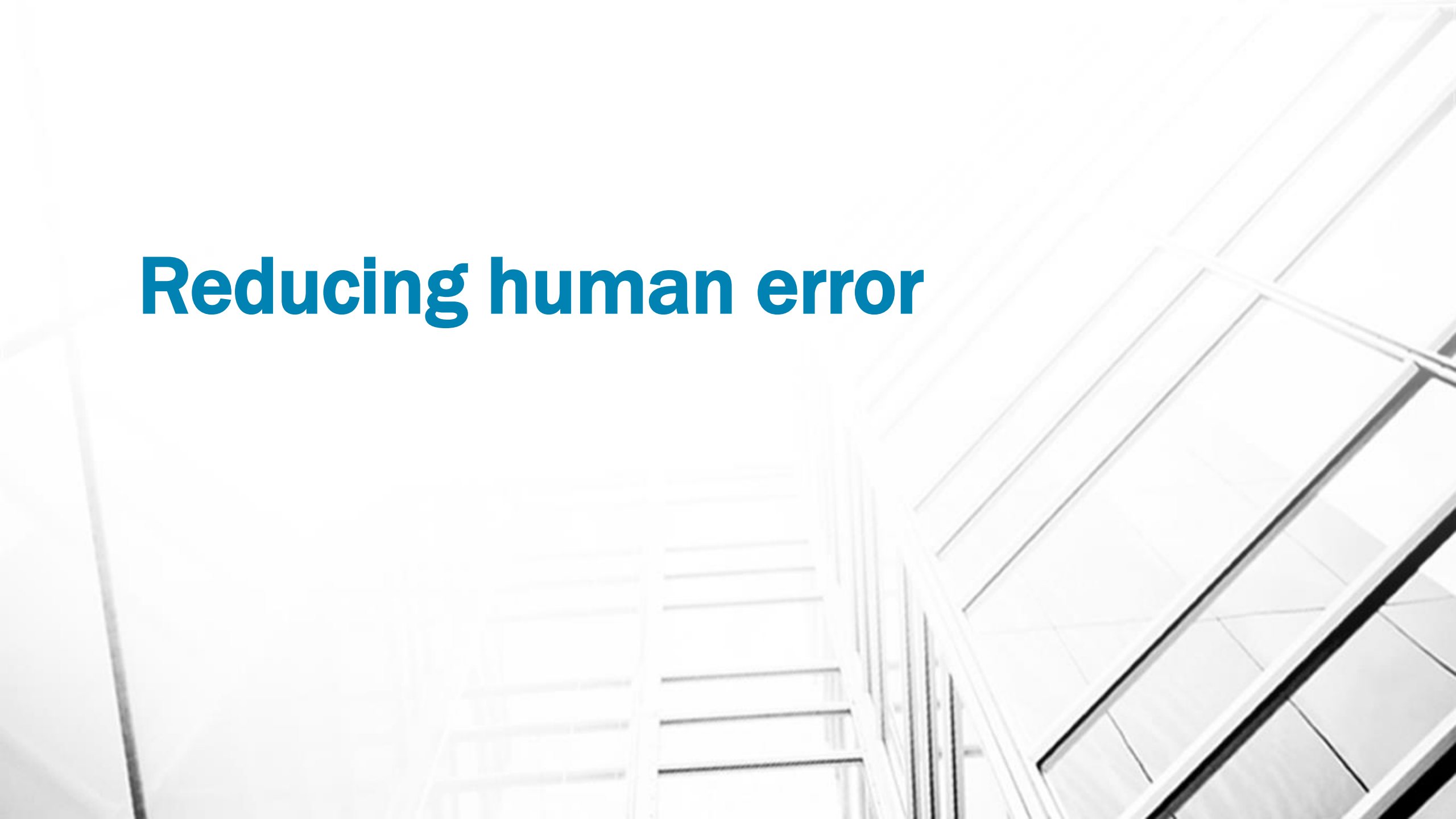
- **Organisational**

- Work pressure; long shifts; insufficient supervision

- **Equipment**

- Poor design; workplace layout

Reducing human error



How can organisations aim to reduce the impact of human error?

Organisational culture

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

How can organisations aim to reduce the impact of human error?

Organisational Safety Culture

- Effective leadership on health and safety practices
- Employee involvement in health and safety
- Investigations of 'near misses'
 - Not just incidents / accidents
- Foster a team responsibility for reporting errors
- Not disciplining staff for reporting errors
 - Further promoting a reporting culture

How can organisations aim to reduce the impact of human error?

Systems design

- Ensure importance is placed upon designing systems that minimise the chance of an employees error that could result in serious consequences
- Particularly important in automated industries
 - E.g., nuclear industry

Human error and fatigue



Fatigue

“Fatigue is the result of prolonged mental or physical exertion; it can effect people’s performance and impair their mental alertness, which leads to dangerous errors”

(HSE, 2005)

Fatigue

- Yeow et al. (2014)
 - Around 48.8% of human errors are likely caused by fatigue, stress, repetition at work and work environments
- Fatigue can be the result of:
 - Insufficient sleep or disruptions in normal sleep pattern (Lerman et al., 2012)
 - Shift rotations (Salma & Kameswara, 2012)
- Fatigue is ultimately a lack of restorative sleep

Fatigue

- Fatigue has been implicated in around 20% of accidents on major roads in the UK
- Estimated cost of fatigue between £115-240 million per year in terms of work accidents alone
- Also suggested to be a root cause of many major accidents..

Herald of Free Enterprise

1987

Ferry capsized on the night of 6th
March 1987 killing 183 passengers
and crew

The captain was on a break and
thought to be asleep in his cabin



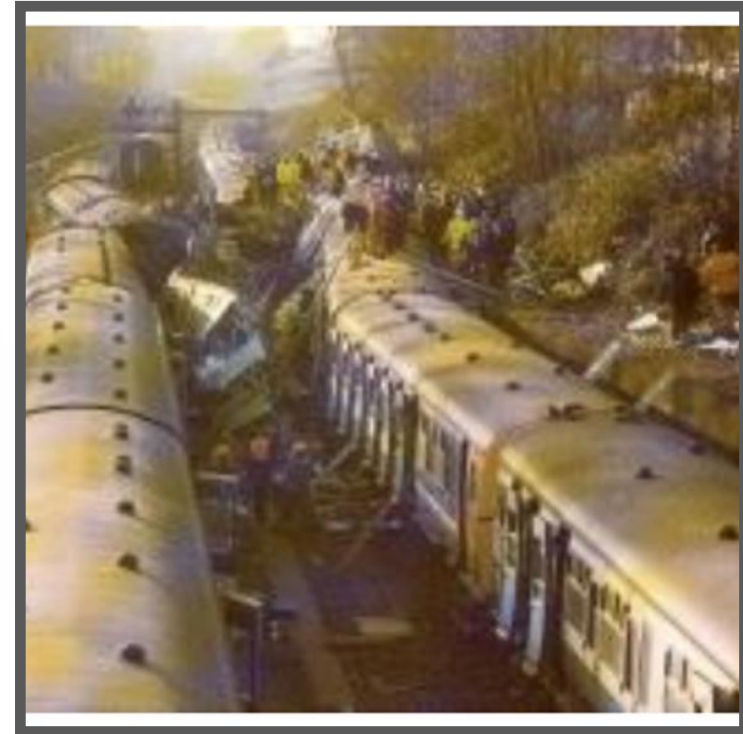
Clapham Junction

1988

12th December 1988 – 35 people died
(484 were left with injuries)

Collision the result of signalling failure –
technician had not been told his working
practices were wrong AND his work had not
been inspected

In addition to this, he had also performed
the work during his 13th consecutive week
of 7-day work weeks



This led to fatigue prevention
policies and recommendations
for industry guidance

Texas City

2005

23rd March 2005 – explosion killing
15 workers and injuring more than
180 others

Implication = result of extensive
periods of 12 hour shifts



Melton Mowbray

2006

Derailment of a freight train near Melton Mowbray on 9th February 2006

Immediate cause = driver had a micro sleep approaching the danger signal, and was only woken after the train had derailed

Driver was suffering from fatigue and had not slept for 22 hours



Causes of fatigue



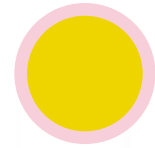
Physical work load

Working posture;
Static load;
Repetitive movements;
Travel / commute time



Environmental work load

Temperature;
Noise;
Humidity;
Light



Mental work load

Irregular work hours;
Job demands;
Stress;
Decision autonomy

Warning signs

- Fatigue is difficult to measure... but there may be some warning signs present in workers
 - Lack of concentration
 - Irritability
 - Poor judgement
 - Reduced vigilance
 - Slower reaction times
 - Reduced capacity for effective interpersonal communication

Reducing fatigue



General HSE view on shift work

- As with any H&S issue, the law requires duty holders to eliminate the risk if possible
 - E.g., to consider whether shift work is necessary in that business
- Employers should:
 - Consider the risks of shift work and the benefit of effective management
 - Establish systems to manage the risks of shift work
 - Assess the risks associated with shift work in their workplace
 - Take action to reduce these risks
 - Check and review shift-work arrangements regularly

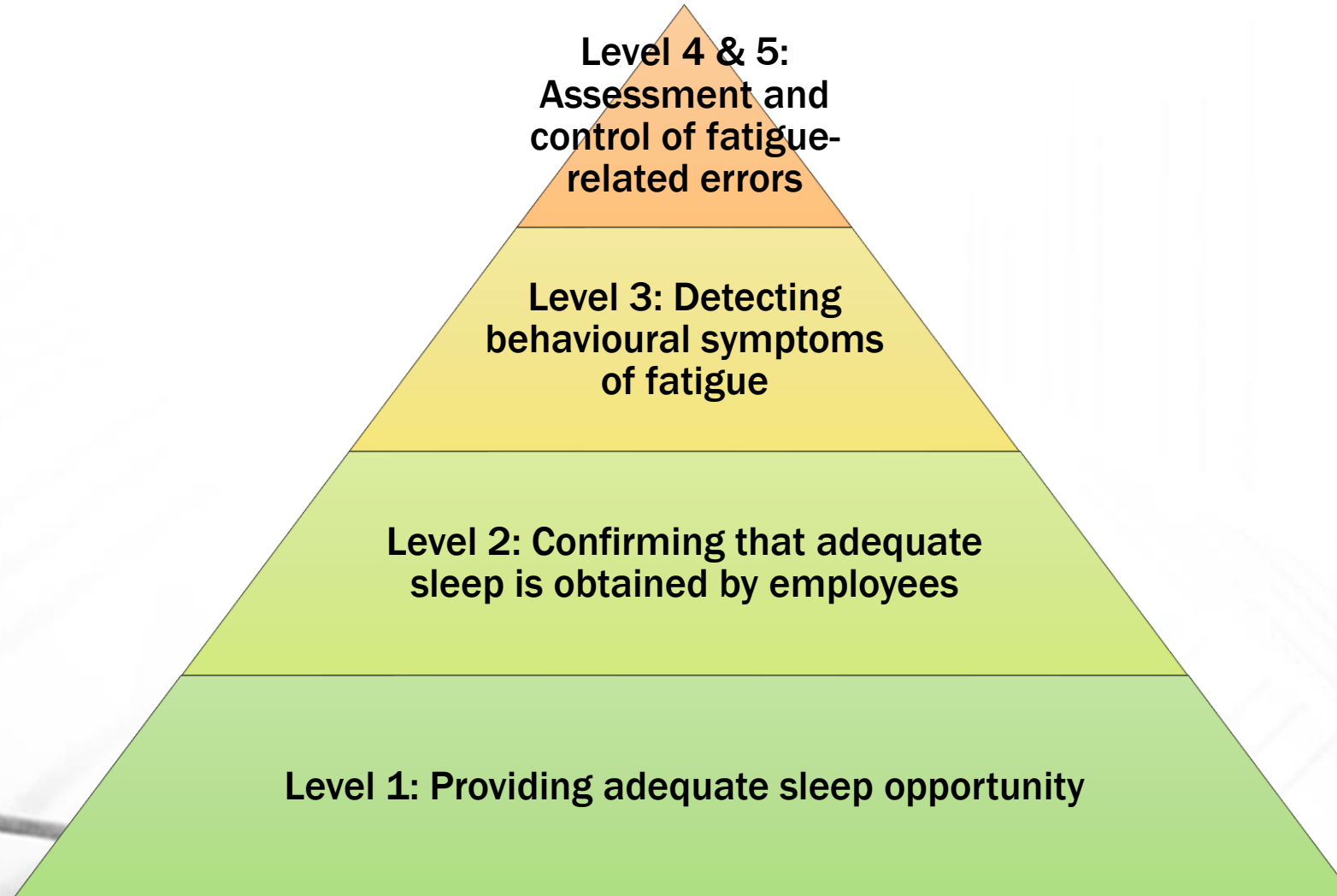
Reducing the impact of fatigue

- Strategic napping
- Bright light exposure
- Pharmacological interventions
 - Psychostimulants
 - Caffeine
 - Hypnotics
 - Melatonin
- Exercise
- Fatigue Risk Management Systems (FRMS)

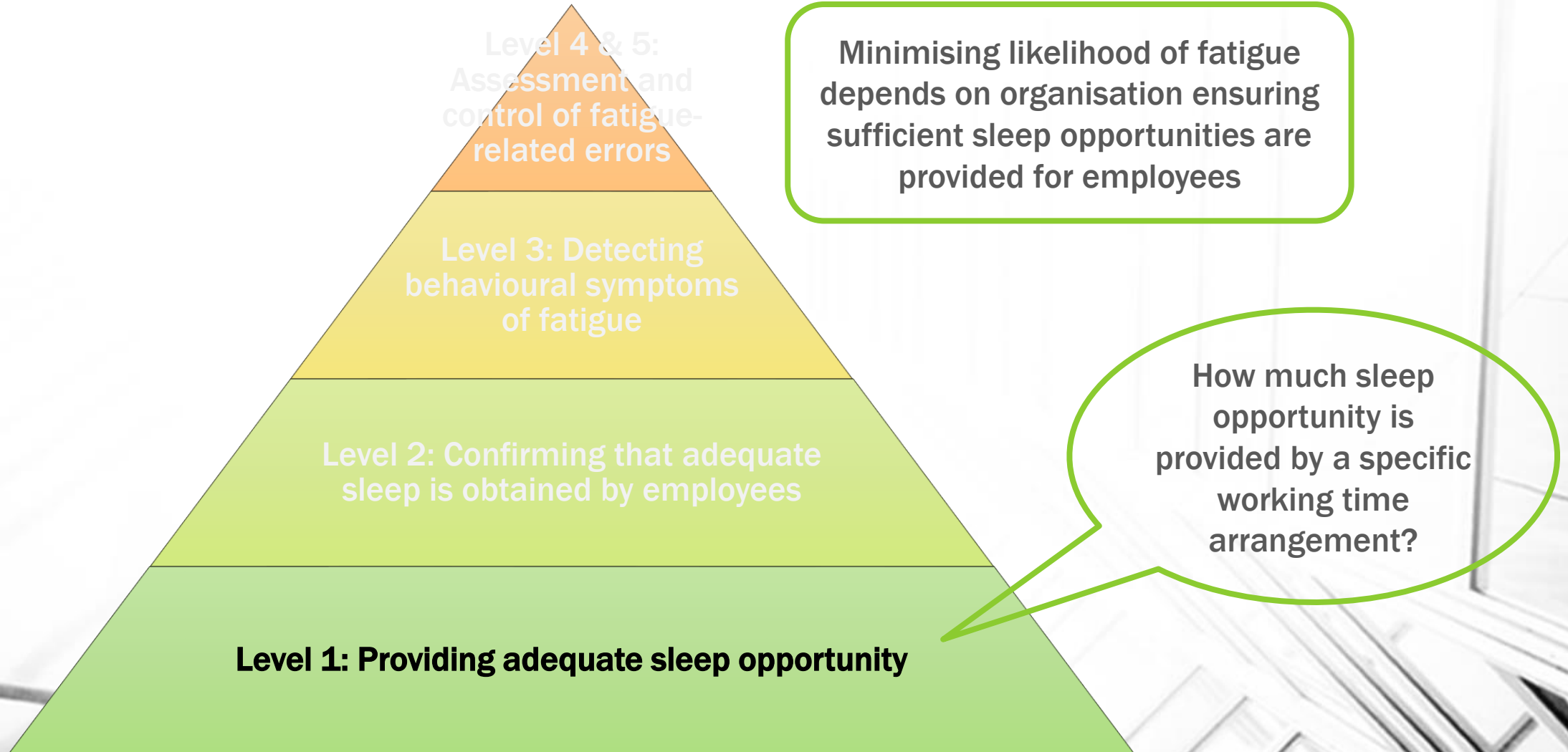
Fatigue Risk Management Systems (FRMS)

- Possible fatigue countermeasures:
 1. Preventative strategies (used before working hours and during rest times)
 - Designed to decrease impact of circadian disruption and sleep loss on performance and alertness
 2. Operational strategies (using during the job)
- FRMS applies scientific evidence of sleep knowledge to manage workers fatigue
- Has developed rapidly in high safety demand jobs (truck drivers, pilots, power plant workers)

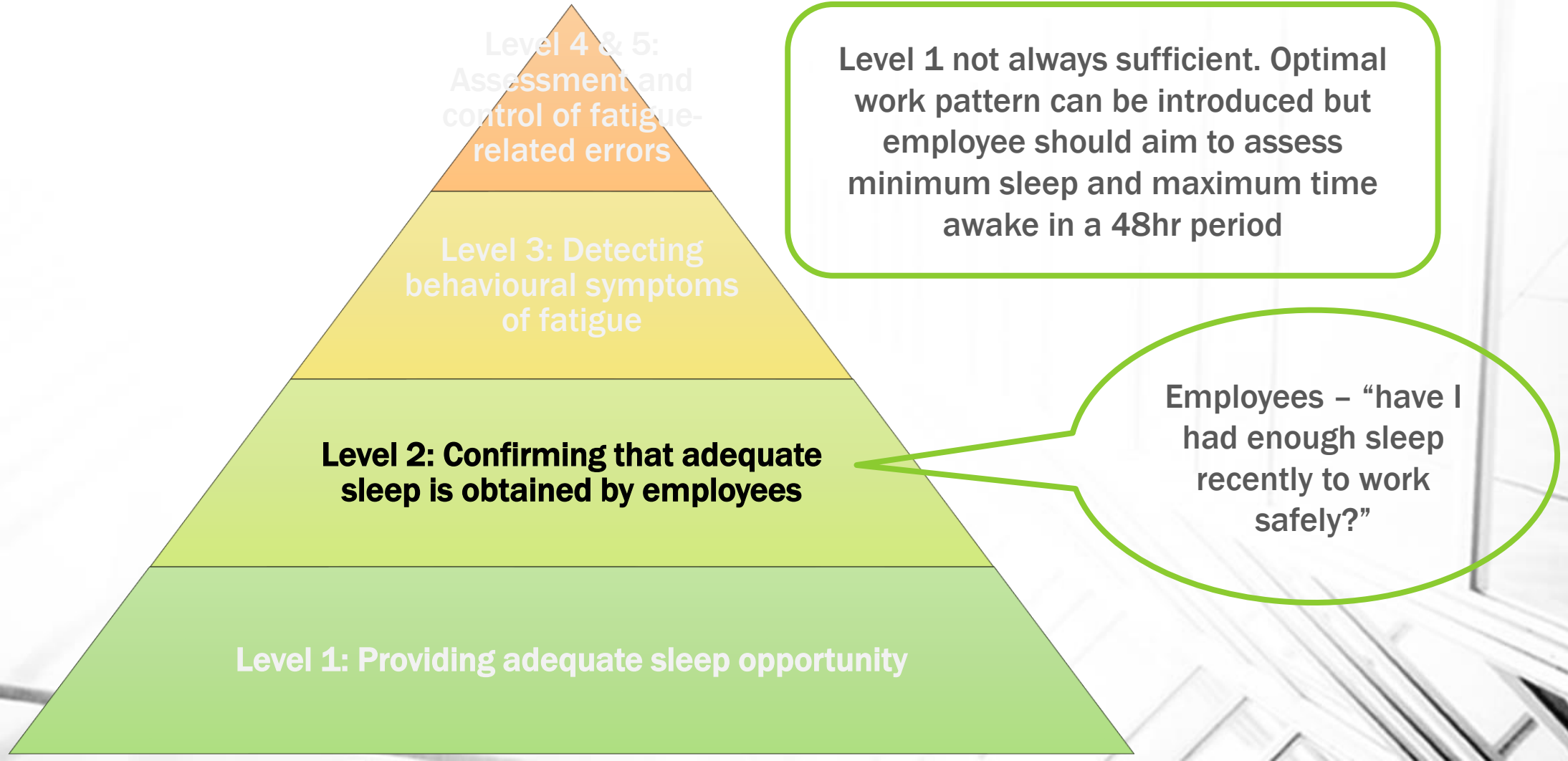
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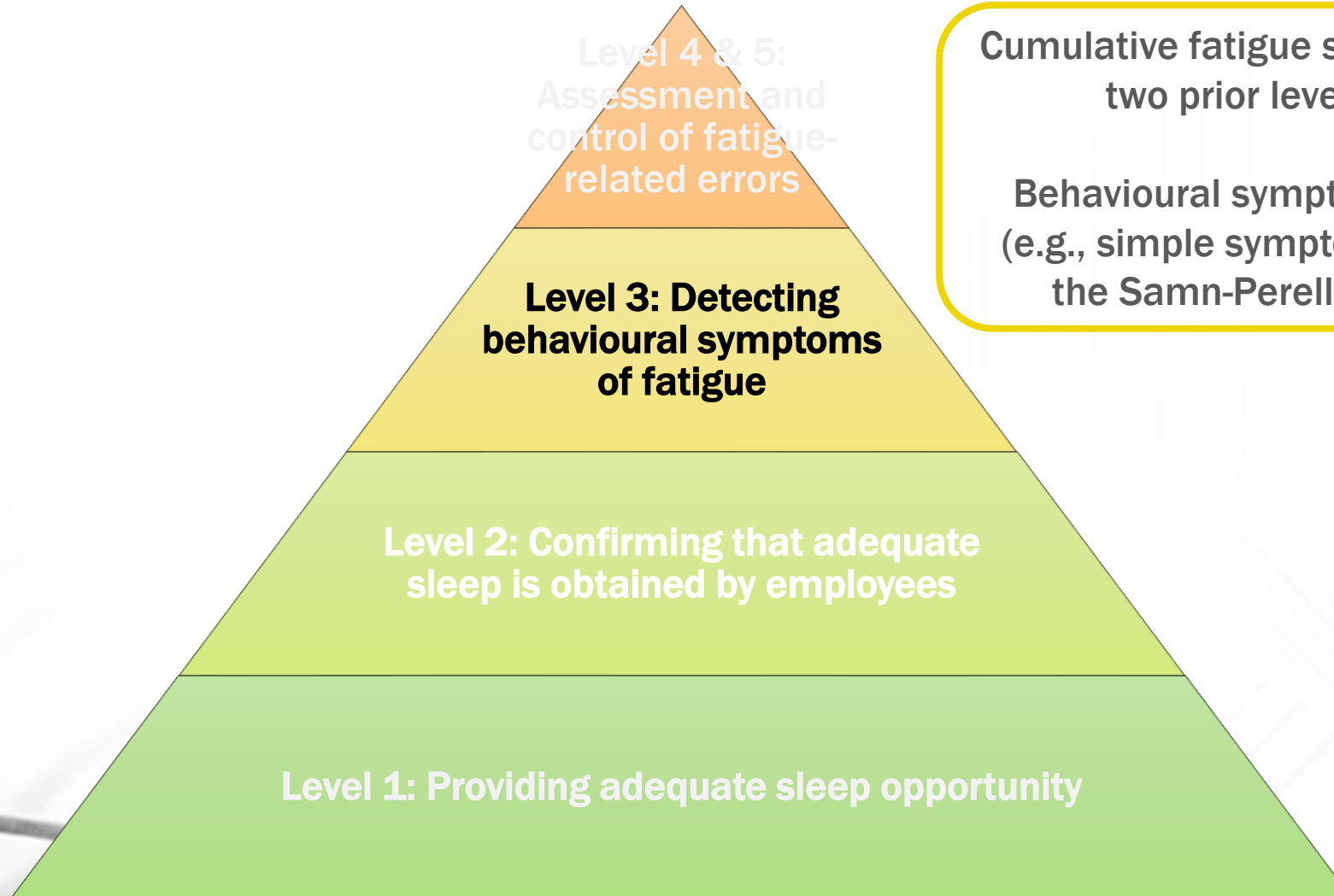
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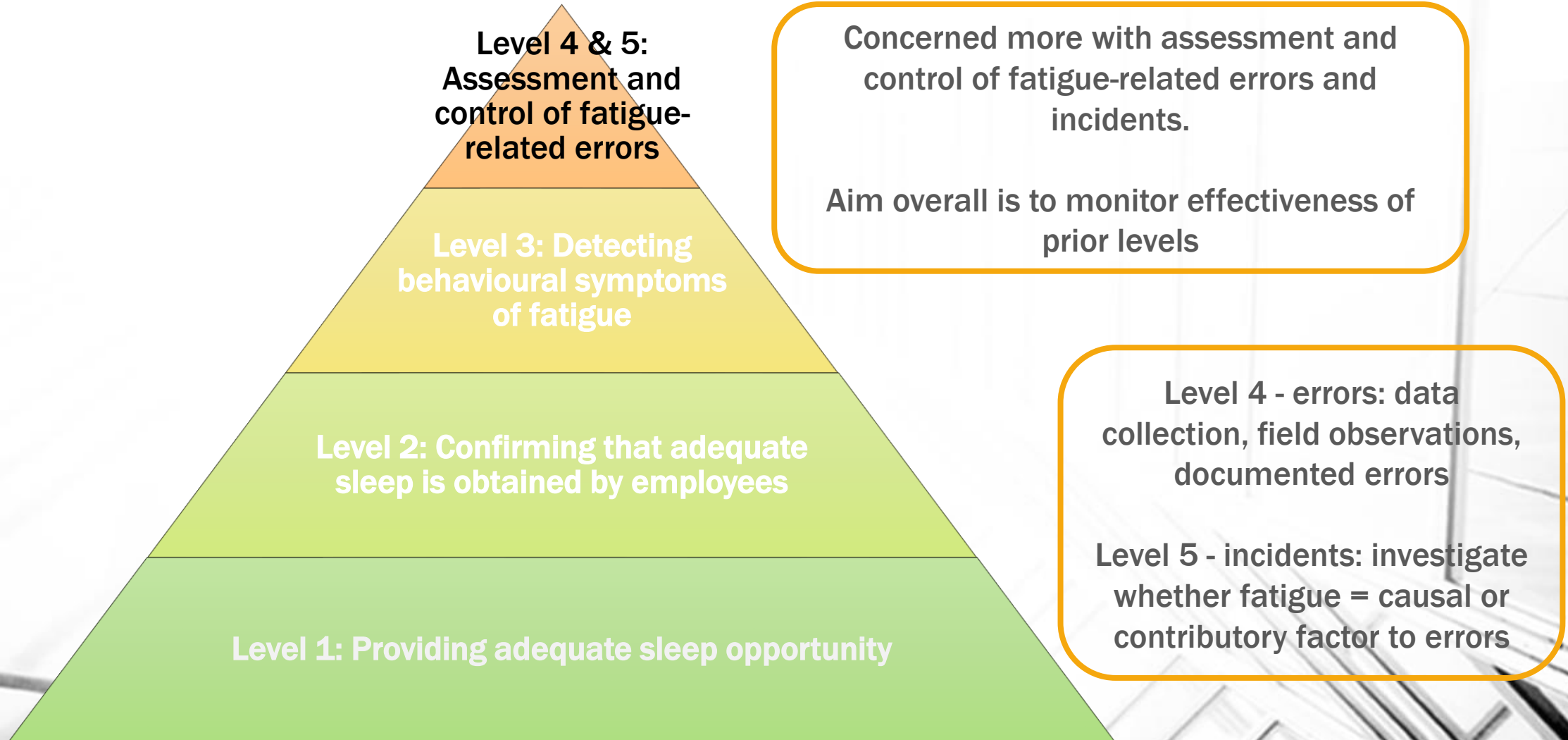
Fatigue Risk Management Systems (FRMS)



Cumulative fatigue still a possibility (even if two prior levels are 'perfect').

Behavioural symptoms can be detected (e.g., simple symptoms checklist such as the Samn-Perelli Fatigue Checklist)

Fatigue Risk Management Systems (FRMS)



FRMS in practice

- In 2006, EasyJet became the first major short haul airline to be issued with a Regulatory dispensation in order to operate a new crew roster pattern which took account of FRMS principles.
- Example of implementations:
 - A sequence of 5 early starts, 2 days off,
 - 5 late starts, 4 days off in place of the previous cycle of 3 early starts,
 - 3 late starts, 3 days off.



Discussion points for this week



- Causes of the Chernobyl disaster...