# Running around and screaming: predicting behaviour in severe accidents

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# Accident sequence

- Introduction and concerns
- Level 2 PSA demands
- Where are the gaps in our modelling capability?
- A model of behaviour
- How can we support operators (what can we claim and how can we be more confident)?
- Conclusions?

# Introduction and Concerns

- Severe Accident management makes demands on operators
  - Prevent escalation
  - Mitigate consequences
  - Achieve long-term stable state
- What do we know about how people will behave in a severe accident?
- How do we judge resilience and preparedness?

# Understanding ‘Claims’

- We understand Type A, B, C errors – for L1 PSA
- SAPs and TAGs push to minimise claims on operators (some claims are unavoidable)
- Understand the claims:
  - EHF2 – Allocation of Function
  - EHF5 – Task Analysis
- We rely on people during severe accidents / BDB events, but…
  - People are dynamic, creative, innovative, pattern-matching, etc
  - People add value – sometimes…
  - People are sensitive to PSFs, stress…
- How do we maximise the benefits we claim?

# Predictable Performance

- Much analysis is about assessing the predictability of performance
- Do we understand ‘high-stress’ behaviour?
- Can we model behaviour in severe accidents?
- Do error types change?
- What sorts of biases and heuristics apply?
- What do we know about behaviour in accidents:
  - Public behaviour?
  - Incident Commanders?
  - Emergency Services...?

# What is a Severe Accident?

- Airbus AF447
- Deepwater Horizon
- US Airways 1549
- Kegworth
- Costa Concordia
- Hillsborough
- Piper Alpha
- 7/7
- RBS
- Fukushima
- Sheppey Bridge
- Southall


COSTA CONCORDIA


TOYOTA

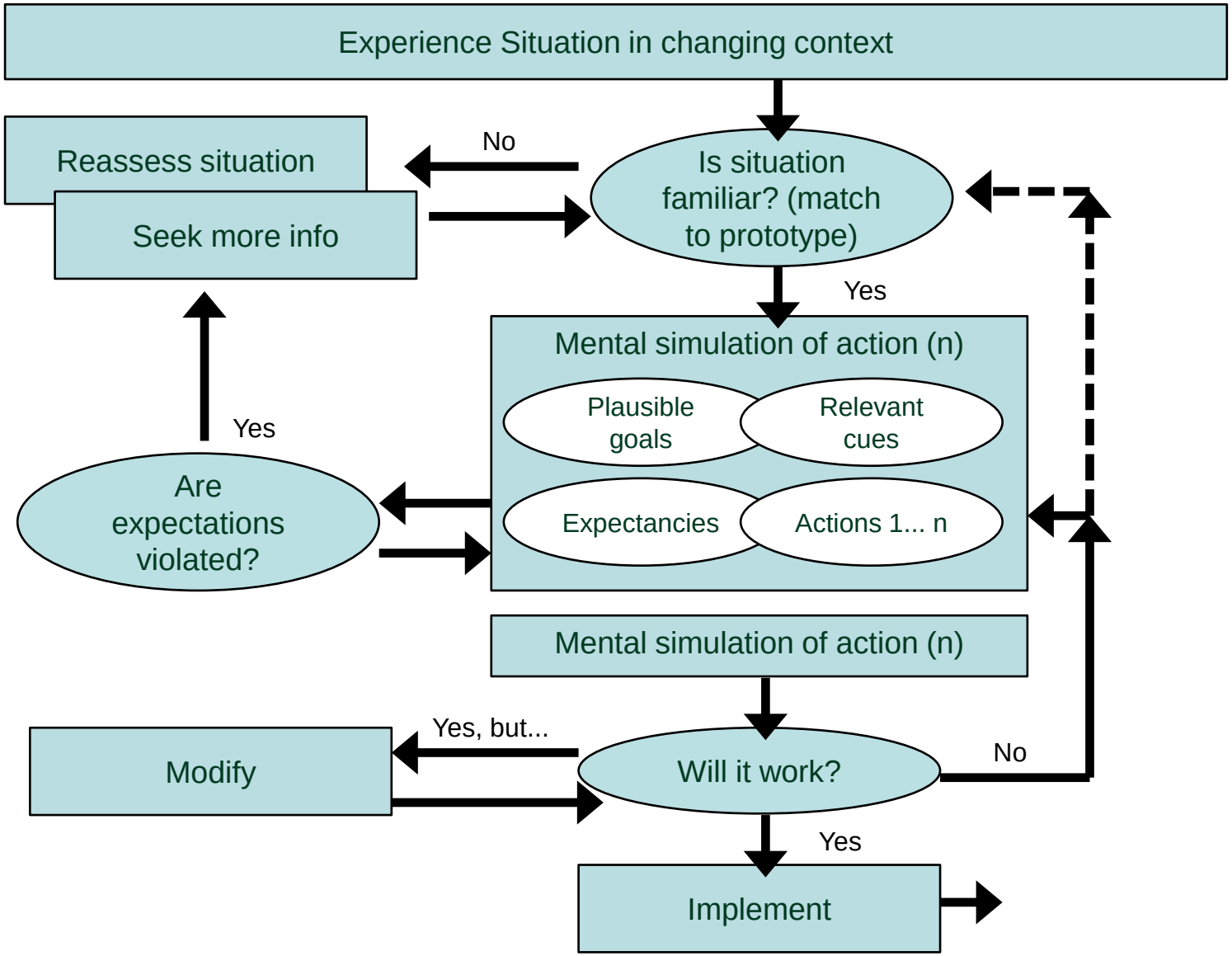
# Level 2 PSA Demands

- We make claims on operators to respond to Severe Accidents / BDB events, but:
  - Procedural guidance is limited
  - Operating in a knowledge-based domain
  - Threats to personal safety
  - Threats to safety of others
  - Fundamental shock
  - Compromised decision-making
  - Compromised memory
  - Perseveration
- Who are the personnel?

# Modelling behaviour

- Influences:
  - Physical
  - Organisational
  - Cognitive
  - Emotional
  - Cultural
- How can we support operators?
- How do we improve their resilience and performance?
  - Situational Awareness
  - CRM
  - ‘Mindfulness’... (applied post-accident)

# RPD Model


Experience Situation in changing context
Is situation familiar? (match to prototype)
No
Reassess situation
Seek more info
Yes
Mental simulation of action (n)
Plausible goals
Relevant cues
Expectancies
Actions 1... n
Yes
Are expectations violated?
Mental simulation of action (n)
Yes, but...
Modify
Will it work?
No
Yes
Implement

# S-R-K

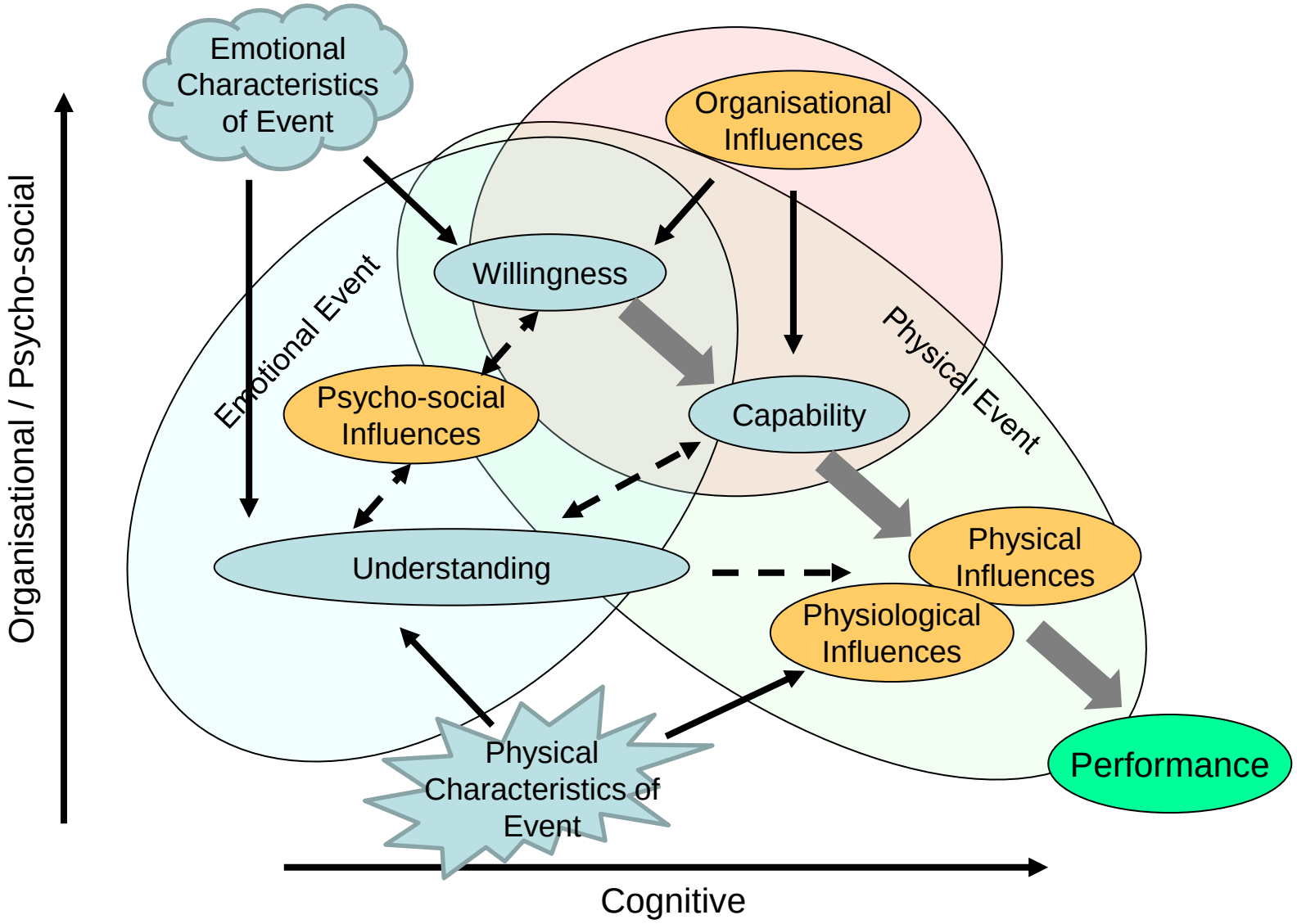
- During a Severe Accident we expect Knowledge-Based (KB) behaviour
  - Its effortful: how do we encourage operators to stay at the KB level?
  - What are the demands of KB thinking (eg increased verification)?
  - What are the ‘error-traps’ in KB thinking (eg group think, confirmatory bias, recency, accessibility, etc)?
  - What is conservative decision-making in KB thinking?

# Behaviour during accidents

- Observed in accidents:
  - 10% constructive
  - 60-80% indecisive
  - 10-15% seriously maladaptive
- State of denial
- Freezing
- Memory lapses

Robinson & Higgins 2013

# The problem space



# Support to operators

- Options:
  - Pre-planning of routines
  - High-validity exercises
  - Resource availability
  - CRM Training
  - Stress-management strategies
  - Emotional support
  - Workload management
  - Cortisol reduction (L-theanine)
- Non-options:
  - Change the societal culture
  - Remove the threat

# Resilience at the Front-Line

- Sense-making
- Confidence and realism
- Dynamic re-planning
- Sacrificing
- Compliance and creativity
- Experience and opportunism
- Diversity of competence
- Assertive and open to others
- Solidarity

Paries 2013

# ...but...

- Most capacities needed to cope with the unexpected are eroded in the continuous attempt to prepare for the expected
- Optimality / brittleness trade-off
  - The more we optimise for a specific context, the more brittle the system will be outside this context
  - Faster, better, cheaper... more brittle...
- Move away from predetermination
  - Recognise complexity
  - Cope with unimaginable rather than try to imagine it
  - Prepare to be unprepared

# Build on human strengths

- Design normal work arrangements to train the skills for dealing with any situation
- Avoid ‘automating away’ needed skills
- Understand types of creativity – adaptive or innovative
- Support hypothesis formation and testing

# Resilience (from people)

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# Training and preparation

- Emergency exercises
  - Regular
  - Real-time scenarios (even if in similator)
  - Worst-case (eg Saturday night)
  - Without warning?
  - Right people (eg when absences being covered)
  - Avoid exercises ‘in sunshine’
- Preparation
  - Prepare for 1st 10 hours?
  - Ensure site ECR/MCR is fully competent
  - On-site personnel resources adequate for severe acc
  - Clear responsibility for decision-making
  - Clear procedures

# Gaps?

- Do our modelling methods apply?
- What are their limits?
- Do we really optimise for severe accidents?
- Do HRA methods apply fully?
- De we understand and account for non-homogeneity of people
- Where can we get data?
- What are the new error modes?
- Do we plan for long-duration events?

# Consider...

- There may be gaps in our toolkit for Level 2 PSA
- There is a lot of knowledge in other domains
- This needs to be organised and oriented
- There is evidence that people ‘save the day’
- Do we give enough consideration to optimising performance in severe accidents (let alone assess it)?
- Don’t assume ‘normal’ reliability unless explicit attention has been given to the challenges of Severe Accidents

“Things that have never happened before happen all the time”

Scott Sagan