Discussion on Risk in Complex Operational Settings

International Conference on Topical Issues in Nuclear Installation Safety: Defence in Depth – Advances and Challenges for Nuclear Installation Safety

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(a)

Product of unreliable system components **(Complicated)**

(b)

Product of improperly aligned, or poorly integrated activities (Interactions, relations) **(Complex)**

Complicated Systems

Designed based on a defined set of rules

Collection of inter-related individual components

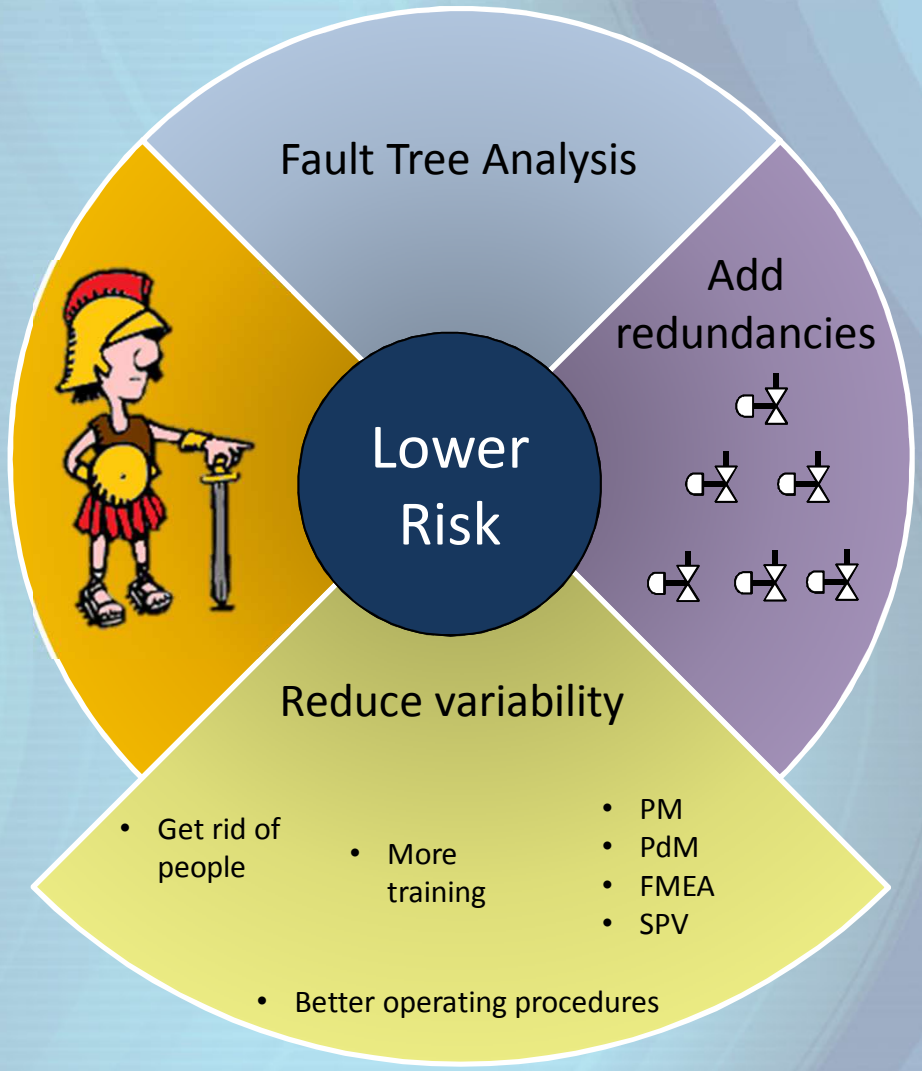
Reliable: Designed such that functioning whole is dependent on collection of parts

- MTBF
- FMEA
- SPV

$$Risk = \sum_{i=1}^{k} c_i p_i$$

Complicated: can disassemble it, put it back together and it still works

Complicated Systems (continued)



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Complex systems

Crew dynamic

Air traffic control

Schedule pressures

Corporate financial state or labour tensions

Crew fit for duty

Distractions

Human factor engineering (or lack thereof)

Maintenance practices

Weather

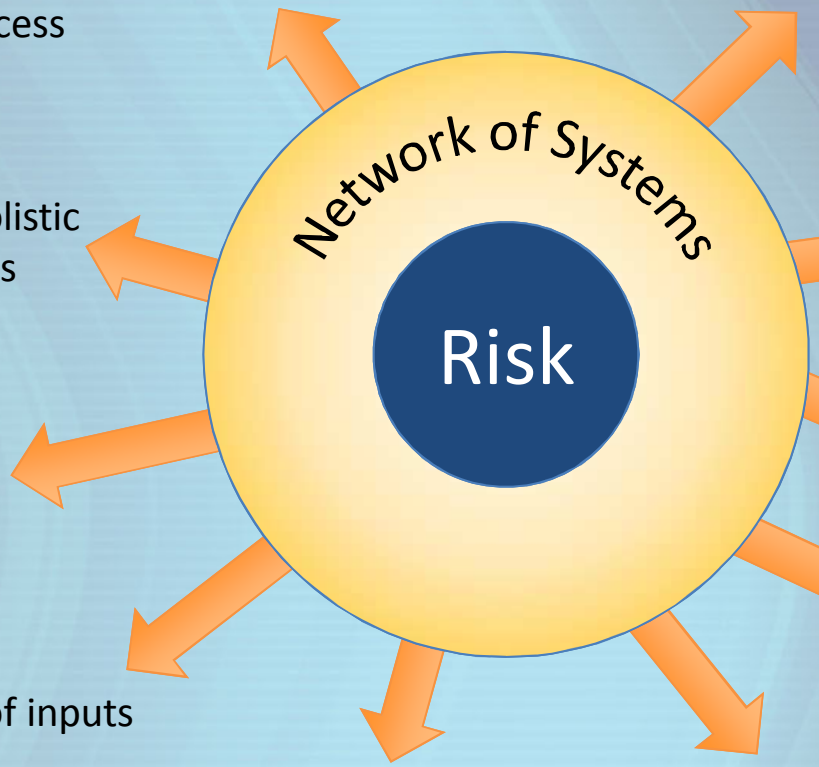
Training

Career pressures

Corporate tone at the top

The complicated aircraft is now suddenly a complex system

Complex Systems (continued)



Almost an organic process

Collection of inter-related individual components with specific design rules does NOT apply

Fundamental understanding of wholistic system >> one persons knowledge

No SPV

Things not hardwired but loosely coupled

Inter-relationships unclear

Large variability of actions that no longer have a direct link from stimulus to output

Diversity of inputs

Perception and perspective can vary widely

Interdependencies versus dependencies

Complex Systems (continued)

Normalisation of deviations (reduced safety merging)

Risk Tolerance / Risk Rationalisation by individual staff

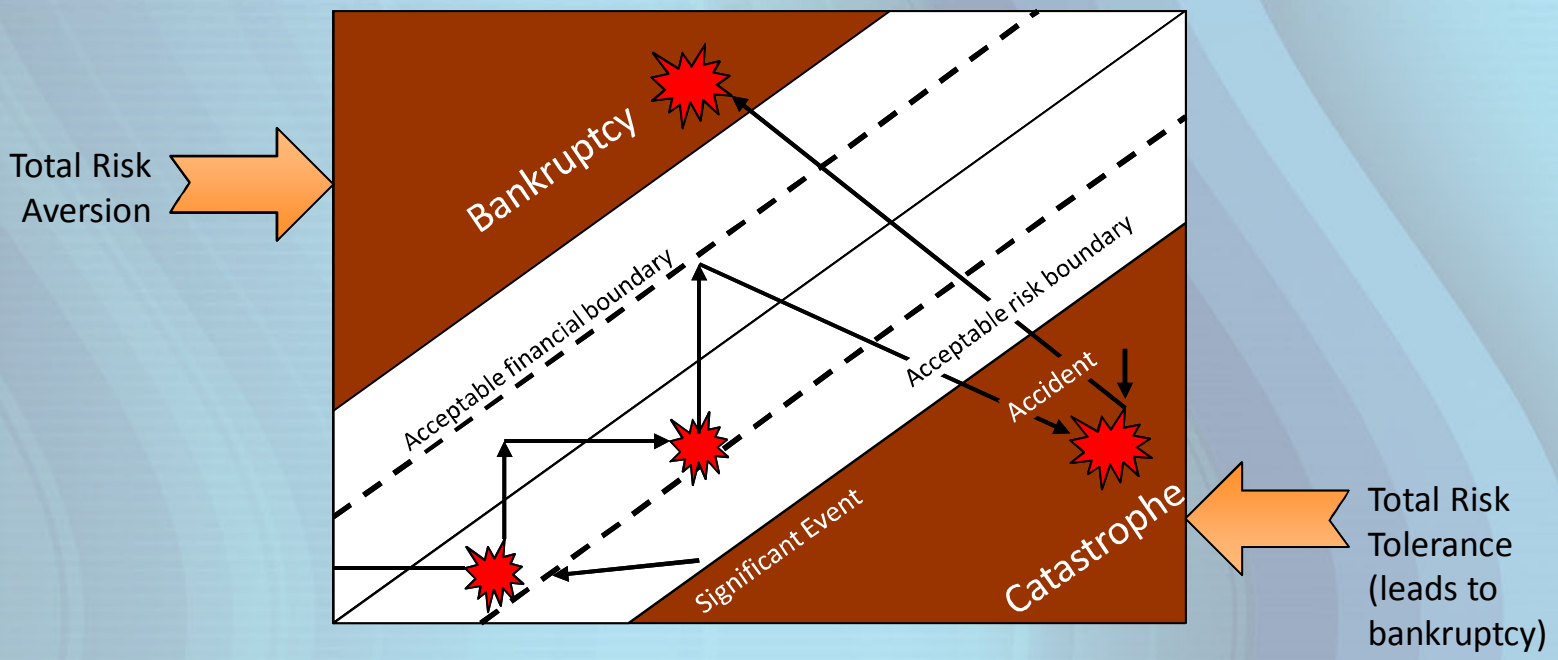
Results are path and time dependent

Risk appetite of organisation (senior managers, supervisors)

Technical depth (or lack thereof) of staff at given moment

Culture feeds off historical normal

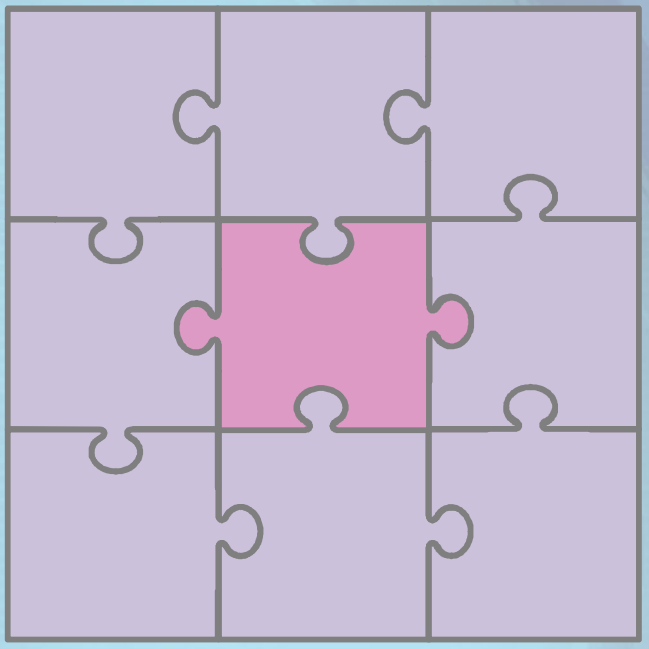
Reactive decision making is risky business



Problem: Where is acceptable risk? (and by whom)

Answer: You only really know where the boundary is when you cross it.

Man's ability to conceptualise, design and construct a technology often outstrips mankind's ability to operate it



Event → Accident investigation → Reconstruct

The event puzzle using Newtonian cause/effect → distill down to the root cause (often human error) → building in future defences

Has served us well over the years, and is powerful

How to deal with complex systems:

- The more exotic the system, the more exotic the problems, and the need for exotic solutions….
- Some ideas to get a foothold:
  1. Talk about risk frequently
  2. Carry out gap analysis between expectations and behaviours in the field “you get what you inspect, not expect”
  3. Actively solicit diverging opinion to (avoids intentional blindness)
  4. Debate “acceptable boundaries”
  5. Discuss antecedents for people’s behaviours including the ‘unofficial messages’
  6. Never allow doubt and uncertainty to go unchallenged

How to deal with complex systems (continued)

7. Demand proof it is safe to operate, not unsafe to operate
8. Demand Operational Decision Making (ODM) forums discuss the above when debating a new issue
9. Create a Nuclear Safety Culture Monitoring Panel (NSCMP) to meet quarterly to:
   a) Discuss the above
   b) Construct the puzzle without first knowing the final picture, ie: avoid the event instead of reacting to it