IAEA **International Experts' Meeting**
on
Human and Organizational Factors in Nuclear Safety in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant

Vienna International Centre – 21 to 24 May 2013

Jean Pariès Dédale SAS France

WHY A PARADIGM SHIFT IS NEEDED

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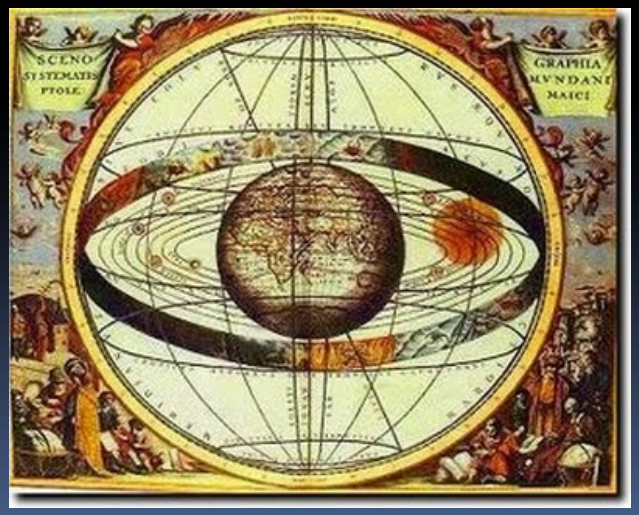
A « paradigm shift »

- Thomas Khun : « *The Structure of scientific Revolutions* » (1962)



- Dominant theory (« Normal Science »)
- Accumulation of contradictions with recognized facts
- Emergence of a credible alternative
- Resistance of science practitionners
- « Paradigm shift »: change of the core conceptual framework

Challenges to the current "safety paradigm"?

- Demonstrated vulnerability to unexpected situations, unexampled events
- So do we need to do better, and more intensively, what we already do…
- Or is the current "safety paradigm" itself challenged?

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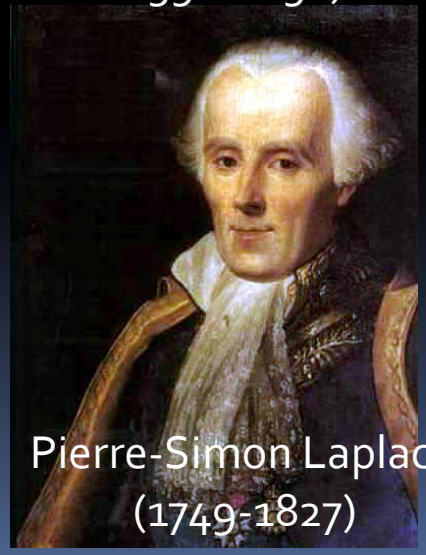
WHAT IS THE CURRENT SAFETY PARADIGM?

Safety-I: the predetermination strategy

- The current safety paradigm is based on :
  - the exhaustive anticipation of all potential situations, including accidental ones
  - and the deterministic or probabilistic predetermination of all the expected (safe) responses
- Safety is warranted by the real world conformity to this designed-to-be-safe world.
- Risk is seen as generated by deviations and variations
  - retrospectively seen as the causes of incidents and accidents
  - hence systematically chased
- The modern Grail: a world where nothing goes wrong, a perfect world (organizations, processes, teams, behaviors)

René Descartes
1596-1650)



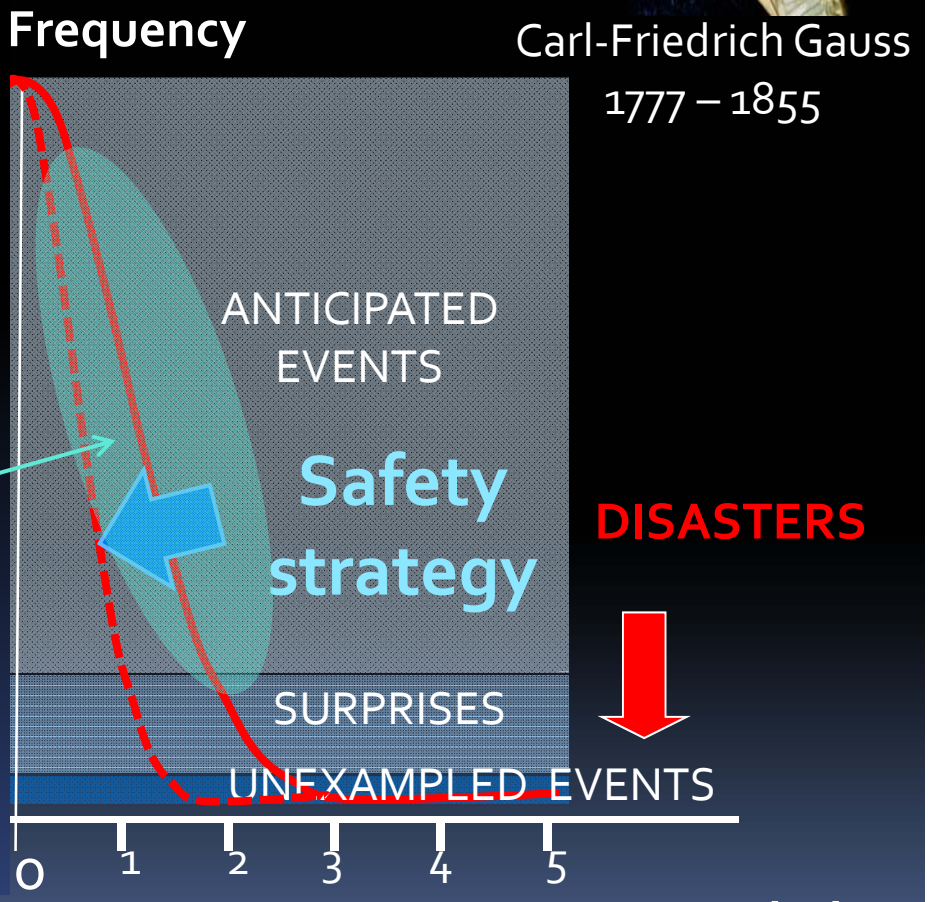
Pierre-Simon Laplace
(1749-1827)

A linear vision of risk

- Normal distribution
- The frequency of low severity events is perceived as a good assessment of disaster probability

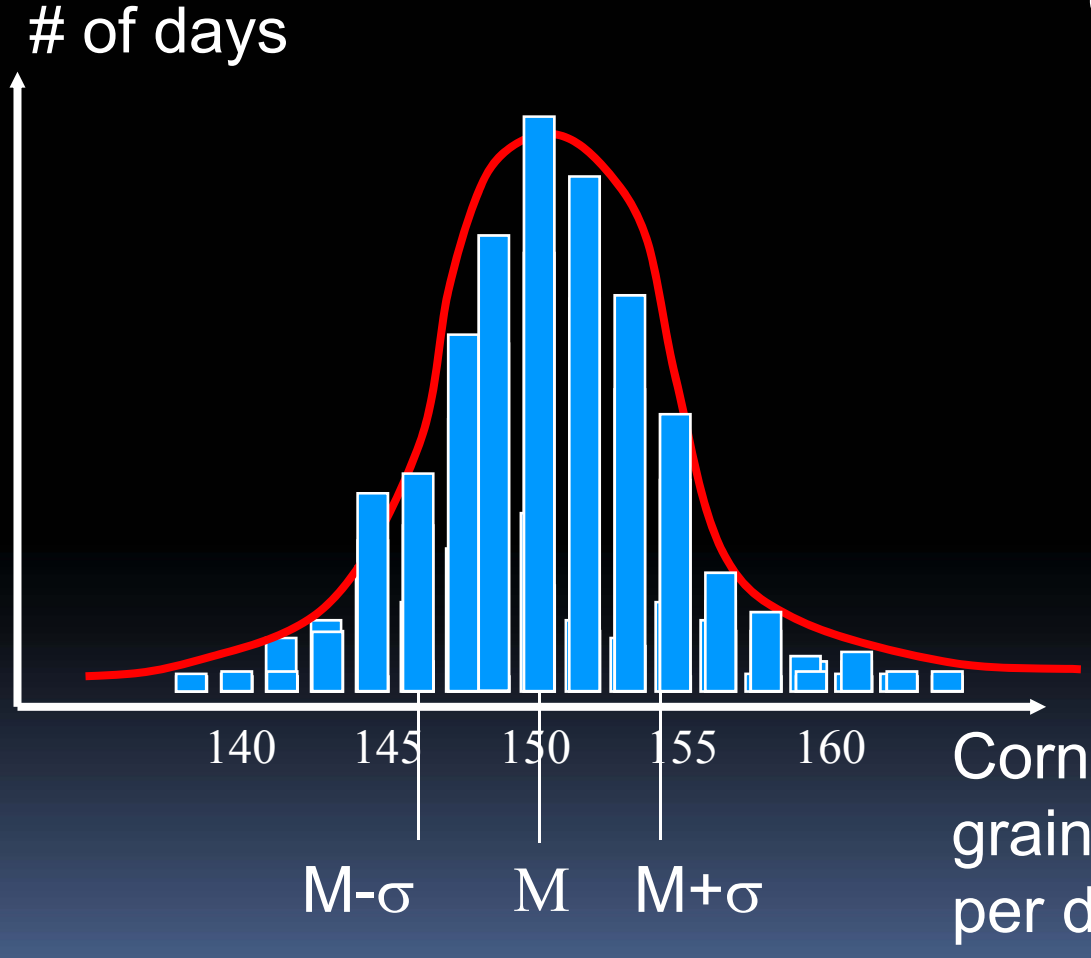
Focus is on this

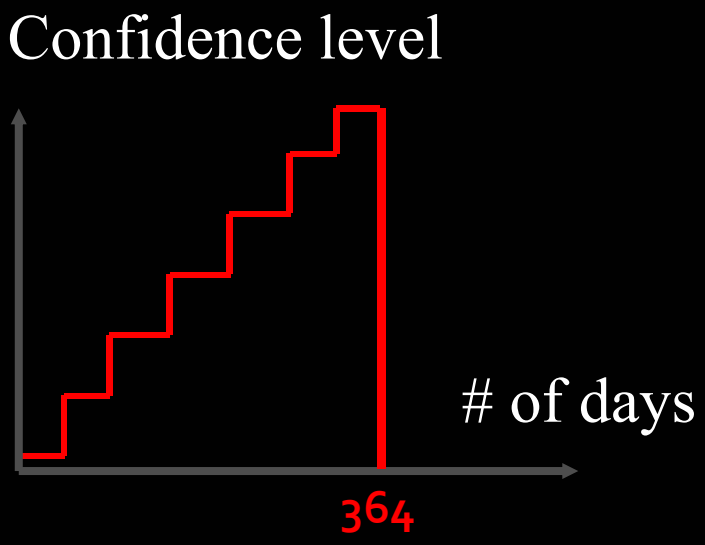
Carl-Friedrich Gauss
1777 – 1855

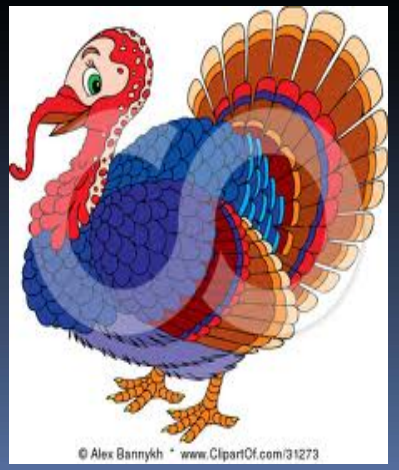


The « inductivist » turkey

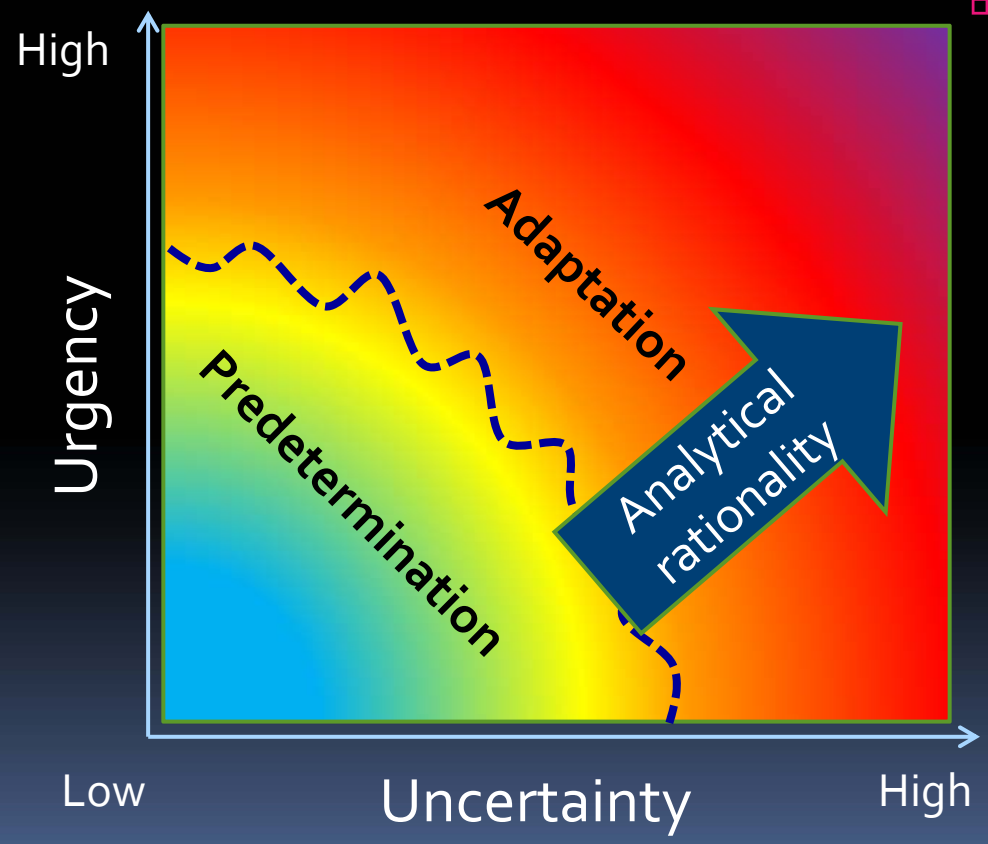
(Bertrand Russel)







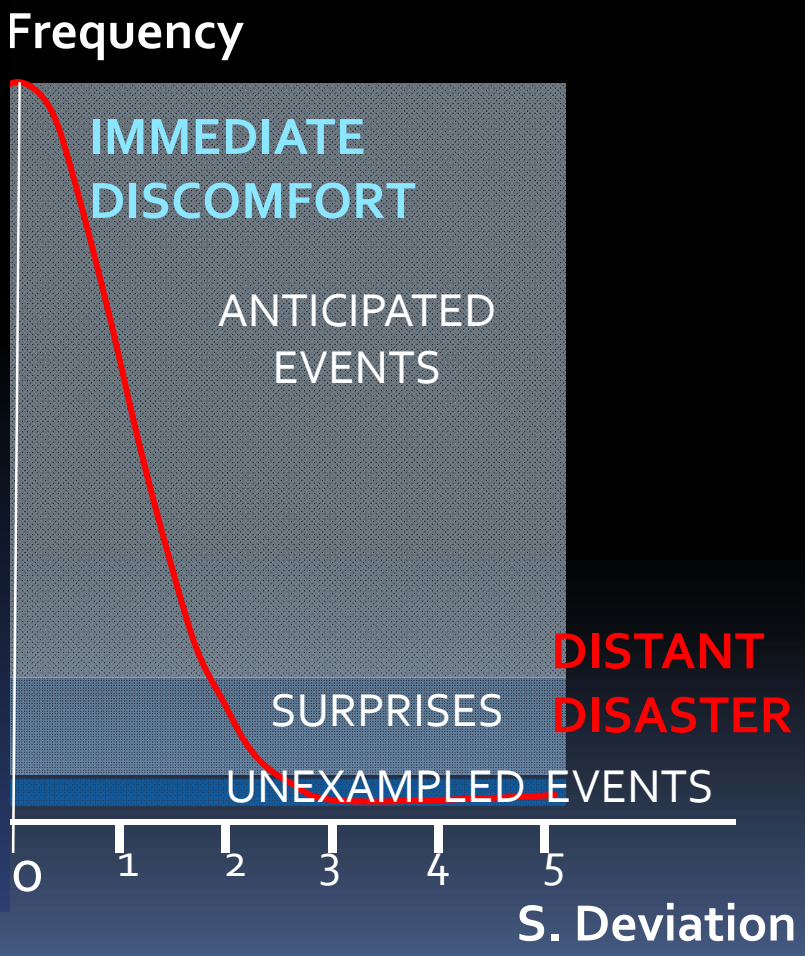
The key issue: how to cope with complexity



- The current safety paradigm strives to extend the predetermination envelope and bets on staying within it .
- The uncertainty generated by the complexity of the system itself and by its environment is skirted through deterministic or probabilistic rationality

Hidden decisions

- Current methods erase a part of the world complexity:
  - postulate an equivalence between all kinds of risks
  - crush the long term into an exponential discount
- A distant catastrophe weights no more than a small immediate discomfort
  - [Risk = Probability * Damage]
- Risk is always a social interpretation, and risk related decisions the result of a political process
- Risk quantification methods do more than facilitating decisions: they make decisions themselves!



Towards Safety-II?
Is there an alternative?…

- The aim should not (only) be to make the world conform to the model, but to maintain control over the world as it is:
  - complex !
  - partially unpredictable!
  - full of "Unknown unknowns"
- This carries a complete change of perspective.
  - Manage the unexpected, and for the unexpected
  - Understand control under uncertainty
  - Understand adaptation
  - i.e. understand why things really go right (i.e. the efficiency of "bounded rationality" – H. Simon)

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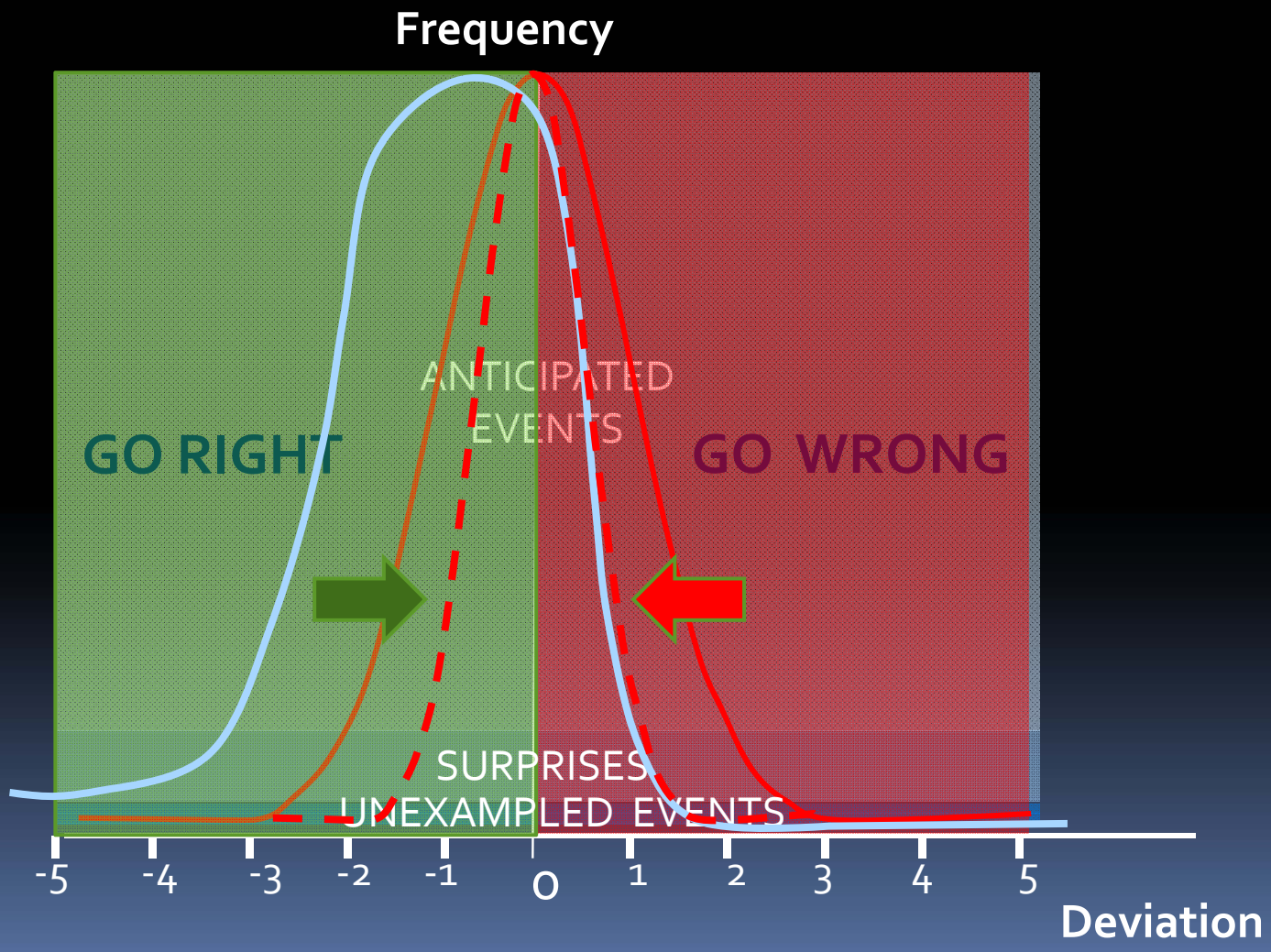
From a failure-centric to a success-centric vision of safety



E.g. a different vision of accidents

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Signals Passed At Danger (SPAD)

Traditional approach :

- "failures" and "causes"
- Why did the driver passed the signal? Fatigue? Distraction? …

Systemic, "positive safety" approach:

- What is the exposure rate of drivers to "red" signals ?
- What is their success rate?
- Can this reliability really be further improved ?
- Is it consistent with safety objectives?
- What is generating "red signals" in the business model?

Resilience

- Itnrnisic alibtiy of a sytesm to mantiain its struructal idetnity, its (mian) fetuares, and at lesat patrilaly its pefromrnace, in the prensece of disutrabnces, inlucding lagre, unsuual, or unteexpecd oens, gonig beoynd tshoe for wcihh the steysm had been dsigneed for, or thsoe to wihch it is adptead.

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Résilient capacities at the front line

- "Sense-making" ability: fast, and globally right comprehension
- Confidence and realism : ("yes we can" and "unable")
- Dynamic re-planning
- "Sacrificing" decisions
- Adherence to procedures and creativity
- Experience and opportunism
- Diversity, large spectrum of competences
- Assertiveness and openness to others
- Strong solidarity among the group

- Most capacities needed to cope with the unexpected are eroded in the continuous attempt to prepare for the expected.

Resilient features at the organization level

- Ability to:
  - quickly and officially recognize a crisis, a state of emergency
  - recognize when to shift priorities across goal trade-offs
  - redefine strategies, focus on "vital functions"
  - make "sacrificing" decisions (including sacrificing lives?)
  - reallocate roles and responsibilities, manage workload
- Management of:
  - margins of maneuver, future adaptation capacities
  - functional vicariance
  - adaptive (not only procedural) competences and expertise
  - redundancies, diversity, slacks, buffers, stocks, and back-ups
  - local autonomy, "empowerment" of front line operators,
  - polycentric rather than hierarchical / centralized governance
- Surveillance of weak signals, watch of bottlenecks ahead, and "requisite imagination" of contingencies.

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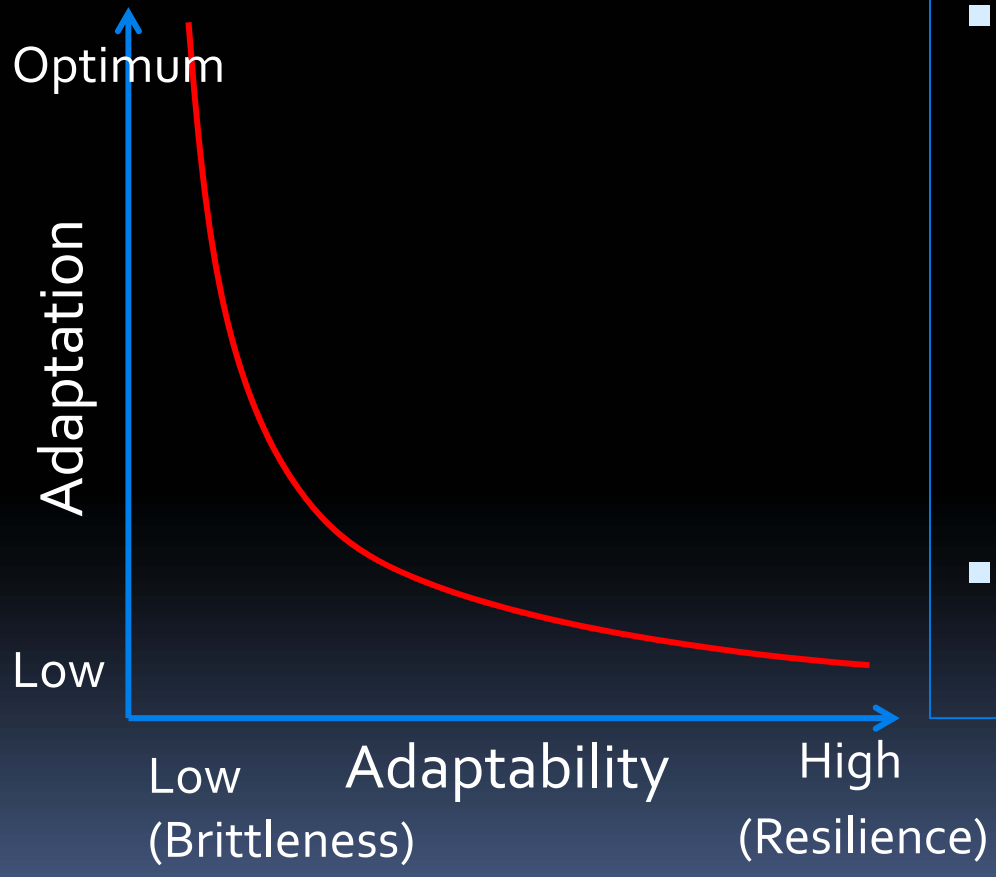
The optimality/brittleness trade-off



- The more we optimize a system for a specific context, the more brittle the system will be outside this context
- Faster, better, cheaper: brittle

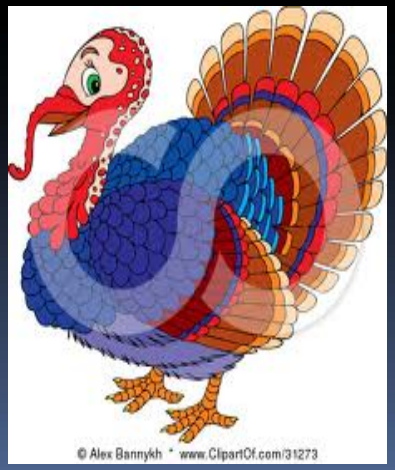
Conclusion

"Things that have never happened before happen all the time" Scott D. Sagan (*The Limits of Safety*)

- A wrong lesson from Fukushima would be: "all this could have been anticipated if only…".
- It may be time to abandon the "predetermination fallacy" (H. Mintzberg)
  - Time to recognize complexity,
  - Time to cope with the unimaginable, rather than trying to imagine it,
  - Time to work on getting prepared… to be unprepared
- This may well be a "paradigm shift"!

Thanks for your attention!

http://www.rea-symposium.org/



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