TNO innovation for life

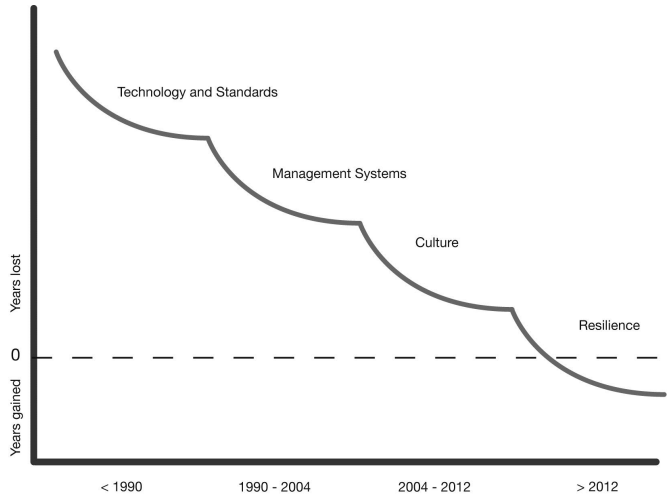
The resilience analysis grid

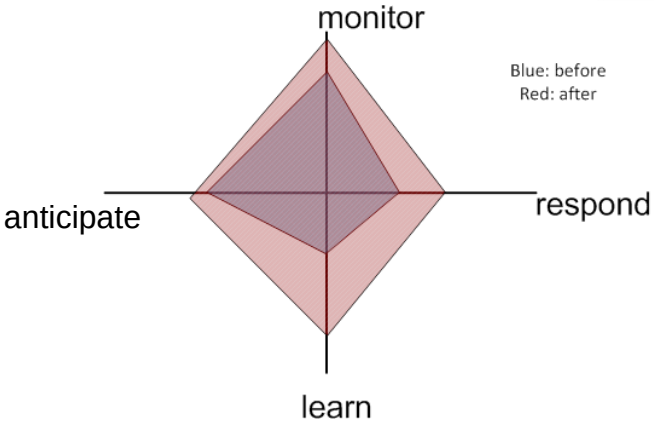
taming complexity?

Raphaël Gallis

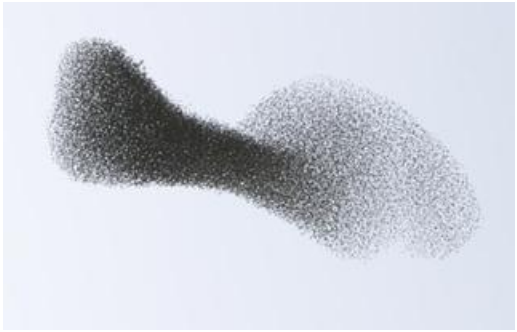
Contents

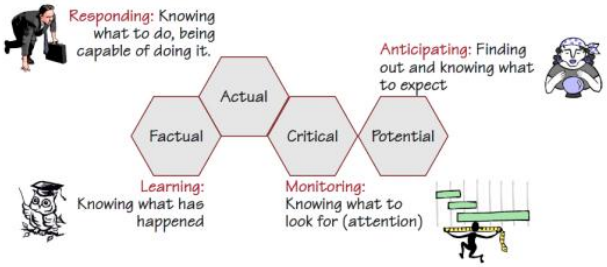
- Complexity
- Safety development
- FRAM
- Resilience
- The Grid
- Discussion



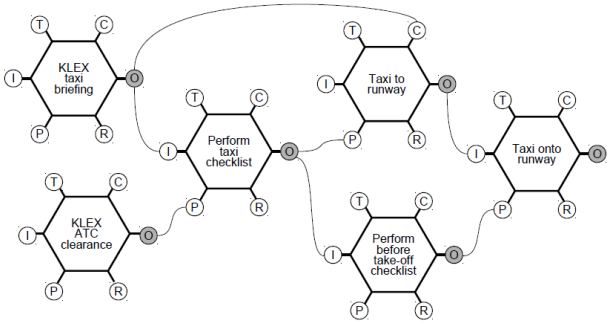


Blue: before
Red: after

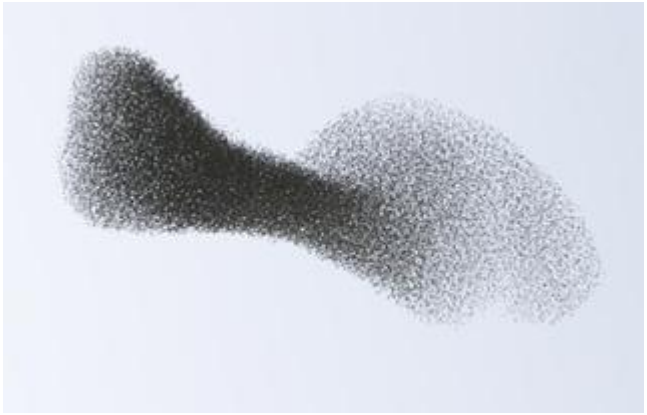




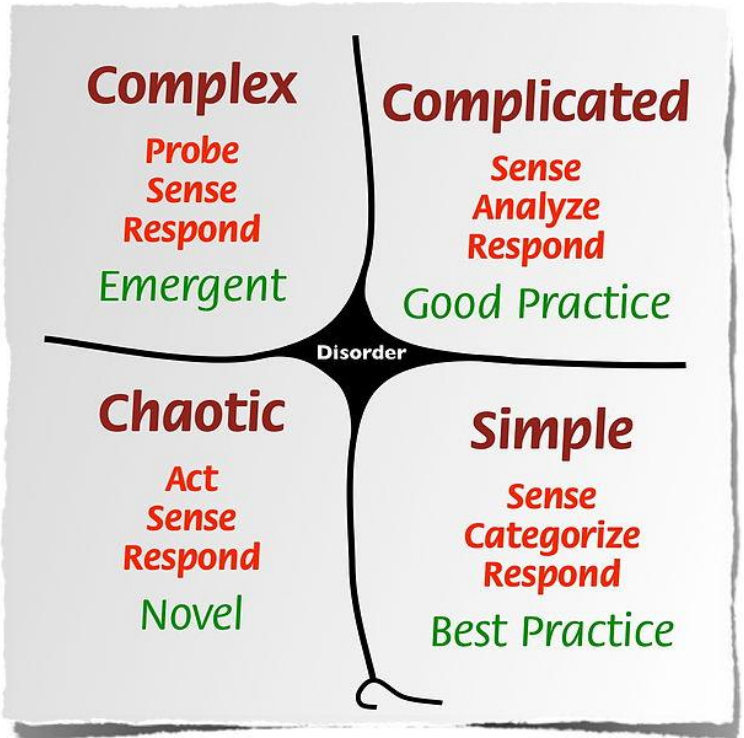
Resilience engineering measures how safe a system is by what it is able to do, hence measures of the positive rather than the negative.



Complexity



- complicated ≠ complex
- The end of Newtonian models
- There is no helicopter! -> Local rules
- Hind sight bias, no timeline
- Emergent properties
- Breaking up in parts does not work
- Systems are not ‘bi-modal’



Dave Snowden: Cynefin

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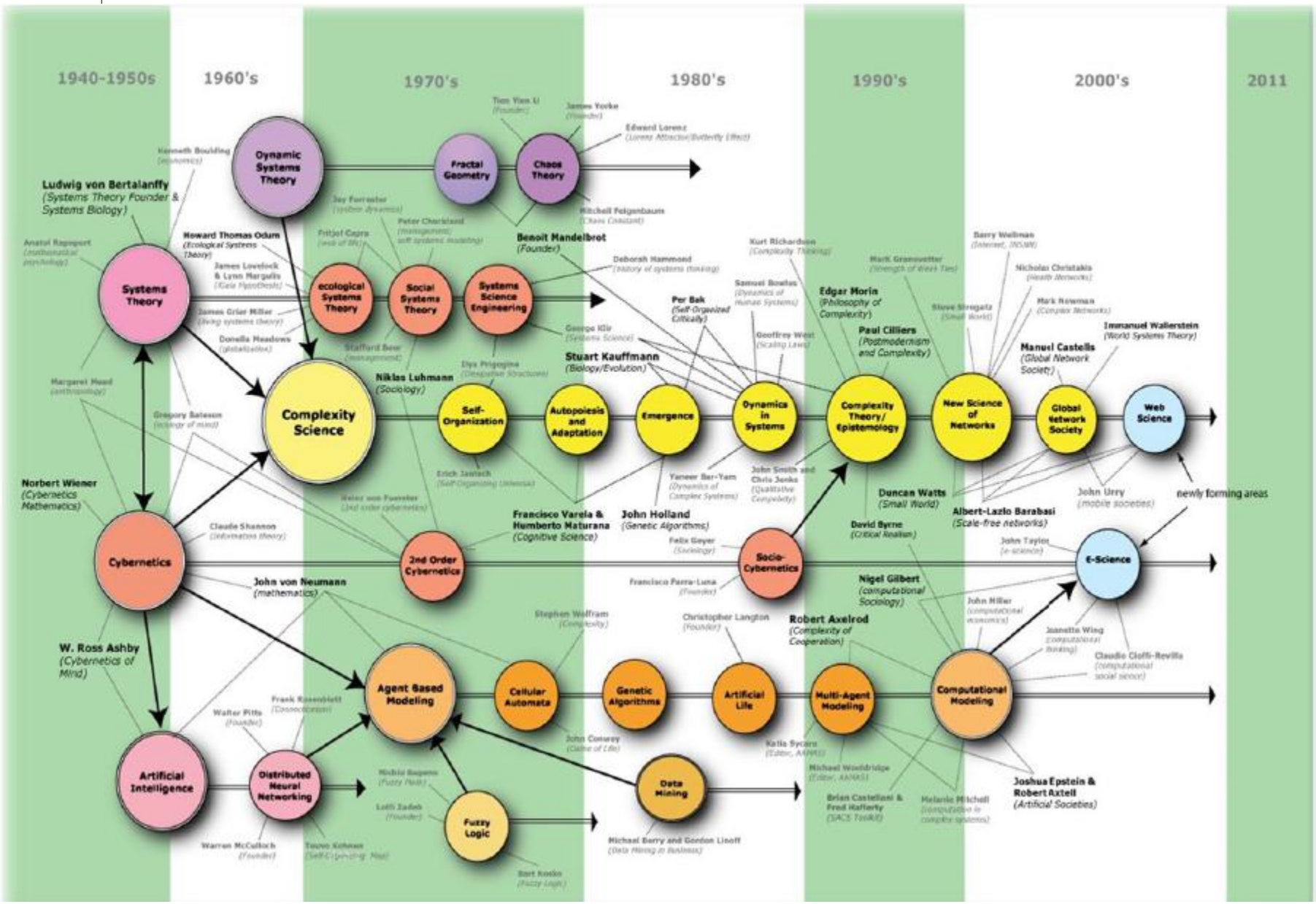
Classical and complex

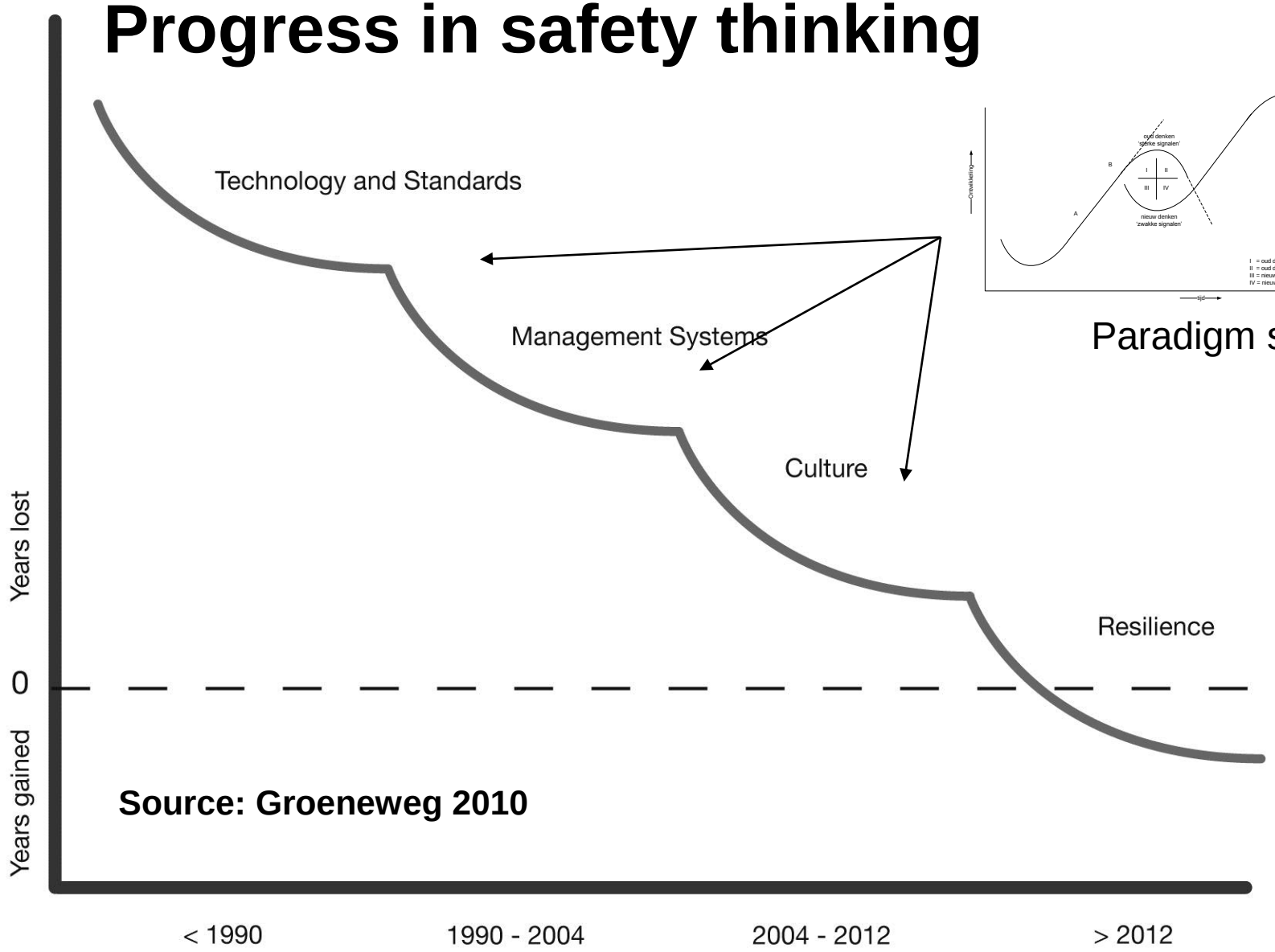
Classical	Complex
Determinism	Probabilistic
Reductionism	Holism
Linearity	Non-linearity
Predictability	Unpredictability
Objectivity	Relativism
Equilibrium	Far from the equilibrium
Reversibility	Irreversibility

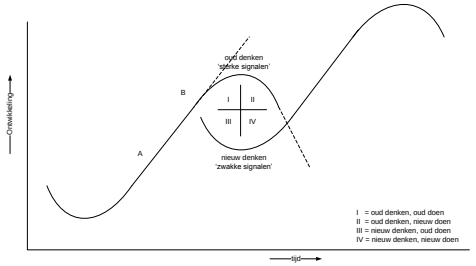
Properties of Complex Adaptive Systems (CAS)

- Agents
- Feedback
- Adaptation
- Openness
- Emergence
- Self organization
- Order and disorder


1940-1950s
1960's
1970's
1980's
1990's
2000's
2011
Dynamic Systems Theory
Fractal Geometry
Chaos Theory
Ludwig von Bertalanffy
(Systems Theory Founder & Systems Biology)
Howard Thomas Odum
(Ecological Systems Theory)
Systems Theory
ecological Systems Theory
Social Systems Theory
Systems Science Engineering
Benoit Mandelbrot
(Founder)
Per Bak
(Self-Organized Criticality)
Edgar Morin
(Philosophy of Complexity)
Paul Cilliers
(Postmodernism and Complexity)
Manuel Castells
(Global Network Society)
Immanuel Wallerstein
(World Systems Theory)
Complexity Science
Niklas Luhmann
(Sociology)
Stuart Kauffmann
(Biology/Evolution)
Self-Organization
Autopoiesis and Adaptation
Emergence
Dynamics in Systems
Complexity Theory/ Epistemology
New Science of Networks
Global Network Society
Web Science
Norbert Wiener
(Cybernetics Mathematics)
Cybernetics
2nd Order Cybernetics
Socio-Cybernetics
E-Science
Francisco Varela & Humberto Maturana
(Cognitive Science)
John Holland
(Genetic Algorithms)
Duncan Watts
(Small World)
Albert-Lazlo Barabasi
(Scale-free networks)
newly forming areas
John von Neumann
(mathematics)
Nigel Gilbert
(computational Sociology)
Robert Axelrod
(Complexity of Cooperation)
W. Ross Ashby
(Cybernetics of Mind)
Agent Based Modeling
Cellular Automata
Genetic Algorithms
Artificial Life
Multi-Agent Modeling
Computational Modeling
Artificial Intelligence
Distributed Neural Networking
Fuzzy Logic
Data Mining
Joshua Epstein & Robert Axtell
(Artificial Societies)

Progress in safety thinking





Paradigm shifts

Source: Groeneweg 2010

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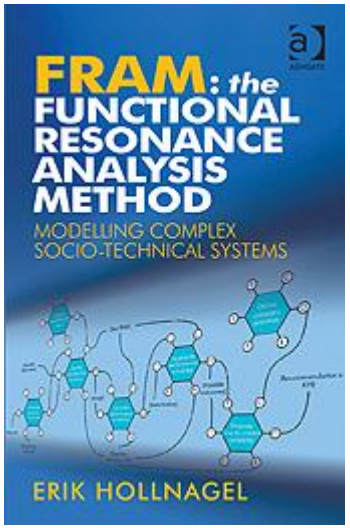
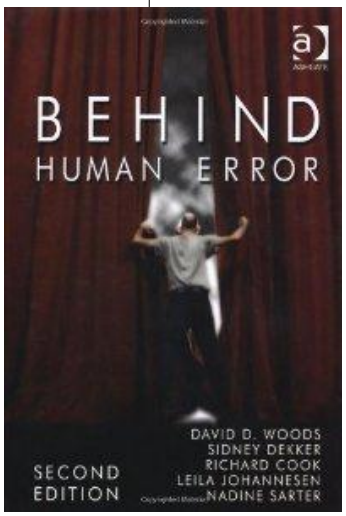
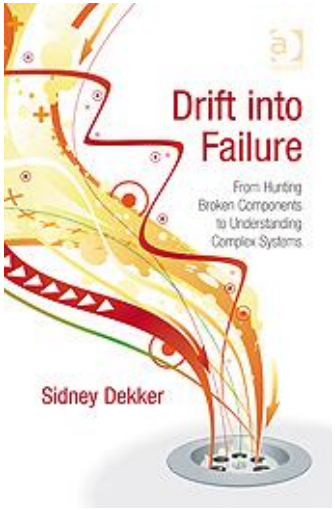
Complexity in safety science

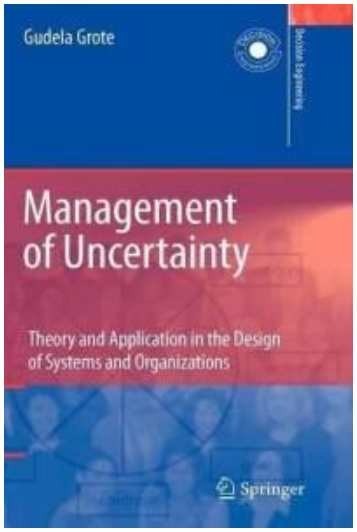
Gudela Grote:

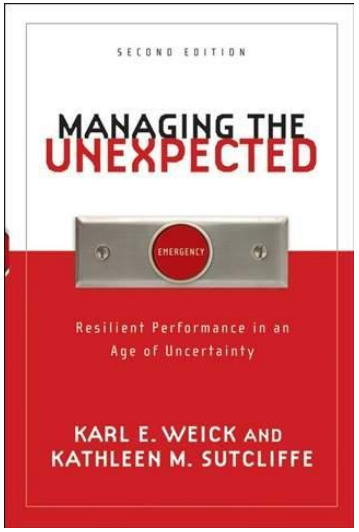
- Zero risk in complex systems is not possible
- Apply flexible rules
- Apply local controls
- Relationship between rules and routines











Eric Hollnagels' view

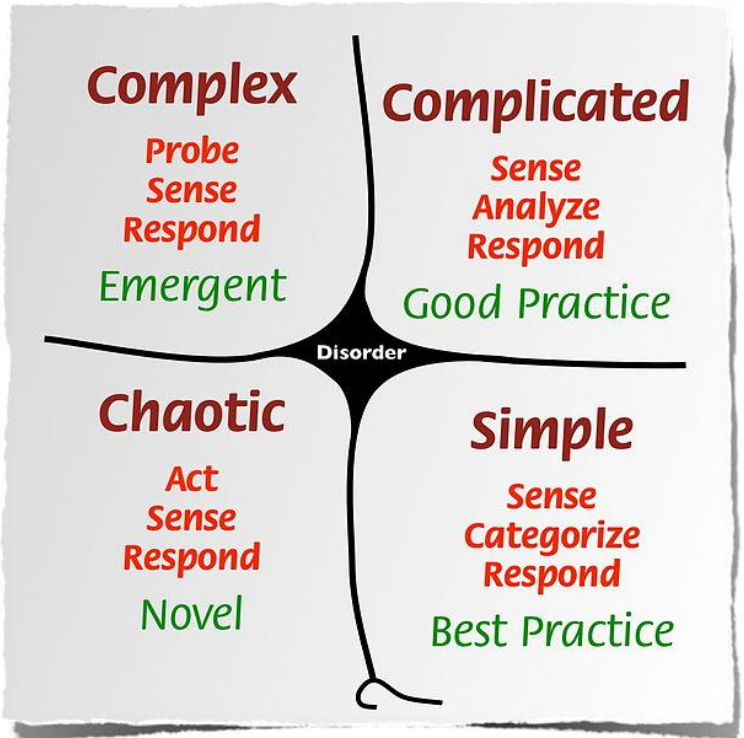
- Safety is based mainly on a technical tradition and reasons in terms of cause – effect relationships where causes are rooted in unreliable system elements: man or technique. *This approach is not enough to understand and prevent future accidents.*

- Variation is inevitable and needed! Safety is more and more about managing performance. It has to take changes and variability in primary processes into account. *A resilient system is able to adjust its functioning prior to- or after a disturbance or change in such a way that it keeps working.*

- Preconditions for safe performance are always underspecified. Functional variation is both needed as inevitable. *It is a source for success as well as for failure.*

Taming complexity

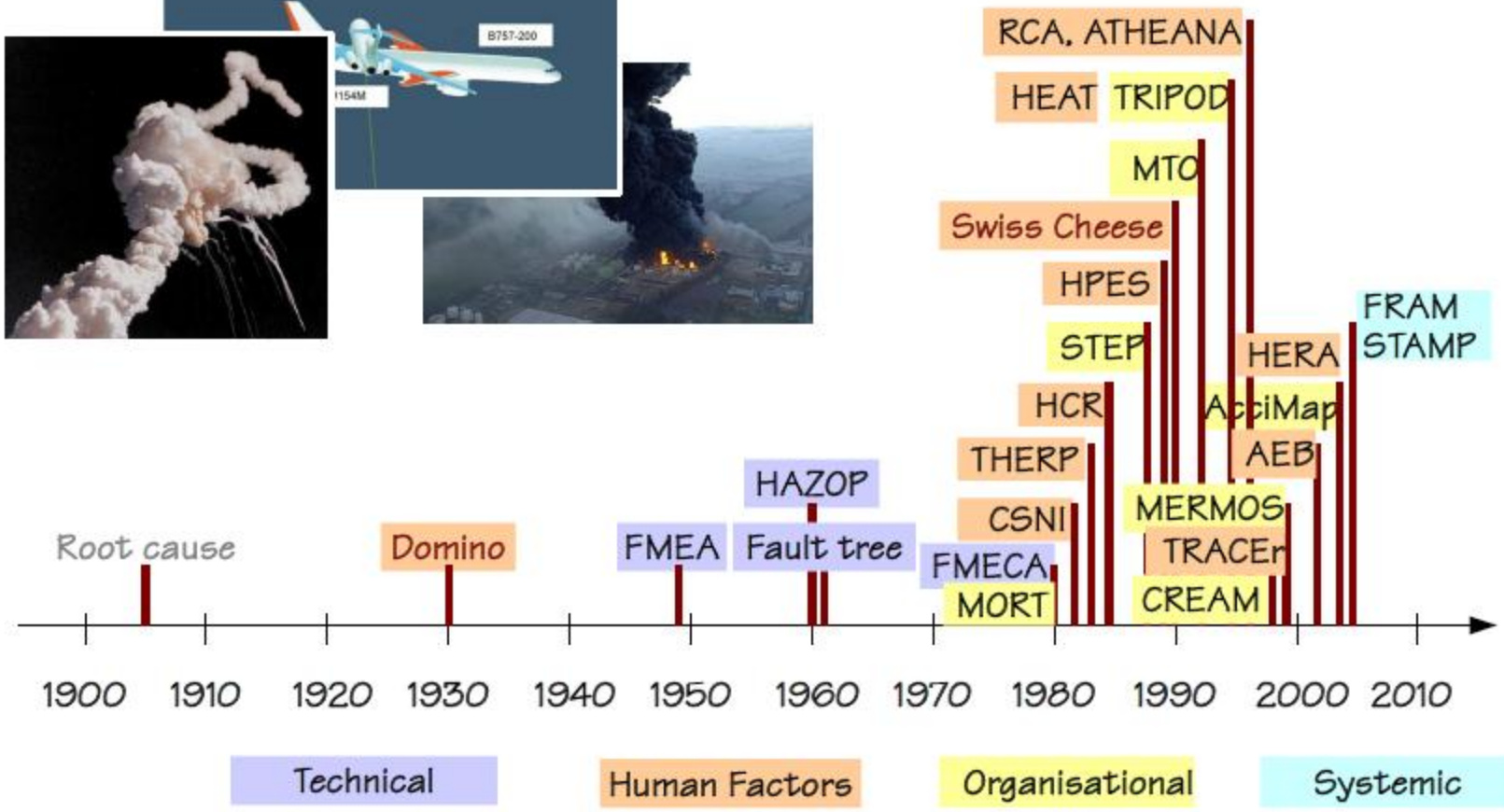
- ETTO (efficiency - thoroughness trade offs)
- Accountability (Pronovost)
- HRO:
  - Preoccupation with failure
  - Reluctance to simplify interpretations
  - Sensitivity to operations
  - Commitment to resilience
  - Deference to expertise
- Local actions & control
- Mindfulness



Classic models have deficiencies:

- Attempt to rationalize
- Attempt to linearize
- Attempt to determine cause - effect
- Hind sight bias
  - If only he had….
  - If only that had…

B757-200
I154M


RCA, ATHEANA
HEAT
TRIPOD
MTO
Swiss Cheese
HPES
STEP
HERA
FRAM
STAMP
HCR
AcciMap
THERP
AEB
HAZOP
CSNI
MERMOS
Root cause
Domino
FMEA
Fault tree
FMECA
TRACEr
MORT
CREAM
1900
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
Technical
Human Factors
Organisational
Systemic

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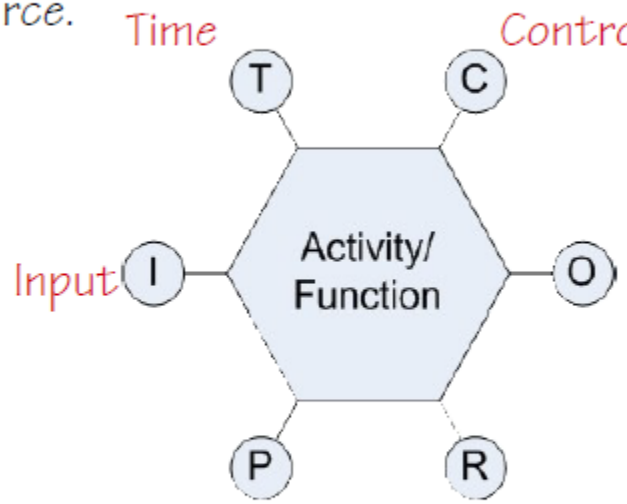
FRAM, the next step after Tripod Beta?

Time available: This can be a constraint but can also be considered as a special kind of resource.

That which supervises or adjusts a function. Can be plans, procedures, guidelines or other functions.

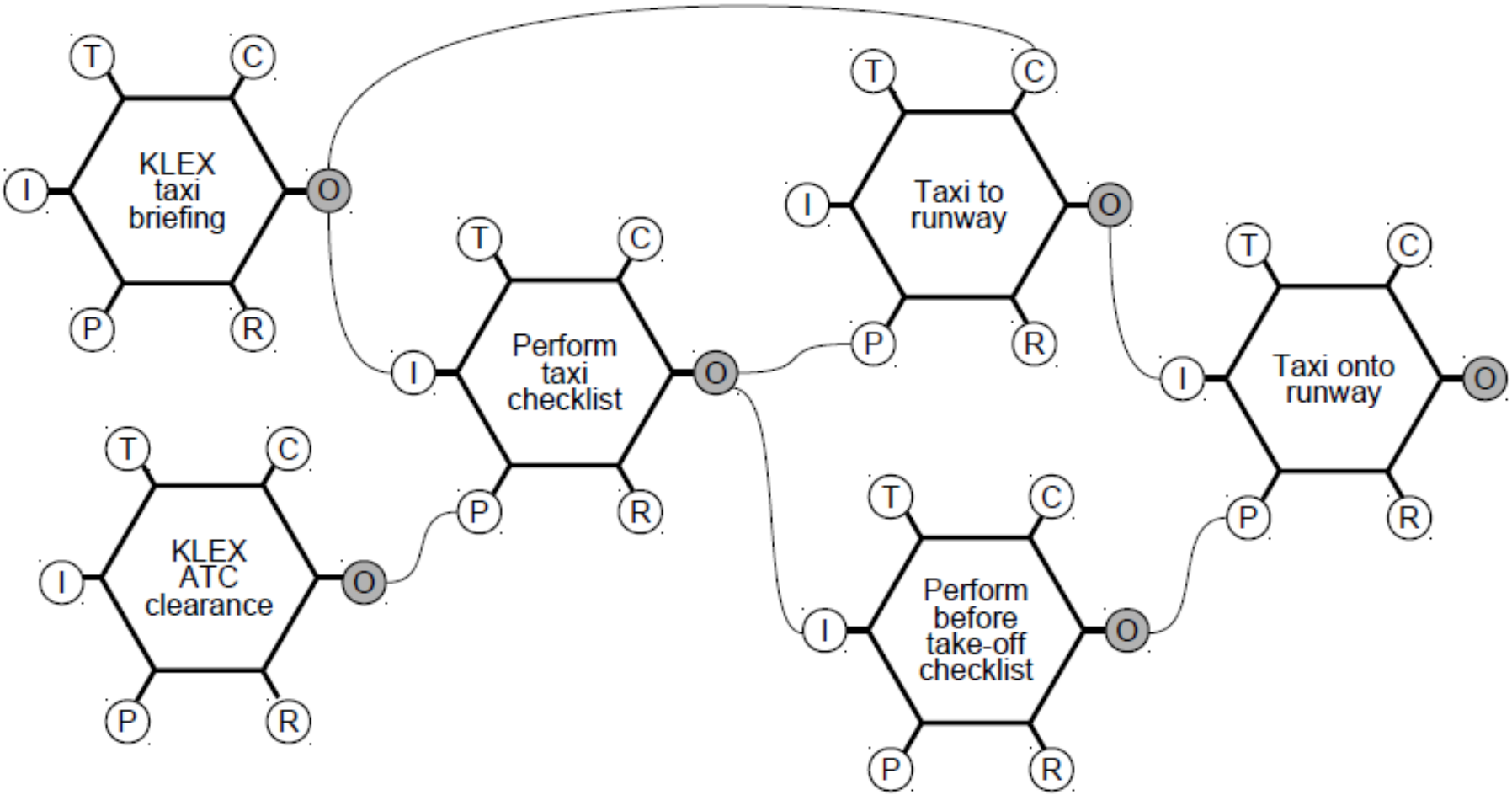


That which is used or transformed to produce the output. Constitutes the link to previous functions.

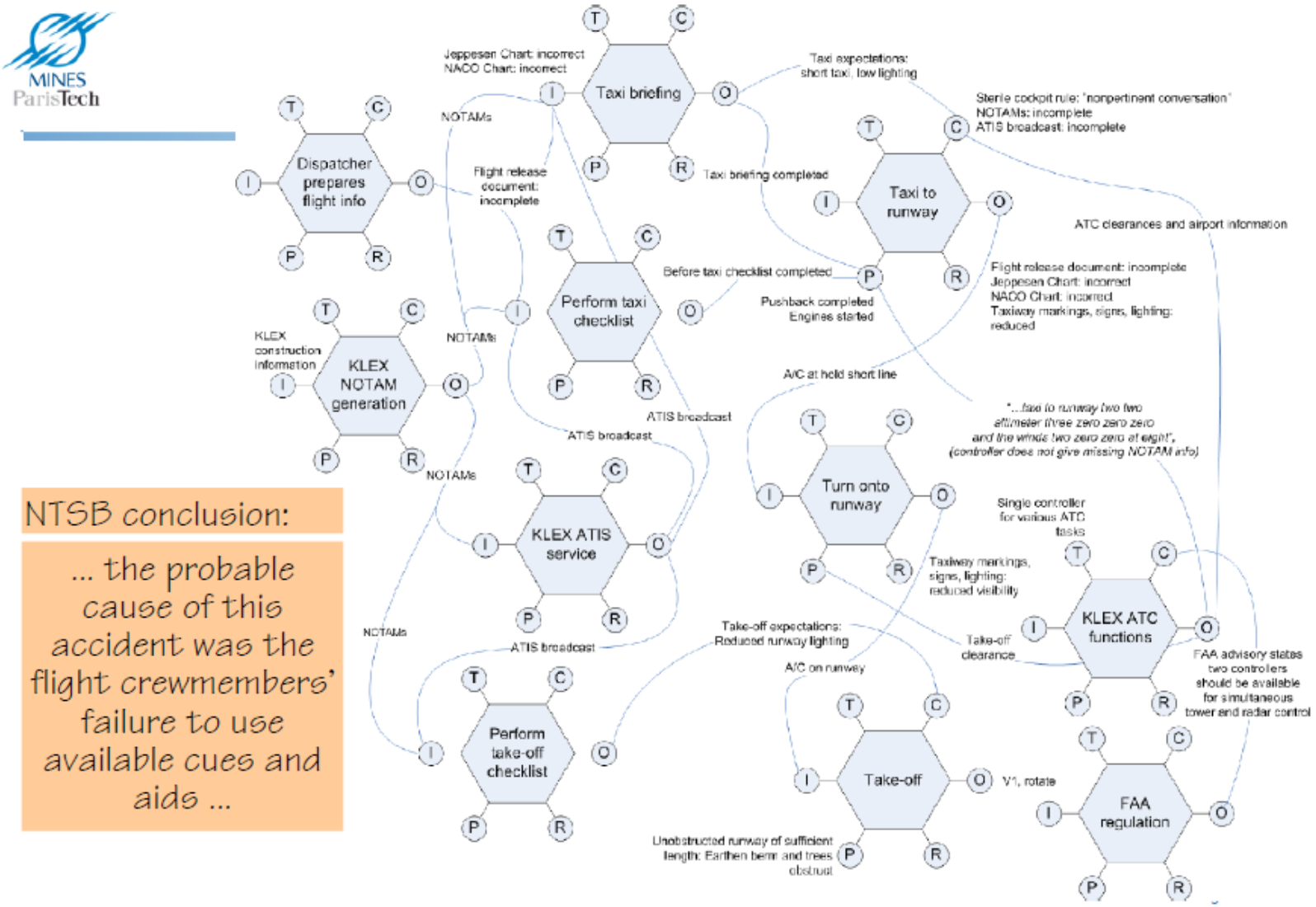
That which is produced by function. Constitute links to subsequent functions.

System conditions that must be fulfilled before a function can be carried out.

That which is needed or consumed by function to process input (e.g., matter, energy, hardware, software, manpower).


KLEX taxi briefing
Perform taxi checklist
Taxi to runway
Taxi onto runway
KLEX ATC clearance
Perform before take-off checklist
T
C
I
O
P
R

FRAM 3



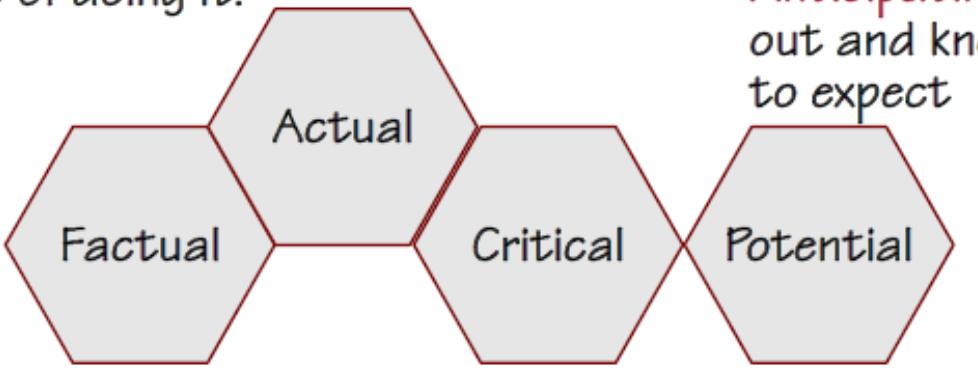
NTSB conclusion:

... the probable cause of this accident was the flight crewmembers' failure to use available cues and aids ...

Resilience

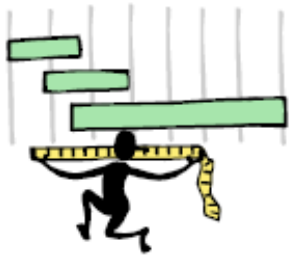
Responding: Knowing what to do, being capable of doing it.

Anticipating: Finding out and knowing what to expect



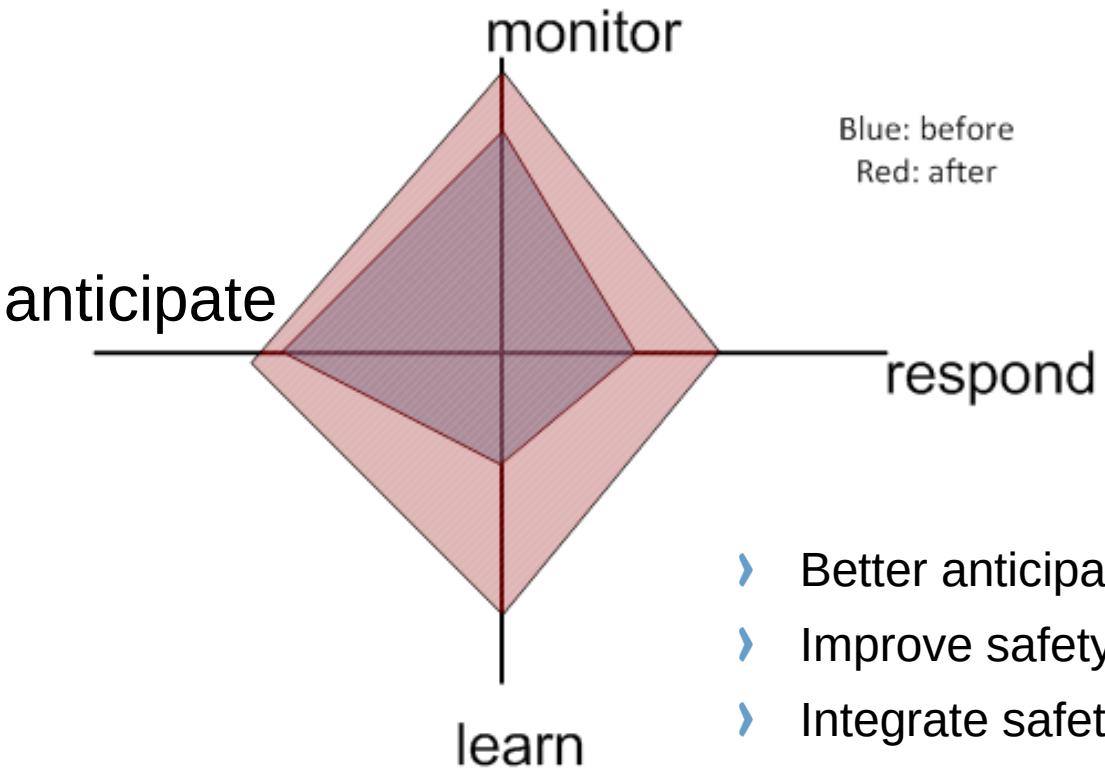
Learning: Knowing what has happened

Monitoring: Knowing what to look for (attention)



Resilience engineering measures how safe a system is by what it is able to do, hence measures of the positive rather than the negative.

The resilience analysis grid: from concept to instrument



Blue: before
Red: after

3 levels:
- Organization
- Teams
- Individual

- Better anticipate (unforeseen) risks than today
- Improve safety by revealing early-warning signals
- Integrate safety management & core business

See also: http://resilience-innovationlab.org

This research project aims at filling in the yellow columns for all 4 capabilities and test the instrument.

We translate the scientifically documented capabilities into audit questions that companies can answer

ANTICIPATE				
theme/attribute/indicator/quality	**question**	explanation	reference	Comments
looks far ahead		future events, conditions		
scope internal and external to system				
keeps eye on irregular threats			Dekker (2008) pg 57	
intuition			Nemeth (2008)	
vigilance			Westrum (2008)	
culture to explore			Nemeth (2008)	
seeking out			Nemeth (2008)	
sensititvity			Westrum (2008)	
foresight				
imagination/open mind			Dekker (2008) pg 56/58	
.....			.....	

Discussion

How do we see:

- Complexity in safety?
- FRAM
- The Grid
- ***Contributing in research to develop the grid into an instrument?***
  Please concact me!

Thank you for your kind attention

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Safe & Healthy Business

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