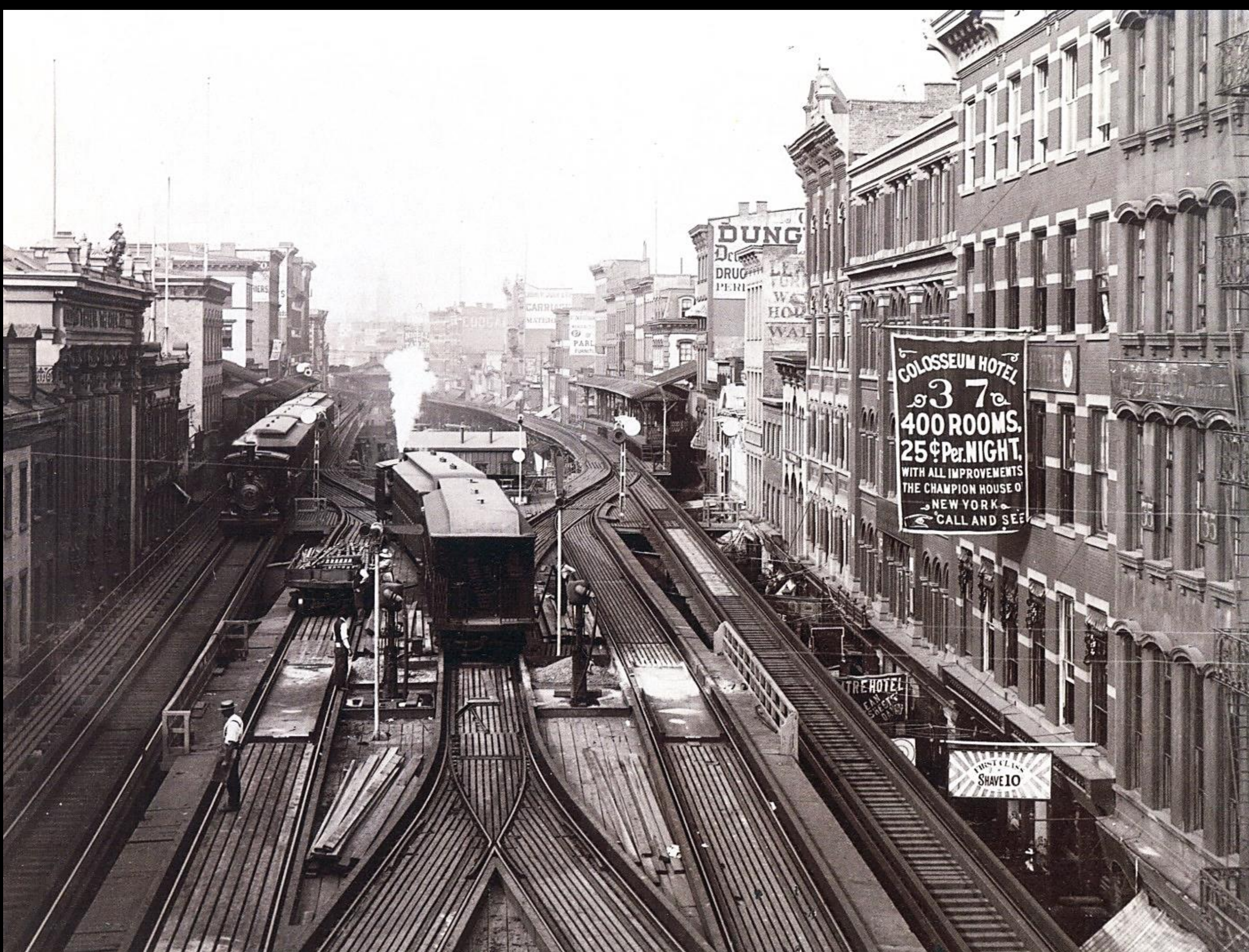
novelty of BDRA?

historic context of safety

big data and safety science

Paul Swuste
Safety Science Group
Delft University of Technology

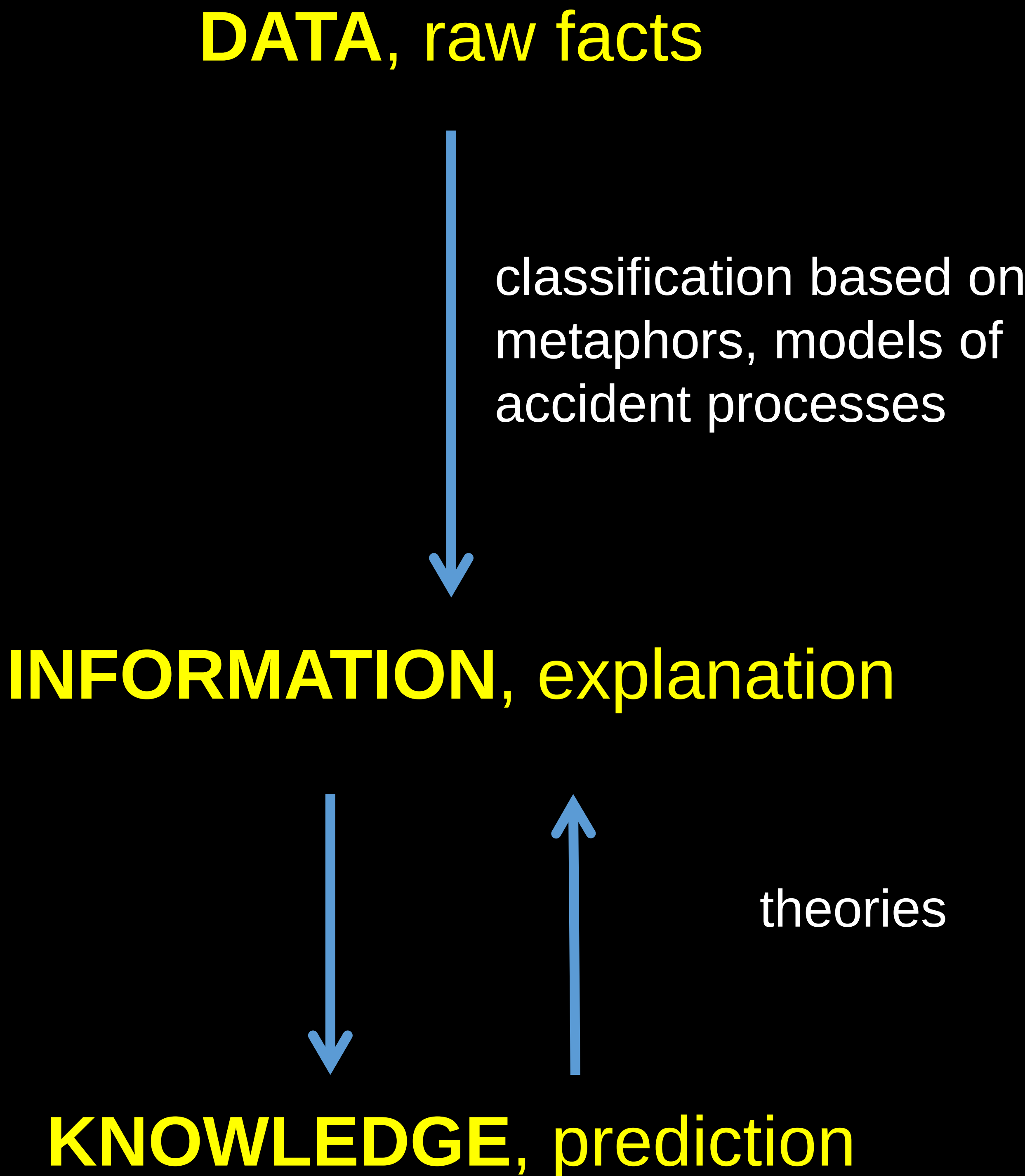
Johnston 1889
chatman street New York city



beliefs and yet unproven relations in safety science

safety first movement-1906	behaviour?
Chernobyl-1986	safety culture?
Robens-1972, Piper α-1988	safety management?
US-1987	high reliability?
BP Texas-2005	safety indicators?

missing links with (major) accident/disaster scenarios


DATA, raw facts
classification based on metaphors, models of accident processes
INFORMATION, explanation
theories
KNOWLEDGE, prediction

timeline – 19th century

1844 safety technique, UK

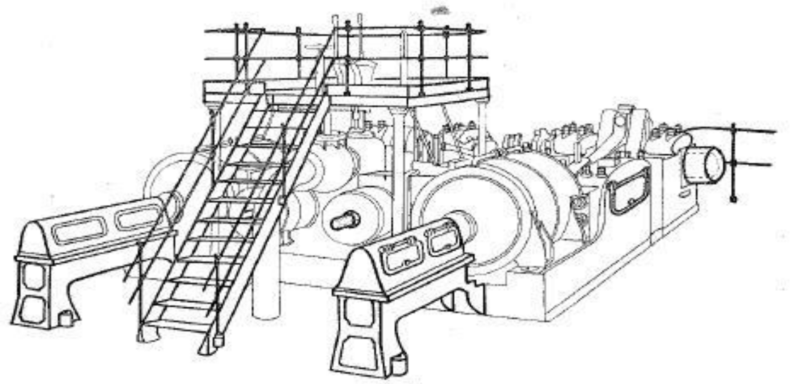


FIG. 7.

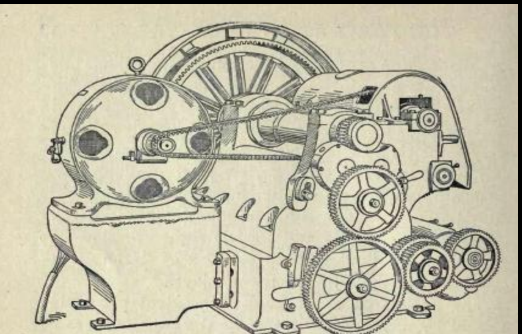


ILLUSTRATION I
Lathe Gears Unguarded.

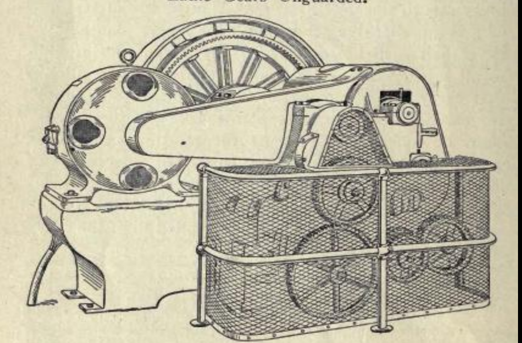


ILLUSTRATION II
Lathe Gears Guarded.

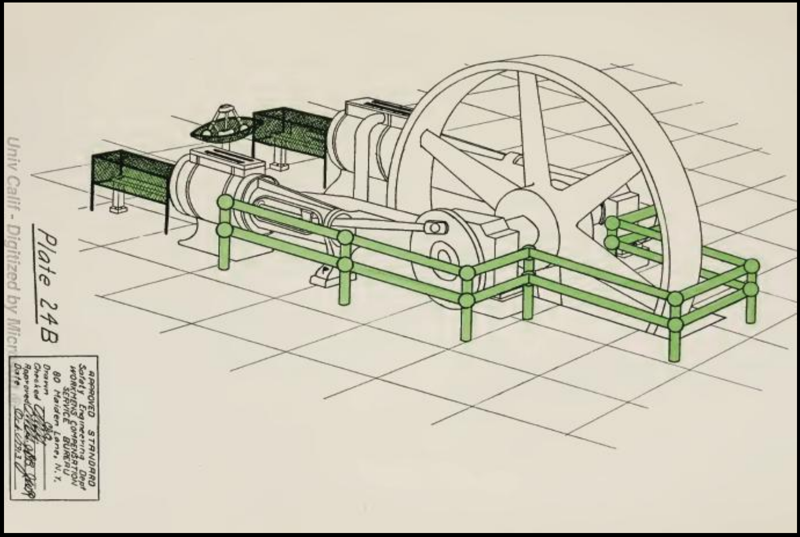


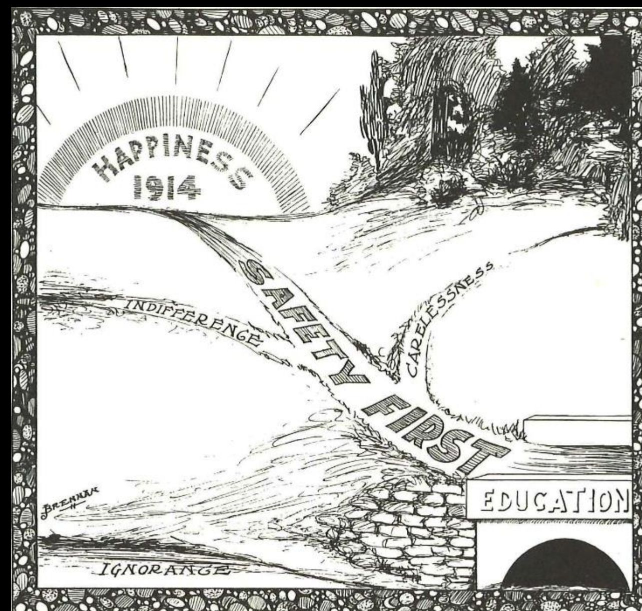
Fig. 3. Valve-Locking Device and Stencil for marking Main Steam Valve of Boiler.*

timeline – 1900s till 1920s

1906 safety first movement, US

1910 external causes, US

1919 accident proneness, UK



THE ROAD TO HAPPINESS

Across the stream of ignorance, over the bridge of education, avoiding the path of carelessness and the byway of indifference, leads The Road to Happiness.

If you know this road, and have been traveling it, appoint yourself a guide — to show your less fortunate brother The Road to Happiness this coming year.

1926 hazard Ξ energy, US

1927 costs 1:4, US

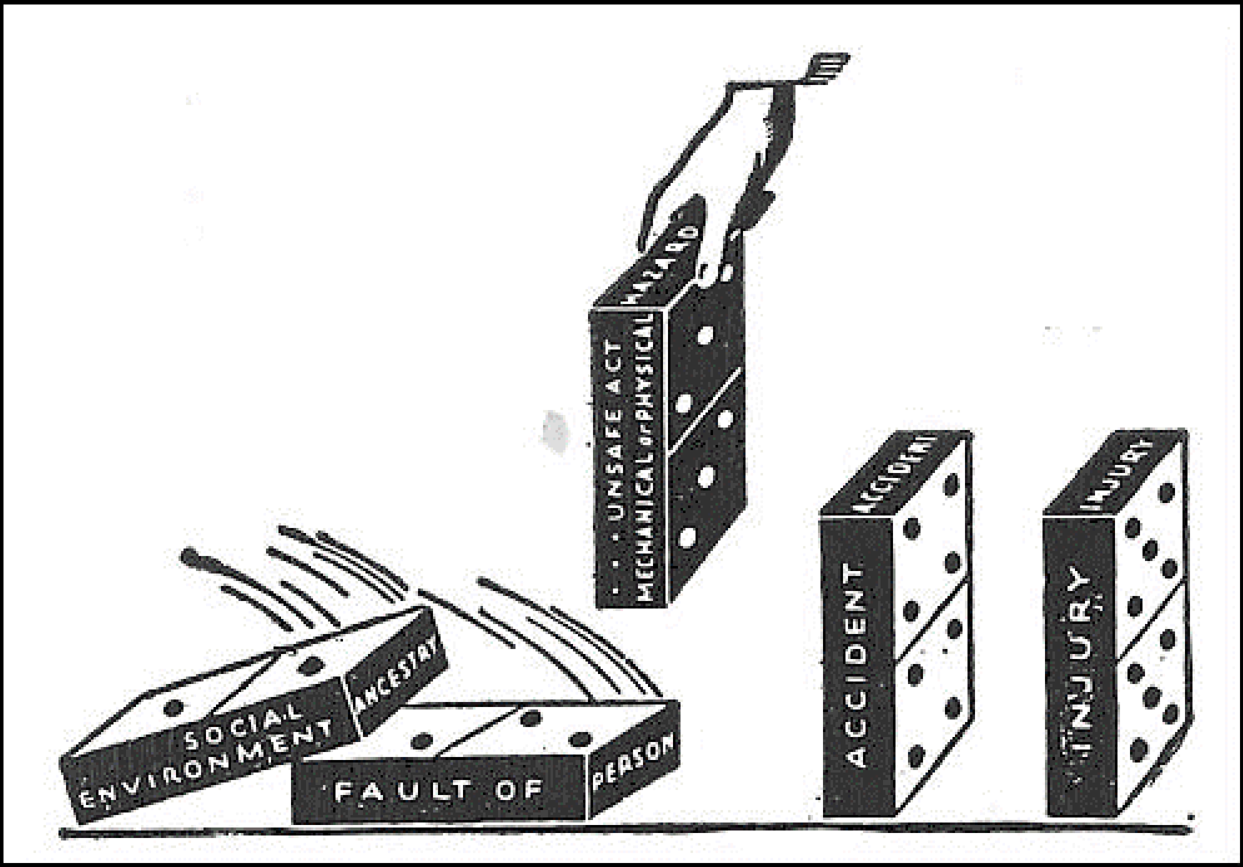
1928 causes 88:10:2, US

1929 mechanism 1:29:300, US

timeline – 1930s till World War II

1935 external factors, UK

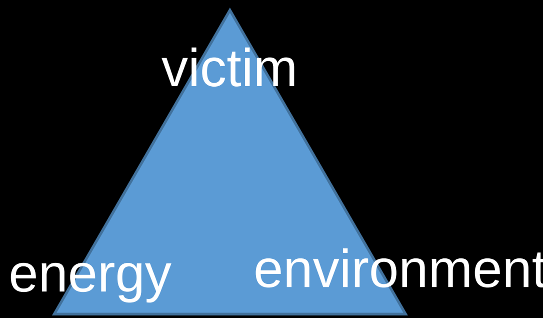
1941 domino's, US (big data)



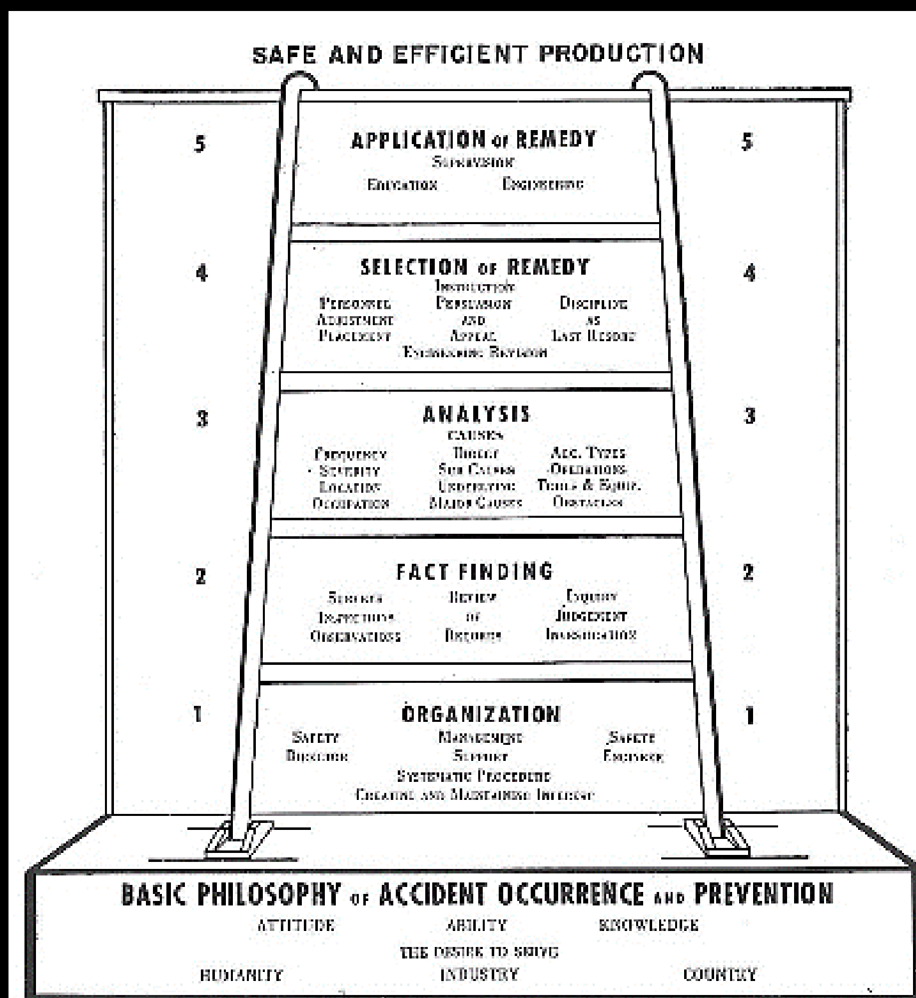
operational research, UK

timeline – after World War II till 1950s

1949 epi triangle, US



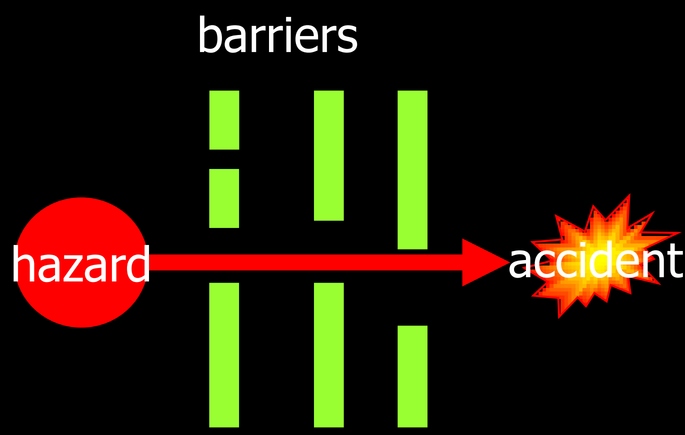
1950 management, US



1951 task dynamics, Nl (big data)

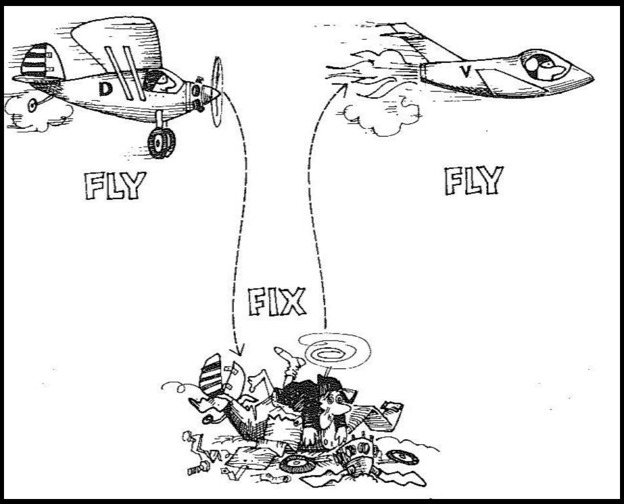
timeline 1960s

1961 barriers, US

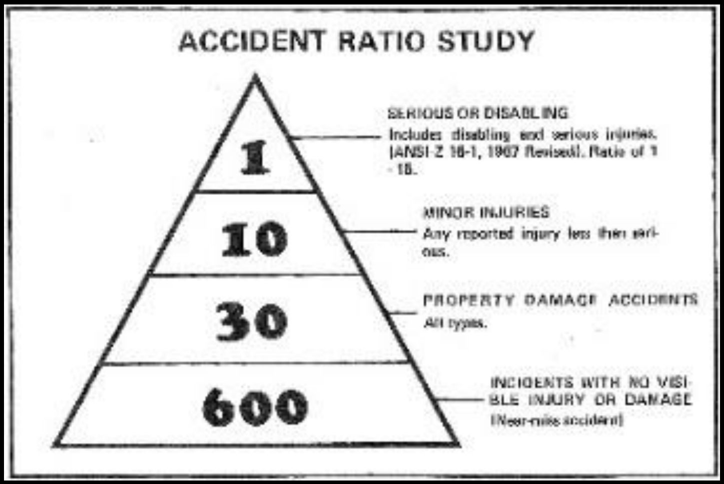


1960-3 hazop, fault tree, FMEA

1964 loss prevention, UK



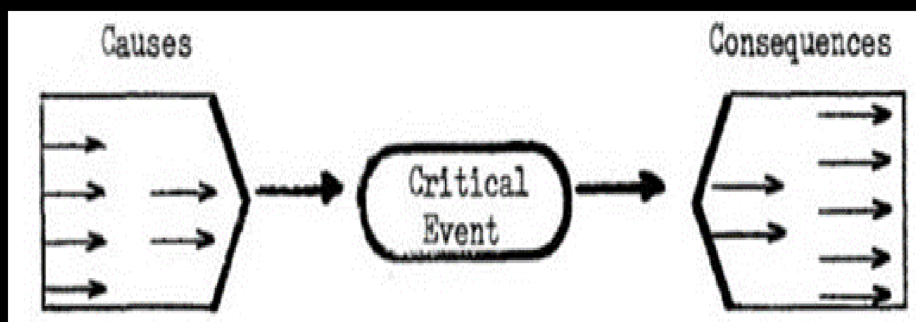
1966 iceberg, damage, US



1967 man-machine system, UK

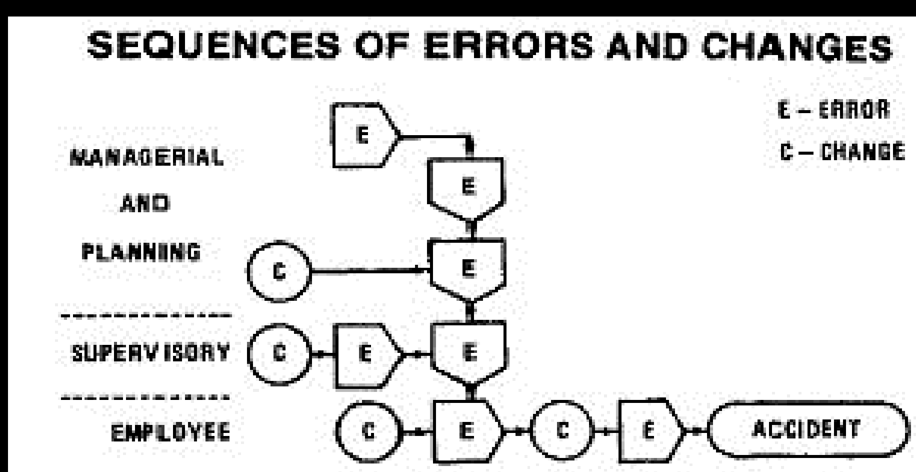
timeline 1970s

1971 organisational culture, UK
safety audits, US
disturbed information, UK
pre-bowtie, Den



1973 MORT, US

Flixborough
Beek
Seveso



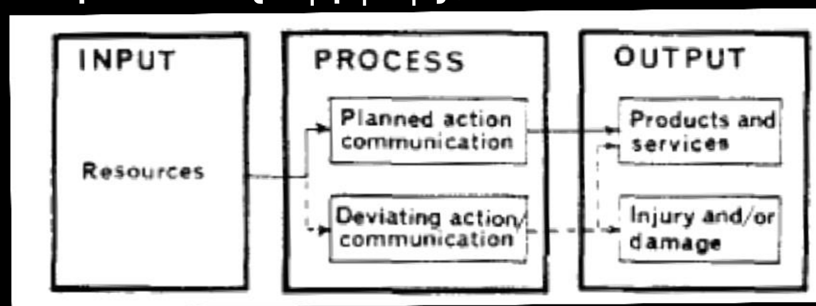
1978 weak signals, incubation, UK (big data)

3 Mile Island

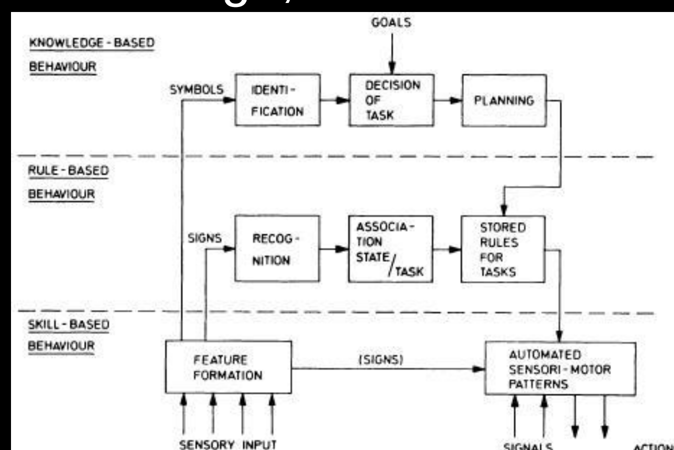
timeline 1980s

1980 safety climate, Israel

1981 process disturbances, Sw
risk triplet $R=\{\langle s_i,p_i,x_i\rangle\}$, US

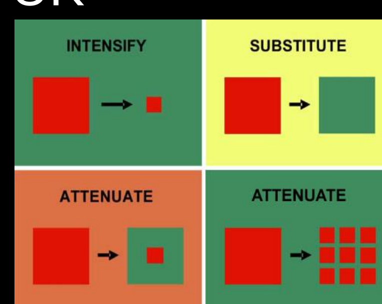


1982 skill-rule- knowledge, Den



Bhopal
Mexico city — 1984 normal accidents, US (big data)

1985 inherent safe design, UK



Chernobyl — 1986 safety culture, USSR

Zeebrugge — 1987 resident pathogens, UK

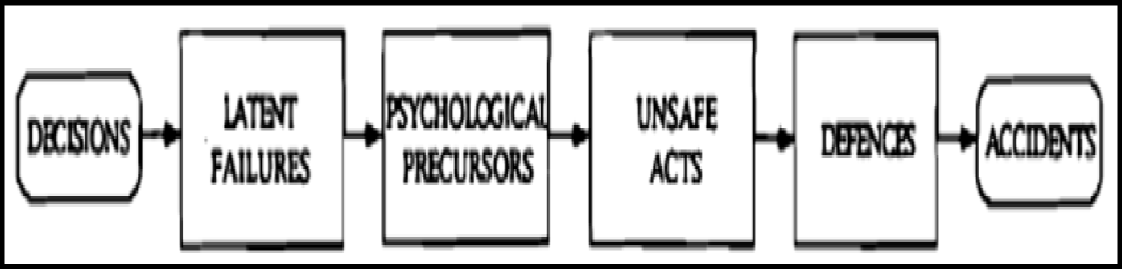
Piper Alpha — high reliability, US

Clapham J

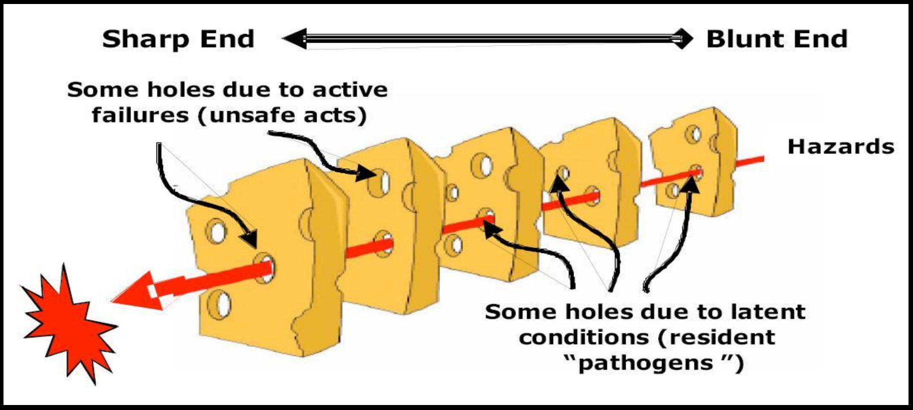
timeline 1990s

1992 latent failures, basic risk factors, Nl

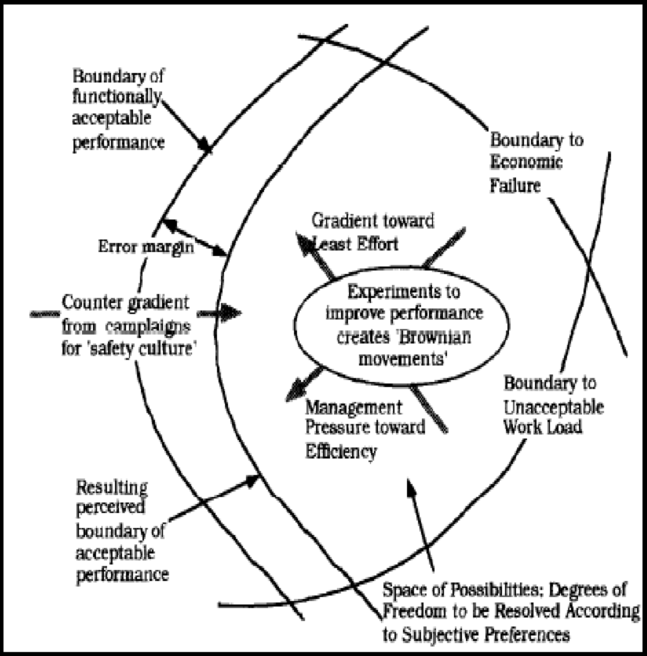
1994 impossible accidents, Nl



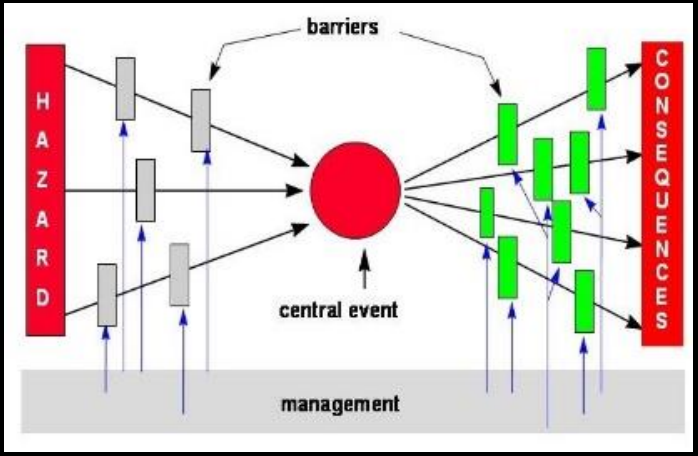
1997 Swiss cheese, UK



drift to danger, Den



1998 bowtie, Nl



Johnson 1970

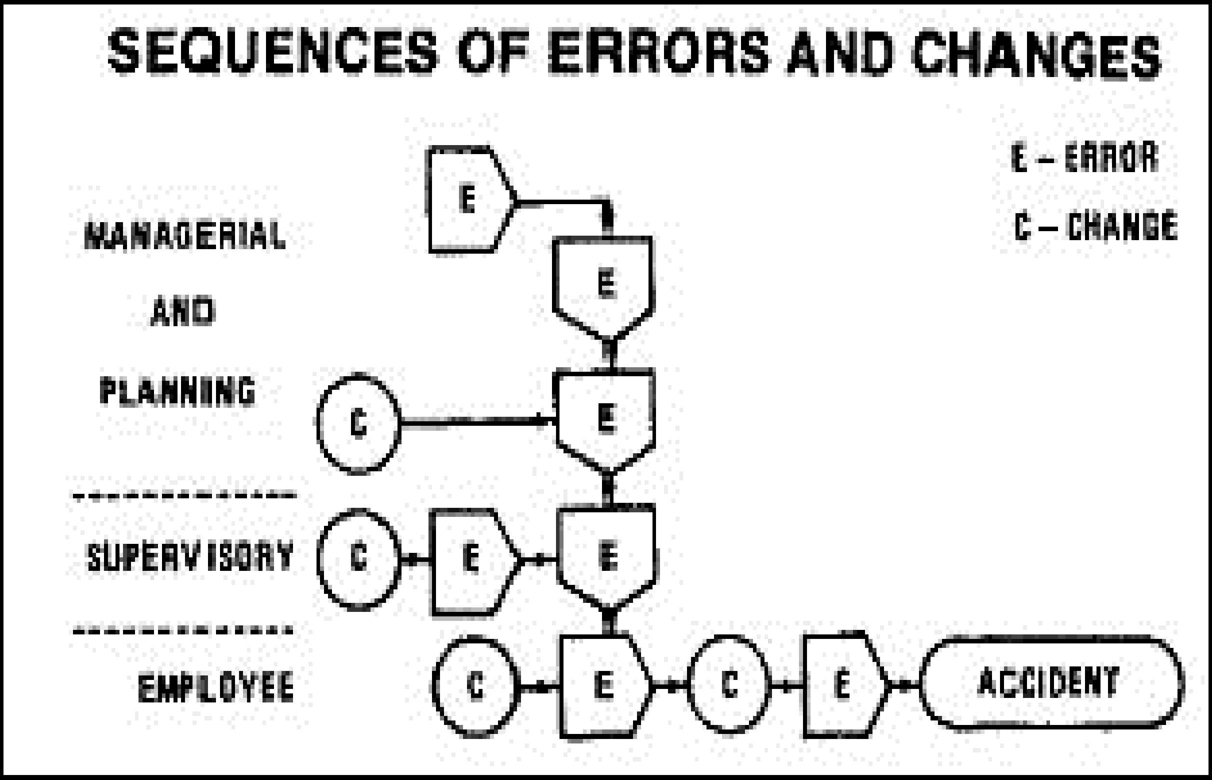
An accident is the result of a complex series of events, related to energy transfer, failing barriers, and control systems, causing faults, errors, unsafe acts, and unsafe conditions and changes in process and organisational conditions.

Johnson W (1970). New Approaches to safety in industry.
Industrial and Commercial Techniques LTD, London

management oversight risk tree

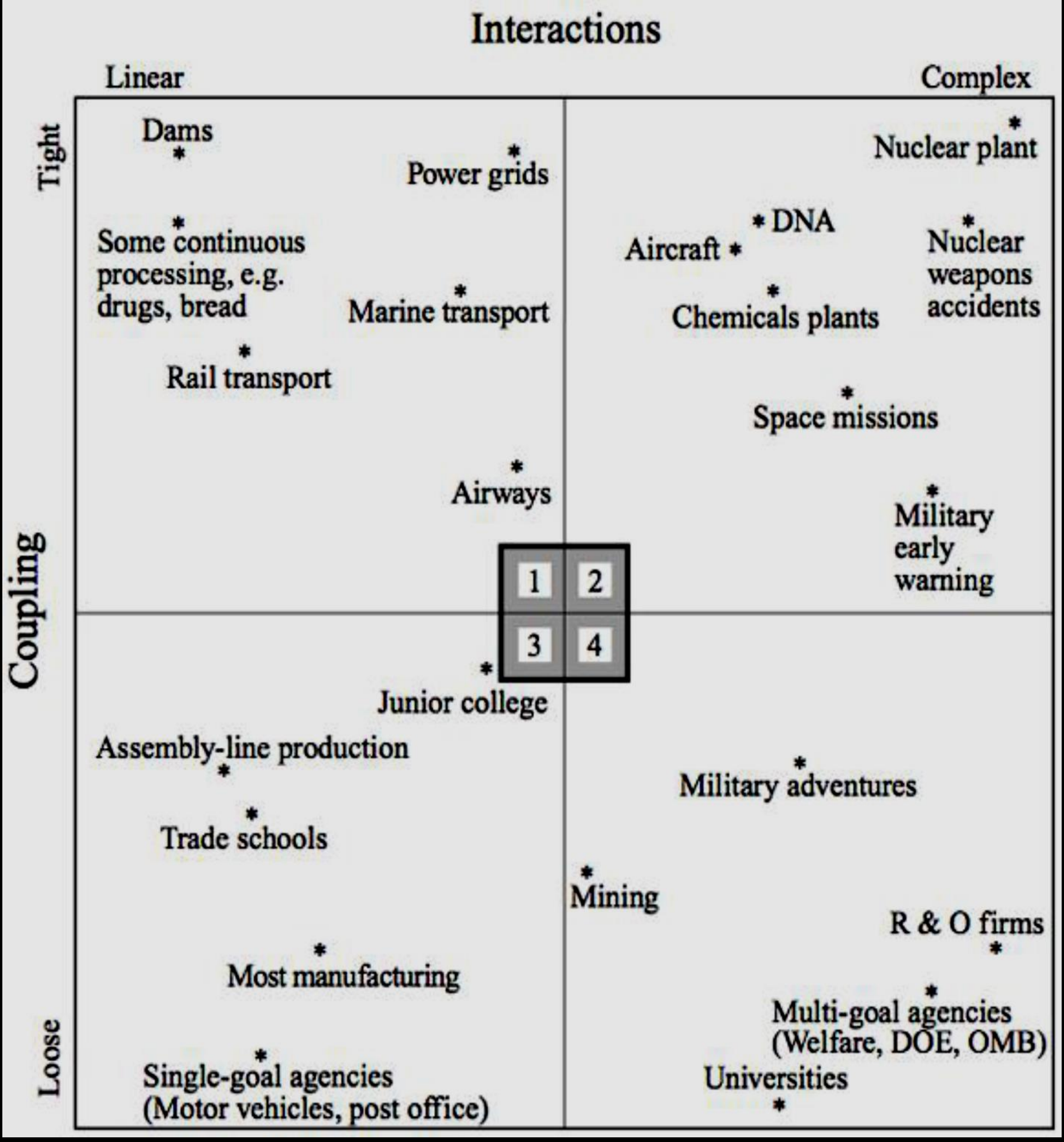
MORT

Johnson 1973



Johnson W (1973). Sequences in accident causation. Journal of Safety Research 5(2):54-57

normal accidents theory
Perrow 1984 (big data)



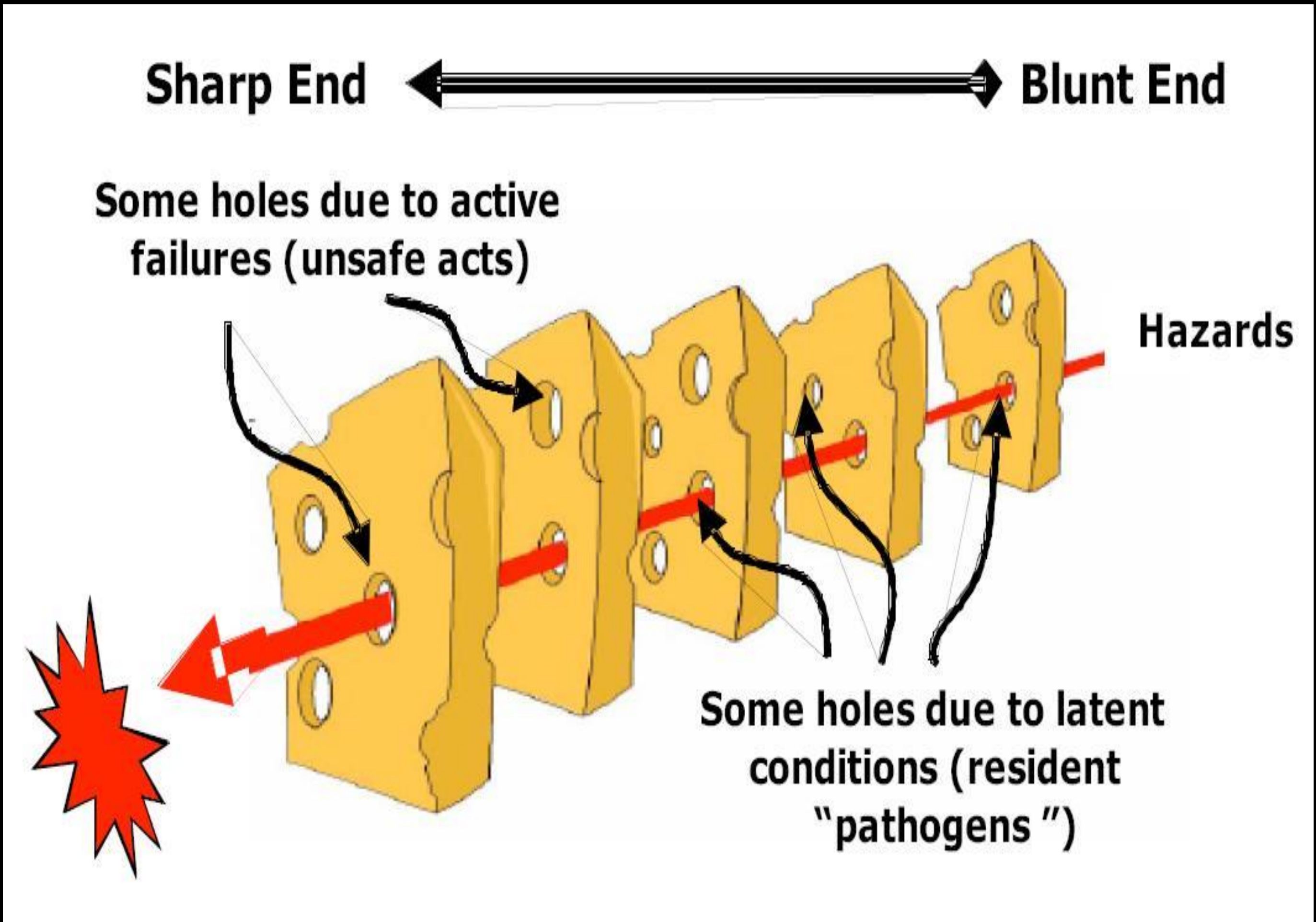
Perrow C (1984). Normal accidents, living with high-risk technologies. BasicBooks, US

high reliability

So you want to understand an aircraft carrier? Well, just imagine that it's a busy day, and you shrink San Francisco Airport to only one short runway and one ramp and gate. Make planes take off and land at the same time, at half the present time interval, rock the runway from side to side, and require that everyone who leaves in the morning returns that same day. Make sure the equipment is so close to the edge of the envelope that it's fragile. Then turn off the radar to avoid detection, impose strict controls on radios, fuel the aircraft in places with their engines running, put an enemy in the air, and scatter live bombs and rockets around. Now wet the whole thing down with salt water and oil, and man it with 20-year-olds, half of whom have never seen an airplane close-up. Oh, and by the way, try not to kill anyone. Senior officer, Air Division

Rochlin G La Porte T Roberts K (1987). The self-designing high reliability organisation: aircraft carrier flight operation at sea. Naval War College Review 40:76-90

cheese theory
Reason 1997



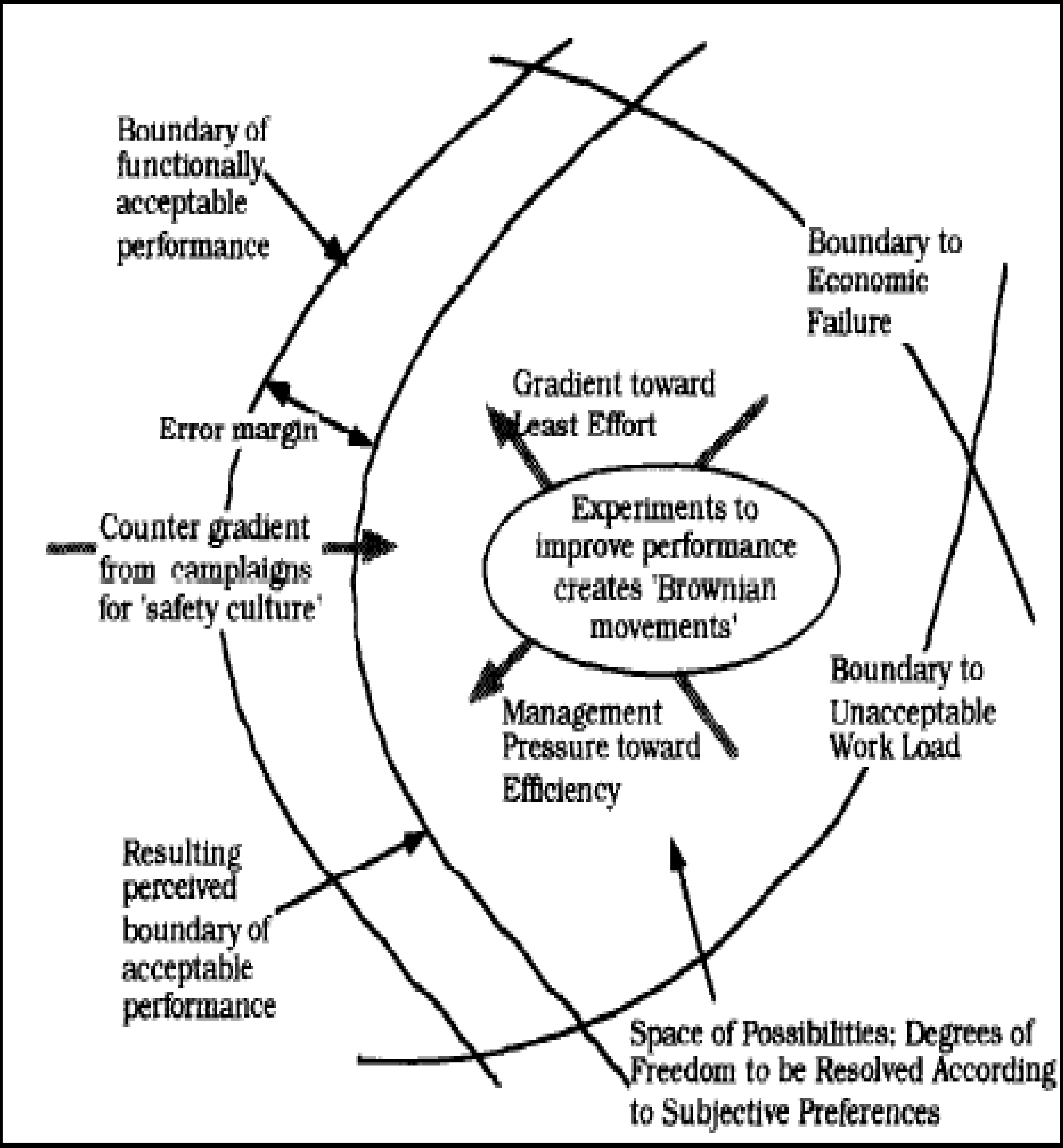
Reason J (1997). Managing the risk of organisational accidents. Ashgate, Aldershot Hampshire

latent failures Groeneweg 1992 (big data)

1. design, poor design installation, equipment, tools
2. hardware, deficiencies in quality of equipment, tools
3. error enforcing conditions
4. maintenance, inadequate management of
5. defences, absent, inadequate protection
6. procedures, deficiencies in quality, workability
7. housekeeping, poor housekeeping
8. training, deficiencies in knowledge and skills
9. incompatible goals, conflicting requirements
10. communication, relevant information ≠ recipients
11. organisation, deficiencies in structure

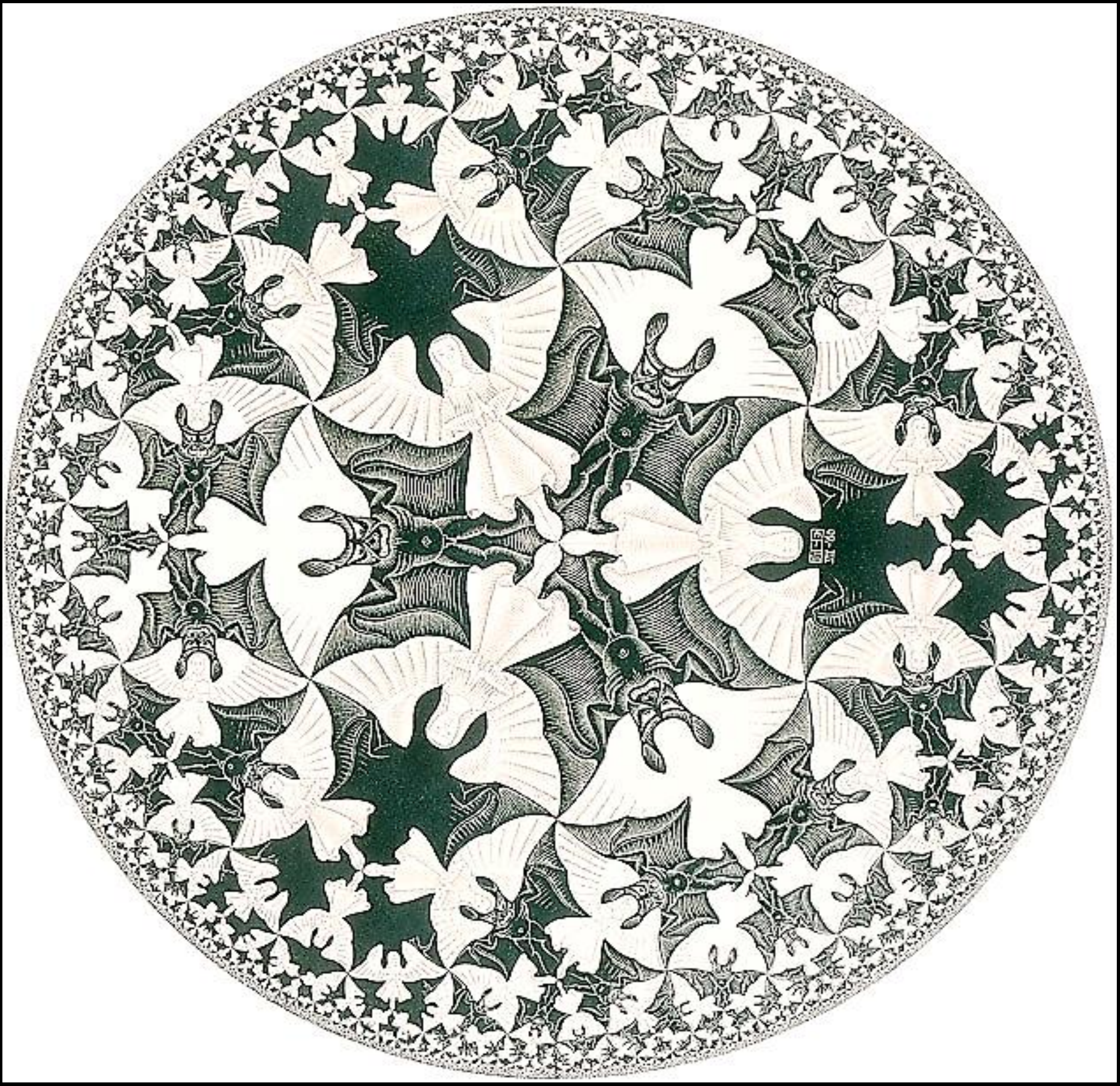
Groeneweg J (1992). Controlling the controllable, the management of safety. Proefschrift Rijksuniversiteit Leiden, DWSO Press

drift to danger model
Rasmussen 1997

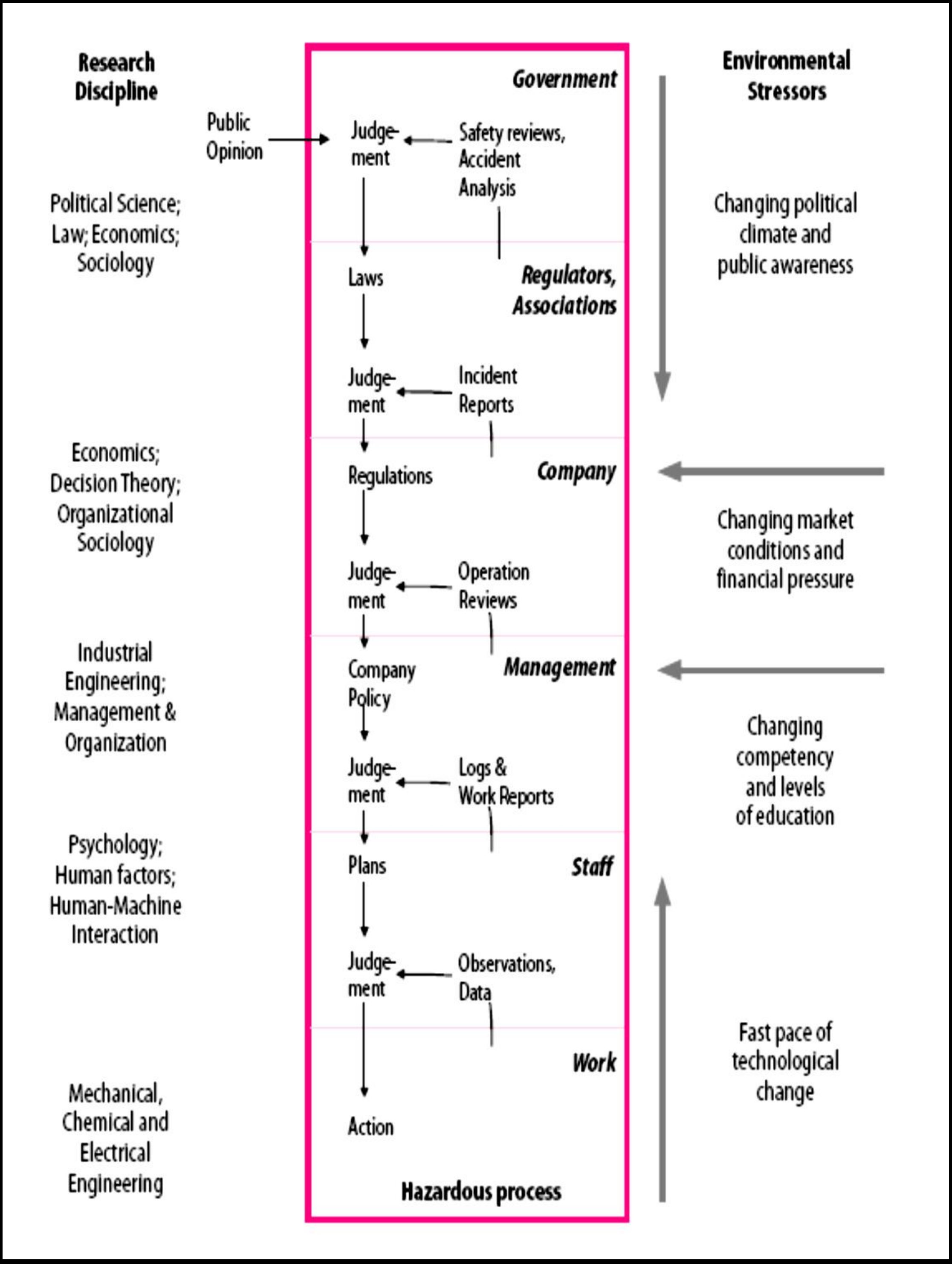


Rasmussen (1997). Risk management in a dynamic society. Safety Science 27(2-3):183-213

devils and angels – Escher 1960

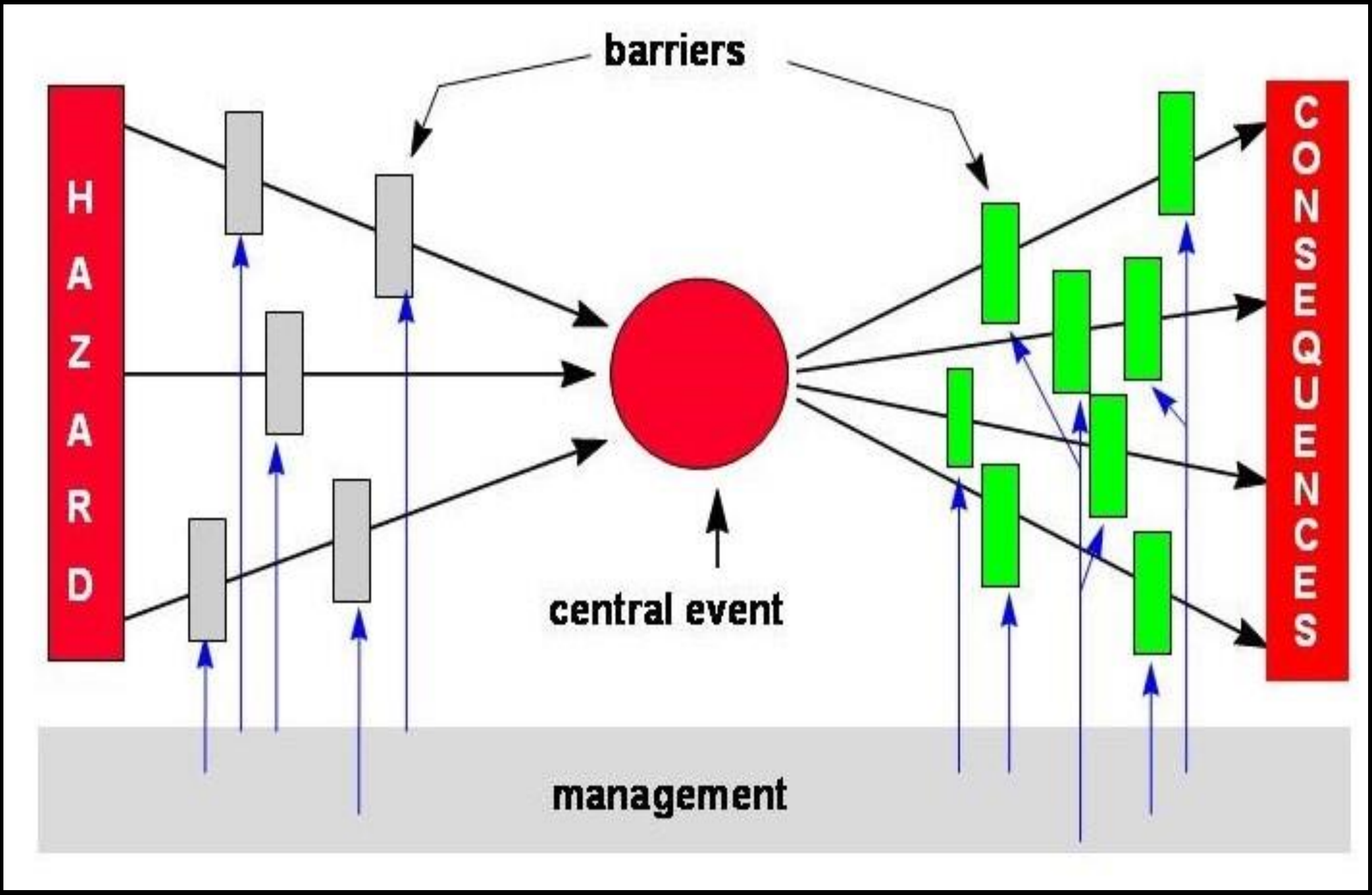


drift to danger model - Rasmussen 1997



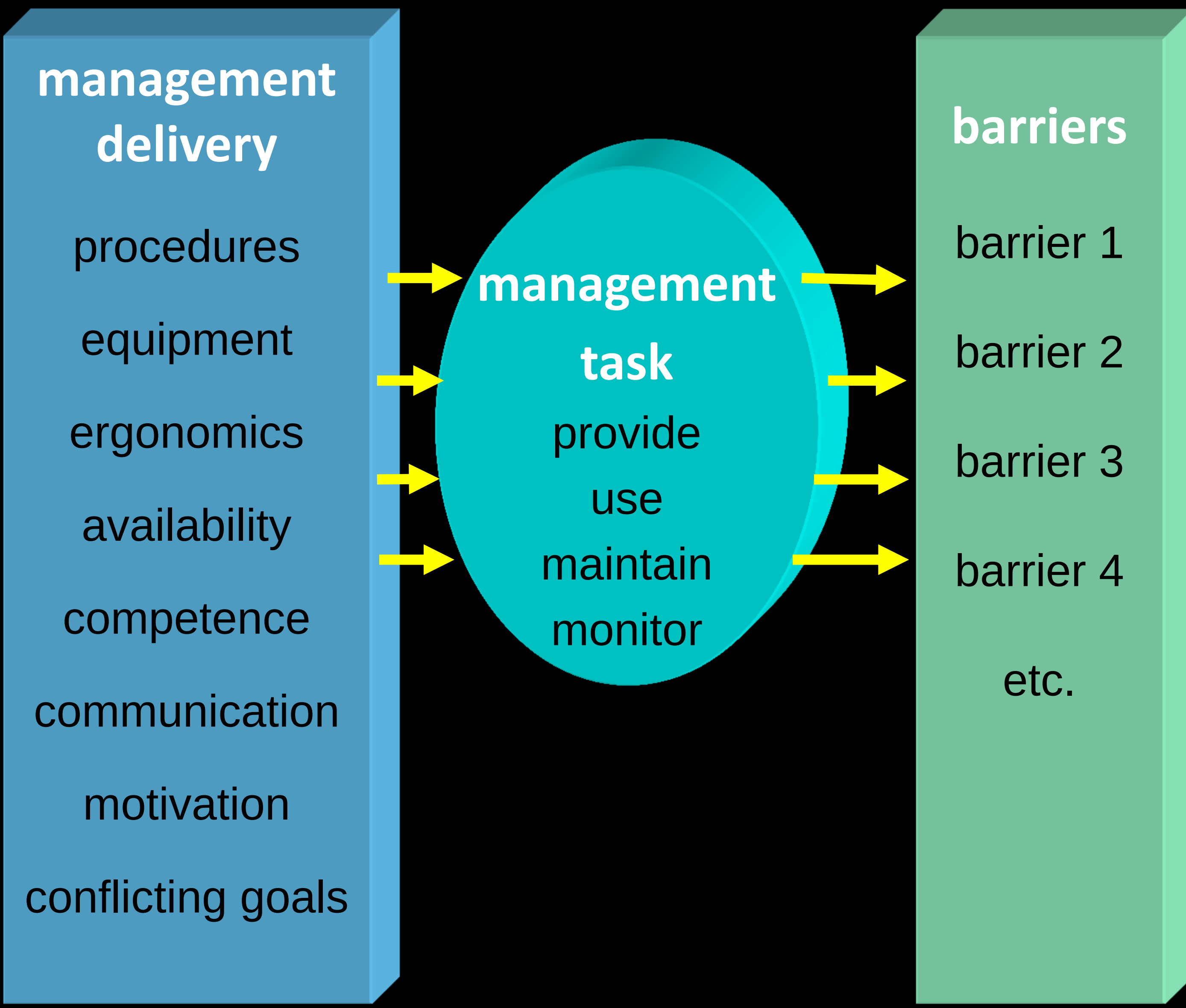
Rasmussen (1997). Risk management in a dynamic society. Safety Science 27(2-3):183-213

bowtie metaphor



Visser K (1998). Developments in HSE Management in Oil and Gas Exploration and Production. In: Safety management, the challenge of change. Hale A Baram M (Eds.). Pergamon, Amsterdam, p 43-66

management factors & barriers



Guldenmund F Hale A Goossens L Betten J Duijn N (2006).
Audit technique quality safety barrier management.
Journal of Hazardous Materials 130(3):234-241

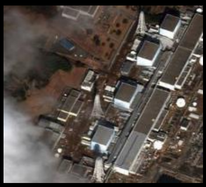
major accidents, a déjà vu
Le Coze 2013

1980s ⟷ 21st century

Challenger ’86 - space - Columbia ‘03

Bhopal ‘84 – process industry - Texas City ‘05

Tjernobyl ‘86 – nuclear industry - Fukushima ‘11



Paper Alpha ‘86 – oil extraction - Macondo ’10

…. shipping, aviation, rail, fuel storage, pipelines,….

(Perrow’s upper segment)

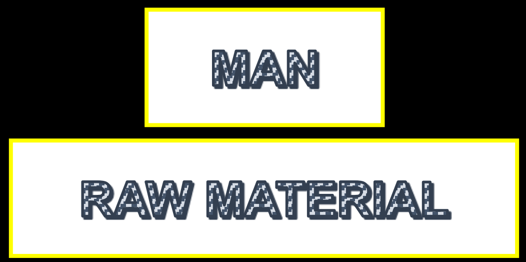
Le Coze J (2013). New models for new times, an anti-dualist move. Safety Science 59:200-218

possible explanations

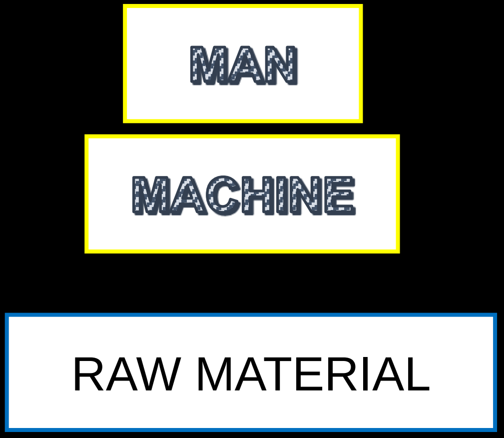
numbers	more platforms, planes, more disasters
	globalisation
economy	splitting activities
	outsourcing, subcontracting
	transparency, more bureaucracy
	conflicts with other corporate goals
	focus on cost Ξ less safety
safety	complexity, process, troubleshooting
	matrix organisation, no oversight
	disaster scenario’s not considered
	LTA’s as measure for process safety

man-machine interactions

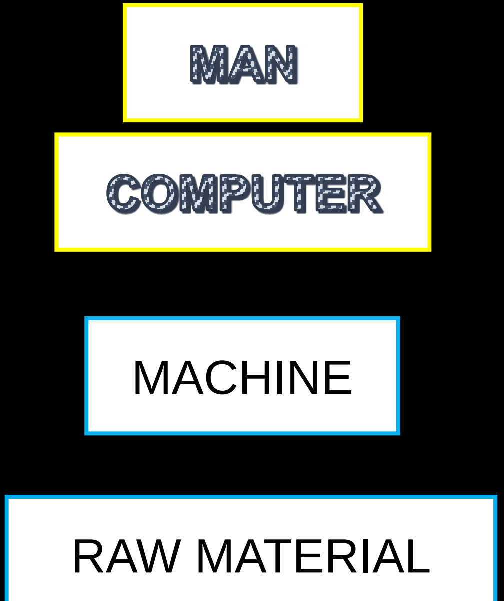
direct feedback



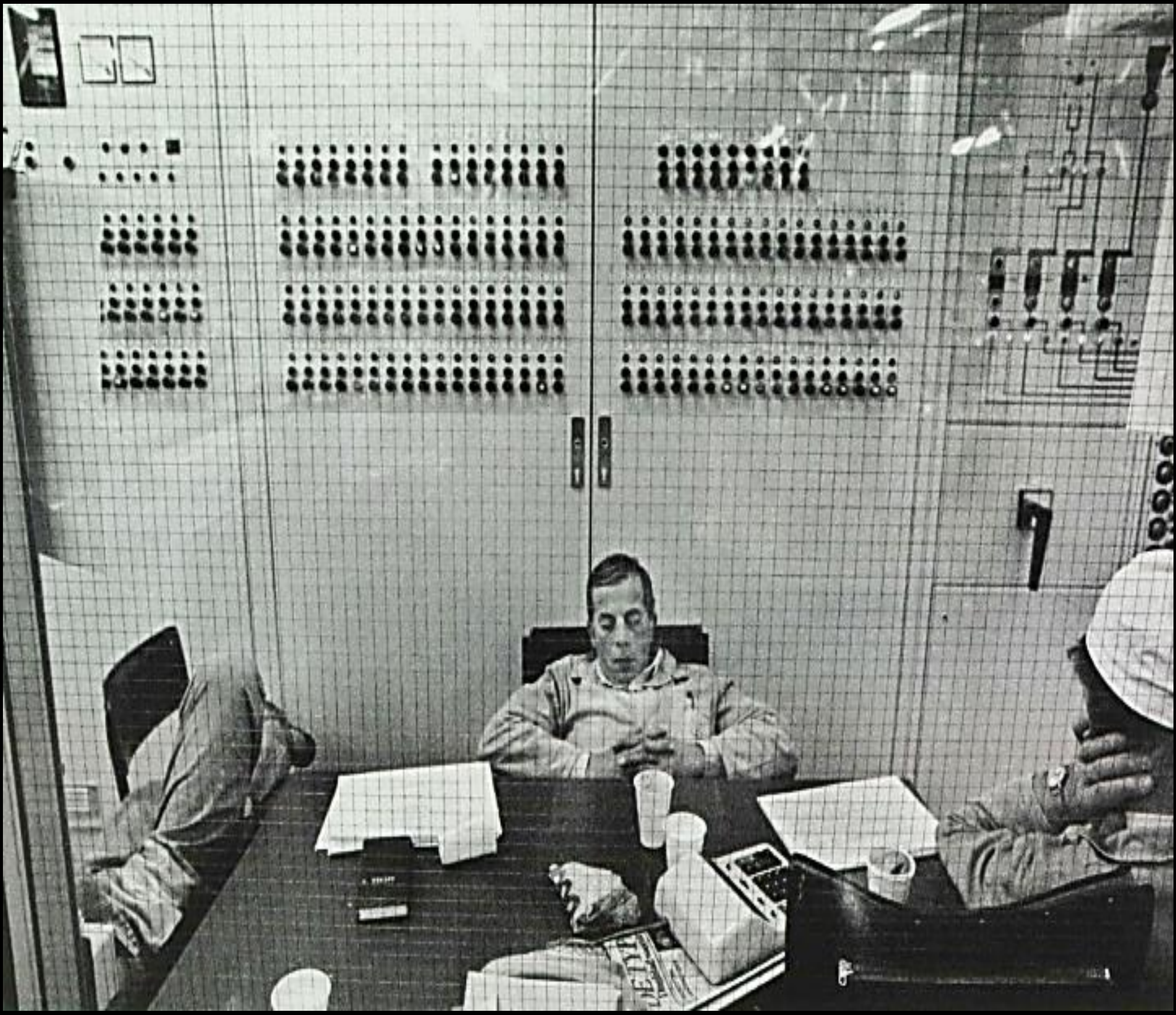
external energy source



computer



automation



Pennarts M (1980). In: The eyes of the union, nineteen photographers picture the 1980s, Stichting FNV Press

RED *for* DANGER

THE CLASSIC HISTORY OF BRITISH RAILWAY DISASTERS

L.T.C. ROLT

general safety scenarios
rail accidents Rolt 1955

1. double line collisions
2. blow-ups and breakdowns
3. bridge failures – storm and tempest
4. other men's responsibilities – permanent way faults and runaway locomotives
5. single line collisions
6. high speed derailments
7. stray wagons and breakaways
8. signalmen's errors
9. driver's errors
10. how much automation?

Are there repetitive scenario's, still occurring today?

from big data to big information

Big data in safety science domain

- Bill Heinrich, US 1927 onwards
- Barry Turner, UK, 1976
- Charles Perrow, US 1984
- Jop Groeneweg, Nl 1992