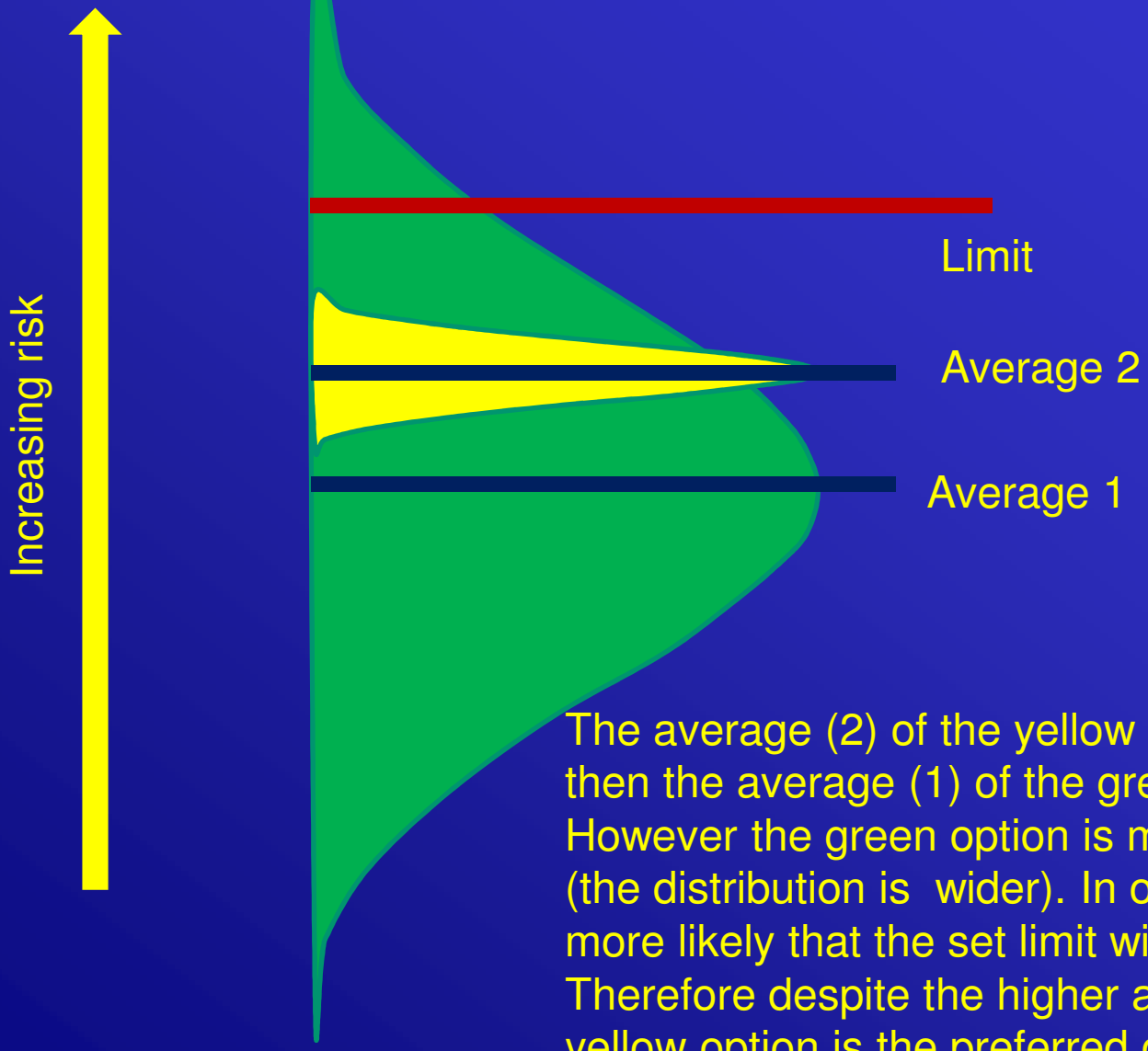
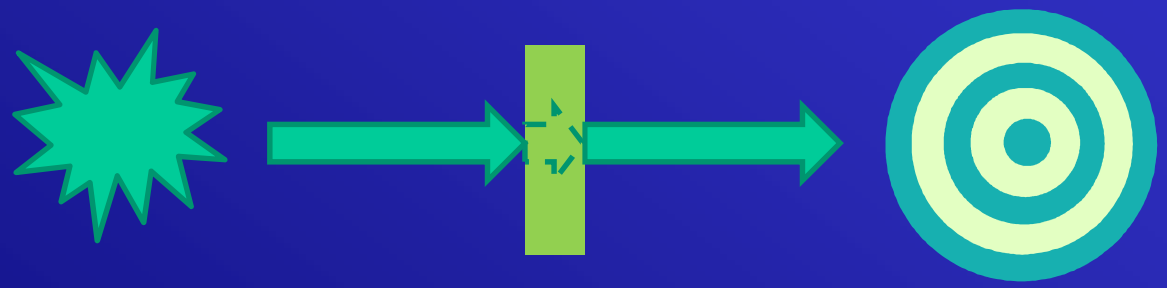

From data to information
to knowledge to wisdom



The average (2) of the yellow option is higher then the average (1) of the green option. However the green option is more uncertain (the distribution is wider). In option 1 it is more likely that the set limit will be exceeded. Therefore despite the higher average, the yellow option is the preferred one if the aim is not to exceed the limit.

Hazard Barrier Target model

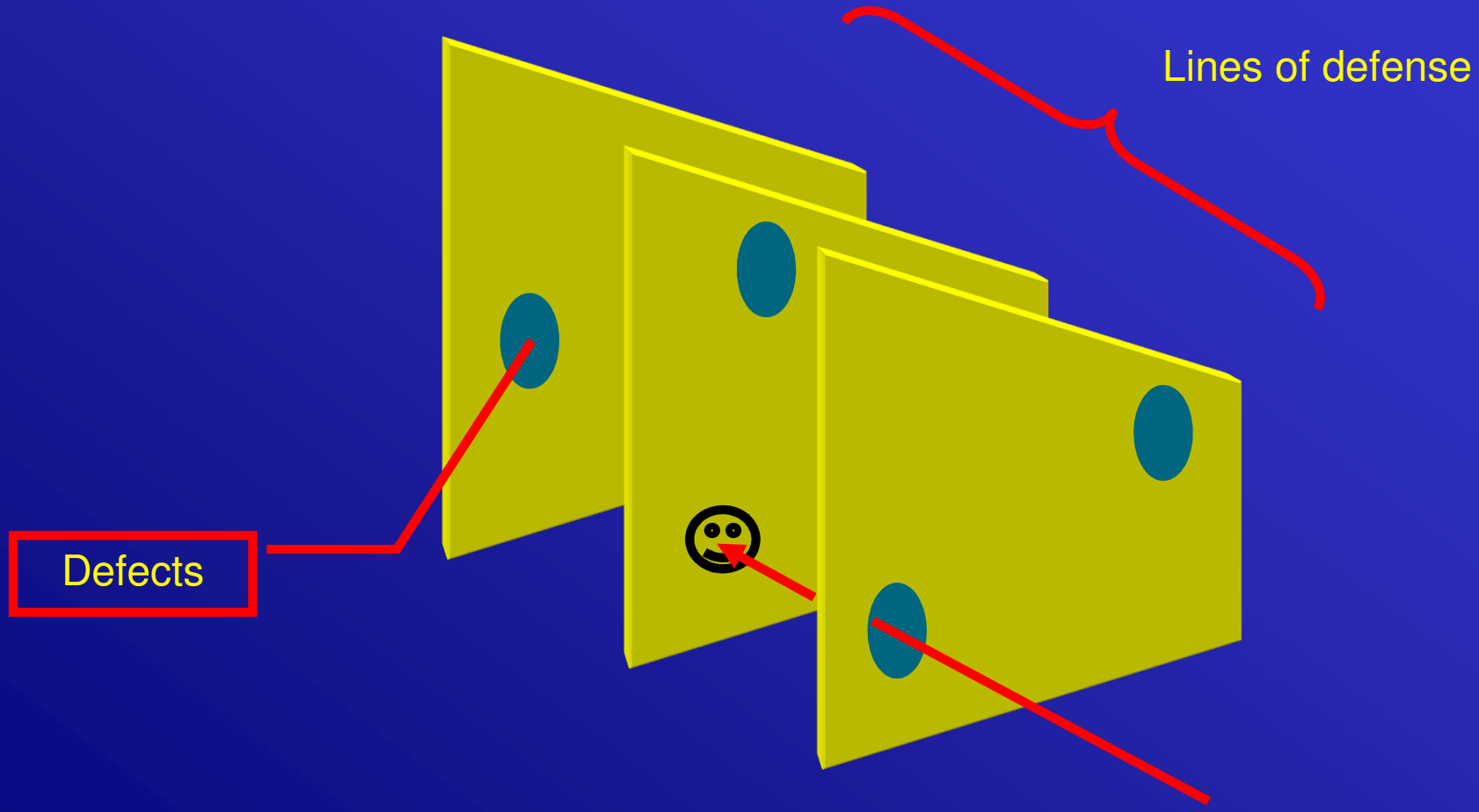


HAZARD BARRIER TARGET

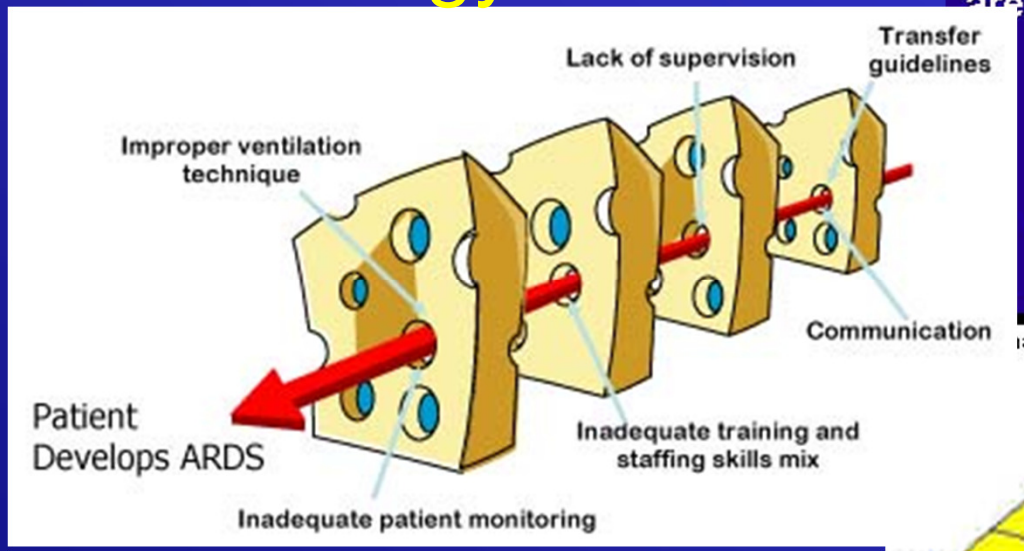
Barrierology (ARAMIS)

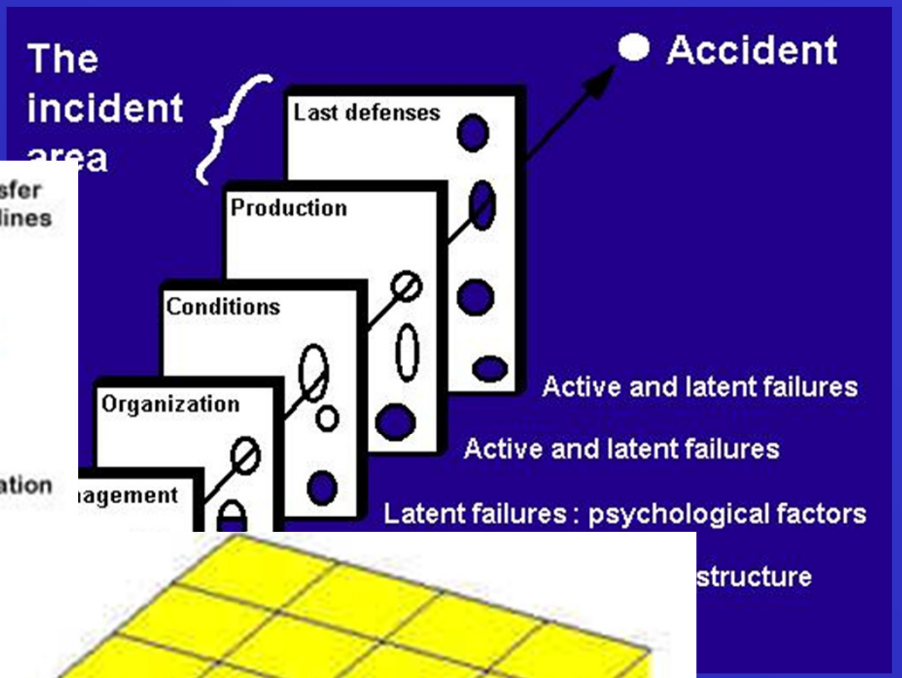
- Material Barrier
  - Shields
  - Fences
  - Relief valves
- Immaterial Barrier
  - Rules
  - Regulations
  - Lines on the floor

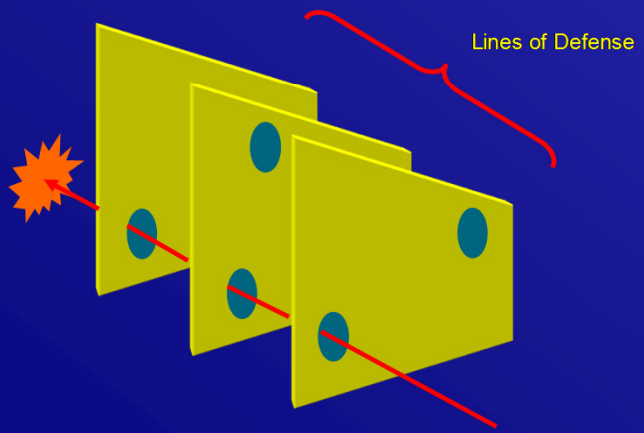
Swiss Cheese model



Cheesology


Lack of supervision
Transfer guidelines
Improper ventilation technique
Communication
Patient Develops ARDS
Inadequate training and staffing skills mix
Inadequate patient monitoring


The incident area
Accident
Last defenses
Production
Conditions
Organization
Active and latent failures
Active and latent failures
Latent failures : psychological factors


Lines of Defense

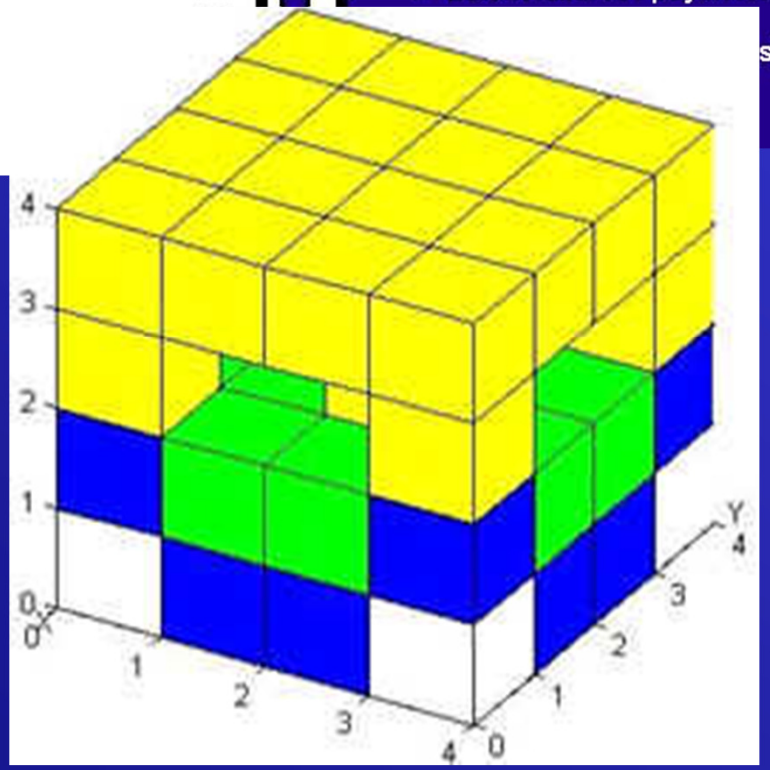

4
3
2
1
0
0
1
2
3
4
Y
0
1
2
3
4

Figure 1.: Black box

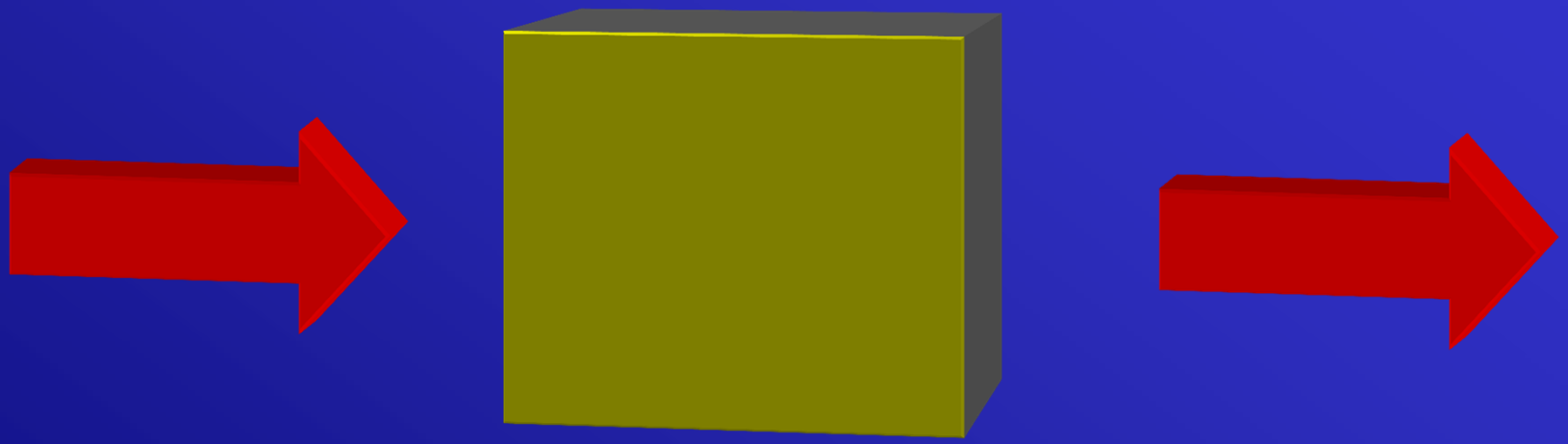
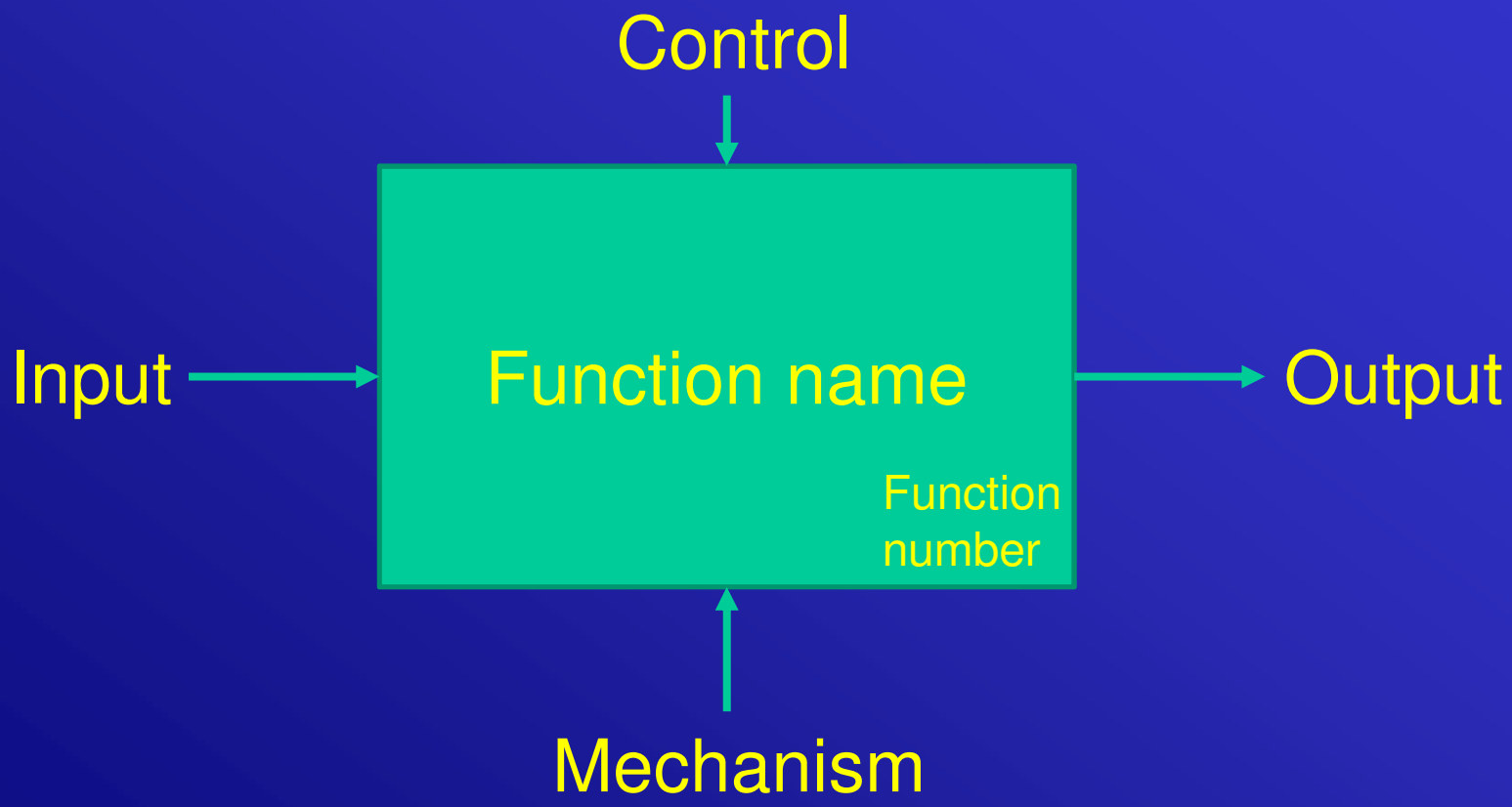
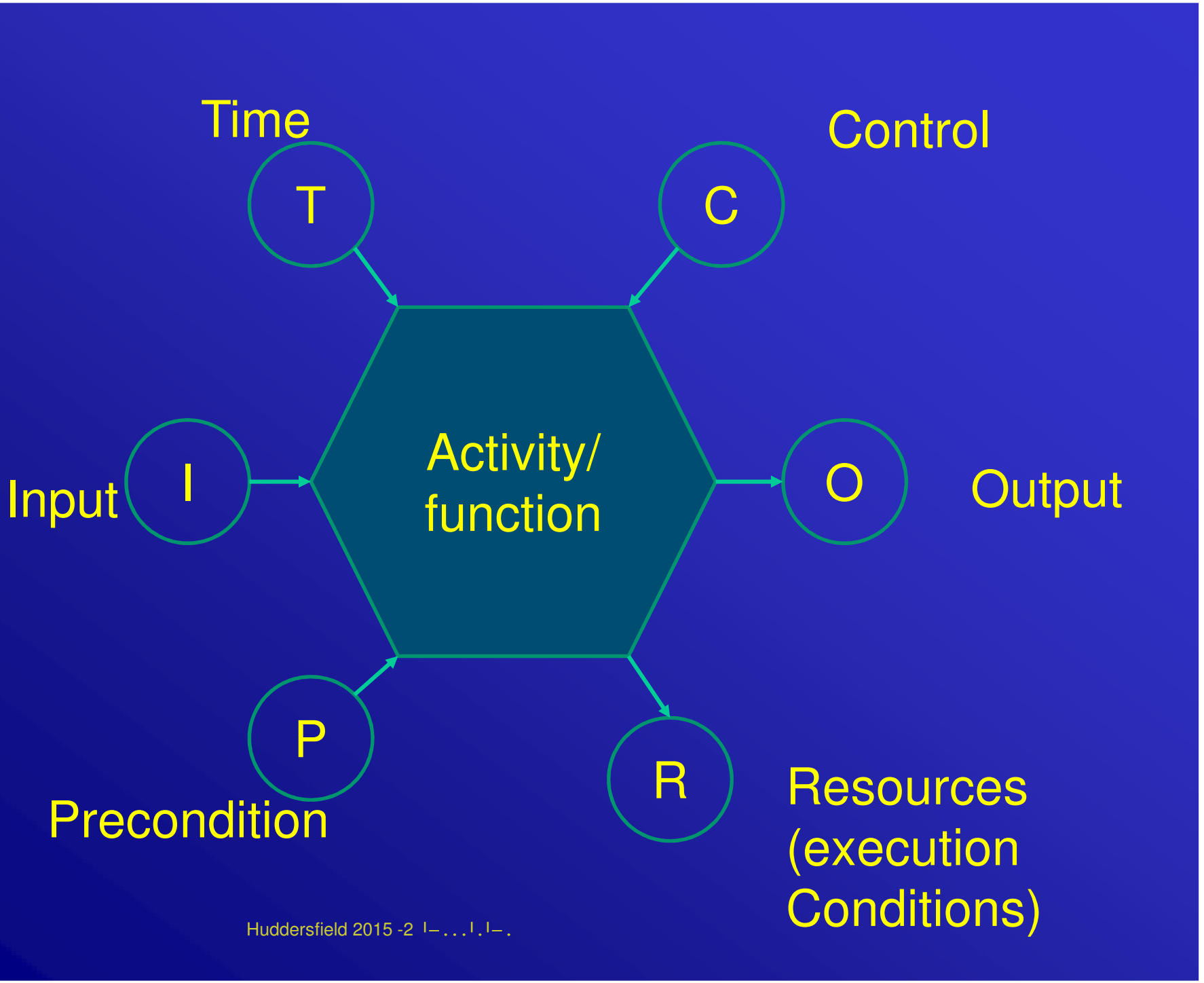
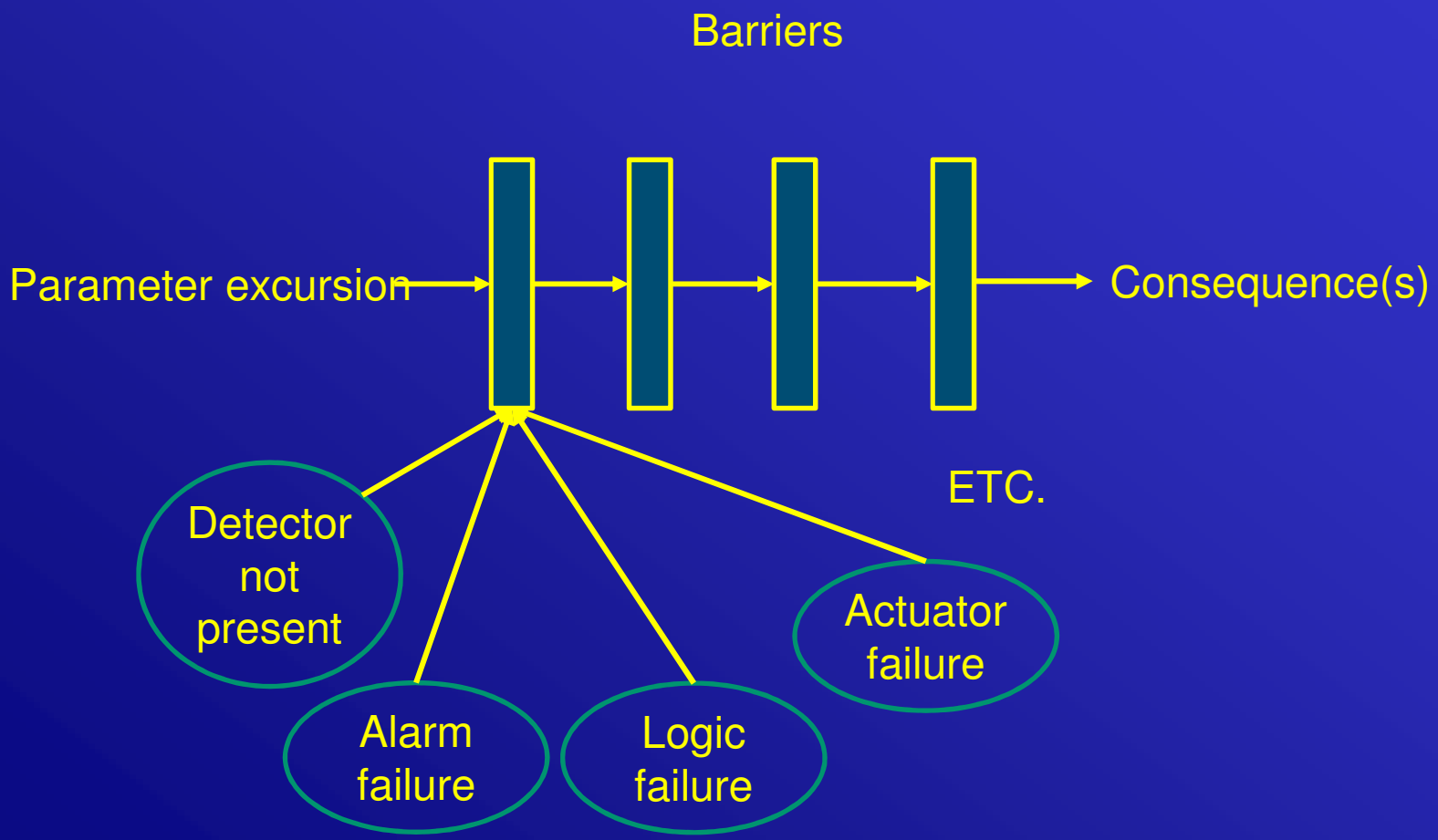
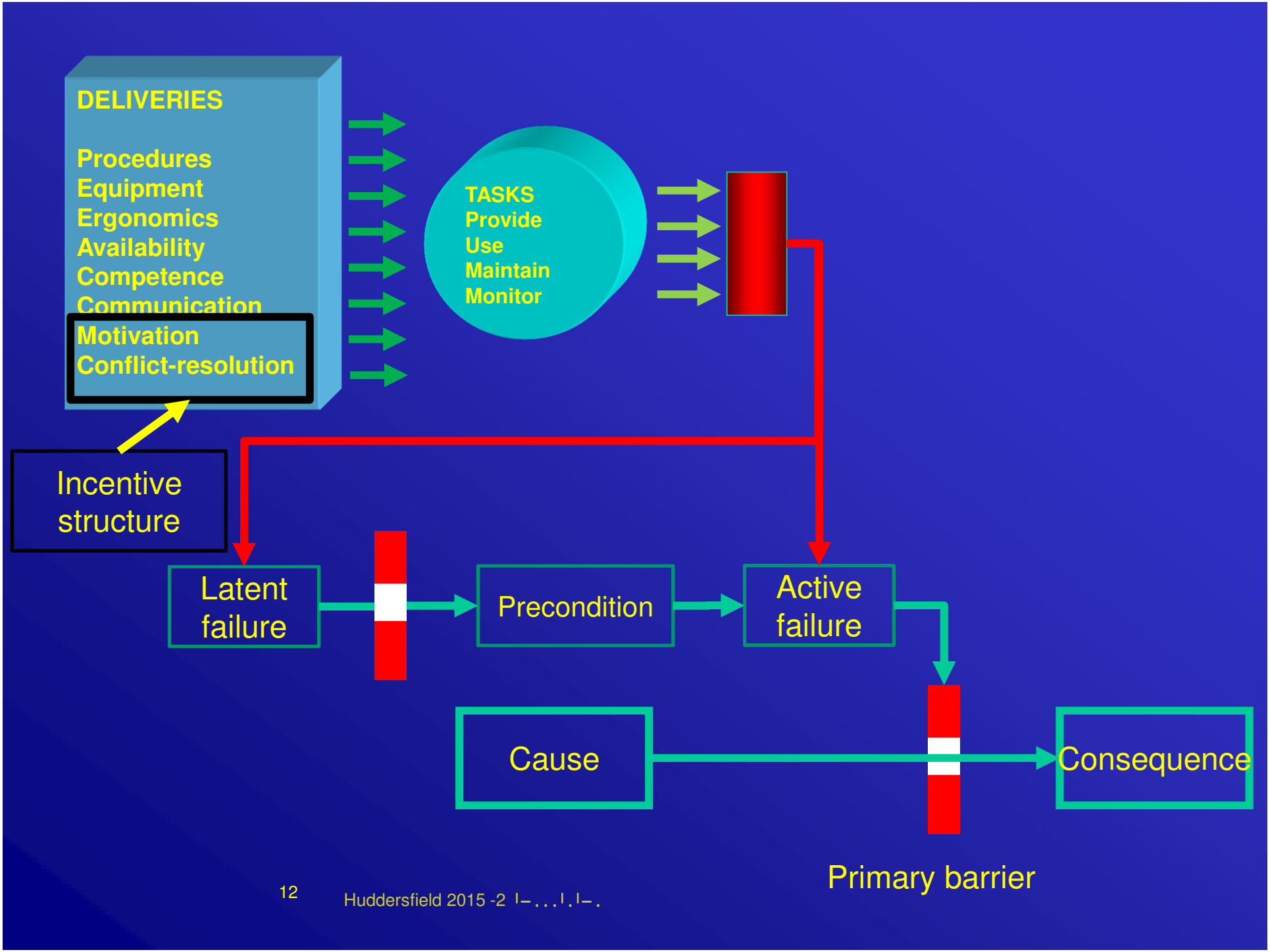


Figure 3: Function box in SADT




Time
T
Control
C
Input
I
Activity/
function
O
Output
P
Precondition
R
Resources
(execution
Conditions)


Barriers
Parameter excursion
Consequence(s)
ETC.
Detector not present
Alarm failure
Logic failure
Actuator failure


DELIVERIES
Procedures
Equipment
Ergonomics
Availability
Competence
Communication
Motivation
Conflict-resolution
TASKS
Provide
Use
Maintain
Monitor
Incentive structure
Latent failure
Precondition
Active failure
Cause
Consequence
Primary barrier

Incentive structure

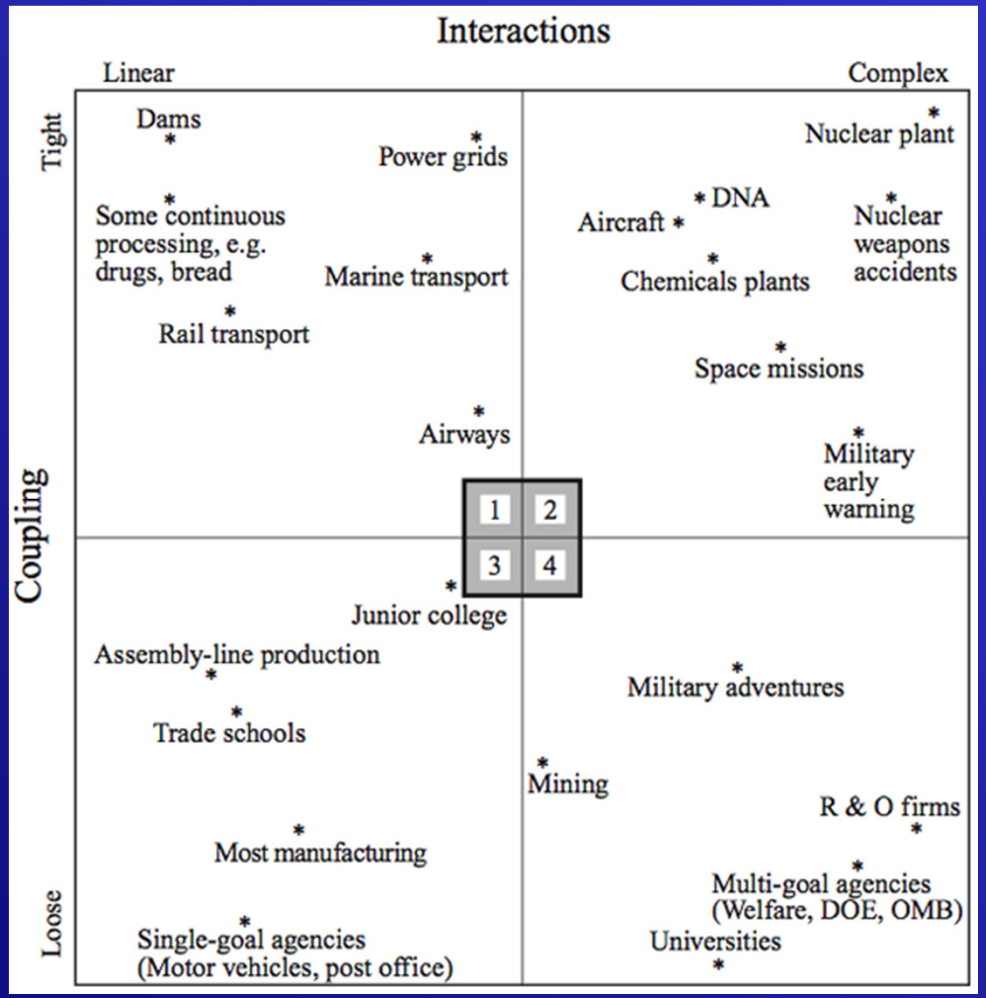
In(ter)dependency

- All this stuff is NOT independent
- Machinery and equipment have producers
- Installation and maintenance is done by contractors
- And then there is Management and Market

Coupling

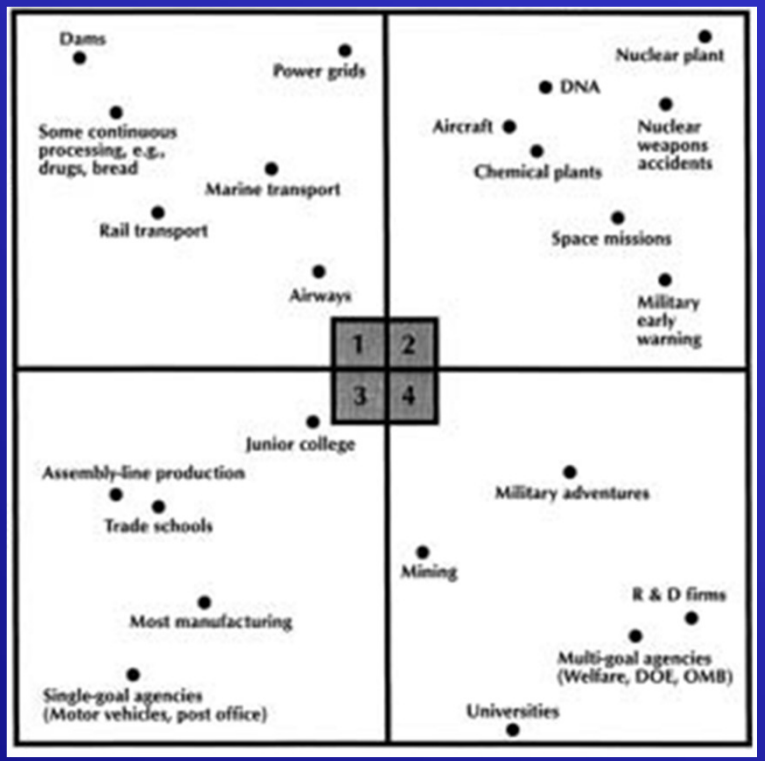
- Too much play: rattle
- Not enough play: overheat
- Just enough play (and some lubrication) ok

Perrow


Interactions
Linear
Complex
Tight
Coupling
Loose
Dams
Power grids
Nuclear plant
DNA
Aircraft
Nuclear weapons accidents
Some continuous processing, e.g. drugs, bread
Marine transport
Chemicals plants
Rail transport
Space missions
Airways
Military early warning
1
2
3
4
Junior college
Assembly-line production
Military adventures
Trade schools
Mining
R & O firms
Most manufacturing
Multi-goal agencies (Welfare, DOE, OMB)
Single-goal agencies (Motor vehicles, post office)
Universities


Normal
Accidents
Living with High-Risk Technologies
Charles
Perrow

The law of requisite complexity



Intractability

Inmaneagability

Naar Eric Hollnagel, Esrel 2011

Look at all behaviour, not only incidents and accidents

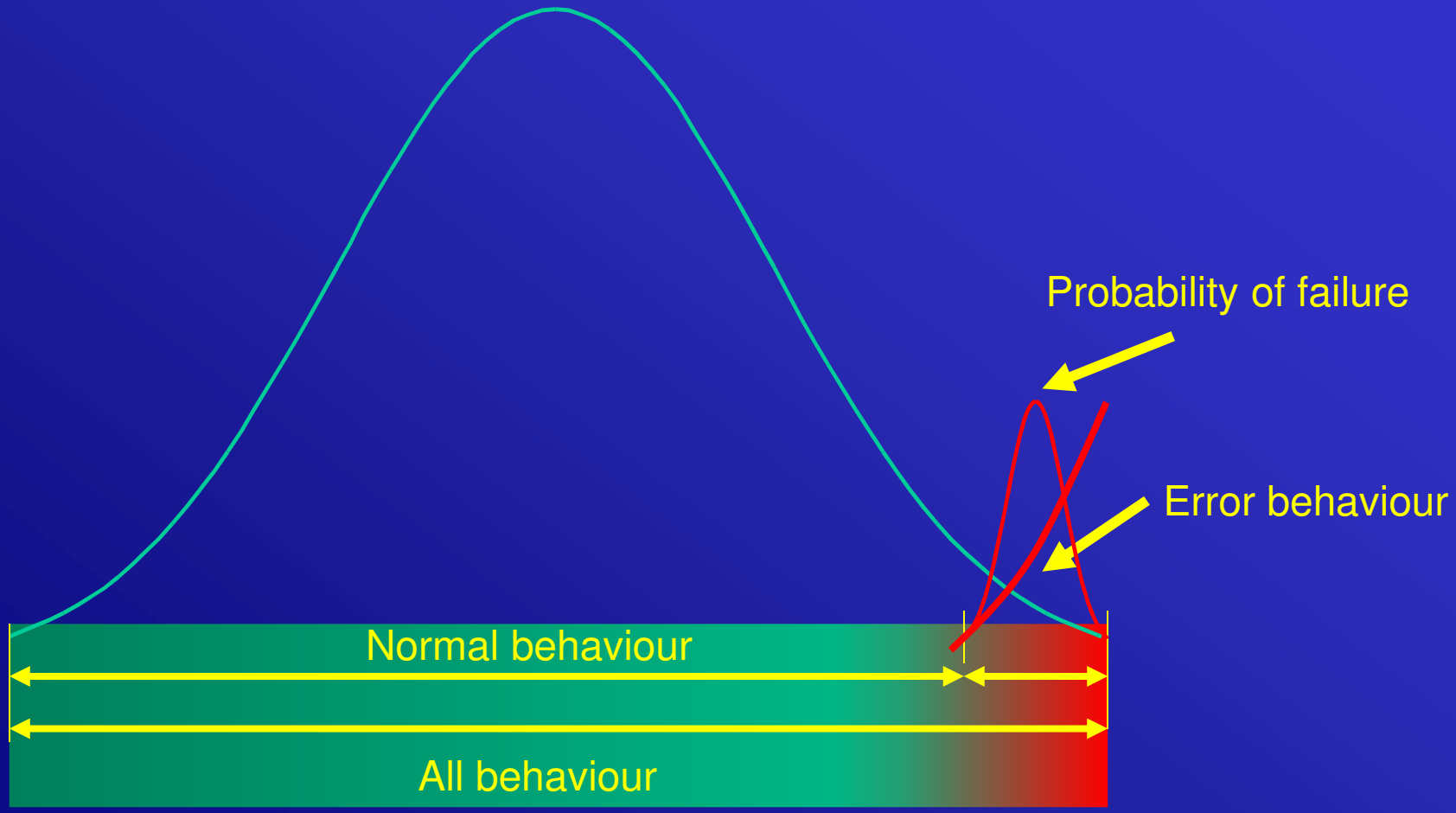
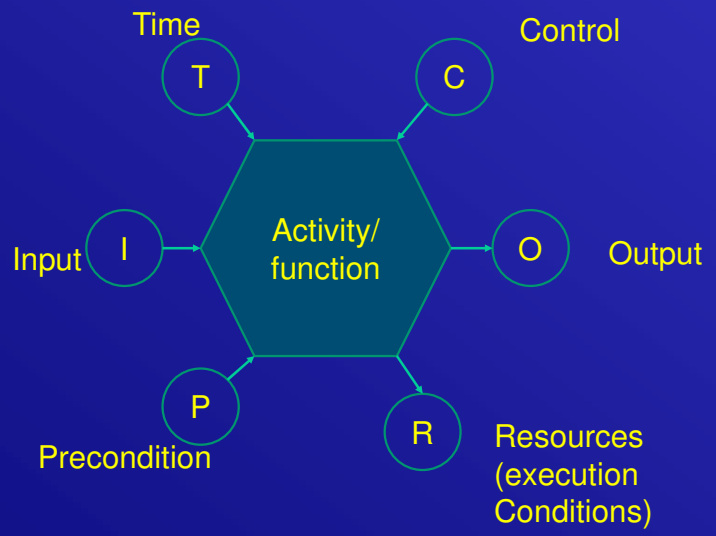


Figure 5: Random variations can give rise to very extreme values


Time
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Resources
(execution
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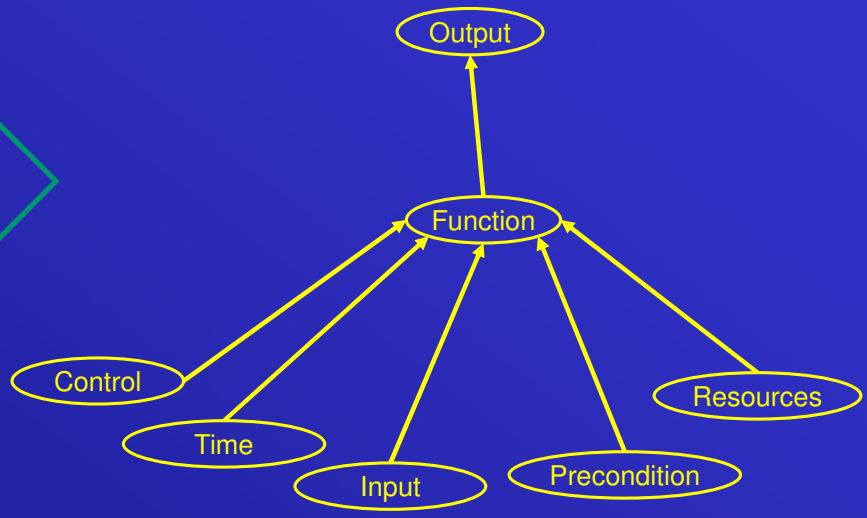
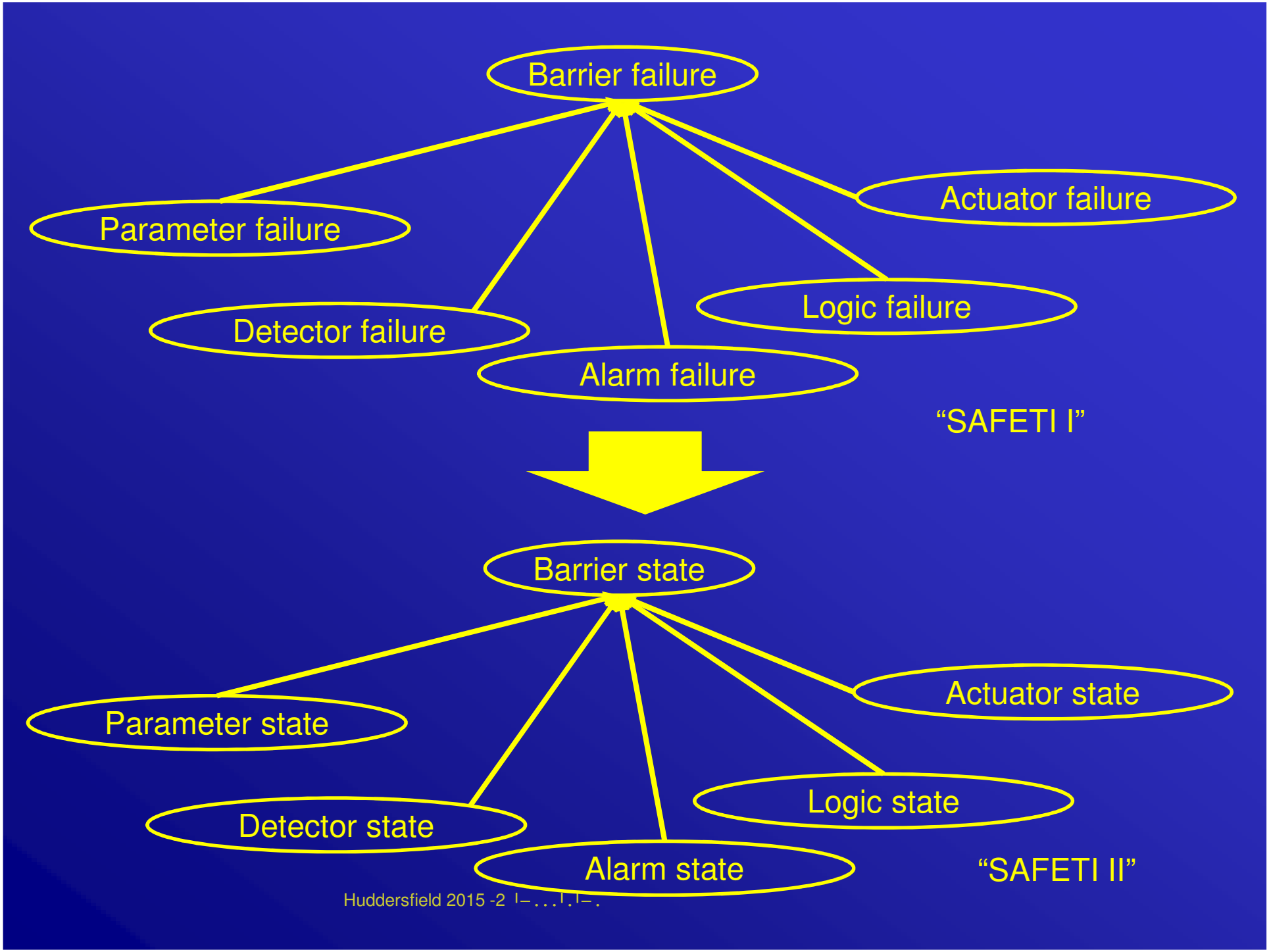
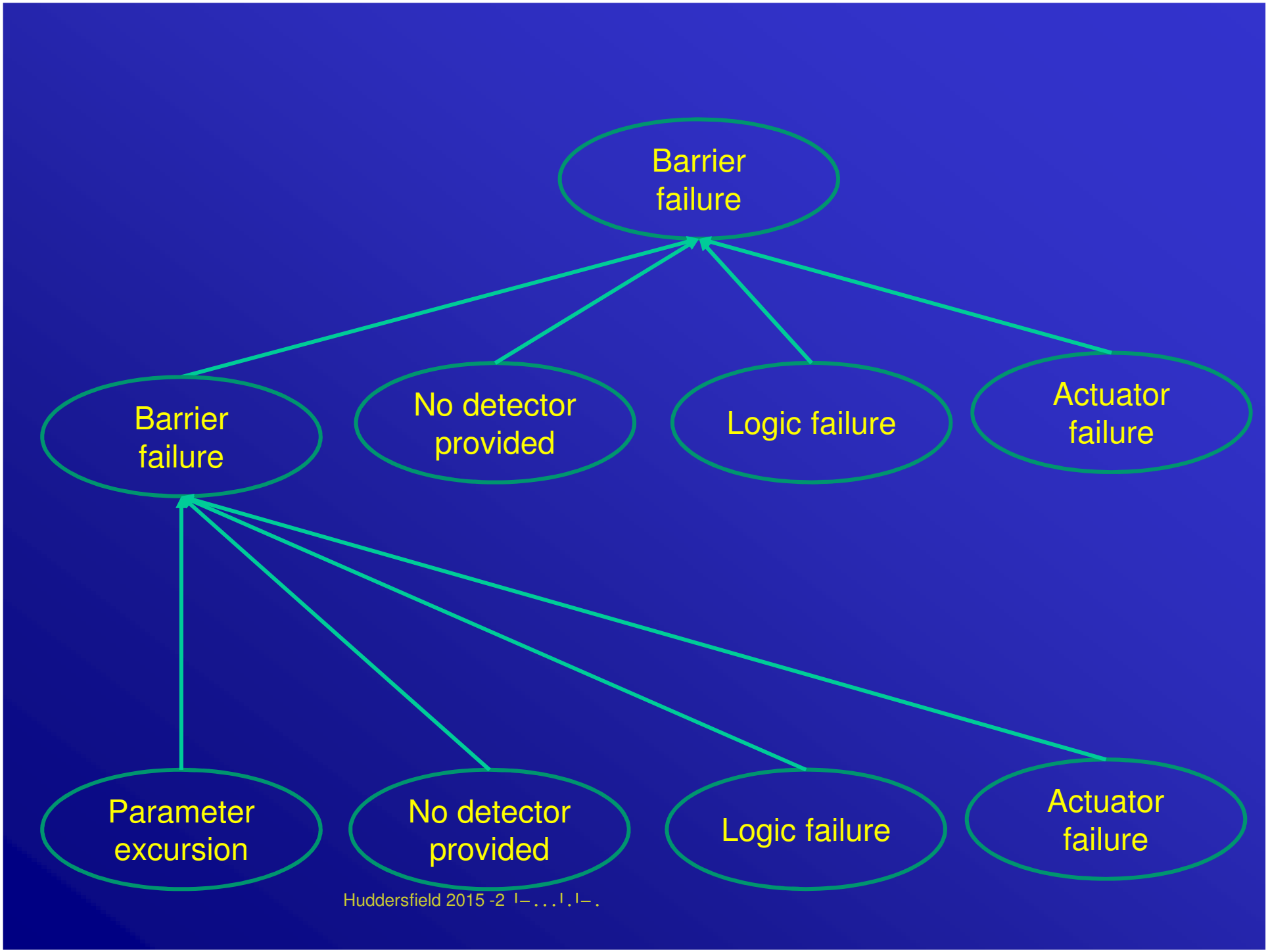
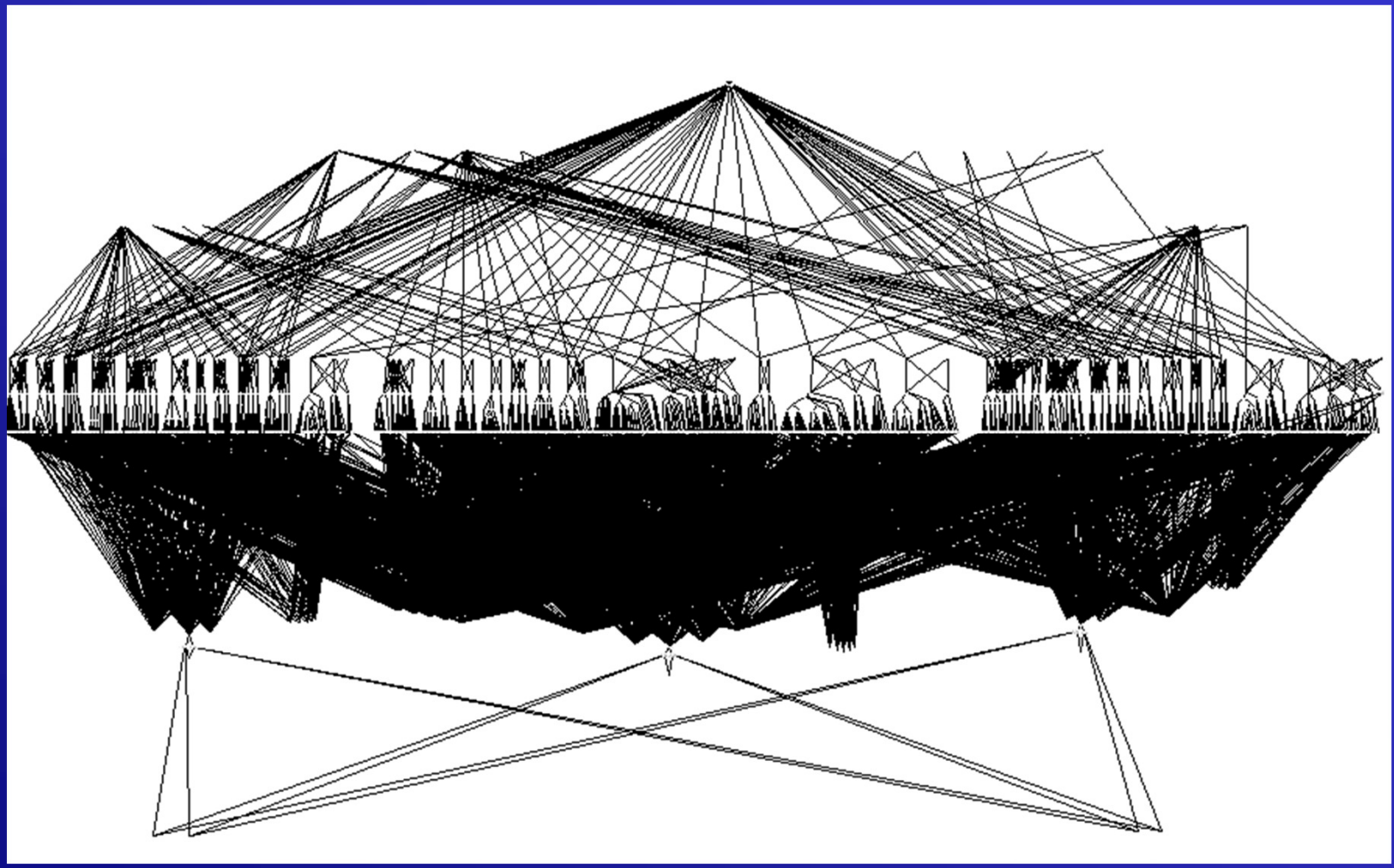

Output
Function
Control
Time
Input
Precondition
Resources

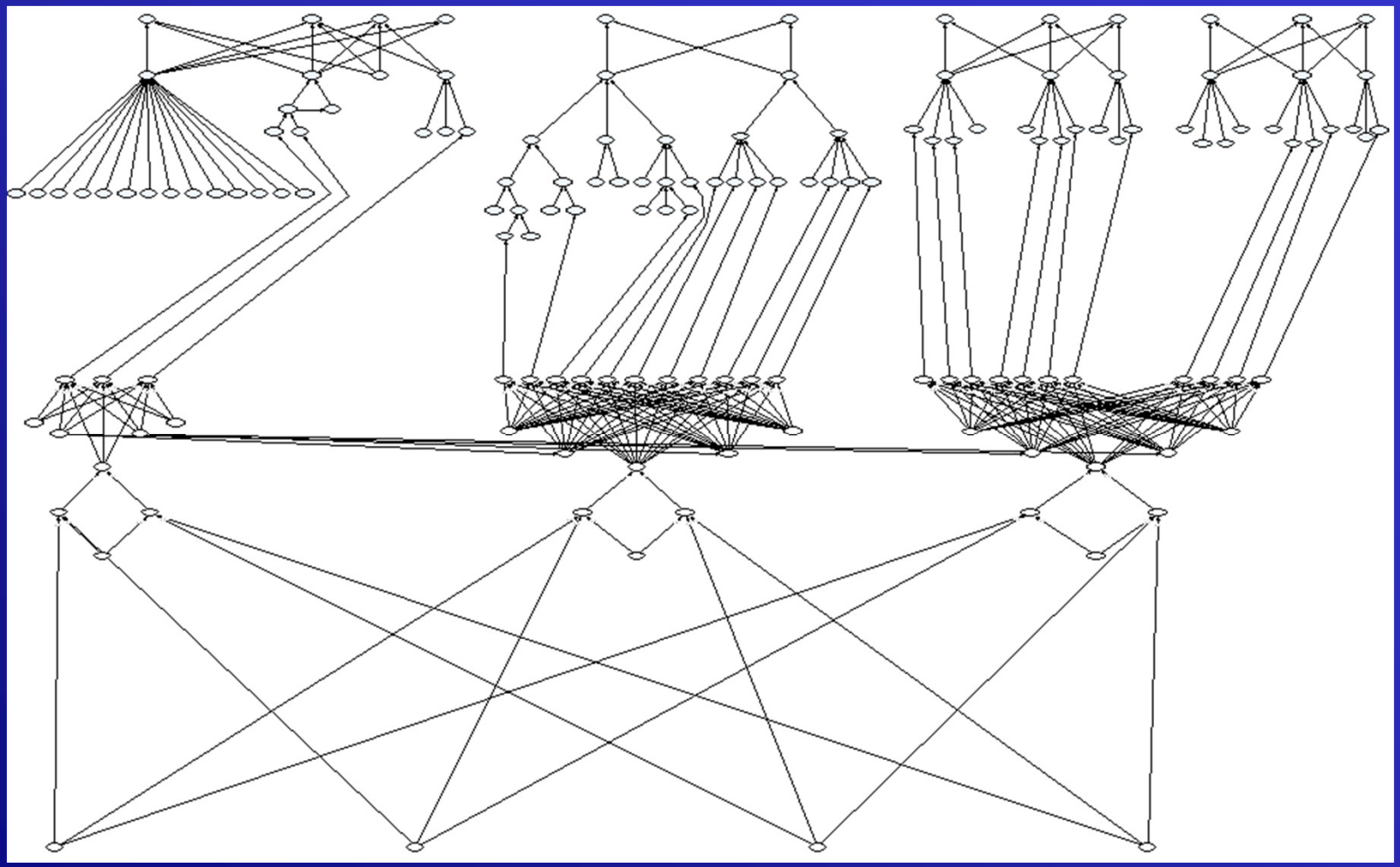

Barrier failure
Parameter failure
Actuator failure
Detector failure
Logic failure
Alarm failure
“SAFETI I”
Barrier state
Parameter state
Actuator state
Detector state
Logic state
Alarm state
“SAFETI II”


Barrier failure
Barrier failure
No detector provided
Logic failure
Actuator failure
Parameter excursion
No detector provided
Logic failure
Actuator failure

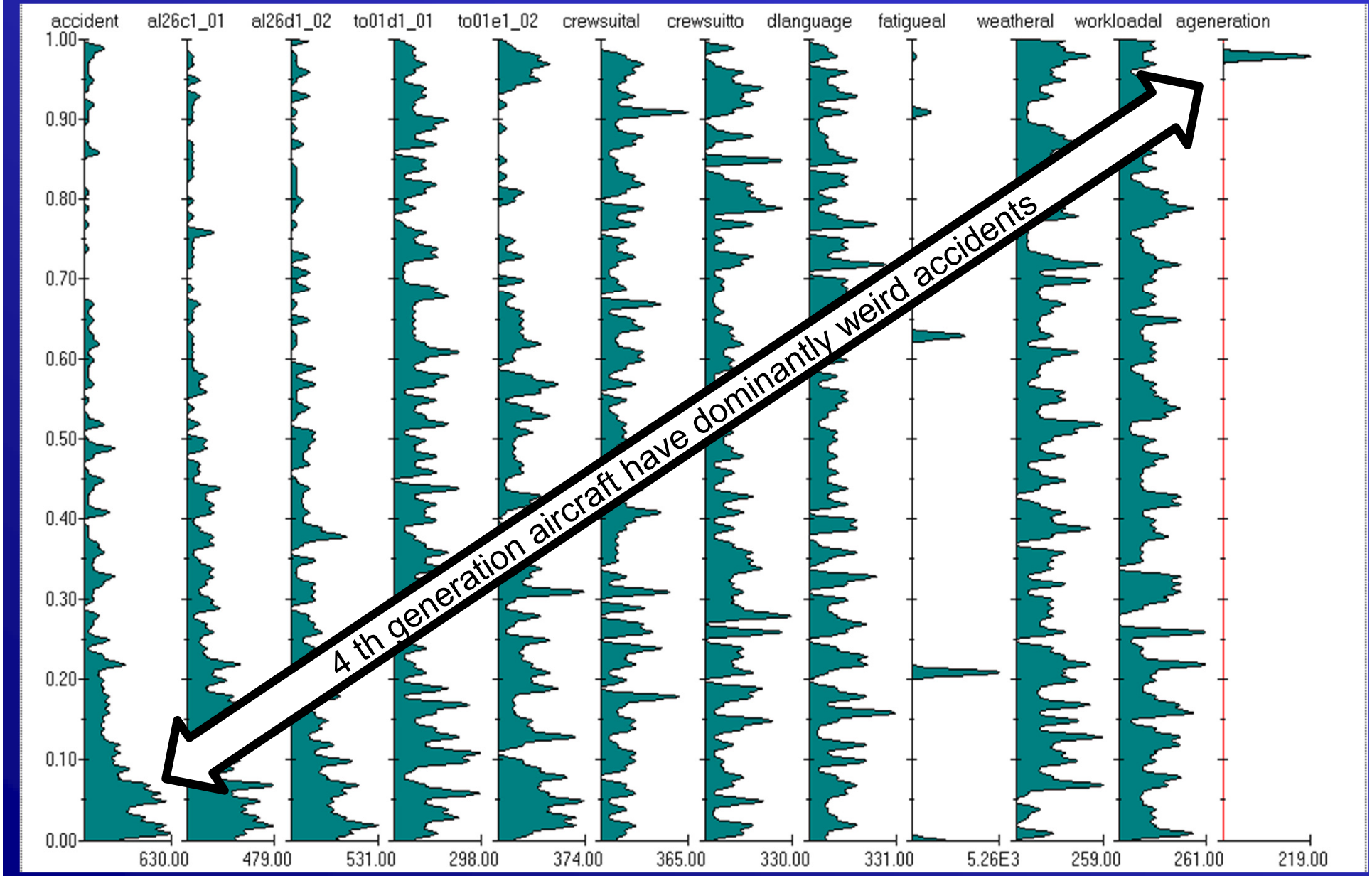


Causal Model for Air Transport Safety: approx. 1500 nodes, 4000 arcs

System failure - spatial disorientation - bad roll handling - reverse truster failure



Conditionalize on latest aircraft generation



Platypus

- Takes Shells inventory list
- Convert it in BBN structures
- Guide the user through necessary specifications
- Connects to human model and management model where appropriate
- Do the sums

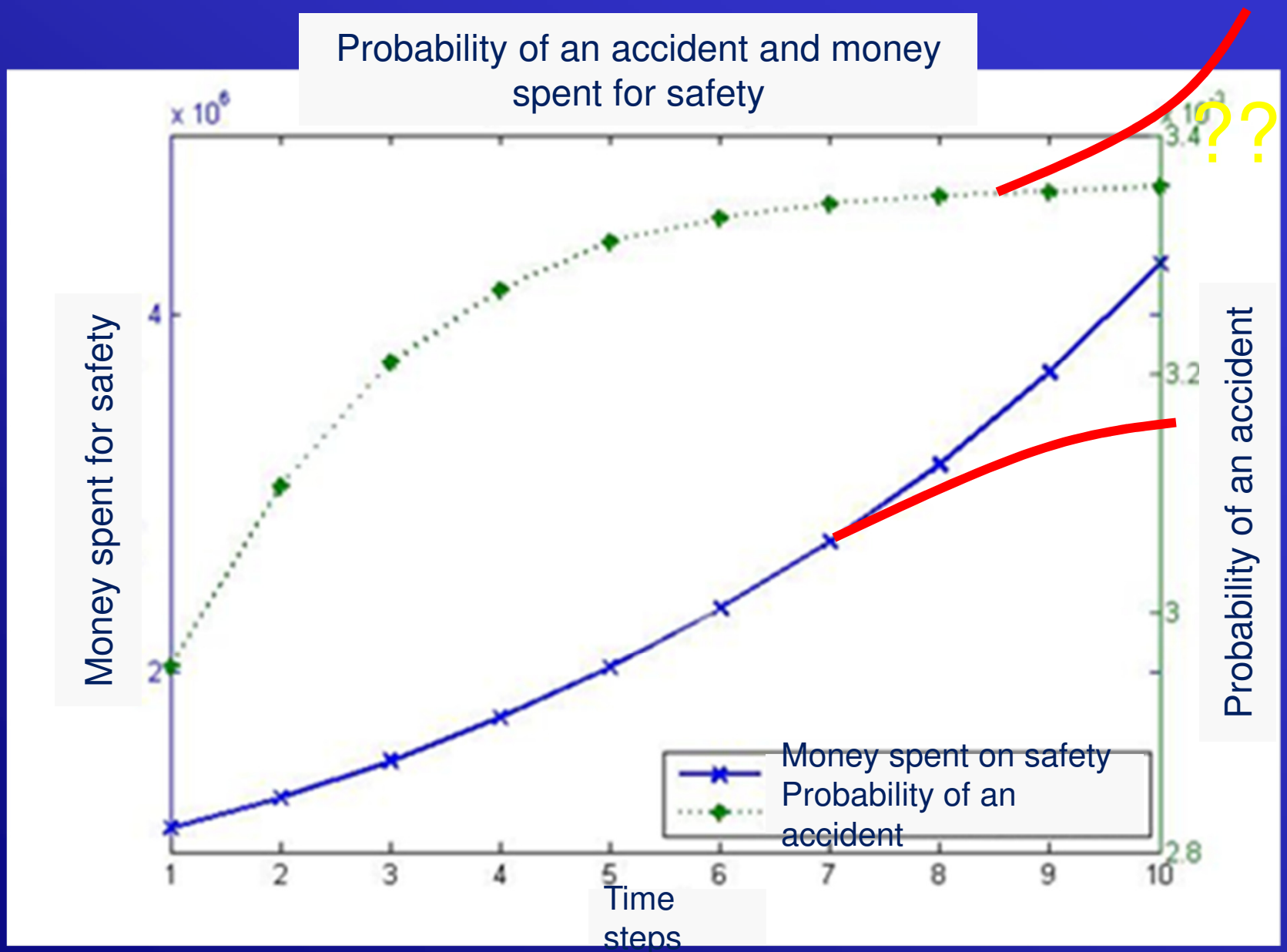


Figure 9: Money spent for safety and Probability of accident – Simulation results for 10 time steps

The denominator problem

You do know the number of accidents

But you do not know how many hours of exposure

or numbers

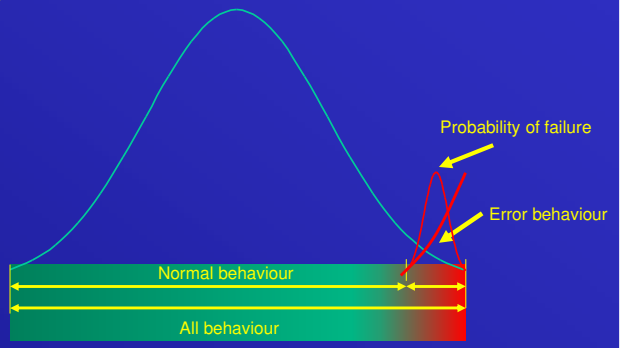
For SPAD: how many signals at danger are passed

How many signals at danger are NOT passed

How many signals are passed at safe??

How many signals are there

Velocity distribution??

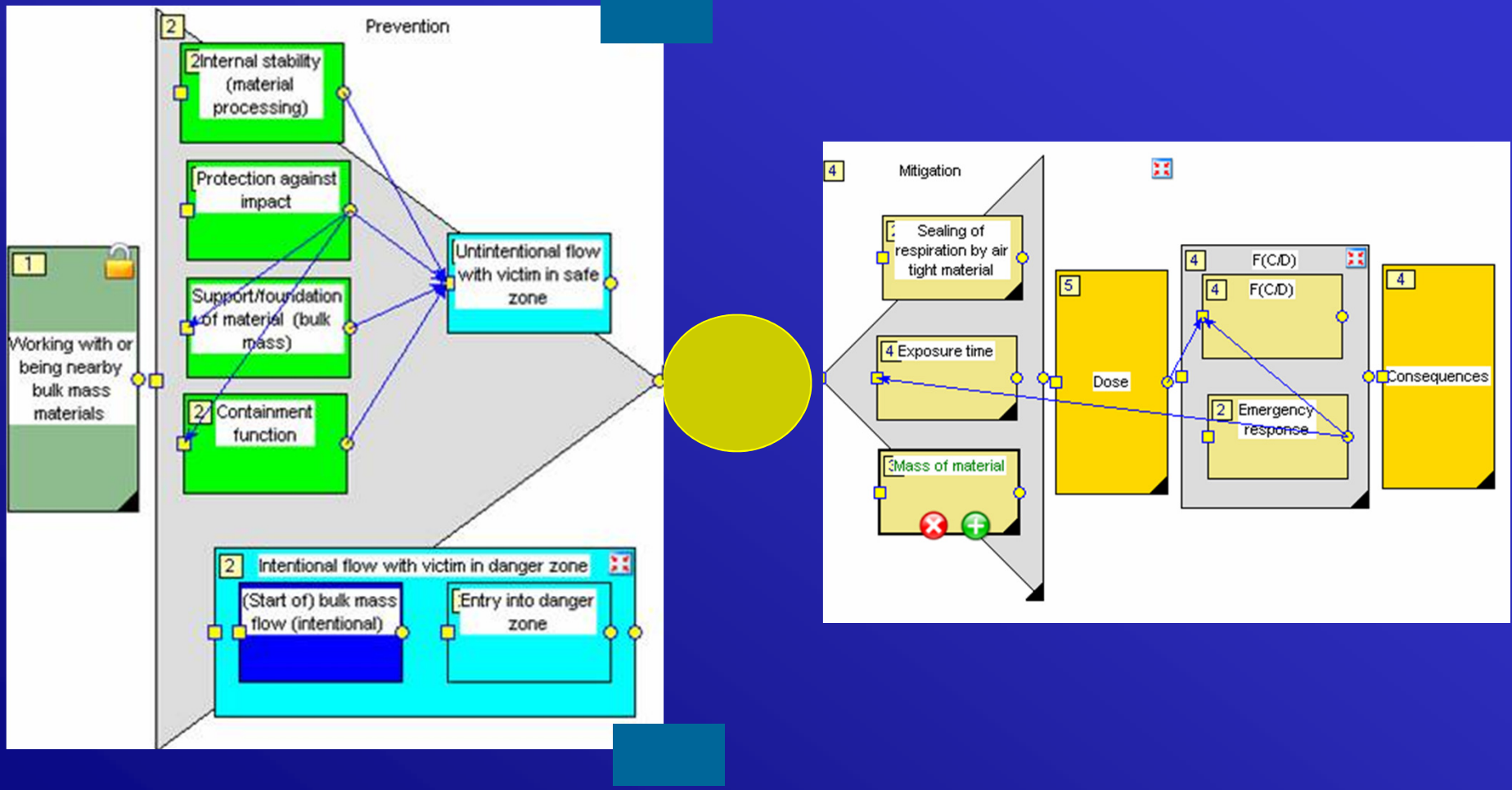


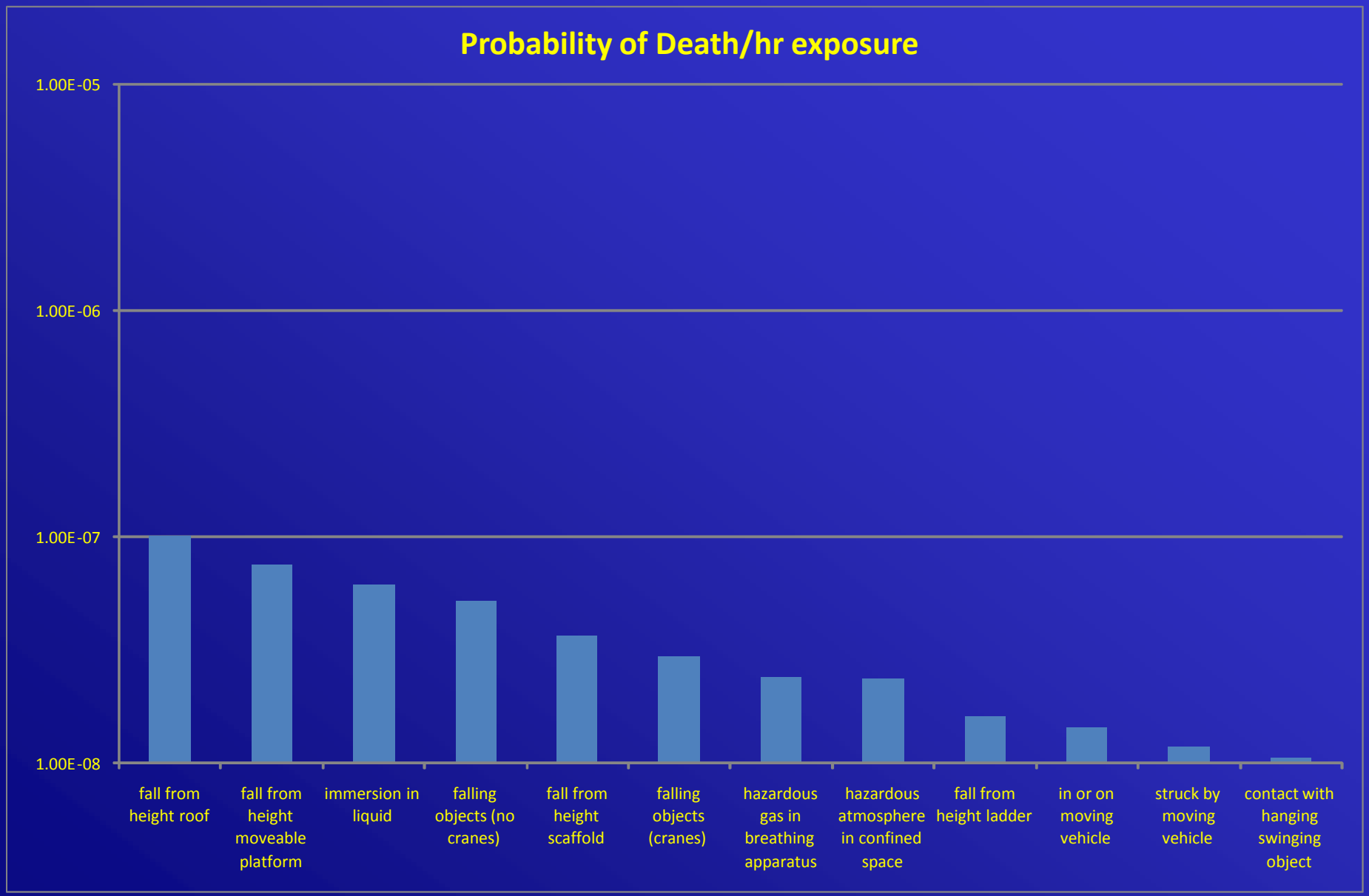
Population problem

- Say factor X is a potential cause for accident S.
  - Result from an inquiry says it is
- How many instances were there when accident S occurred without factor X
- How many instances were there when the factor X occurred without S occurring
- Is it more likely to have S given X??

WORM

- Not only a database of ALL accidents
- But also an intensive investigation into exposure.
- Som


2
Prevention
2Internal stability (material processing)
Protection against impact
Support/foundation of material (bulk mass)
2 Containment function
1
Working with or being nearby bulk mass materials
Untintentional flow with victim in safe zone
2
Intentional flow with victim in danger zone
(Start of) bulk mass flow (intentional)
Entry into danger zone
4
Mitigation
Sealing of respiration by air tight material
4 Exposure time
3Mass of material
5
Dose
4
F(C/D)
4
F(C/D)
2 Emergency response
4
Consequences


Probability of Death/hr exposure
1.00E-05
1.00E-06
1.00E-07
1.00E-08
fall from height roof
fall from height moveable platform
immersion in liquid
falling objects (no cranes)
fall from height scaffold
falling objects (cranes)
hazardous gas in breathing apparatus
hazardous atmosphere in confined space
fall from height ladder
in or on moving vehicle
struck by moving vehicle
contact with hanging swinging object

Data

- Use quantification from storybuilds
  - These are probabilities given a reported accident
- Get the exposure data from survey
- NB user survey nr 1 shows that many “barrier failure events” never result in a reportable or reported accident.
  - This should be a warning for drawing improvement conclusions

Causality problem

- In Oldenburg a long term correlation was shown between the number of storks and the number of babies born
- ERGO:
- From he post accident investigation(s)….

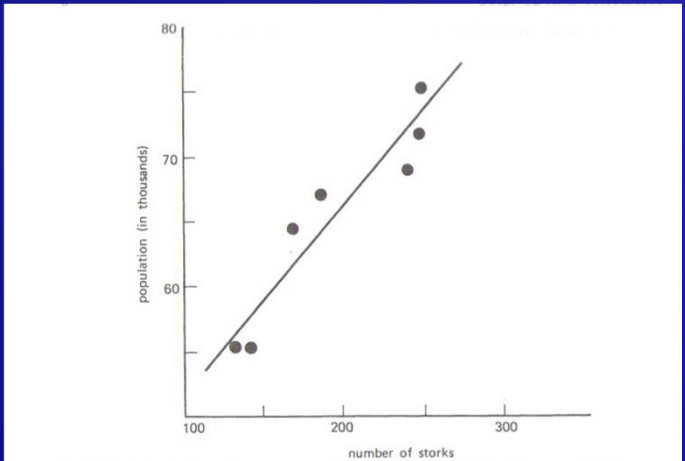


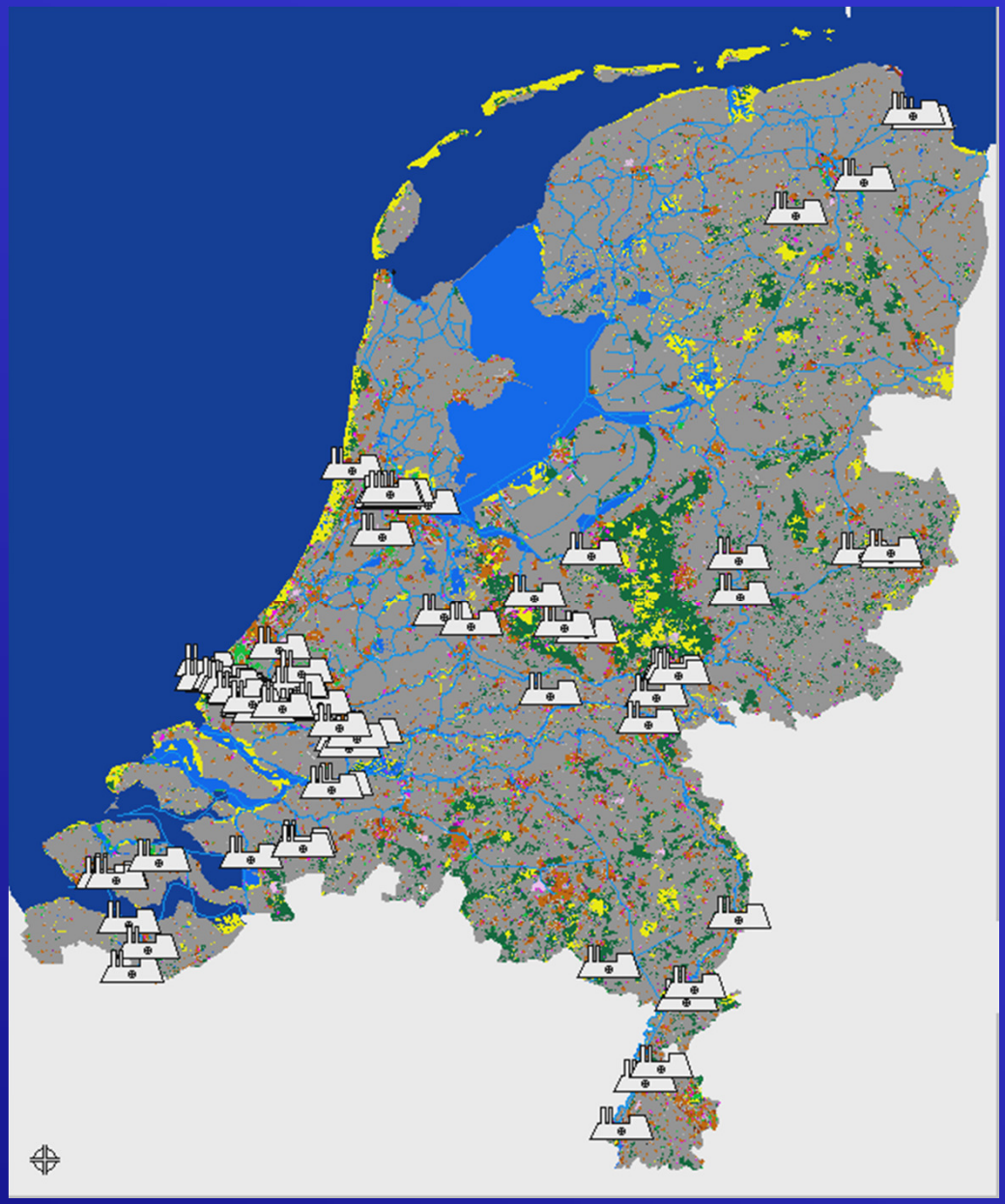
FIGURE 1.4. A plot of the population of Oldenburg at the end of each year against the number of storks observed in that year, 1930–1936.

Find the accidents problem

- Events with very low probability (say 10-5 or lower)
- Either need long perion of observation
  - But Homo Sapiens only exists for 200,000 yrs
- Or large population

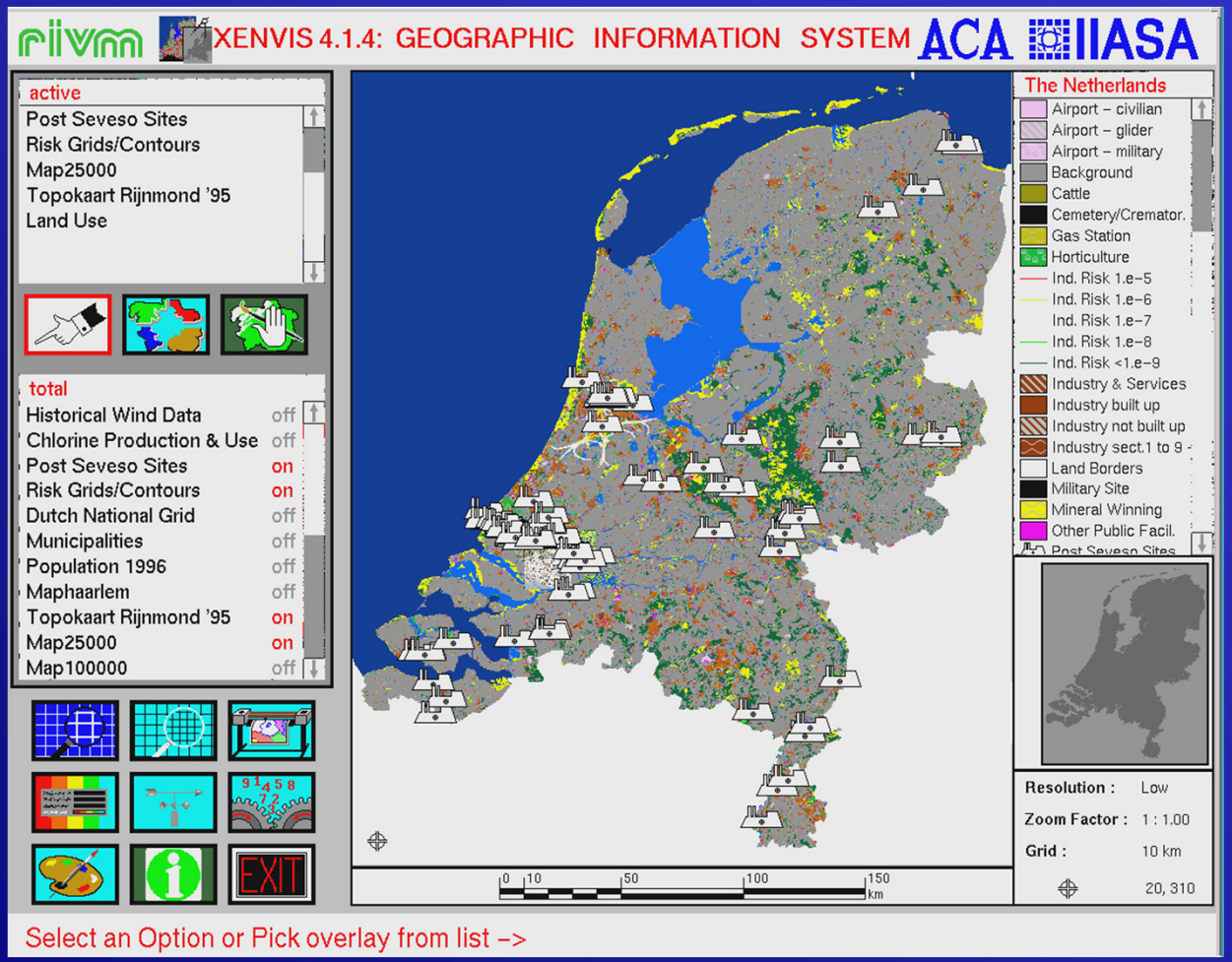
- And to significant it would be better to have 10M than 1M observations.
- IE Big Data

Location of hazardous sites in the Netherlands

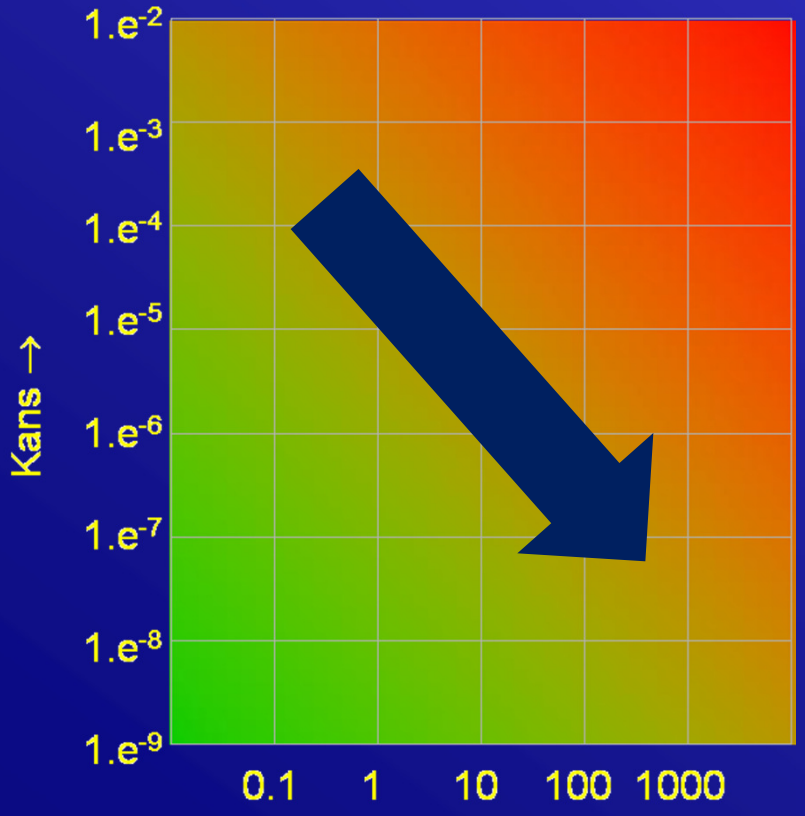


National risk-contours

Locatie informatie



Large consequence, small probability, large uncertainties



Swans

- Were all white
- Untill 1697
- There proved to be black ones too
  - Willem de Vlamingh

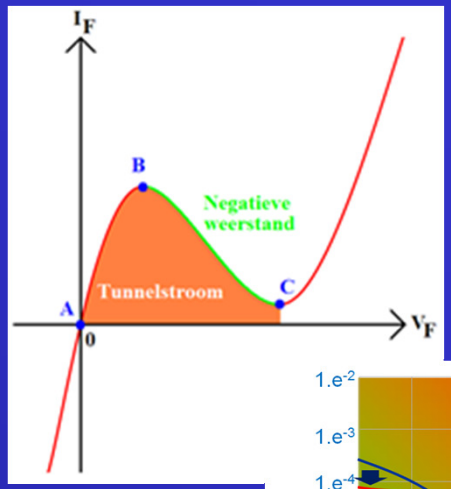
Dragons

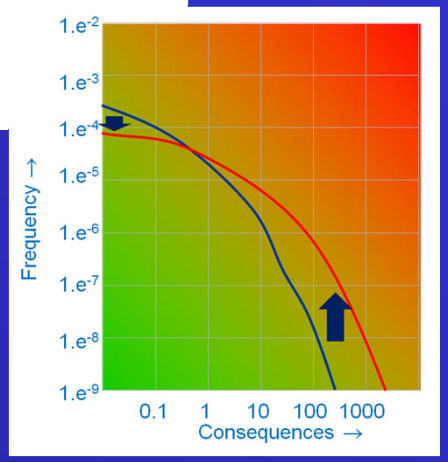
- There are millions of books about dragons
  - (and there was not one about black swans)
- Do we need an anti dragon defense shield (ADDS)

- And if we think we don't, what are we going to say, when one appears.

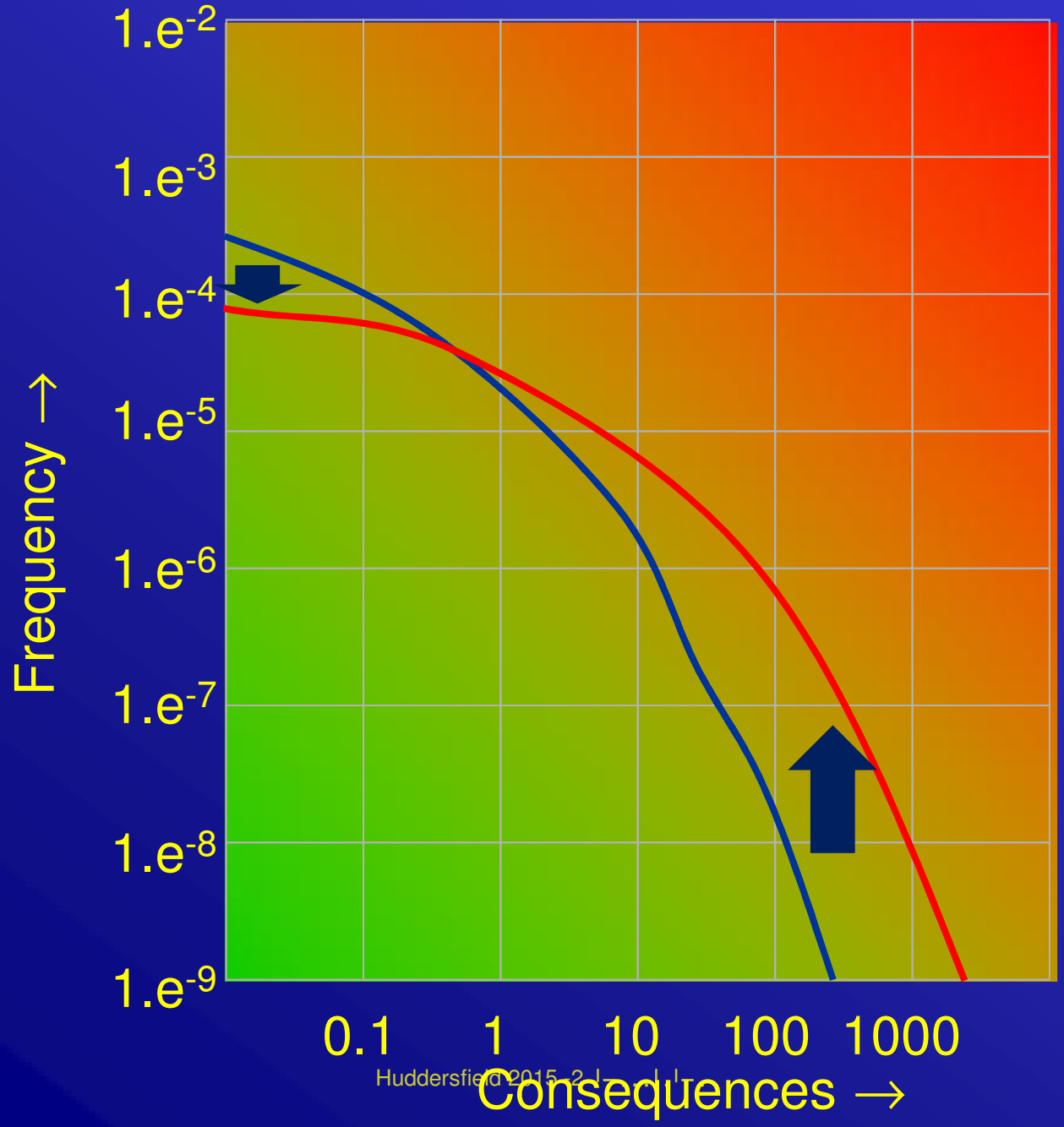
Non zero is NOT ZERO

- Tunnel diode
- Eleven meter tsunami's
- Stock prizes going down
- People not paying there debts
- Floods in the Netherlands
- Oil wells kicking back
- …..etc





- Much of the political debate is because politicians (and managers) confuse low probability with zero probability
  - (This will not happen to us)



Variability rotates the FN curve counterclockwise

If we treat epistemological uncertainty the same as variability it has the same effect.

But variability we (could) know
In uncertainty we do not know

Variability inceases the probability of (large) accidnets

If you can

- Do some work and improve your information position
  - But for purely aleatory problems this will not help
- Better estimate of the outcome
- Better estimate of the uncertainty
- You might learn something.

Reduce variability (if you can)

- Same as quality control really
- So monitor the behavior of people and give feedback.
- Eg consistent speed profiles reduce the probability of SPAD.
- But this requires more data (and the data become big)

- Laws of nature – as we understand them - usually apply
  - A change in our understanding is very unlikely
- Mathematical logic usually applies
  - But this is sometimes difficult to accept
- Often the question is not WHETHER something can happen but WHEN it will happen.
  - And whether you can avoid the consequences.


Think
Think Big
Think Big Data
But Think First
The End