NTNU

Kunnskap for en bedre verden

MIRMAP – Modelling Instantaneous Risk for Major Accident Prevention

Stein Haugen
Institutt for marin teknikk
NTNU

Hva er risikoanalyse?

Risikoanalyse er mange avanserte beregningsmetoder, store mengder data og utstrakt bruk av kunnskap og erfaring

eller….

Risikoanalyse er en hjelp til å ta beslutninger som påvirker risiko

Innhold i presentasjonen

- Om prosjektet
- Beslutninger
- Beslutningstyper
- Operasjonelle risikoanalyser vs strategiske
- Risikotyper
- Usikkerhet

- Presentasjon av metoden

- Bruksområder og avslutning

Før oppstart

- Forprosjekt finansiert av Gassco
- Søknad til PETROMAKS i 2012 – NFR, Statoil og Gassco finansiering

- Ny søknad til PETROMAKS i 2013 – i praksis samme søknad

MIRMAP (2013-2017)

- Modelling Instantaneous Risk for Major Accident Prevention
  - Finansiert av:

    The Research Council of Norway GASSCO Statoil

  - Budsjett ca 10 mill kr
  - Forskningspartnere

    NTNU Institutt for marin teknikk SAFETEC

    NTNU Samfunnsforskning AS Preventor

  - Xue Yang, PhD-student ved NTNU

Objectives

As expressed in the project plan:

- “The objective of this project is to explore and define the concept of *instantaneous major hazard risk* and how this can be analysed in *living risk analysis*, as a basis for providing better decision support in an operational setting.”

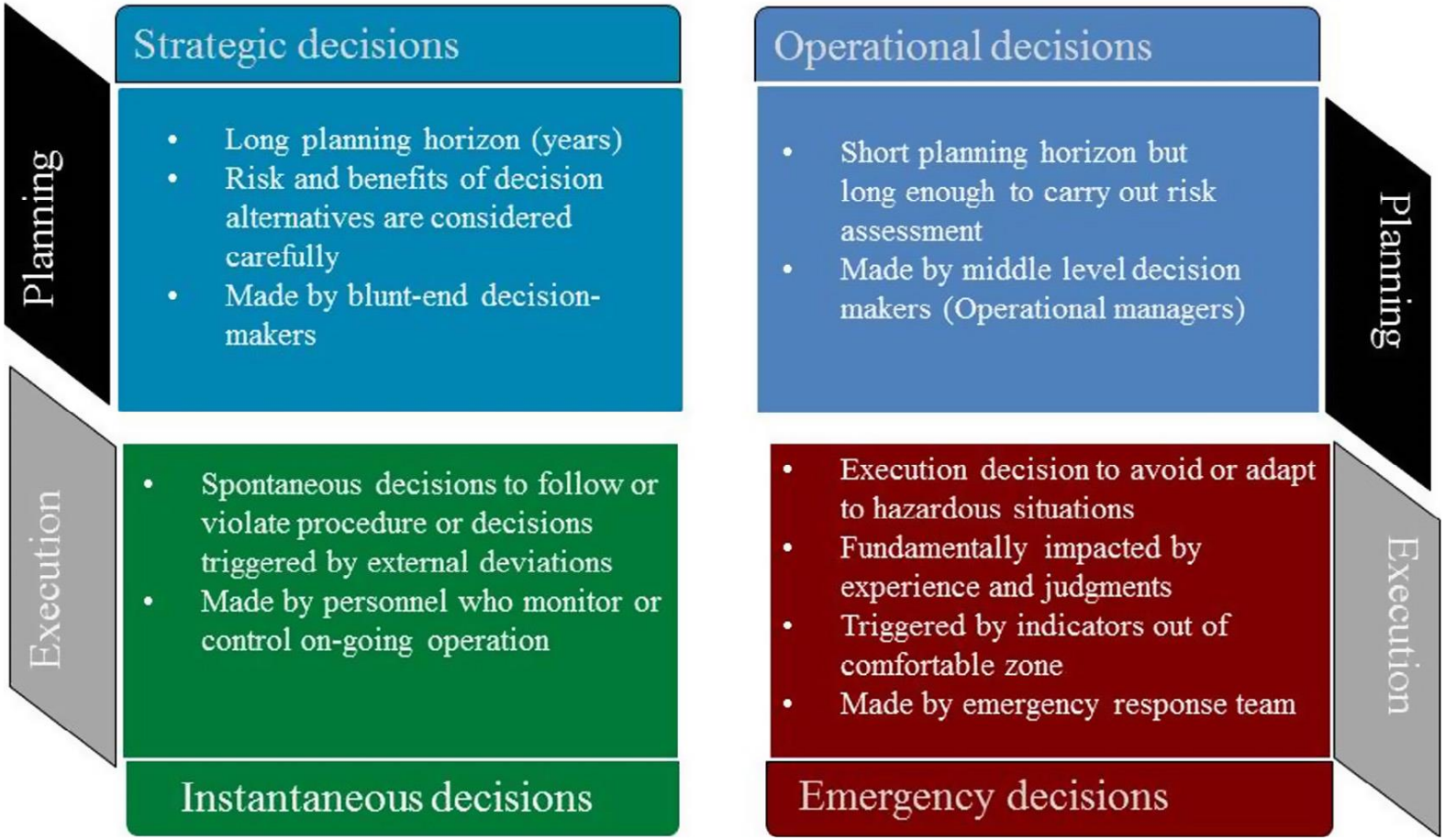
- Focus on providing better decision support to operational planning and decision-making
  - Work-order preparation and planning, work permit preparation and planning
  - Not execution («sharp end»)
  - Major acidents, not occupational

Decisions

- Long-term decisions (strategic planning)
  - The plant lifetime should be extended for another ten years – do I have to upgrade my safety systems?
  - My maintenance costs are a heavy burden – can I reduce the cost and still maintain acceptable safety?
  - What explosion overpressure do I need to design for to achieve acceptable safety?

- Day-to-day planning of activities (operational planning)
  - Is it safe to perform all of these activities at the same time?
  - The most experienced operator on the shift is off sick – do I have to postpone some activities?
  - This is a complicated operation with potentially high risk, but it needs to be done – is it safe to do now?

Decisions


Planning
Strategic decisions
Long planning horizon (years)
Risk and benefits of decision alternatives are considered carefully
Made by blunt-end decision-makers
Operational decisions
Short planning horizon but long enough to carry out risk assessment
Made by middle level decision makers (Operational managers)
Planning
Execution
Spontaneous decisions to follow or violate procedure or decisions triggered by external deviations
Made by personnel who monitor or control on-going operation
Instantaneous decisions
Execution decision to avoid or adapt to hazardous situations
Fundamentally impacted by experience and judgments
Triggered by indicators out of comfortable zone
Made by emergency response team
Emergency decisions
Execution

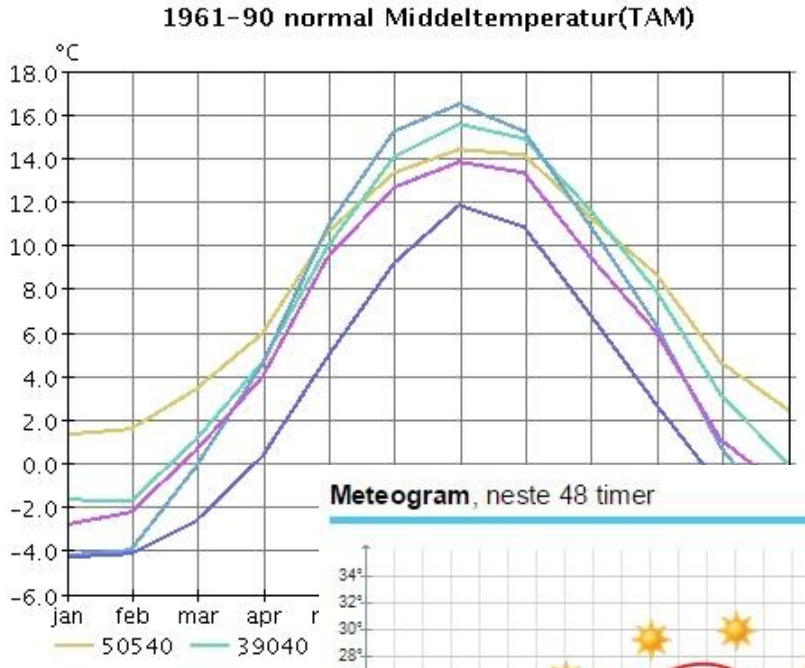
A problem with QRAs?

- QRAs and the methodology was originally developed to support strategic decisions
  - Largely successful in reaching this target
- Like all engineering models, QRAs are simplifications of the real world
  - Take into account (only) the factors that are important for the result
  - Explicitly model (only) factors that we can influence
  - Explicit: Layout and equipment
  - Implicit: Activities and organization
- What happens when we need to support other types of decisions, with other factors that can be influenced?

A long-term (strategic) decision:
The weather is awful - I want to move!

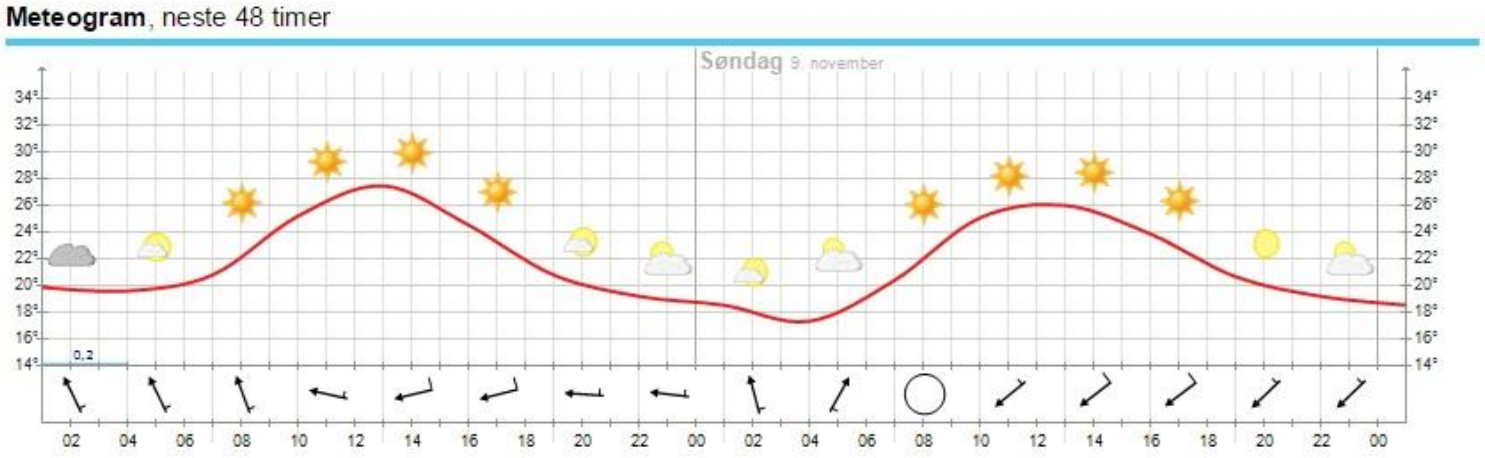
A short-term (operational) decision:
What should I do this weekend?

Decision basis



Climate statistics?

Or weather forecast?



Our hypothesis: «Risk climate» and «risk forecast» is not the same – and we need both for different decisions

Design vs Operation

- Design
  - Develop a solution that in the long term gives the lowest risk on average over the life-time of the system that we are designing
  - Can change technical solutions and average level of operations to achieve the goal

- Operation
  - Avoid accidents today
  - Technical systems are largely fixed, can more or less only change operational and organizational factors

Operational planning in oil&gas

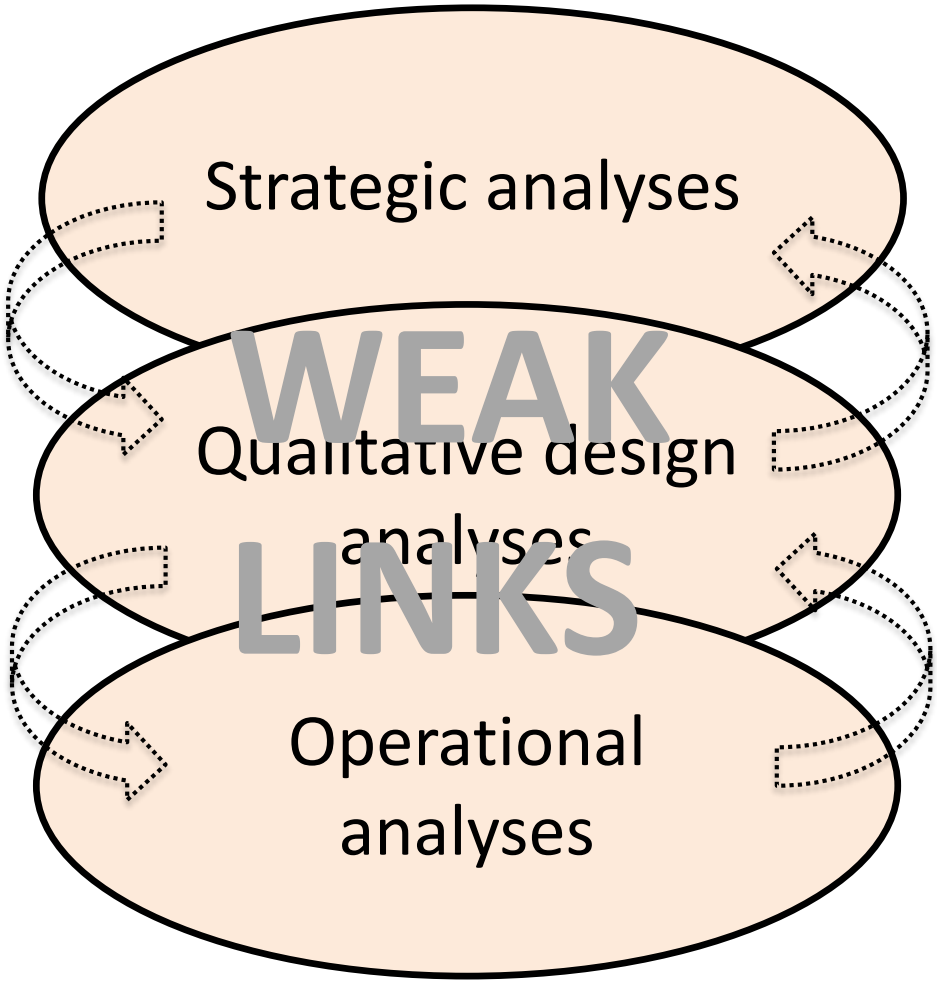
- Key objectives with regard to safety:
  - Each activity must be performed safely
  - The total set of activities must be performed safely together
- Constraints:
  - Technical solutions that are present
  - Possible degradations in barriers – technical, operational and organizational
  - Availability of resources – people, equipment, time,…
  - External conditions
- Put simply the objective is:
  - “We want to get through (also) this day without anyone being killed or injured!”

Types of risk analyses – oil&gas

Quantitative risk analysis (QRA)

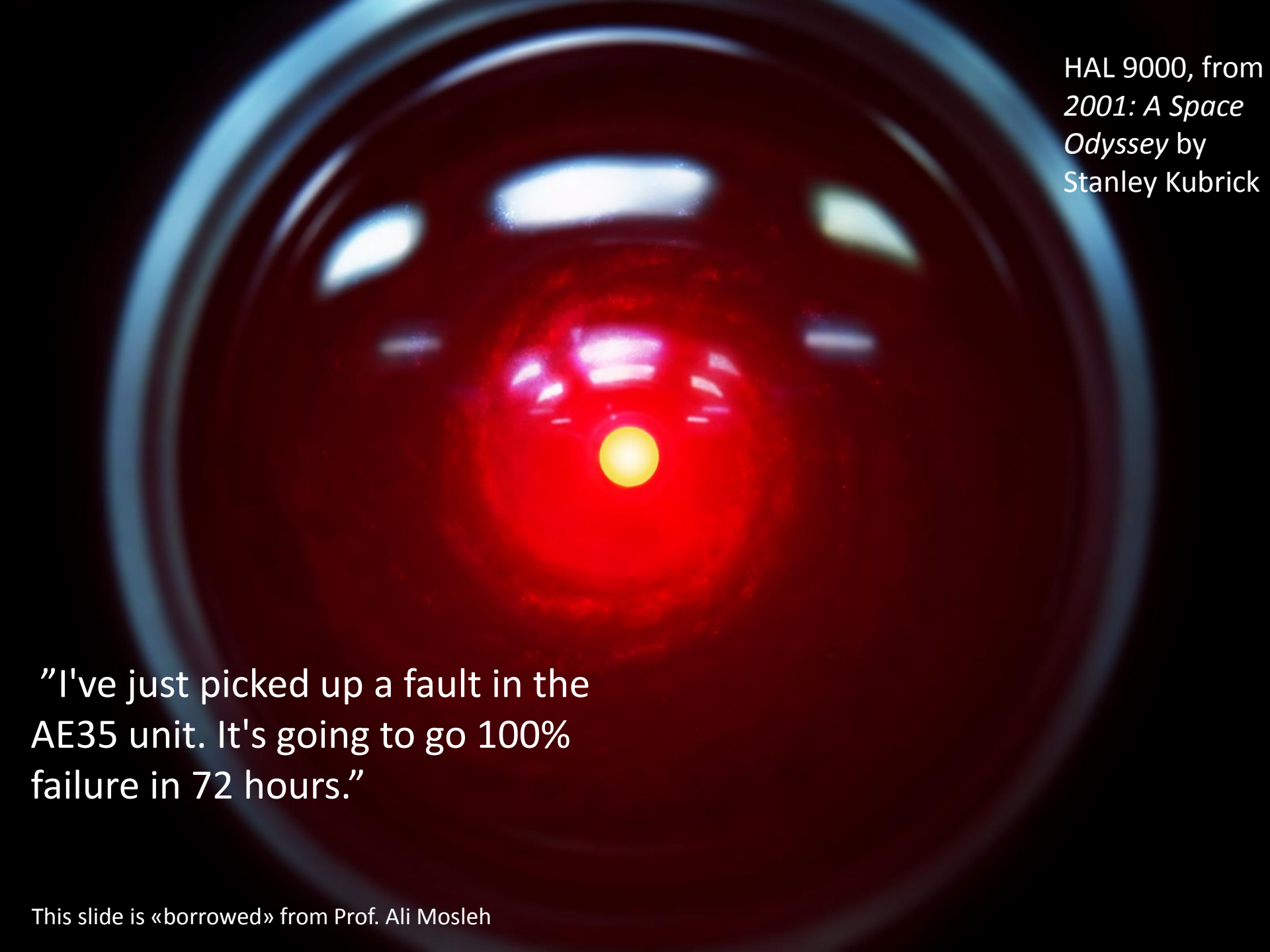
Qualitative analysis mainly (FMECA, HAZOP etc)

Qualitative analysis mainly (Risk matrix, SJA)



«Climate statistics»

«Weather forecast»



HAL 9000, from *2001: A Space Odyssey* by Stanley Kubrick

”I've just picked up a fault in the AE35 unit. It's going to go 100% failure in 72 hours.”

This slide is «borrowed» from Prof. Ali Mosleh

What we have tried in MIRMAP

- Develop a method that can exploit the strengths of both QRA and operational risk analysis

- Some elements of this:
  - Activity-based risk analysis taking into account the configuration and the condition of the technical systems
  - Quantitative, to enable ranking of activities
  - Using relevant models and information from QRA to the extent necessary and useful

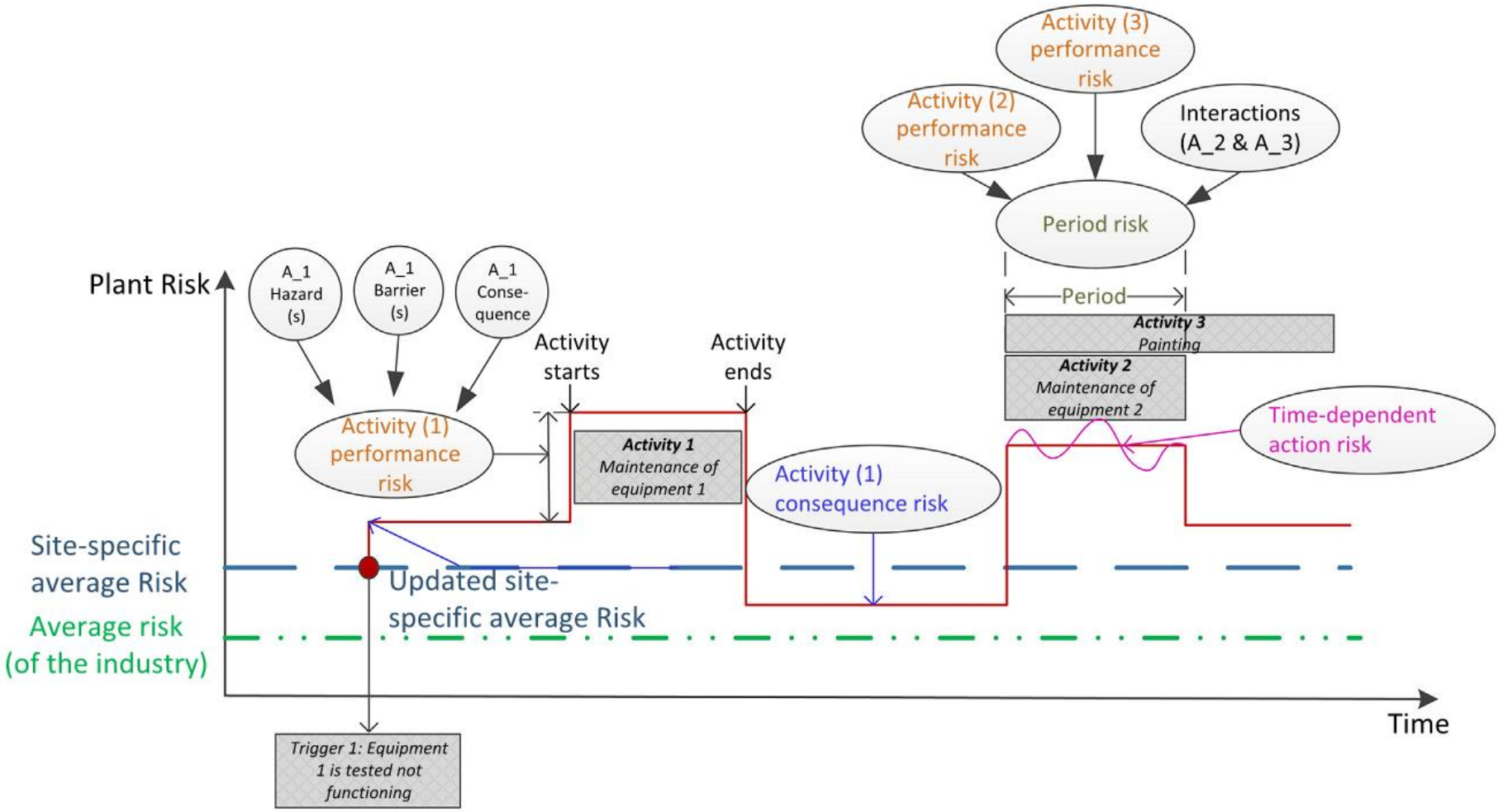
Challenges

- To have a good understanding of risk
  - Short-term and long-term effects of decision alternatives
  - Individual activities
  - Totality of activities
- To incorporate the (many) constraints in the decision basis

$\Rightarrow$ To make consistent decisions
  - Safe…
  - …but not overly conservative

Risk «types»

Risk type		Description
Average risk		Risk for an industry, a nation or an even wider scope averaging over a large group of plants, activities, areas and personnel
Site-specific average risk		Risk for a specific plant, averaged over a year and taking into account specific characteristics of the particular plant
Activity risk	Activity consequence risk	An expression of the effect that completing an activity will have on the risk level after the activity has been completed (risk after the activity)
	Activity performance risk	An expression of risk level associated with performing a specific activity (risk during the activity)
Period risk		An expression of risk for a plant or facility over a (normally short) period of time
Time-dependent action risk		An expression of short-term risk variation while performing one or several activities


Activity (3) performance risk
Activity (2) performance risk
Interactions (A_2 & A_3)
Period risk
Period
Activity 3 Painting
Activity 2 Maintenance of equipment 2
Time-dependent action risk
Plant Risk
A_1 Hazard (s)
A_1 Barrier (s)
A_1 Conse-quence
Activity starts
Activity ends
Activity (1) performance risk
Activity 1 Maintenance of equipment 1
Activity (1) consequence risk
Site-specific average Risk
Updated site-specific average Risk
Average risk (of the industry)
Time
Trigger 1: Equipment 1 is tested not functioning

Risk Classification

Measuring risk

- The key is avoiding accidents – more focus on probability (or uncertainty) than risk
  - Statistically expected consequences are not relevant in the same way as in strategig decision

- Relative risk
  - Ranking of activities, absolute values are not focused on

Lack of knowledge

- A key difference between strategic risk analysis and operational risk analysis is the use of probabilistic vs factual information
  - Strategic, long-term: Use average probability of failure of barriers, average number of operations, average number of people in area, etc
  - Operational: We can to a much larger degree know if barriers are working or not, what operations are taking place, who will be present, etc
- Uncertainty is expressed in terms of lack of knowledge

Presentasjon av metode

- Over til Nathaniel!

Potential use

- When preparing Work Orders
  - How much will «my» WO contribute to risk, based on the plant status as it is today?
  - Identify limitations to be taken into account in planning
- When preparing plans up to 3 months ahead and to Work Order Plan
  - Earlier identification of all WOs with high risk
  - More consistent comparison and evaluation
- During preparation of Work Permits
  - Which WPs represent a high risk? Prioritize
- Work Permit Meeting (approval)
  - Better and more consistent basis for comparing, approving and modifying activities

Work required

- Developing a MIRMAP risk analysis will require significant effort
  - Less than QRAs that are performed today
  - Replacing existing QRAs will imply similar effort
  - Model can be run on a daily basis with very limited effort
- Risk model “templates” for activities?
  - Many similarities between plants
  - A library of models will save time and effort

Availability of data

- Input from the QRA will be applied
  - Technical systems, consequences – relatively static information, long intervals for update (years?)
- Daily updates
  - Types of activities, number of activities, where they are taking place, how many people are involved, systems/-components that have failed, maintenance status, etc.
  - Data collection must be automatic to make this feasible and cost-effective in practice.
- Information is typically available in the maintenance management/planning system and the work permit system.

Conclusion

- The main «finding» from MIRMAP is that we need to remind ourselves why we do risk analysis!
- After we understood this, we could use standard risk analysis methods to develop suitable input to decisions

- Testing has indicated:
  - Can identify high risk contributors among activities
  - Sensitive to differences
  - Can support understanding of why risk is high
  - Can improve planning