Investigation of complex accidents, analysing and learning from accidents

Workshop Croatian Institute for Health protection and safety at work 23-26th May

program

- Accident causation
- Complex accidents
  - Stakeholders
  - System levels involved
- Accident investigation
  - Methods
  - Project
- Getting impact
  - Addressee
  - Learning cycle


Complex accidents

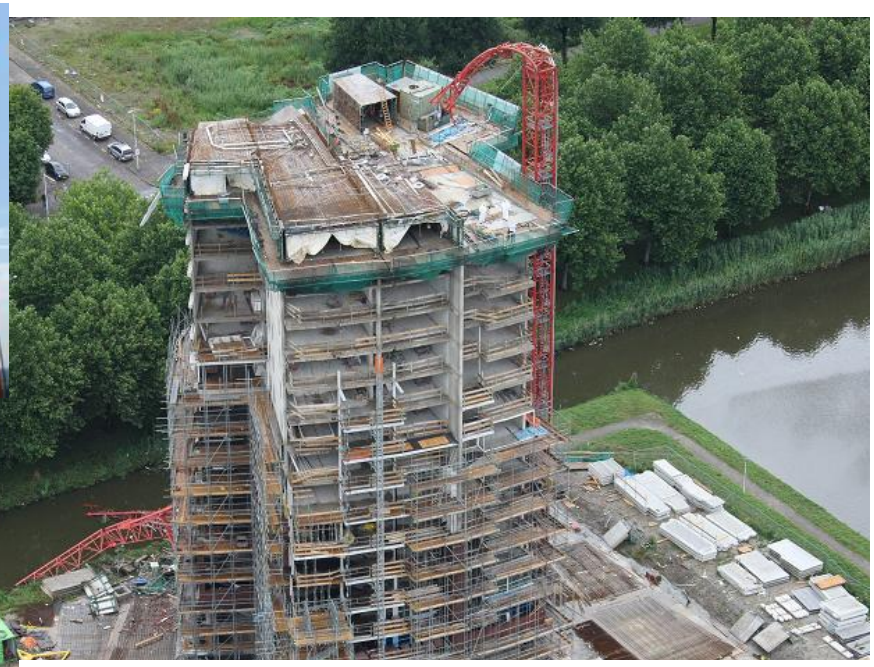
Accident: a moment…..

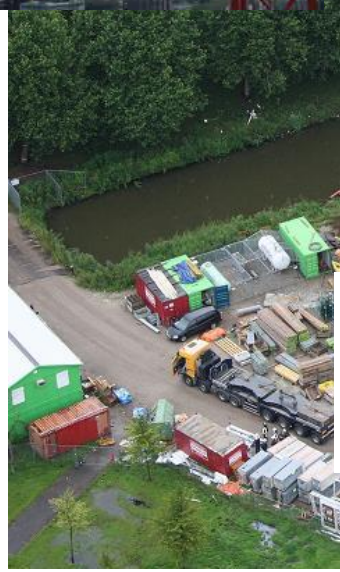
When we understand that what we saw as safe was wrong (Turner)

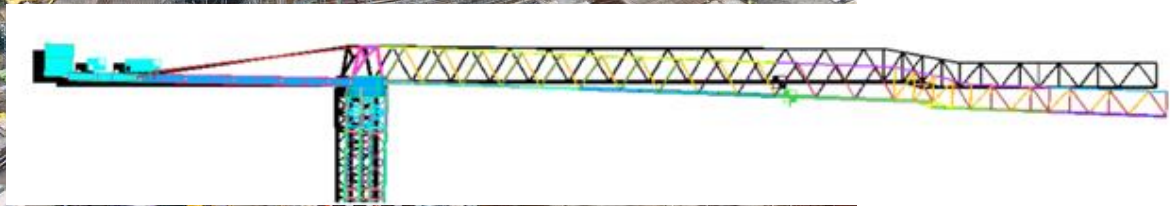
An opportunity to learn!

Complex?

What you look for is what you get







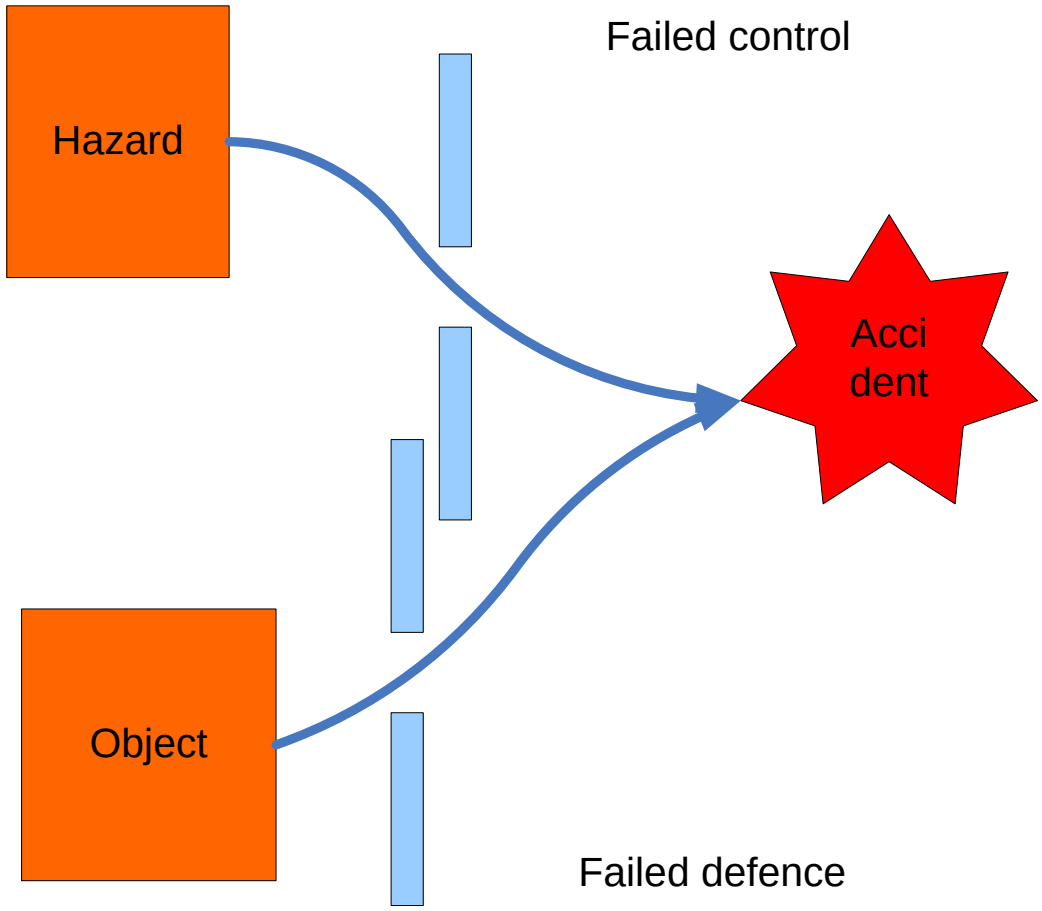
Example risk matrix used by oil companies

INCREASING PROBABILITY →

INCREASING SEVERITY ↓

Potential Severity	People	Asset/Production	Environment	Reputation	A Never Heard of in industry	B Has occurred in industry	C Has occurred in NPC	D Occurs several times a year in NPC	E Occurs several times a year at this site	Analysis level
1	Slight injury First Aid or medical treatment	Slight Damage, no disruption to operation	Slight Effect	Slight Impact (public awareness)		LOW				SUMMARY ANALYSIS
2	Minor injury LWA 4 days or less RWC	Minor Damage (<$1,000,000 / or brief disruption)	Minor Effect	Limited Impact (local public media)			MEDIUM			SUMMARY ANALYSIS
3	Major injury (LTA, PPD < 4 days)	Local Damage ($1-10,000,000)	Localised Effect	National Impact (extensive adverse media)				HIGH		FORMAL INVESTIGATION
4	Single fatality	Major Damage ($10-100,000,000 / partial operation loss)	Major Effect	Regional Impact (extensive adverse media)						FORMAL INVESTIGATION
5	Multiple fatalities	Extensive Damage (>$100,000,000 / & substantial operation loss)	Massive Effect	International Impact (extensive adverse media)				INTOLERABLE		FORMAL INVESTIGATION

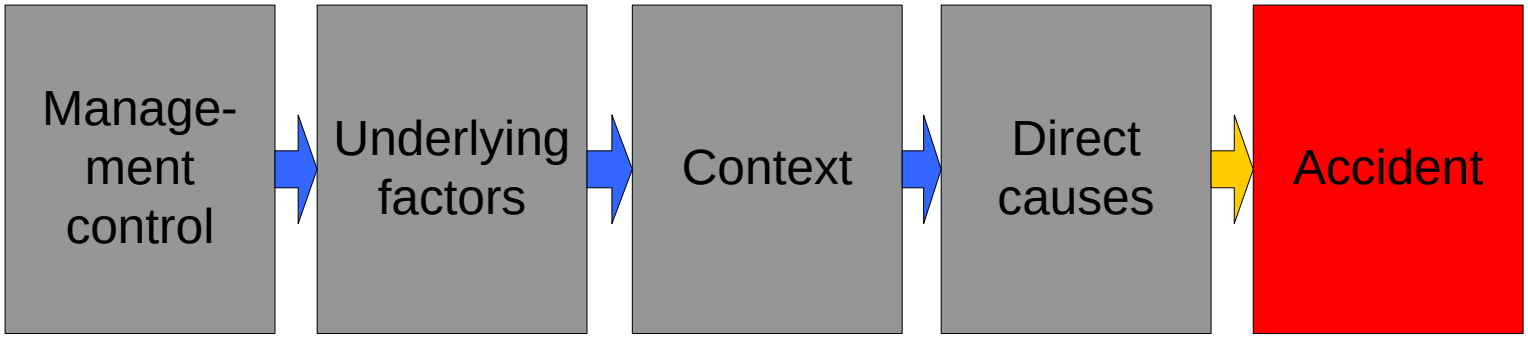
Energy barrier



Factors

- Technical
- Human
- Socio technical (interaction within organizations)
- Inter organizational (dynamic and changing relations)

Accident causation



e.g:

Design

Hardware

Maintenance

Organization

Procedures

Training

Communication

Incompatible goals

Enforcing conditions

Housekeeping

Defences

Direct (immediate) causes

- What, when, how, where, who

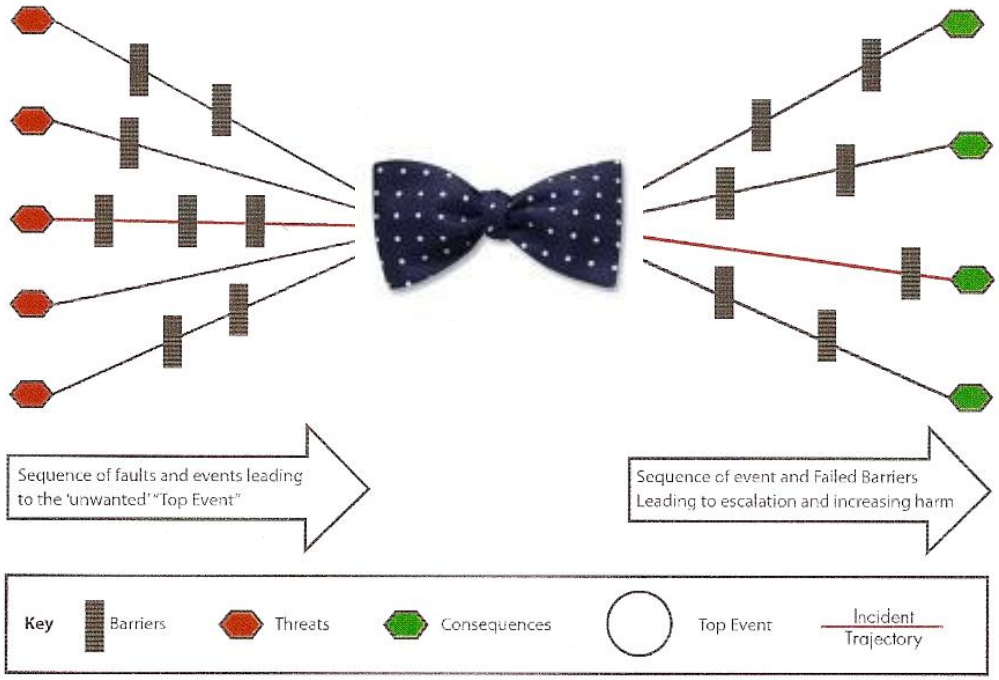
Context

- Why, Why

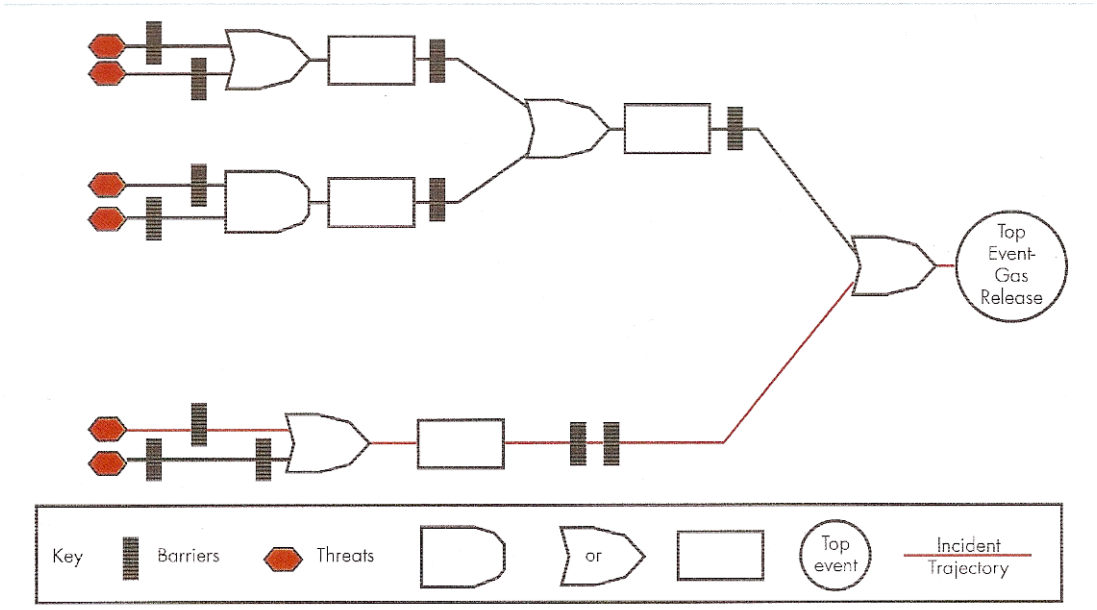
Underlying factors

- Why, why, why,

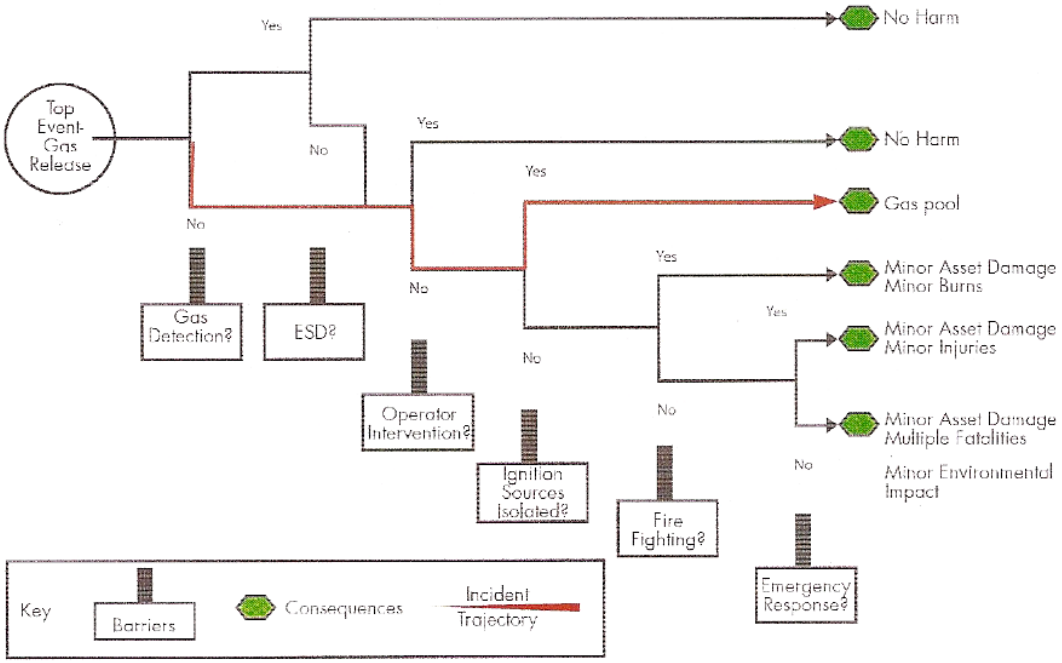
Bow tie

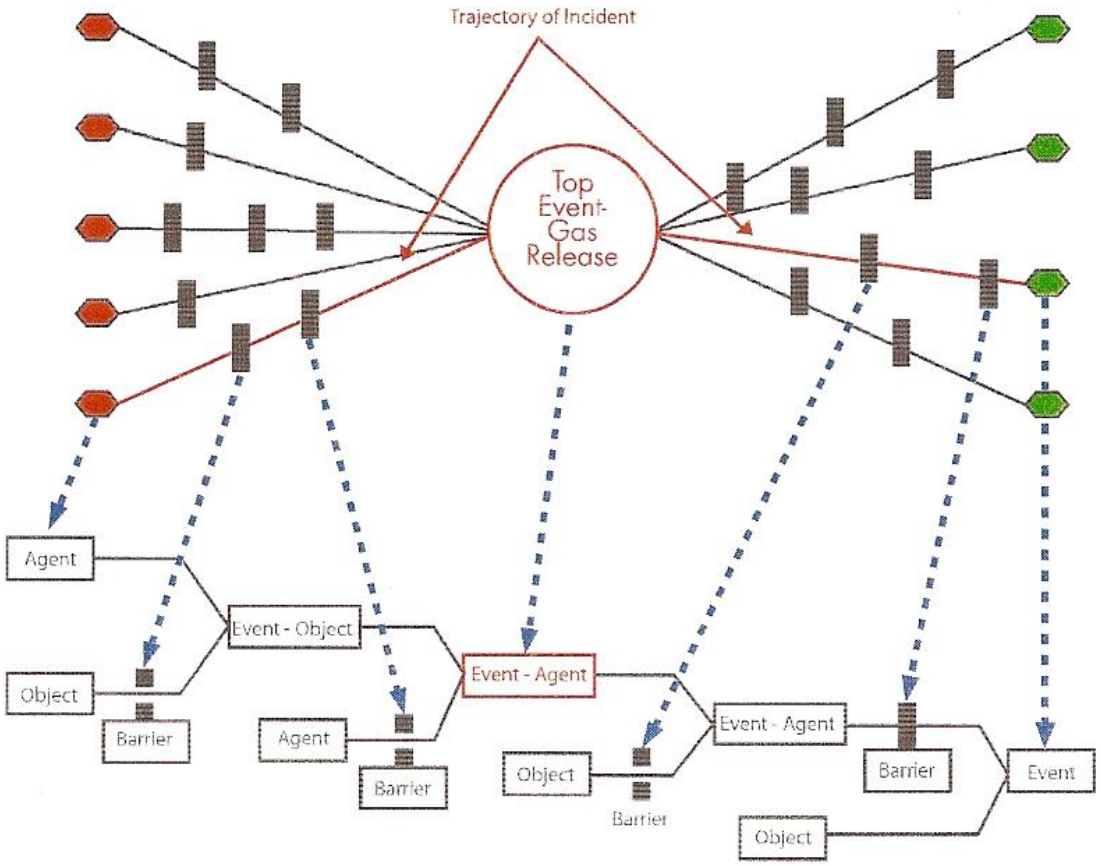

Sequence of faults and events leading to the 'unwanted' "Top Event"
Sequence of event and Failed Barriers Leading to escalation and increasing harm
Key
Barriers
Threats
Consequences
Top Event
Incident Trajectory

Fault tree

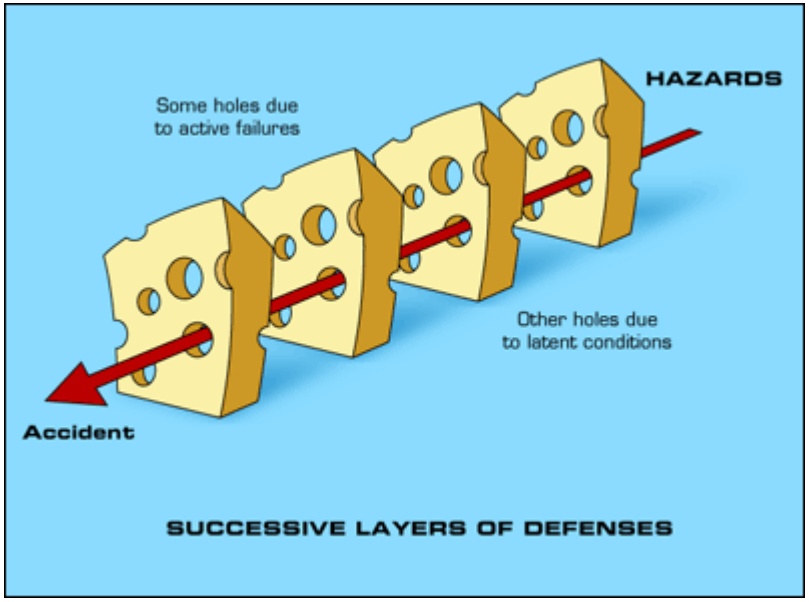

Top Event- Gas Release
Key
Barriers
Threats
or
Top event
Incident Trajectory

Event tree

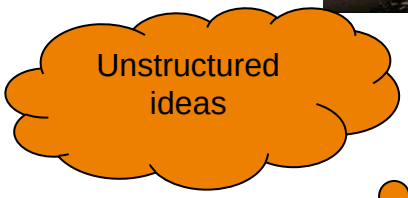

Top Event- Gas Release
Yes
No
Gas Detection?
Yes
No
ESD?
Yes
No
Operator Intervention?
Yes
No
Ignition Sources Isolated?
Yes
No
Fire Fighting?
Yes
No
Emergency Response?
No Harm
No Harm
Gas pool
Minor Asset Damage Minor Burns
Minor Asset Damage Minor Injuries
Minor Asset Damage Multiple Fatalities
Minor Environmental Impact
Key
Barriers
Consequences
Incident Trajectory

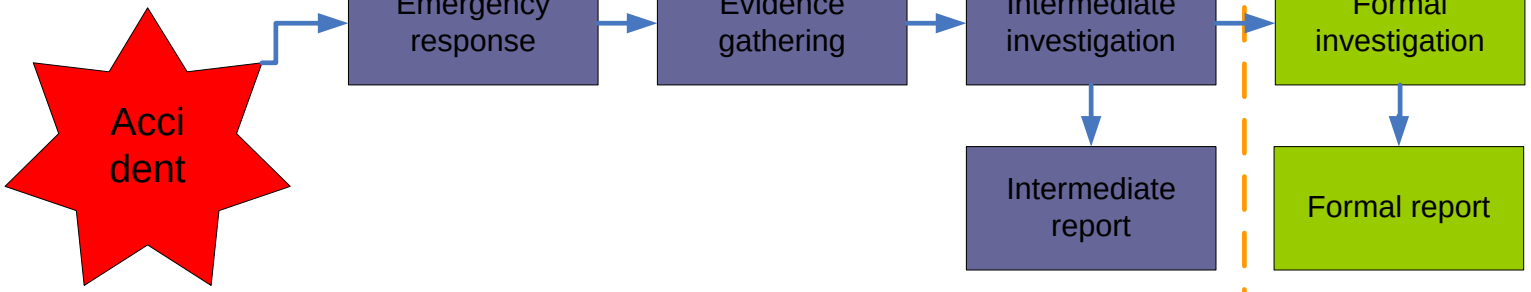

Trajectory of Incident
Top Event- Gas Release
Agent
Event - Object
Object
Barrier
Agent
Barrier
Event - Agent
Object
Barrier
Event - Agent
Barrier
Event
Object

Swiss cheese?

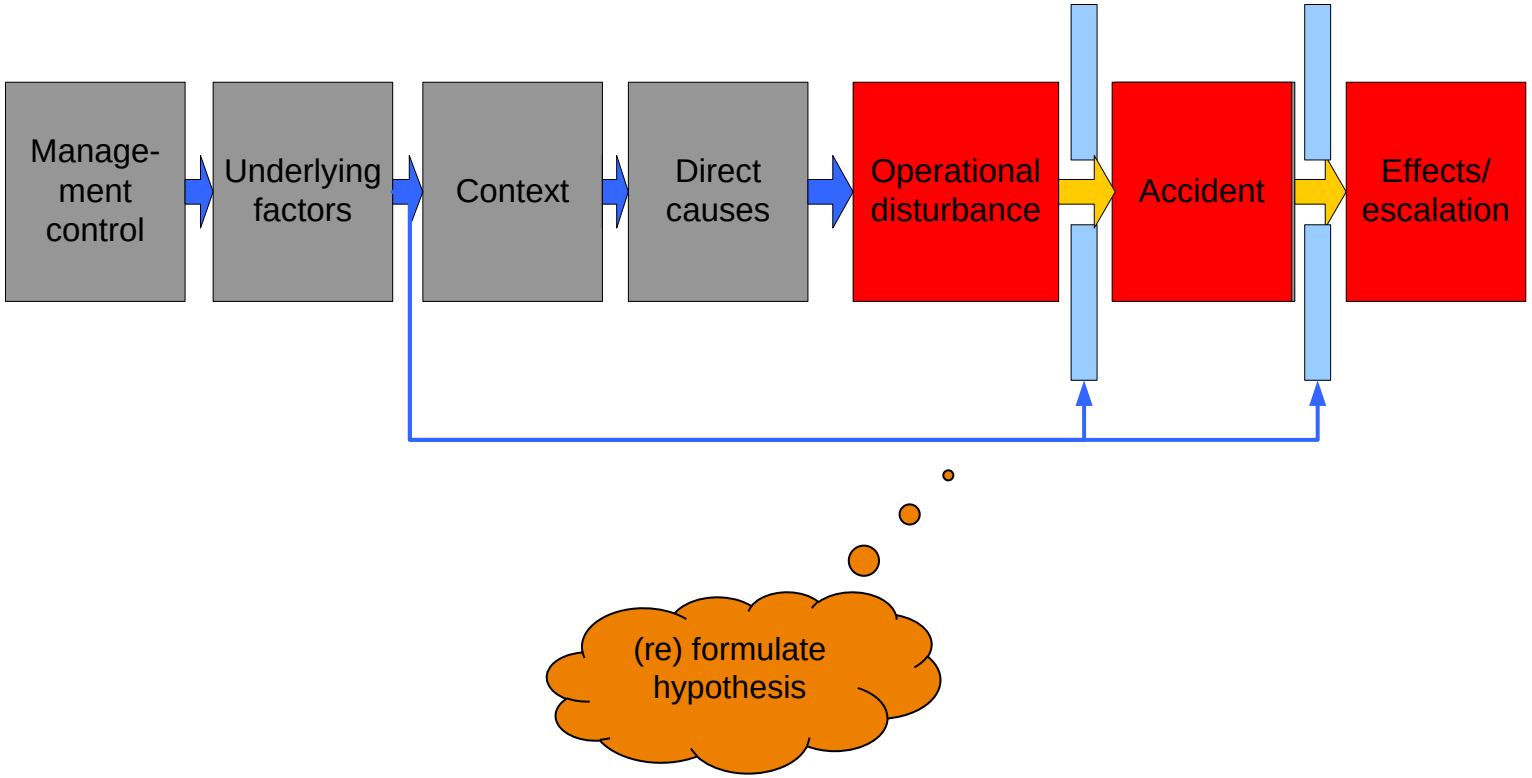


Value of investigation



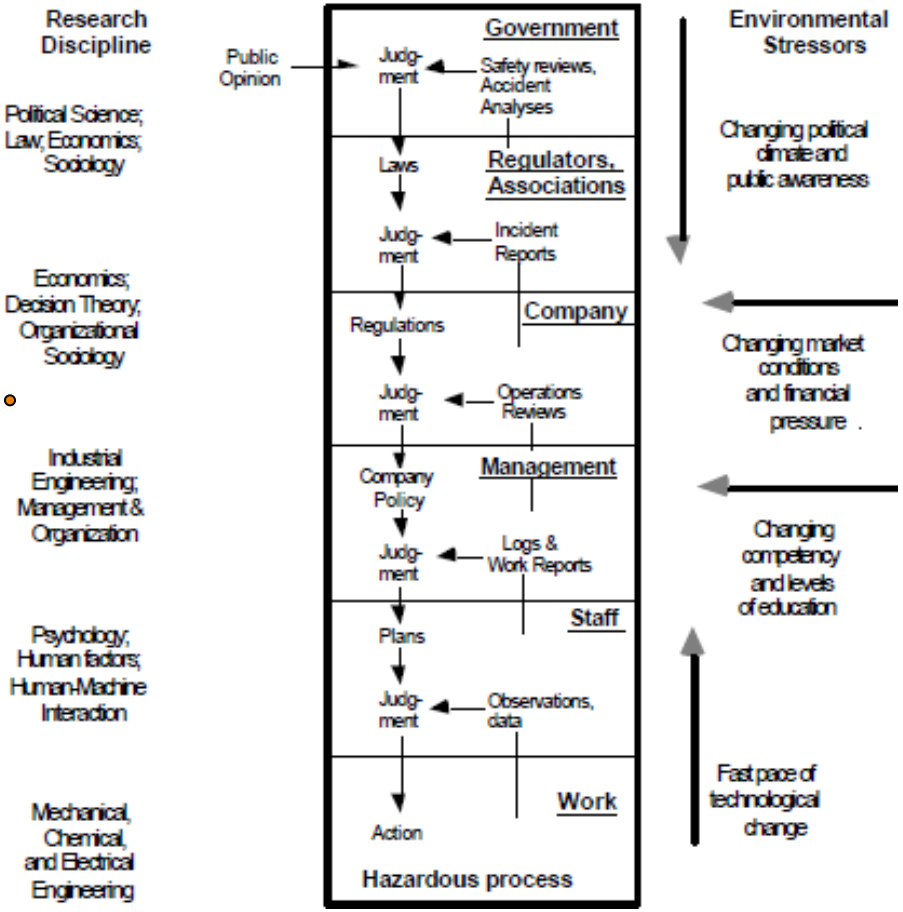


What to look for?



Socio-technical system : who needs to learn?

Borders/scope of investigation?



Source: Rasmussen accimap

Complex accidents: when to investigate

- Risk:
  - Potential for recurrence
  - Potential consequences
  - Population at risk
- System and stakeholders involved: interests, company policy, political pressure
- Legislation and other duties
- Learning impact
- Agreement with authorities

- If necessary commitment, budget, allows it…

What to investigate?

- World view, safety culture company
- Aim: learn or blame, pay?
- Methodology chosen
- Technical, organizational perspective
- Intra or inter organizational (organizational chains, networks)

- Task or project (Instruction, procedures, contract)

Methods (a priori knowledge, models)

- STEP: sequential timed event plotting
- Change analysis: what is difference with accident free situation
- MORT: fault tree of technical organizational factors
- TRIPOD BETA: energy barrier analysis
- STAMP: dynamic system analysis

REF:

•ESREDA

•NTNU

Project organization

How to start (1)

- Relevant?
- Assessment need, aim and value of results
  - Contracts, company procedure, legal obligation
  - Research questions
  - Methodology, world vision
  - No blame. Learning?
  - Who needs to learn?
  - Agreement on independency and objectivity
- Immediate action:
  - Response team available to start investigation on place incident immediately?

How to start (2)

- Intermediate action
  - Determine scope, depth and time line investigation
  - Assess context accident: stakeholders involved, authorities active?
  - Determine relation management
  - Organize investigation team
- Assignment investigation team
- Project organization
  - What, how and when to deliver
- Start and conduct accident investigation

Investigation team

- Project leader
- Research leaders (sub project leaders)
- Secretary
- Team members:
  - independent and objective
  - expertise
  - diverse views
- Back office
  - support
  - data storage
  - Archive
  - Catering

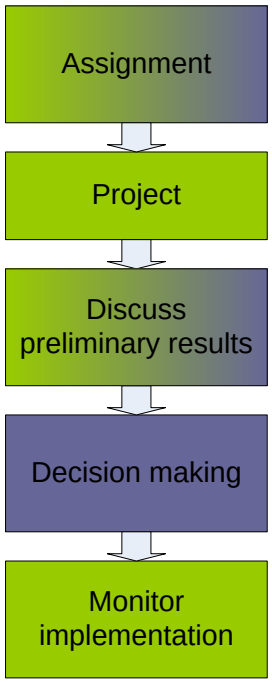
Qualities team members

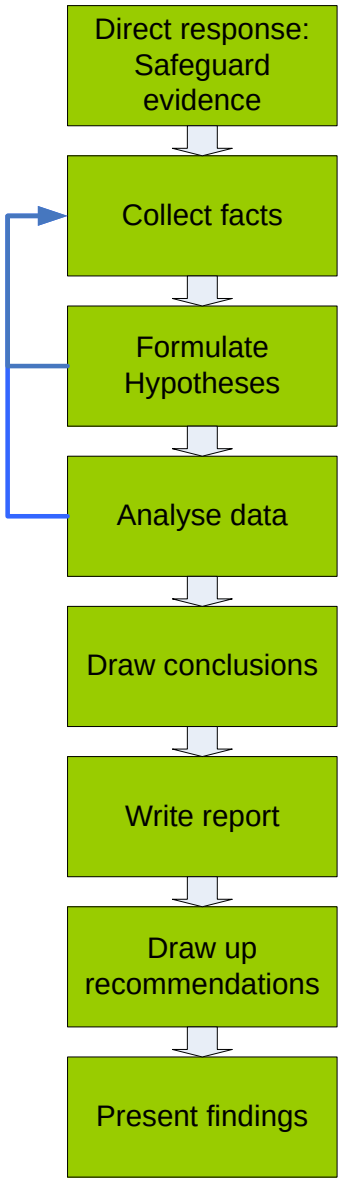
- Integrity
- Objective
- Perseverance to trace symptoms
- Curiosity
- Observing details
- Imagination
- Humility
- Intuition
- Tact
- Robust
- Expertise, skills
- Team player

Terms of reference

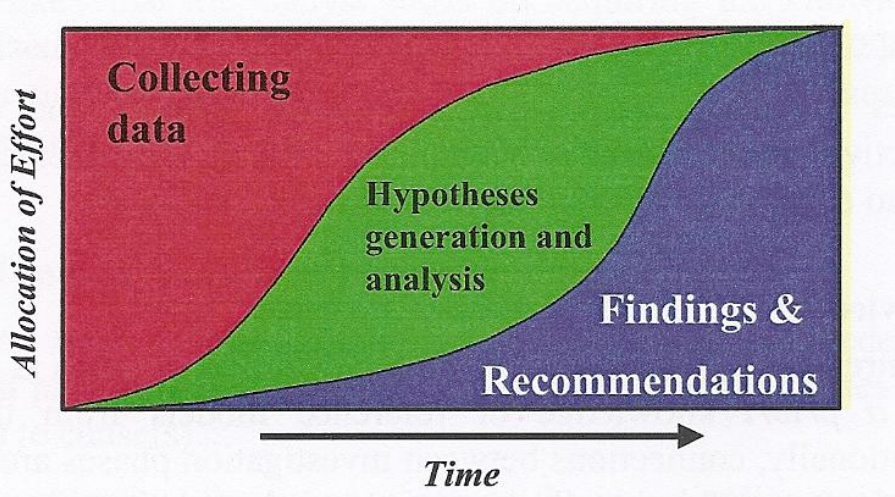
- Link to management, communication lines
- Type of investigation
- Aim
- Research questions
- Scope, object of investigation (system border)
- Project team (leader, memebers, authority)
- To who to report: addressee
- Budget
- Time scale
- Deliverables

Plan


Assignment
Project
Discuss preliminary results
Decision making
Monitor implementation


Direct response: Safeguard evidence
Collect facts
Formulate Hypotheses
Analyse data
Draw conclusions
Write report
Draw up recommendations
Present findings

Balance of efforts



Cope with characteristics aftermath accident

- Complexity, company starting up work
- Communication
- Stakeholders
  - power and authority relations
- Stakeholders on “playing field”
  - criminal investigation team
  - authorities
  - insurance
  - investigation board
- Addressee(s) asking for preliminary results
- Pressure for results
- Coping with external influences

Conducting the investigation

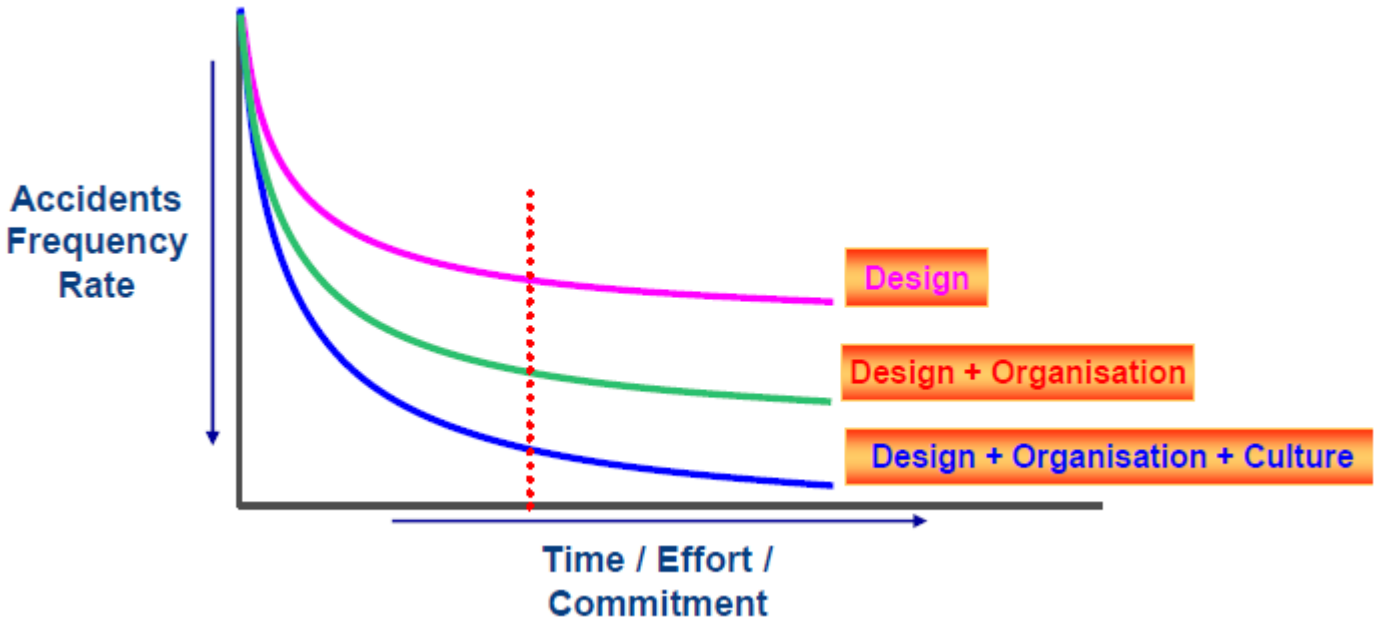
Key data to be covered: fact finding

- The event
  - process, activity
  - consequences
  - place, parts, positions
  - functions, roles, people
  - timeline
  - identify witnesses
  - work documents

Needed:

- *Camera*
- *PPE*
- *Recording device*
- *Measuring device*
- *Sample containers*
- *Identification tags*
- *Torch*
- *Catering*
- *Etc.*

Aspects to be taken into account



DOES and DON'Ts

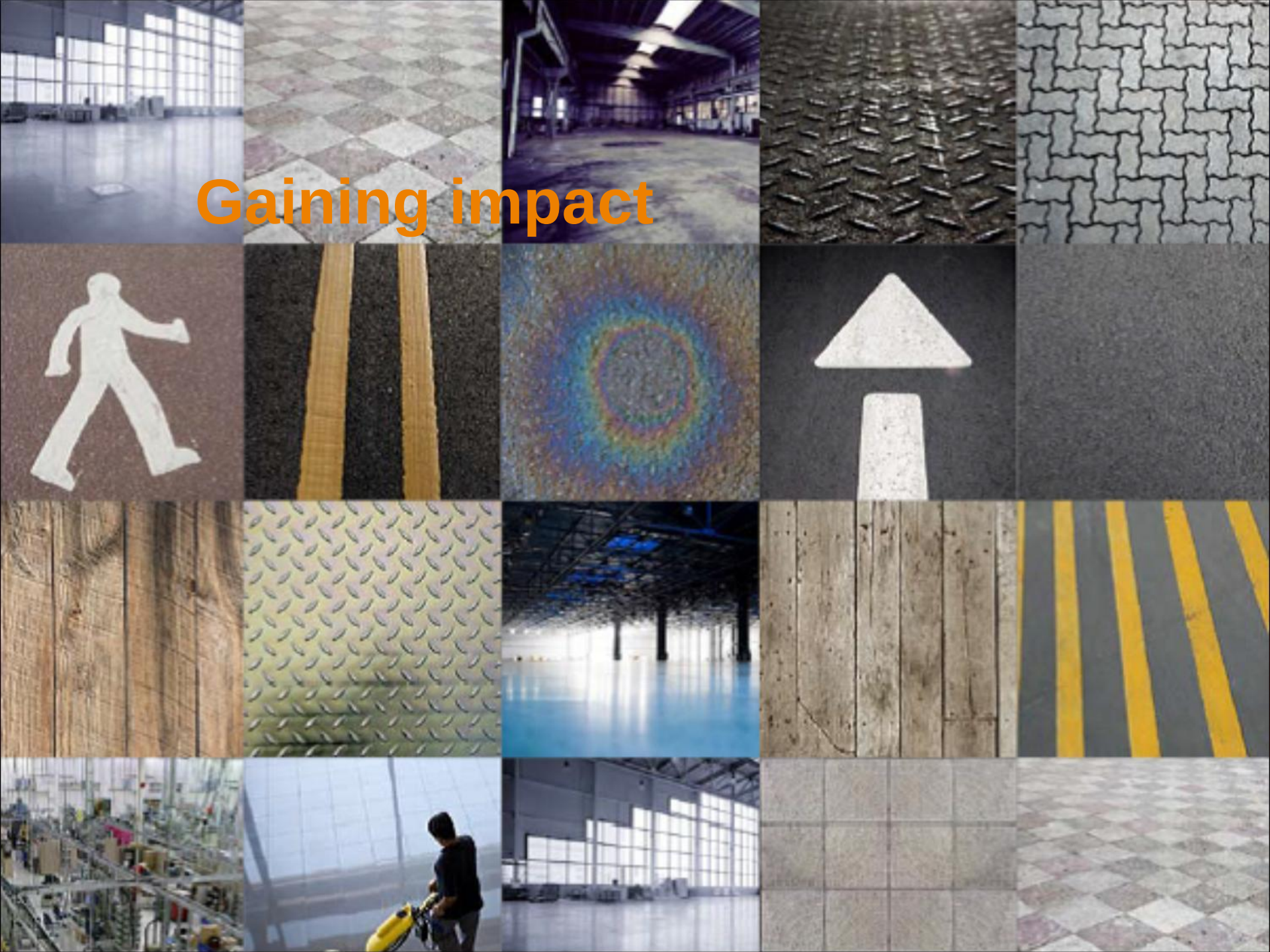
- Do not:
  - Be subjective
  - Not fact based
  - Communicate outside project team
  - Looking for guilty person: who's to blame
  - Work beyond scope without agreement of commissioner

- Have open mind and be objective, professional, reliable, aimed at learning!

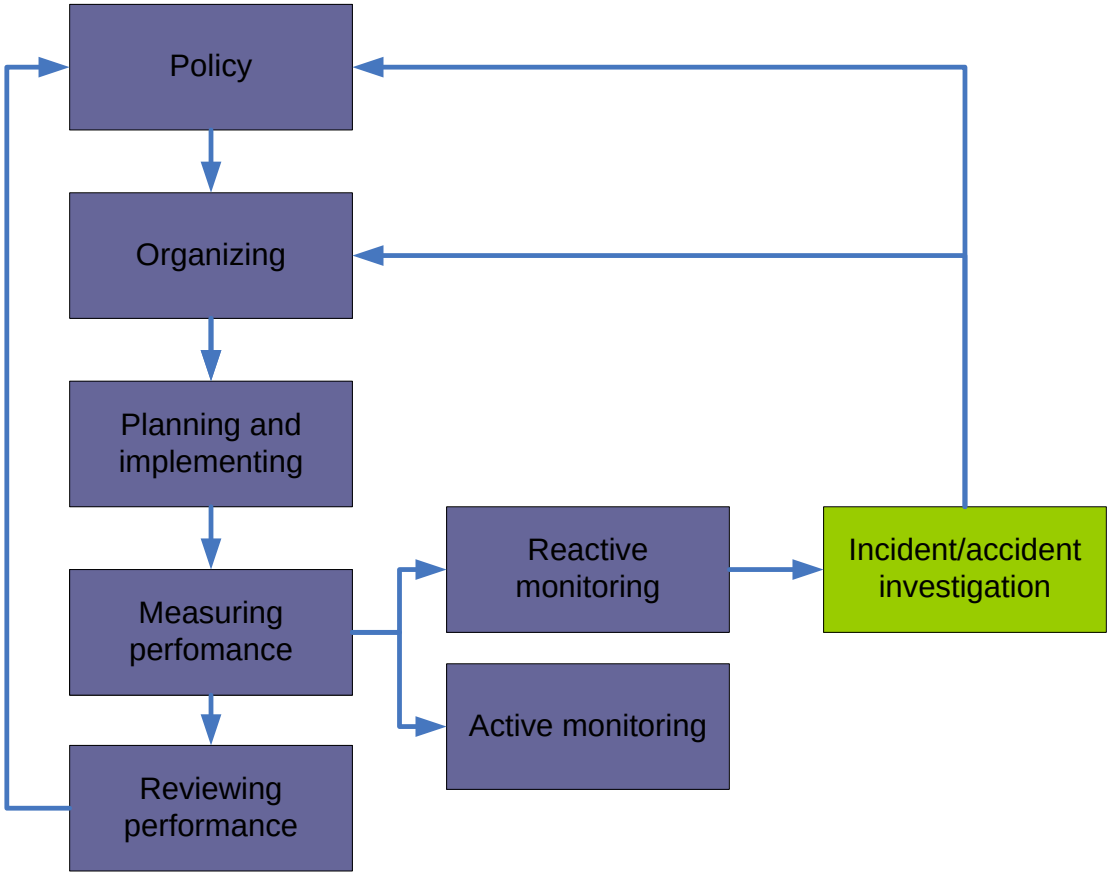
How to report

- Final aim: learning

- Summary
- Back ground and purpose
- Factual information
- Analysis/methods followed
- Results
- Conclusions
- Urgent recommendations
- Safety recommendations
  - If possible and wanted: site letter with expert opinion (other learning opportunities)
- Dissemination and communication results

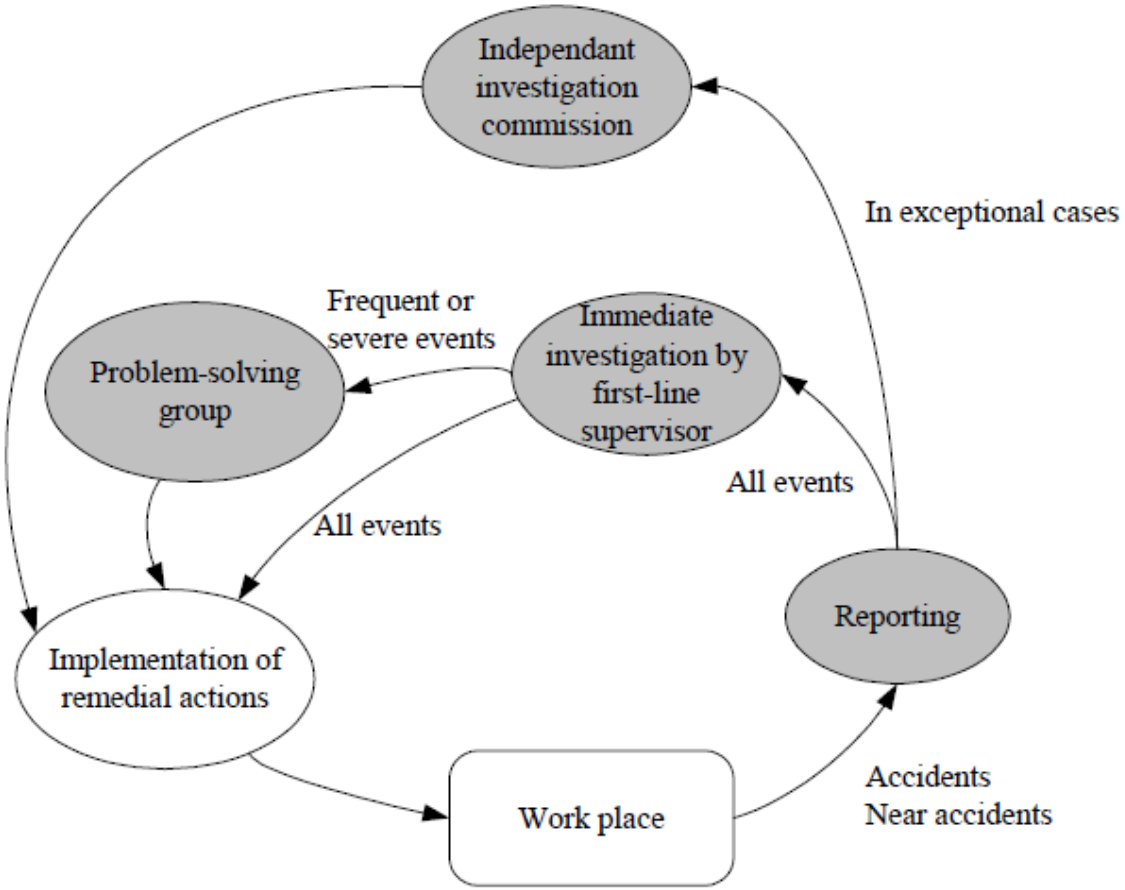

Gaining impact

OHS management: learning cycles

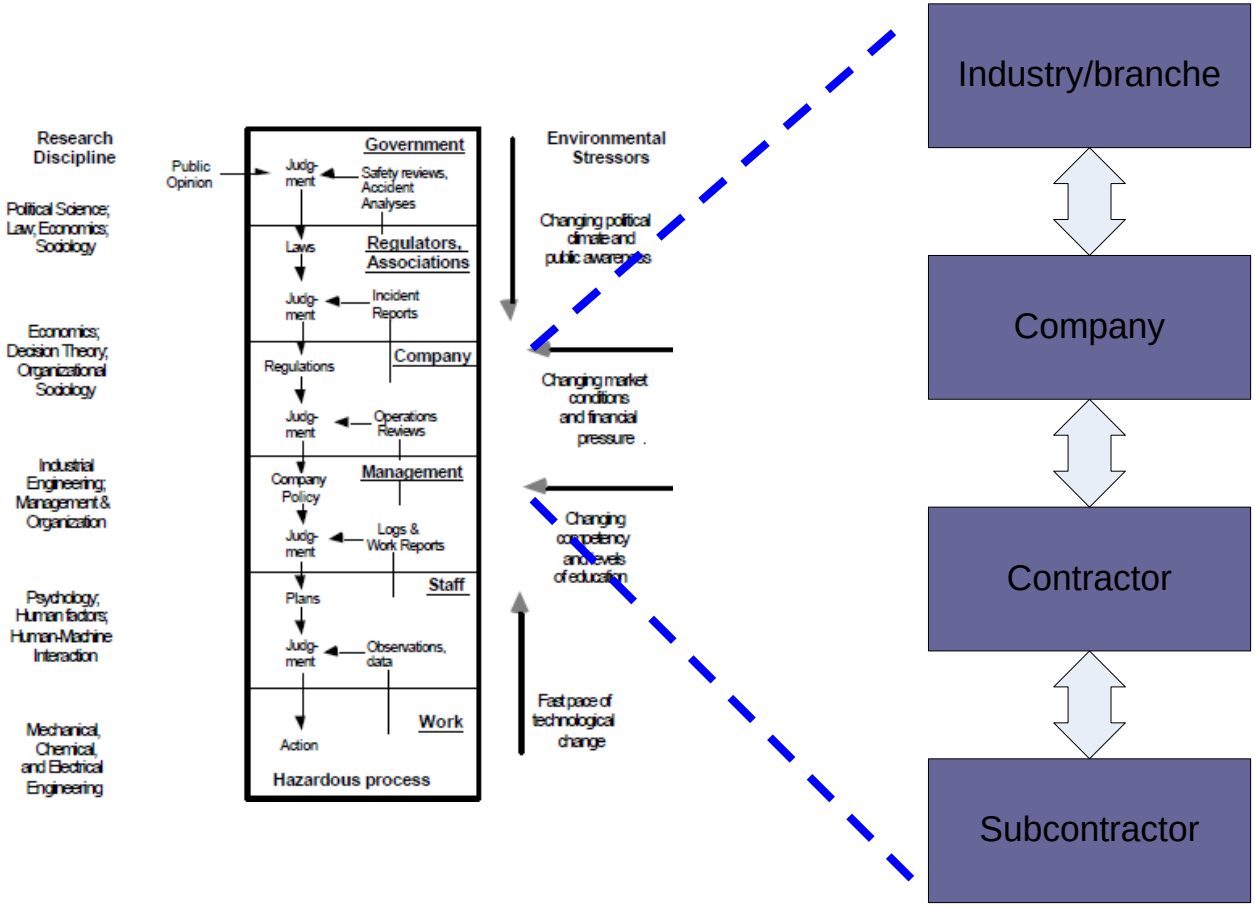


REF

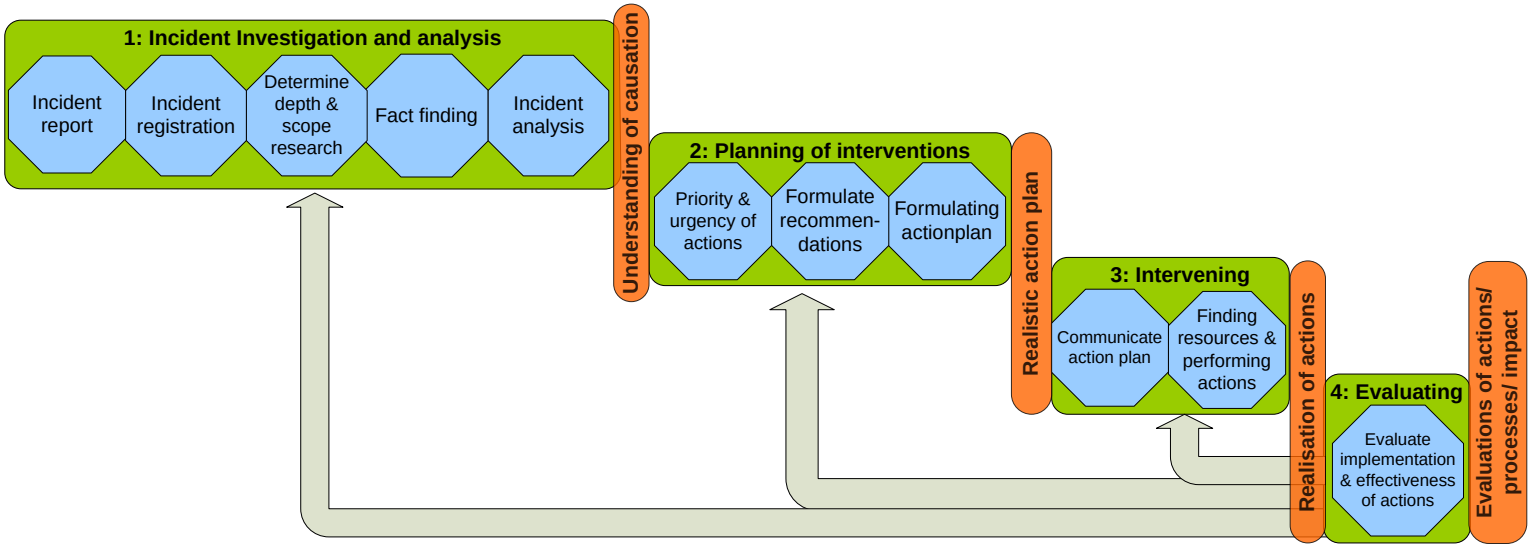
- *OHSAS*
- *Successful H&SM*


Independant investigation commission
In exceptional cases
Frequent or severe events
Problem-solving group
Immediate investigation by first-line supervisor
All events
All events
Reporting
Implementation of remedial actions
Work place
Accidents
Near accidents

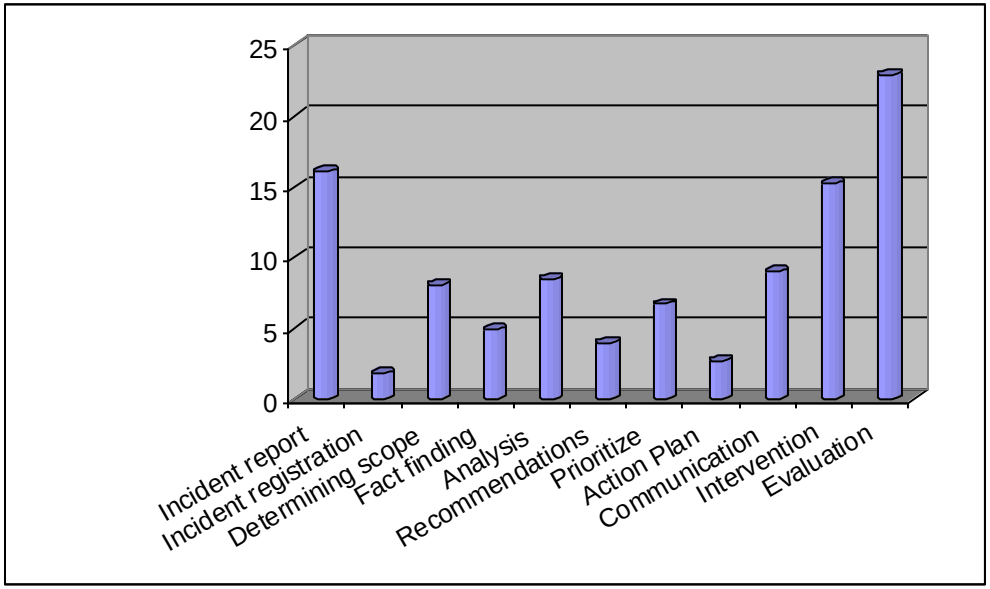
Who needs to learn



Learning barriers



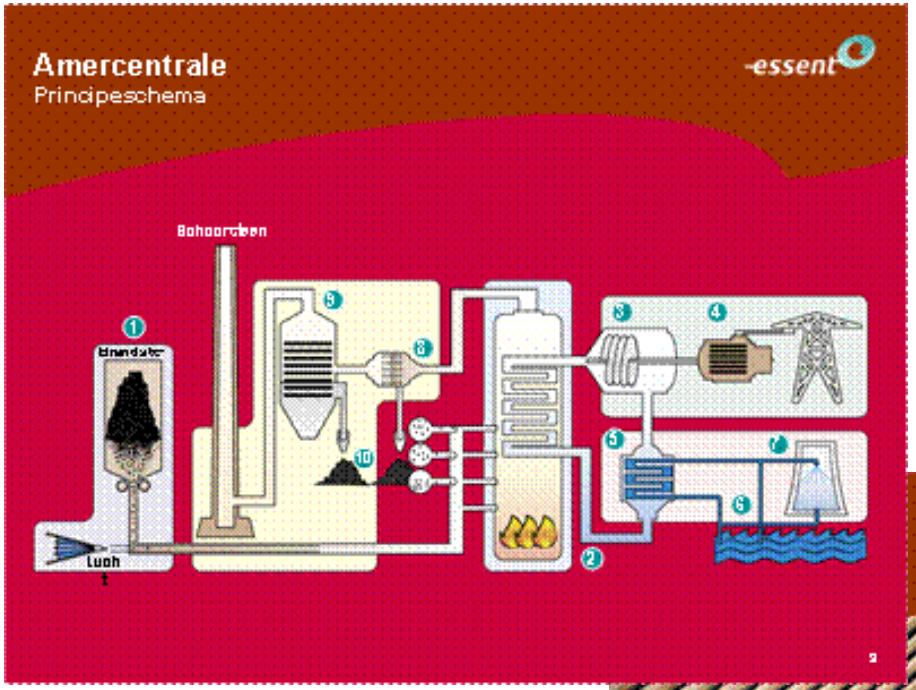
Where do you think the main bottleneck is located?




Getting impact

Accident electricity powerplant Amercentrale

- plant shut for major overhaul
- boiler shut down for cleaning, repairing and inspection of boiler walls
- collapsing scaffold
- 5 persons killed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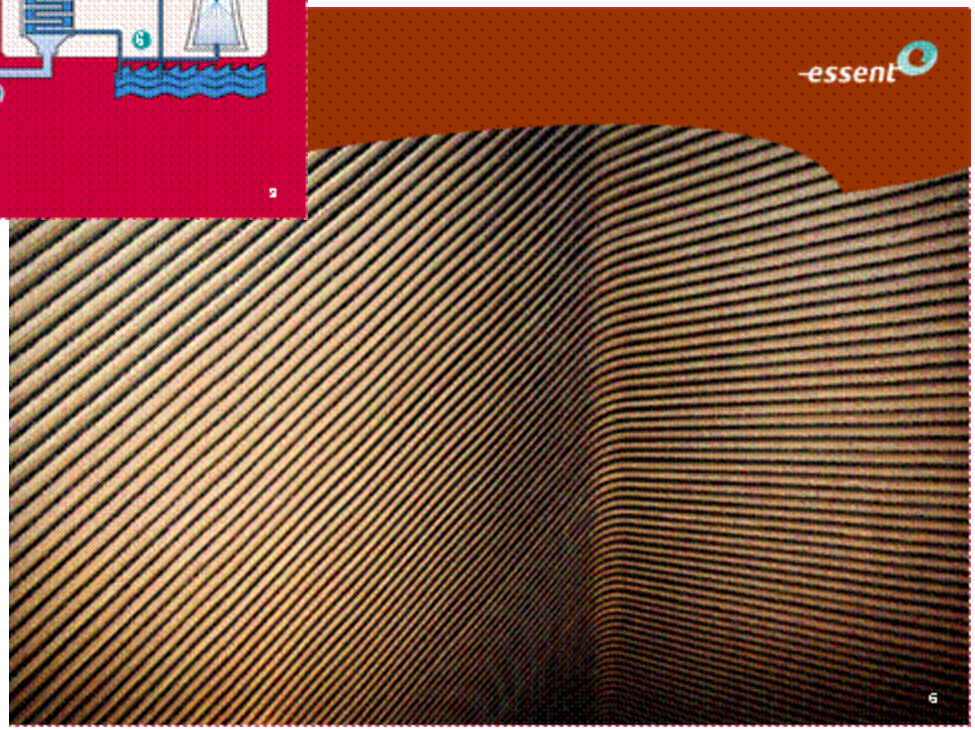
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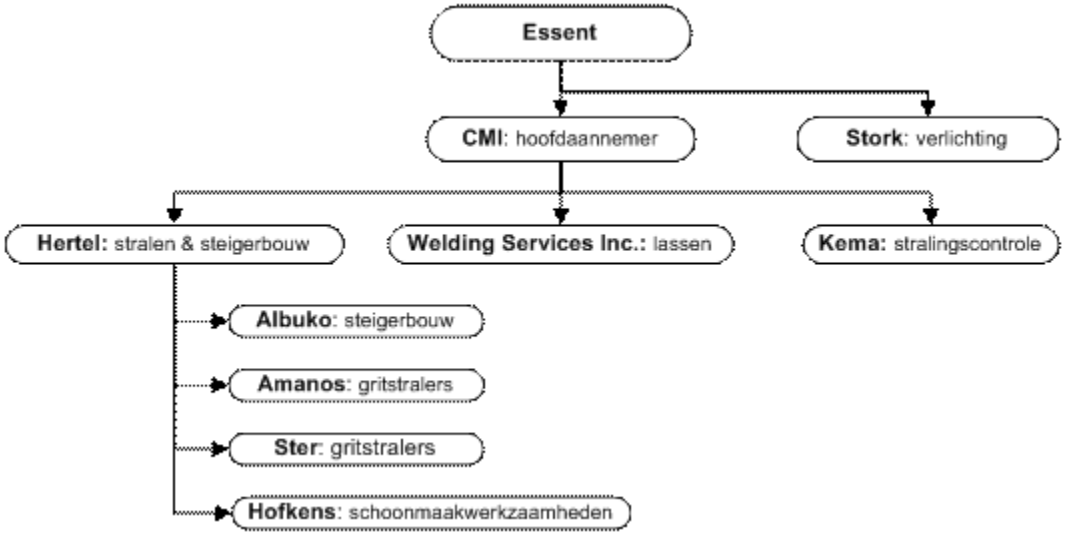
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Stork: verlichting
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Welding Services Inc.: lassen
Kema: stralingscontrole
Albuko: steigerbouw
Amanos: gritstralers
Ster: gritstralers
Hofkens: schoonmaakwerkzaamheden


ALBUKO


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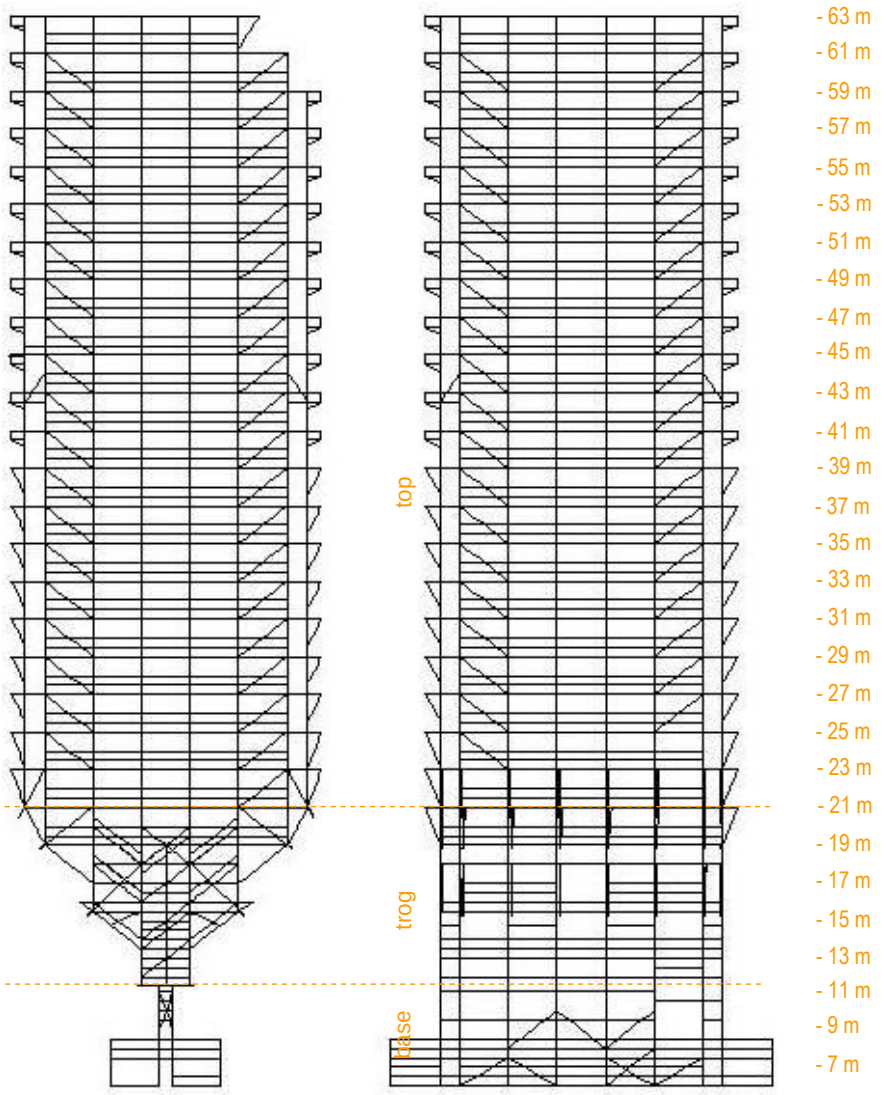
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- 11 m
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- 7 m
top
trog
base

Exercise 1: case 2 develop investigation plan *30-45 minutes*

- *You are called by Amercentrale to do accident research….*

- Summarize accident (5 minutes)
- What are direct causes?
- What are indirect causes?

- Exchange of results

- What preventative measures you would advise on several levels?
- Who should implement?

- Exchange of results

Exercise 2: case 2 develop project plan

30-45 minutes

- *You are called by Amercentrale to do accident research….*

- Define aim project
- Design first 10 steps to be done in the project
- What roles/functions need to be performed
- Design investigation team
- Propose research question

- Jan and Johan provide information

- Observations?
- What role would you prefer?
- Who would/need you to cooperate with
- What is next step of further developing services institute