STAMP
Systems Theoretic Accident Model and Process

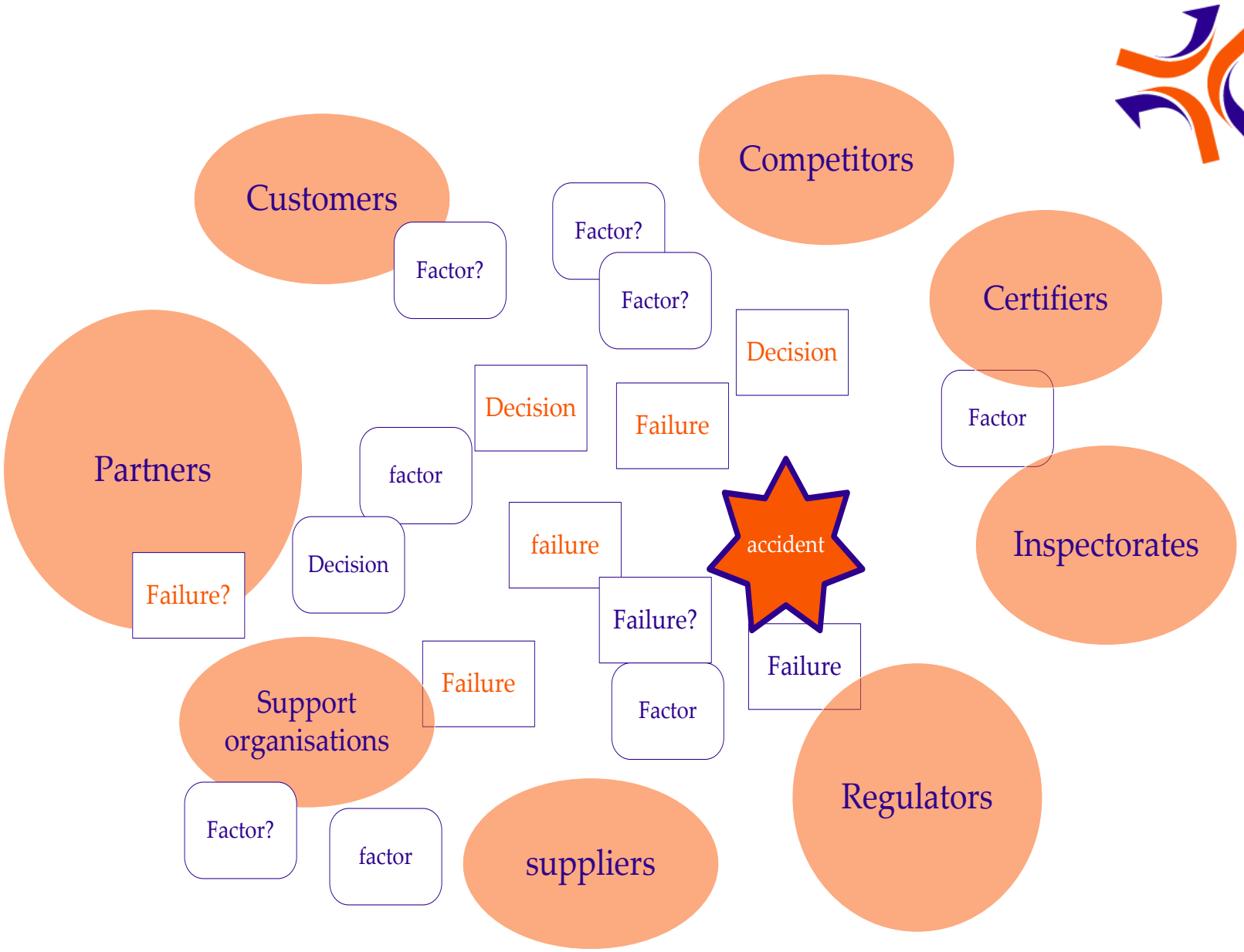
Kirsten van Schaardenburgh-Verhoeve

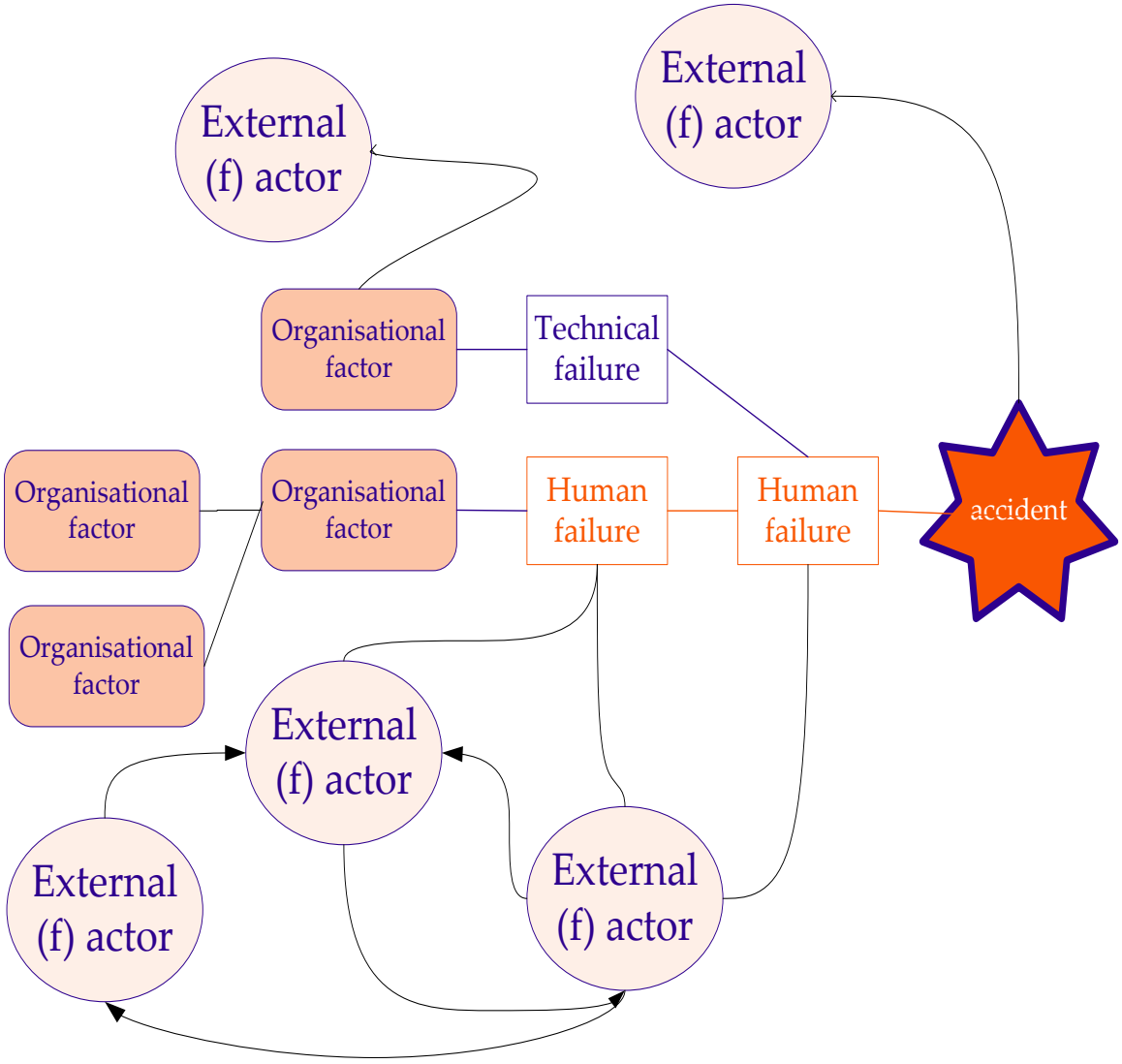
Content

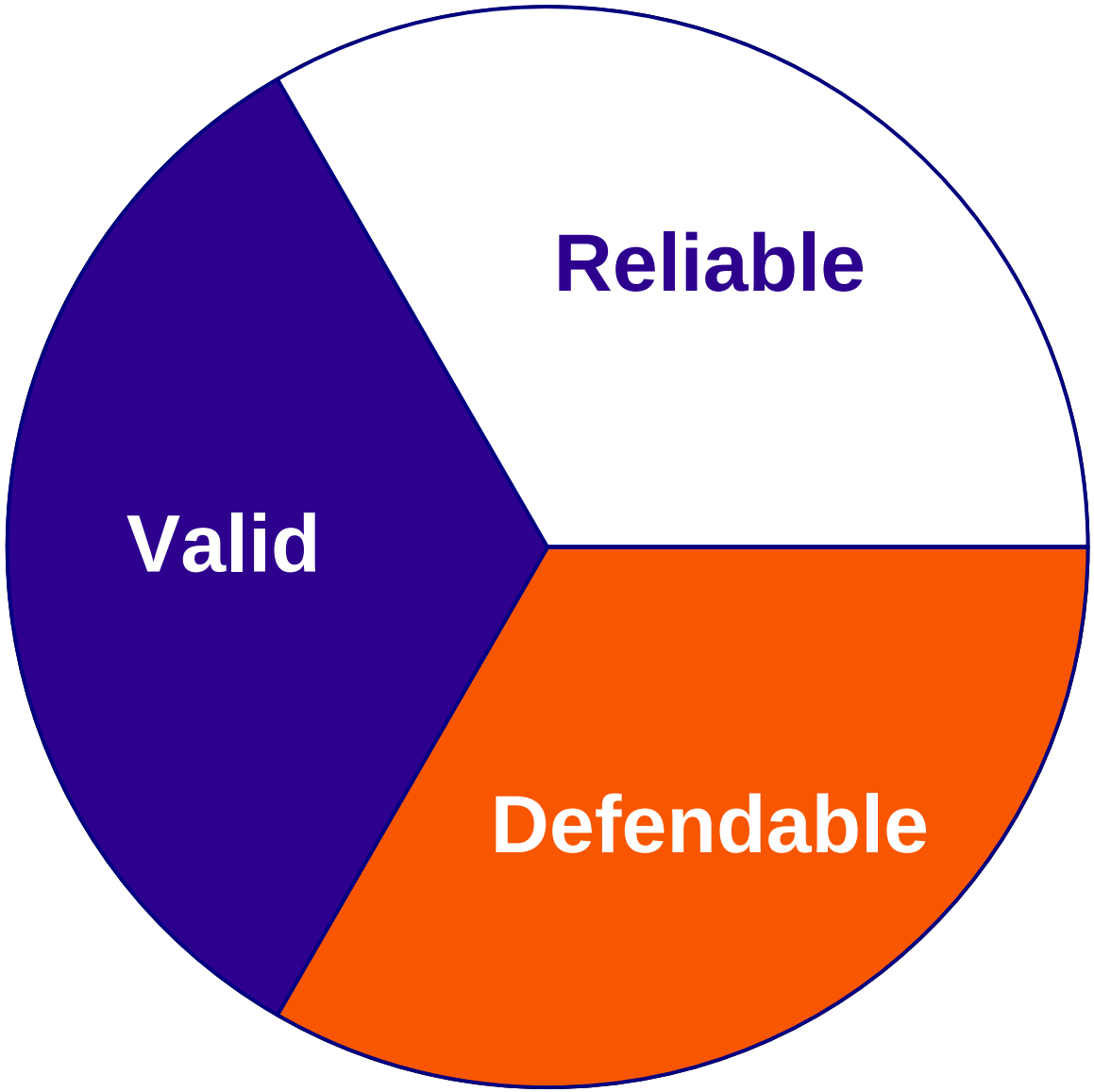
- Methods
  - Why use methods
  - Methods available
- STAMP
  - Theory of accident causation
  - How to apply
  - Macondo incident

Methods

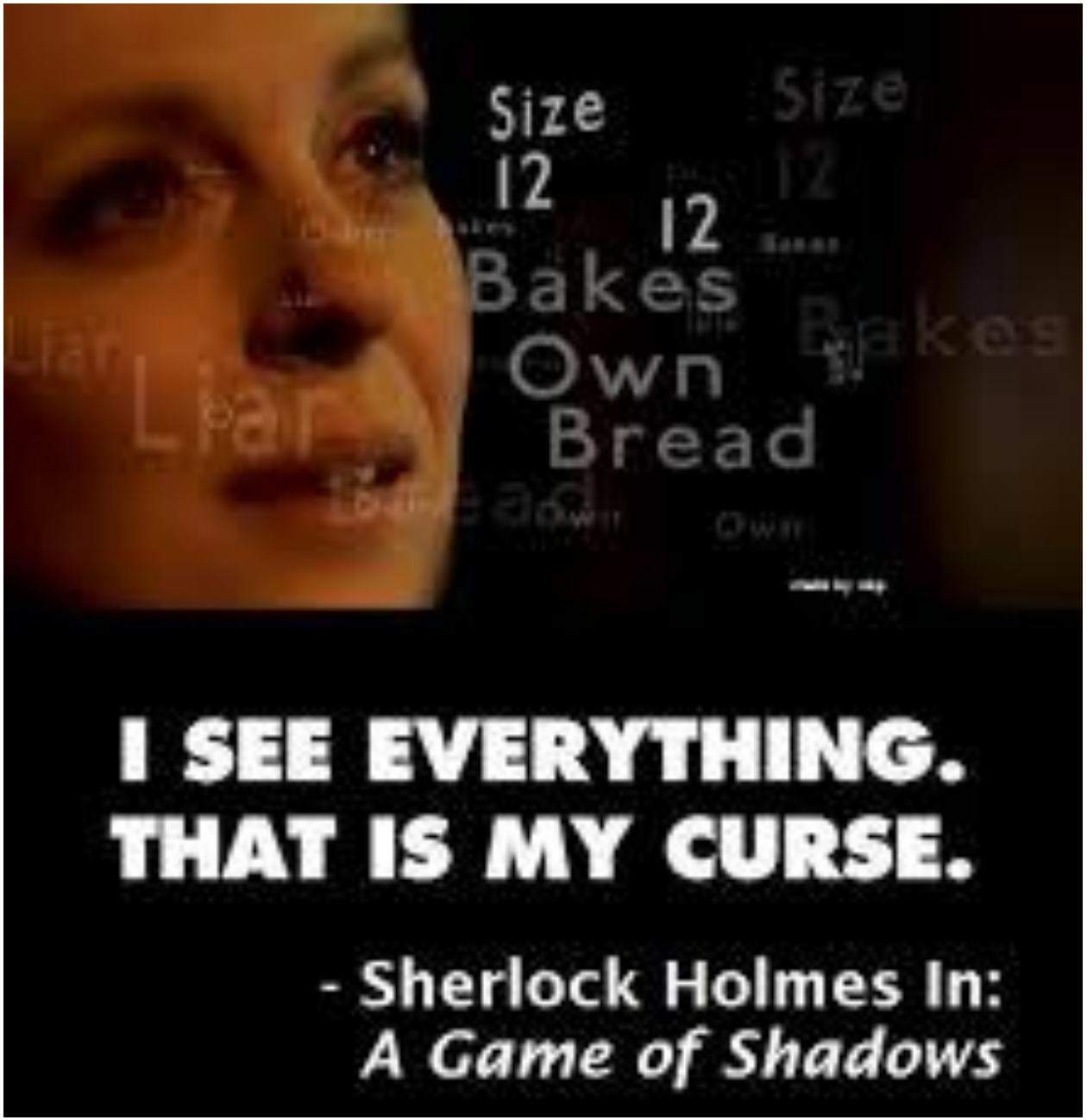

accident

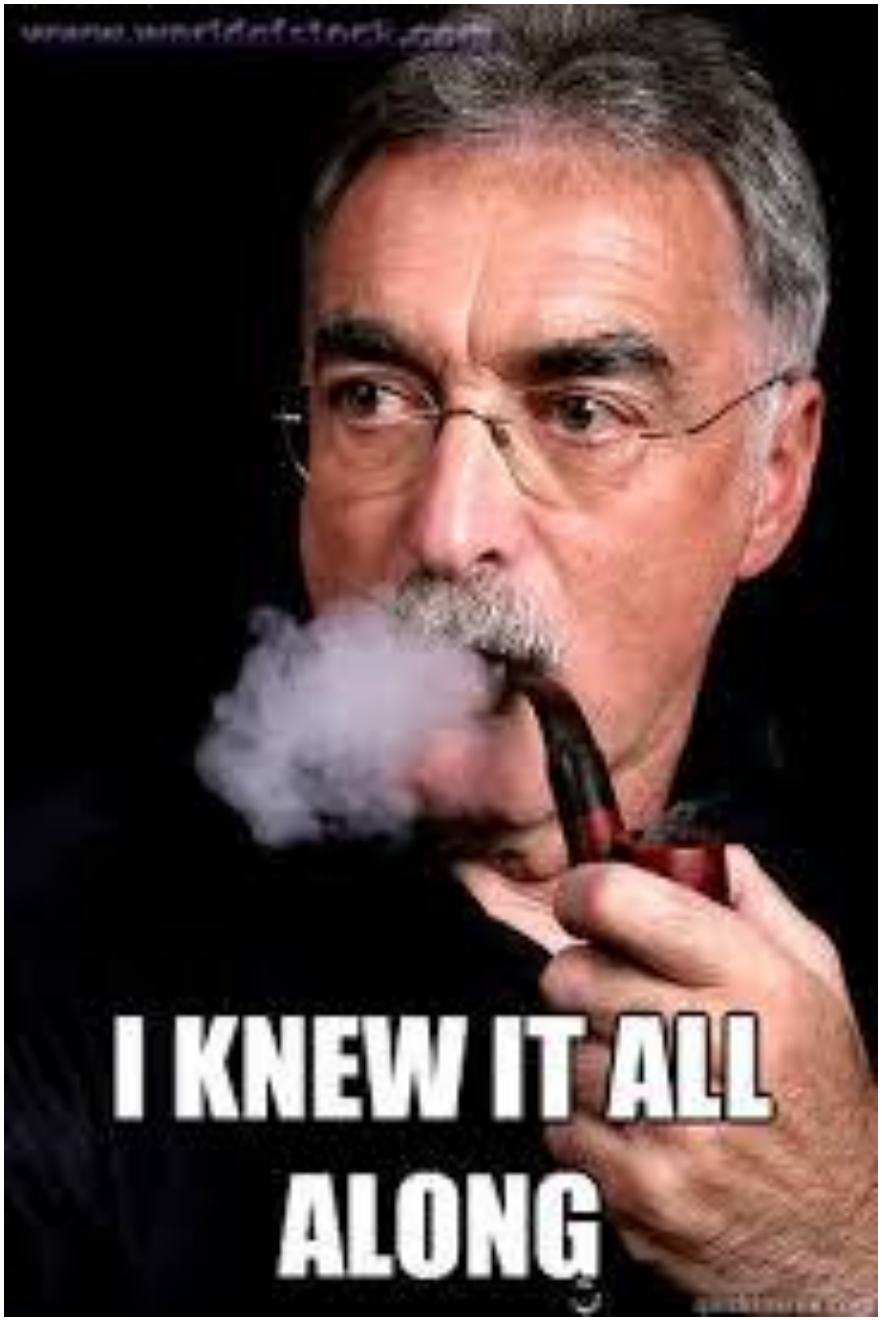

Customers
Competitors
Factor?
Factor?
Factor?
Certifiers
Decision
Factor
Decision
Failure
Partners
factor
accident
Inspectorates
failure
Decision
Failure?
Failure?
Failure
Support organisations
Failure
Factor
Factor?
factor
suppliers
Regulators

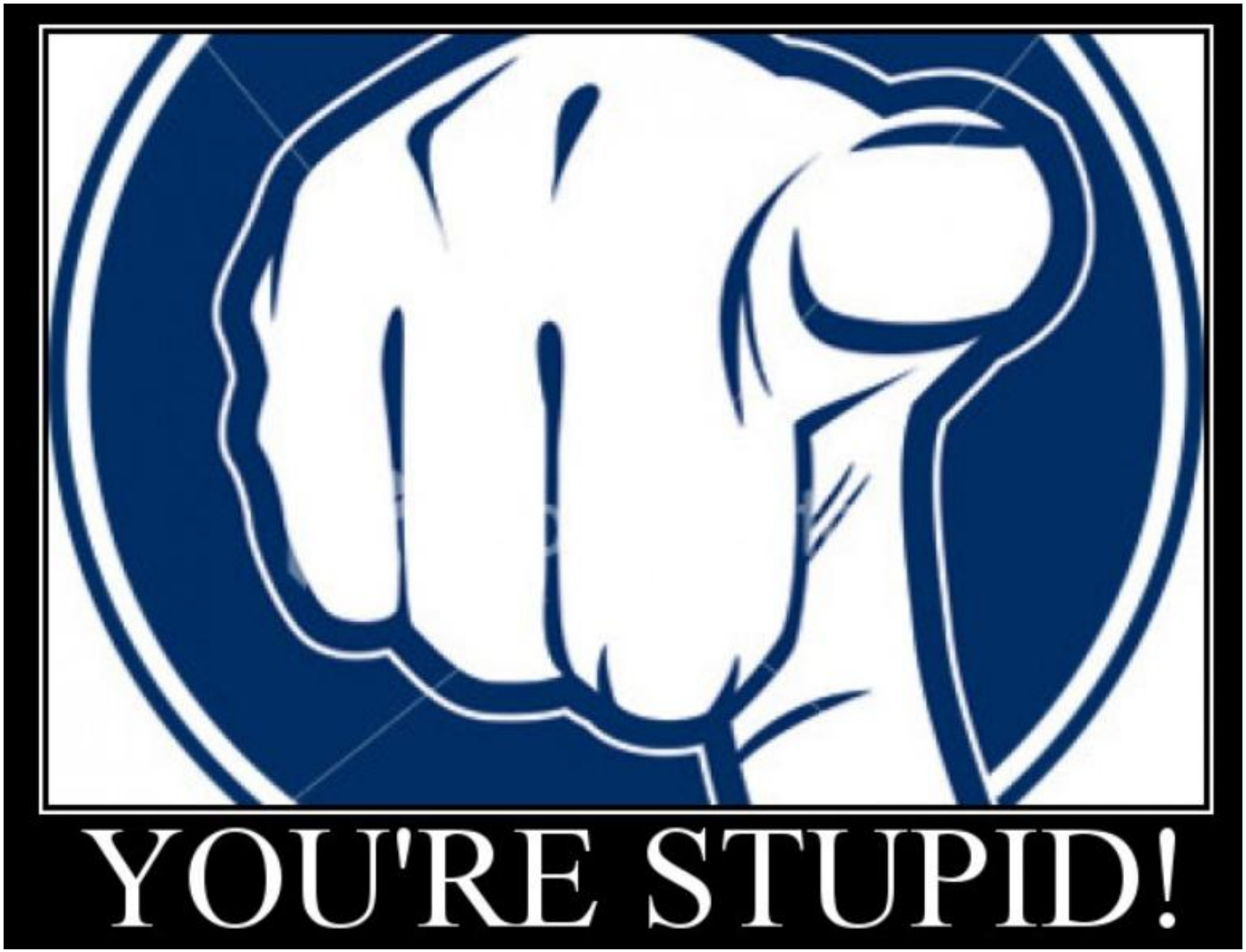

External
(f) actor
External
(f) actor
Organisational
factor
Technical
failure
Organisational
factor
Organisational
factor
Human
failure
Human
failure
accident
Organisational
factor
External
(f) actor
External
(f) actor
External
(f) actor

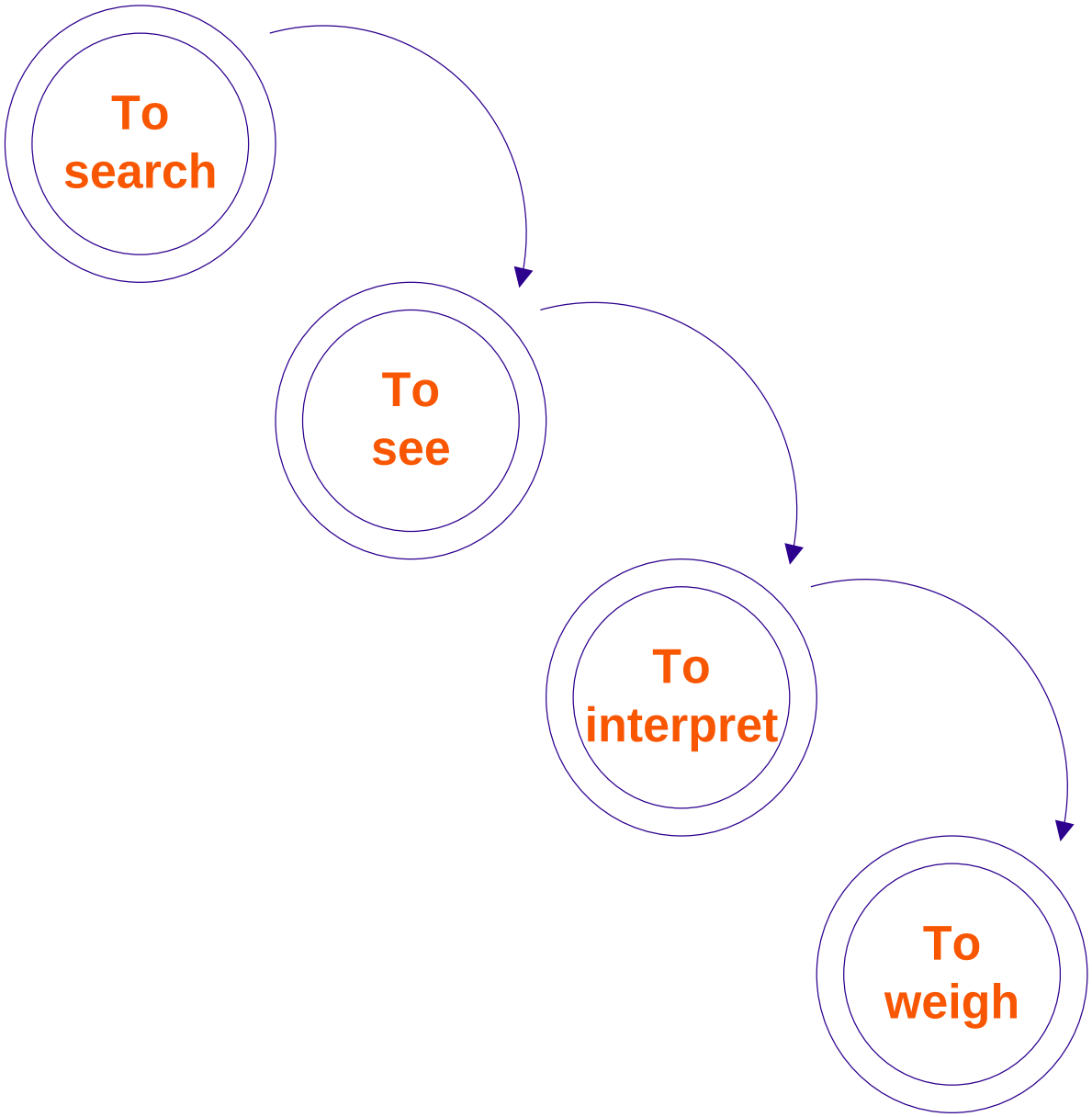

Reliable
Valid
Defendable


Hindsight

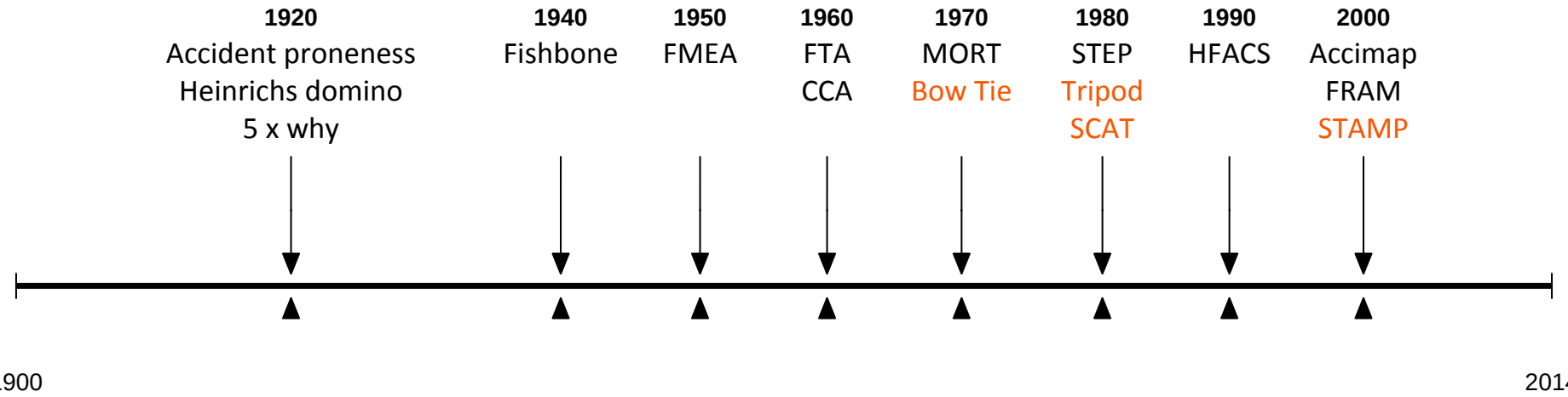

Size
12
12
Bakes
Own
Bread
Liar
I SEE EVERYTHING.
THAT IS MY CURSE.
- Sherlock Holmes In:
A Game of Shadows

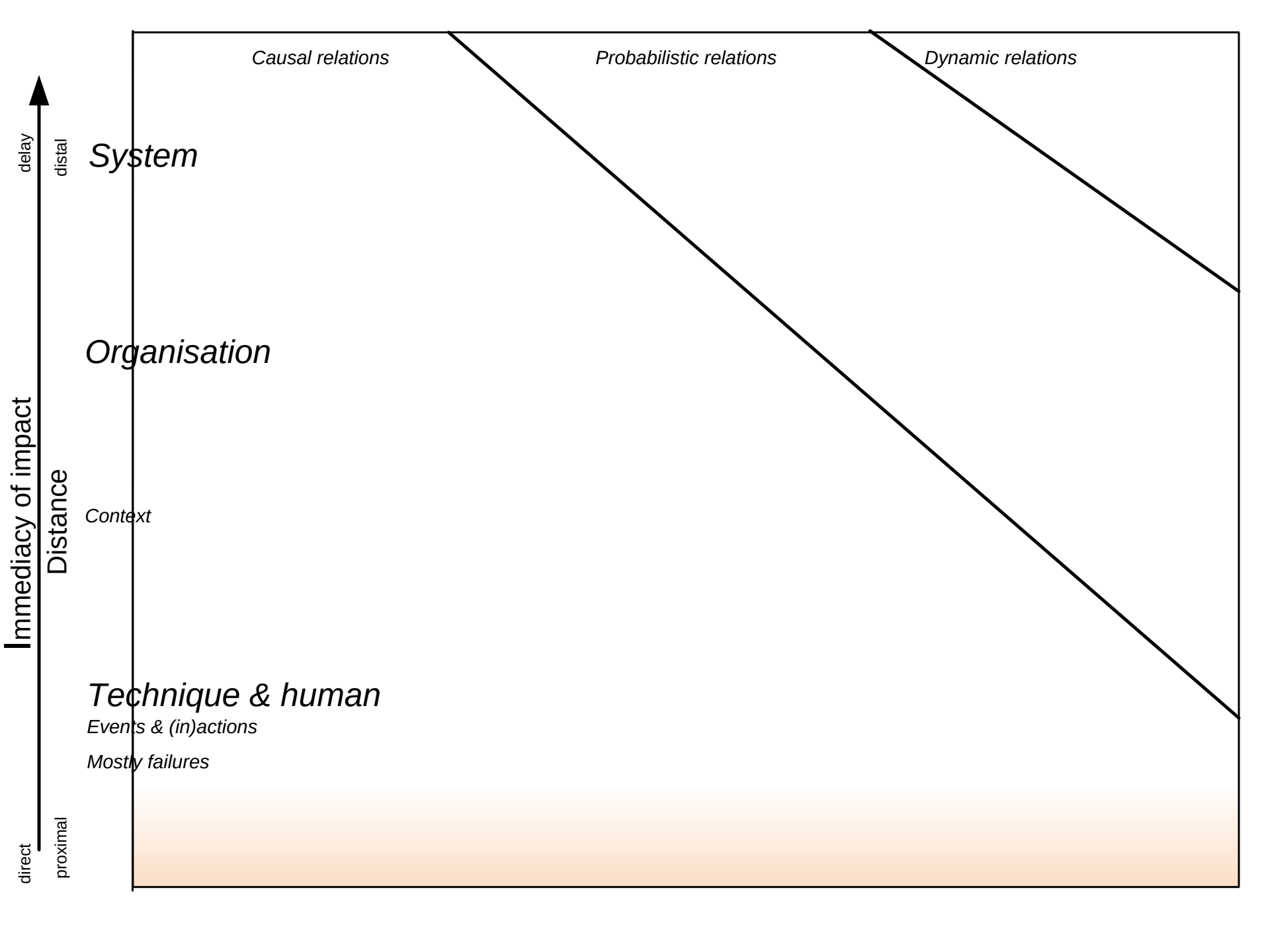

I KNEW IT ALL
ALONG

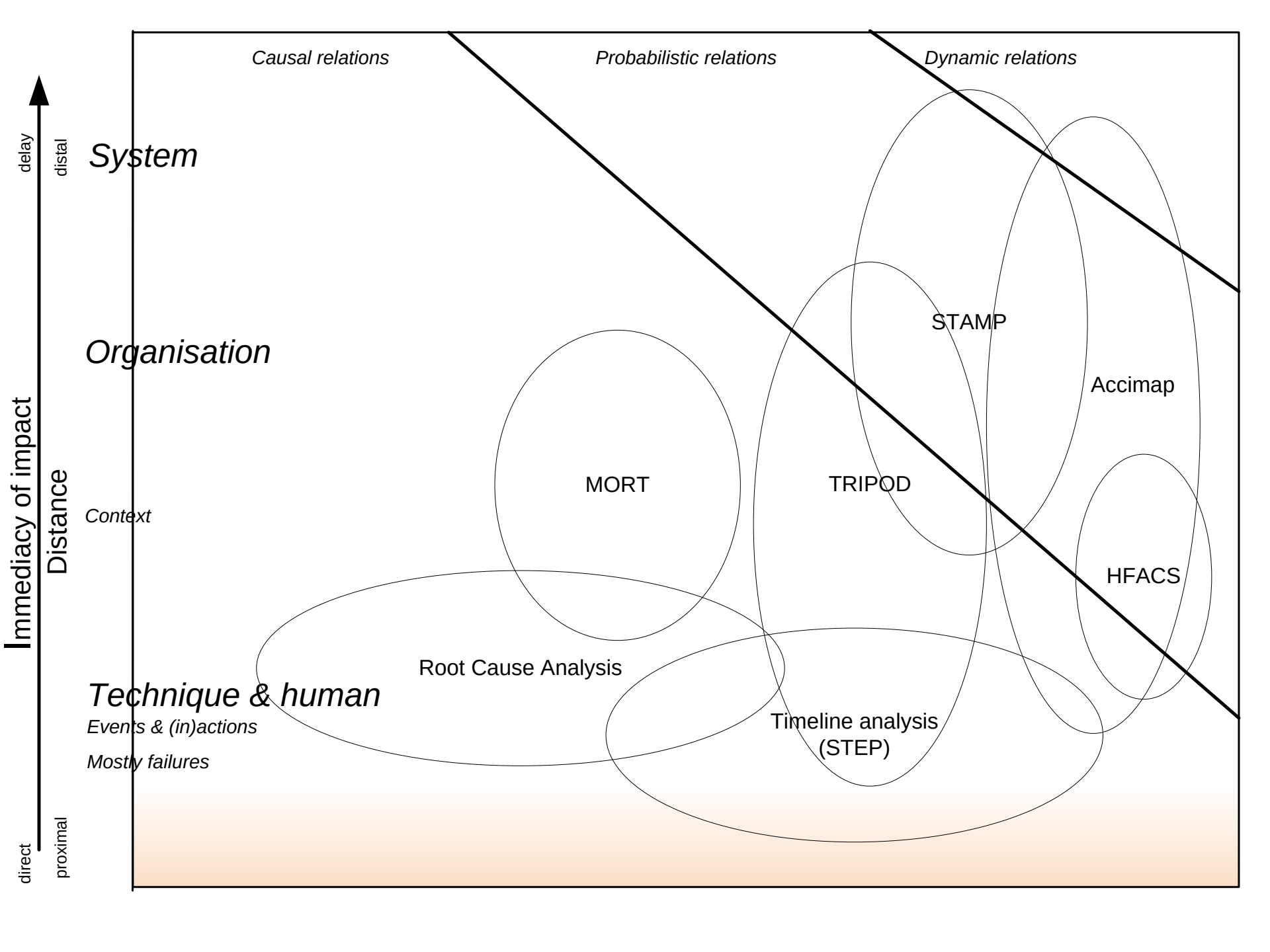

YOU'RE STUPID!


To search
To see
To interpret
To weigh

Development of methods




Causal relations
Probabilistic relations
Dynamic relations
delay
distal
System
Organisation
Immediacy of impact
Distance
Context
Technique & human
Event's & (in)actions
Mostly failures
direct
proximal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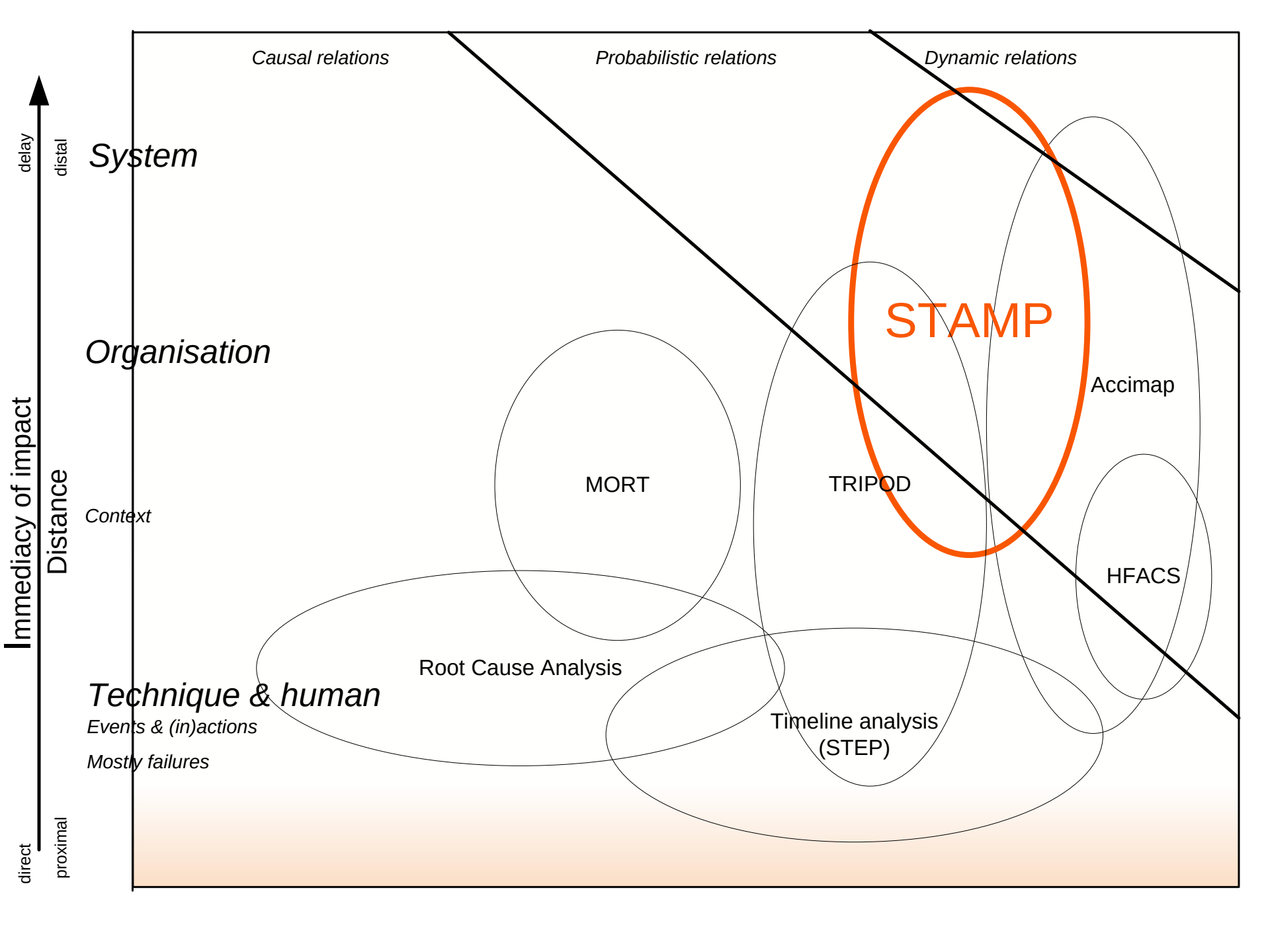
Distance
direct
proximal
STAMP
Accimap
MORT
TRIPOD
HFACS
Root Cause Analysis
Timeline analysis
(STEP)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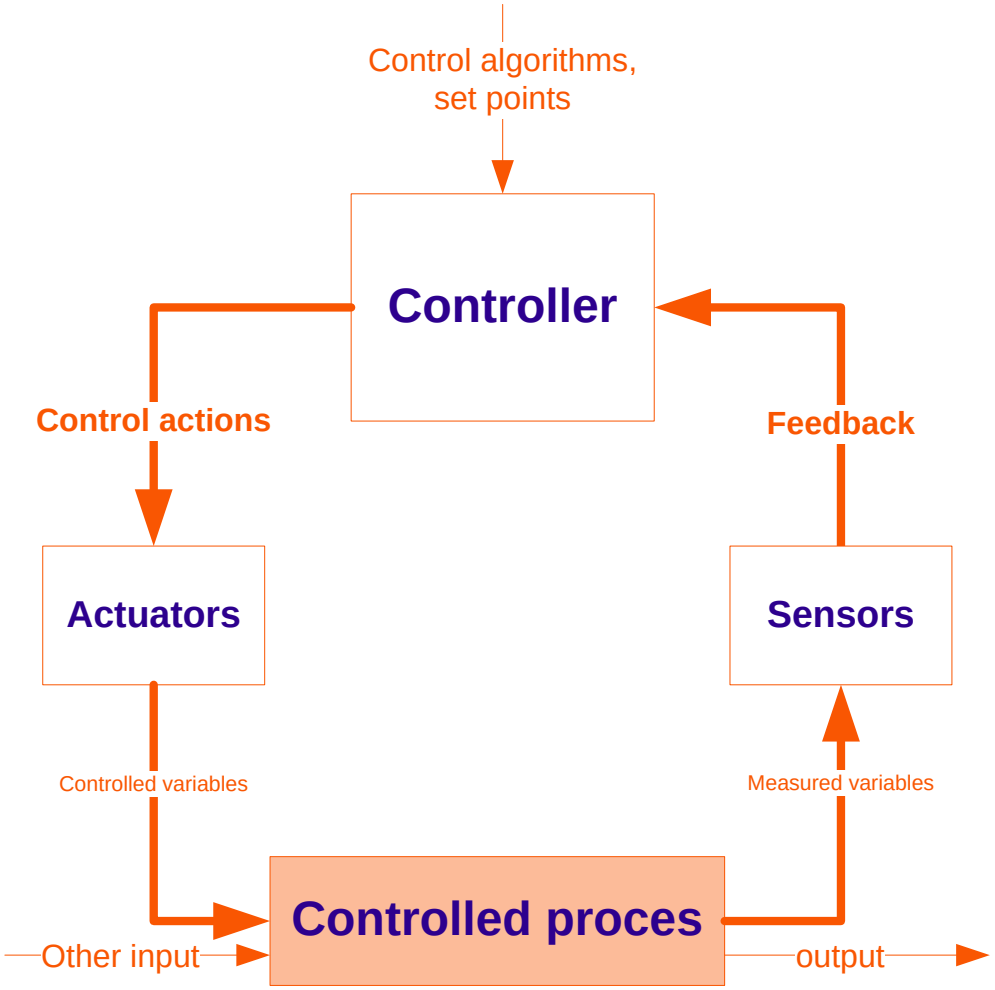
(STEP)

STAMP
Systems Theoretic Accident Model and Process

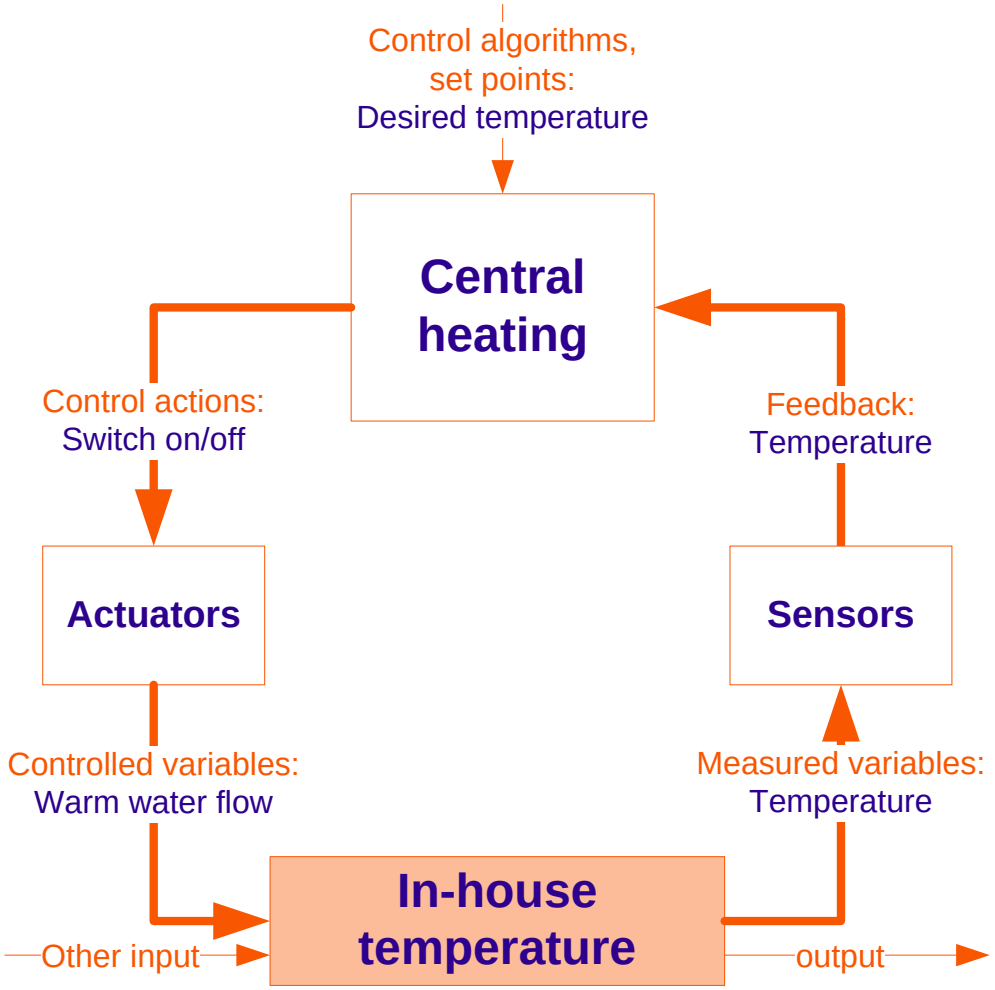
Accident causation model

- Safety = a **control problem**
- Accident = system state + worstcase environmental conditions
- Focus on **system**, rather than components and failures

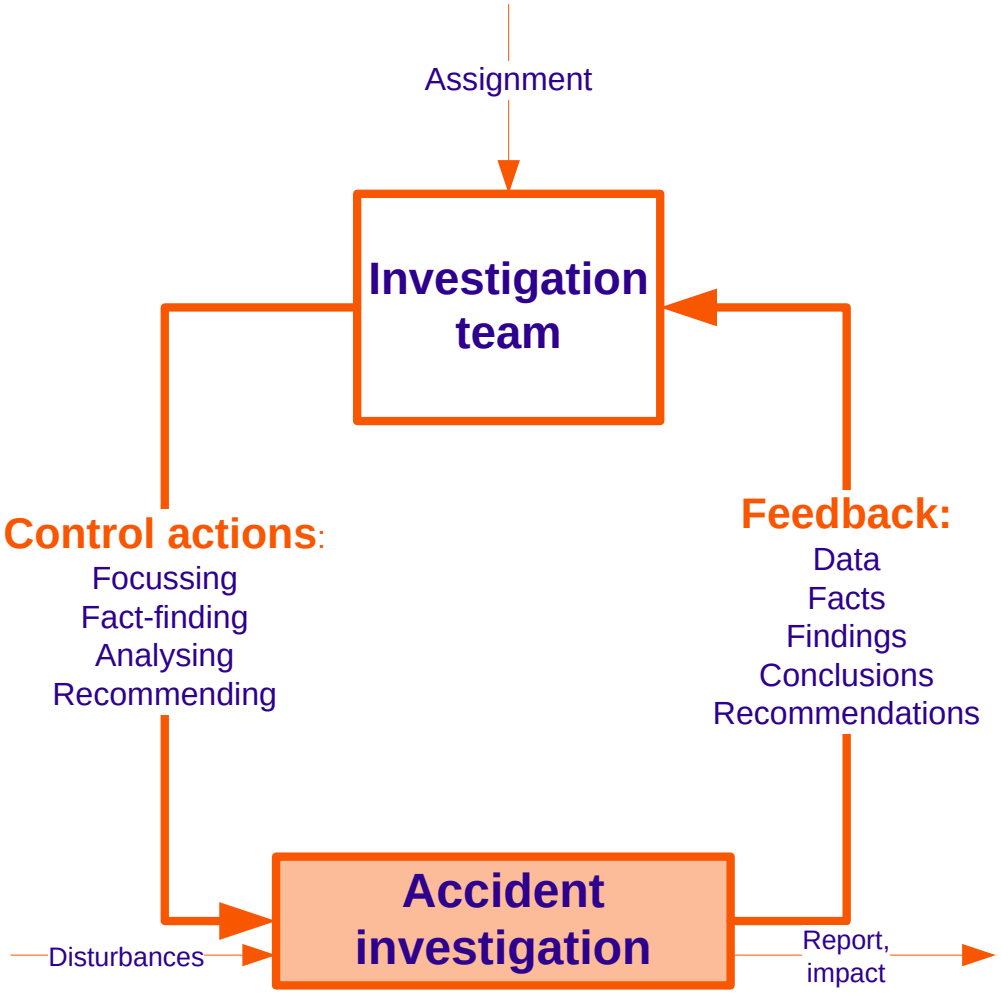
Basic control structure



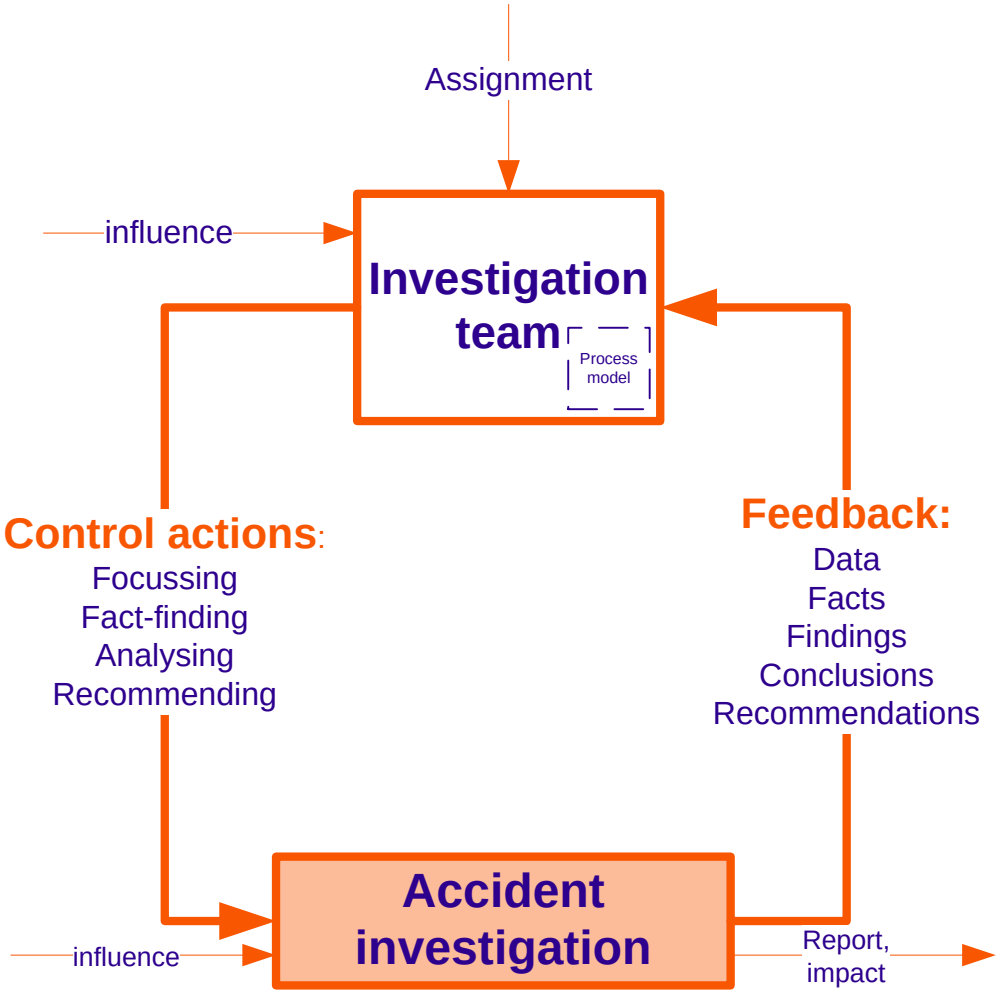
Control structure: example

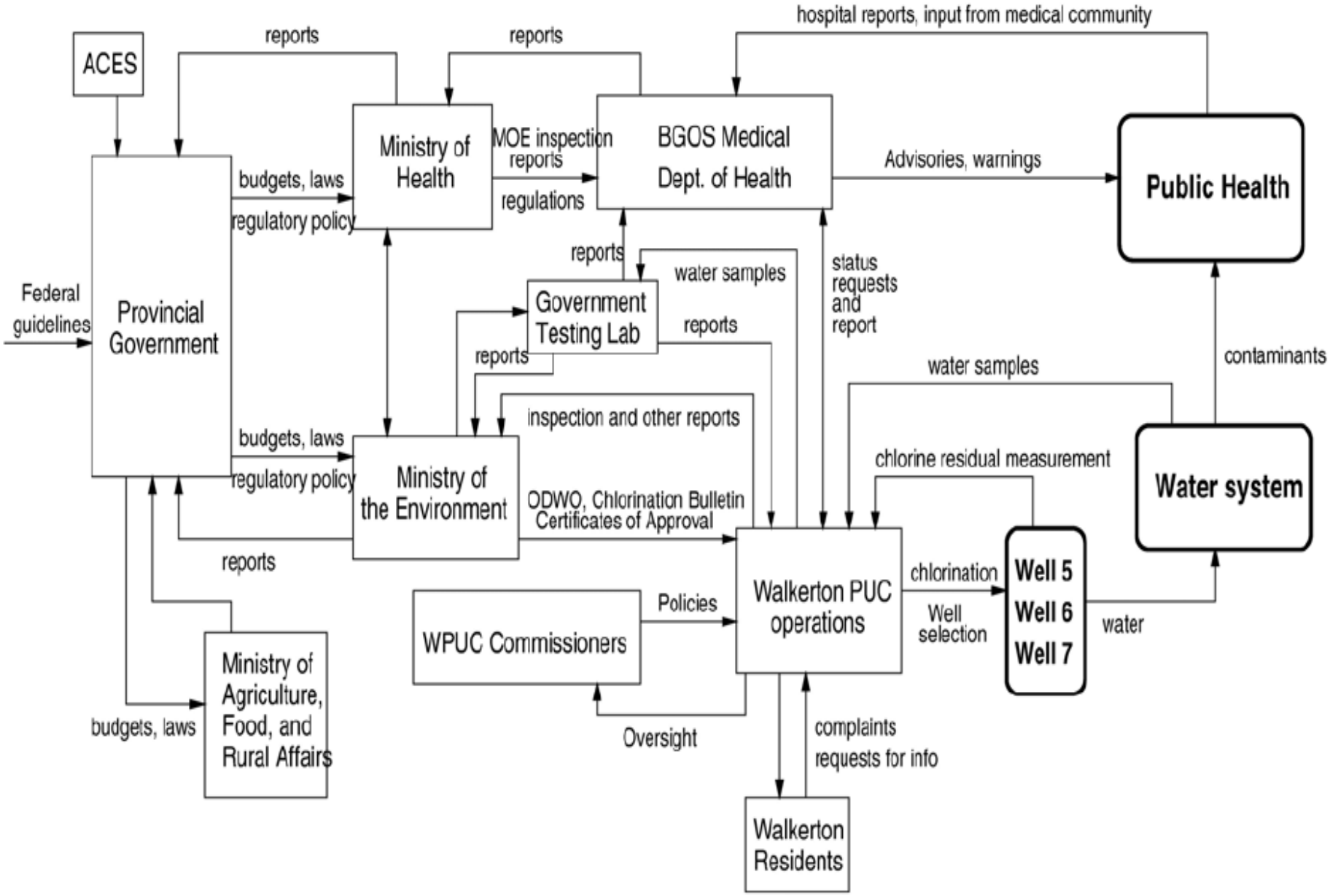


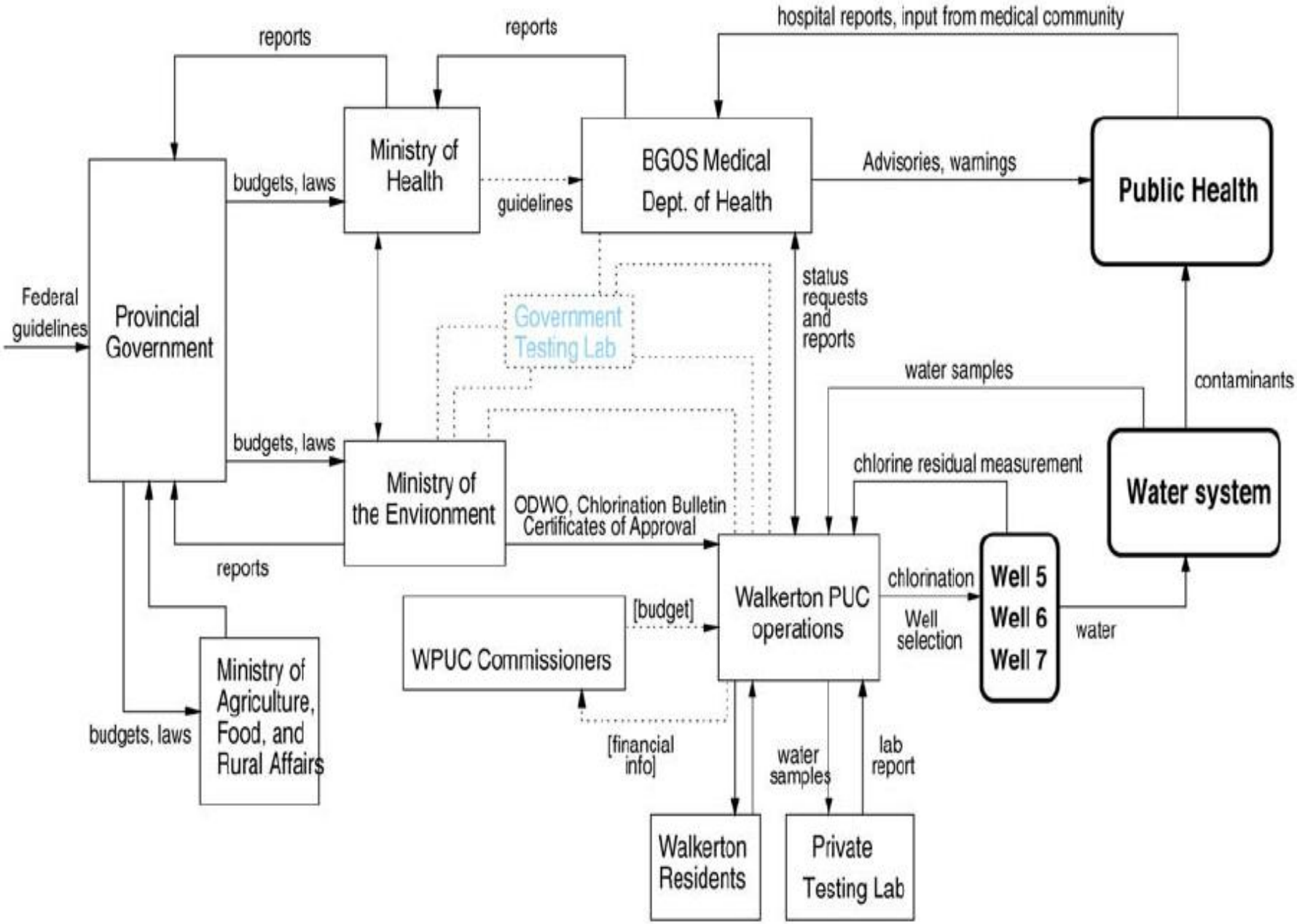
Control structure: example



Control structure: example




ACES
reports
reports
hospital reports, input from medical community
Ministry of Health
MOE inspection reports
regulations
BGOS Medical Dept. of Health
Advisories, warnings
Public Health
budgets, laws
regulatory policy
Federal guidelines
Provincial Government
reports
water samples
Government Testing Lab
reports
reports
status requests and report
contaminants
water samples
inspection and other reports
budgets, laws
regulatory policy
Ministry of the Environment
chlorine residual measurement
Water system
ODWO, Chlorination Bulletin
Certificates of Approval
reports
chlorination
Well 5
Well 6
Well 7
Walkerton PUC operations
Policies
WPUC Commissioners
Well selection
water
budgets, laws
Ministry of Agriculture, Food, and Rural Affairs
Oversight
complaints
requests for info
Walkerton Residents


reports
reports
hospital reports, input from medical community
Ministry of Health
BGOS Medical Dept. of Health
Public Health
budgets, laws
guidelines
Advisories, warnings
Federal guidelines
Provincial Government
Government Testing Lab
status requests and reports
water samples
contaminants
budgets, laws
Ministry of the Environment
chlorine residual measurement
Water system
ODWO, Chlorination Bulletin
Certificates of Approval
reports
chlorination
Well 5
Well 6
Well 7
Walkerton PUC operations
[budget]
WPUC Commissioners
Well selection
water
Ministry of Agriculture, Food, and Rural Affairs
budgets, laws
[financial info]
water samples
lab report
Walkerton Residents
Private Testing Lab

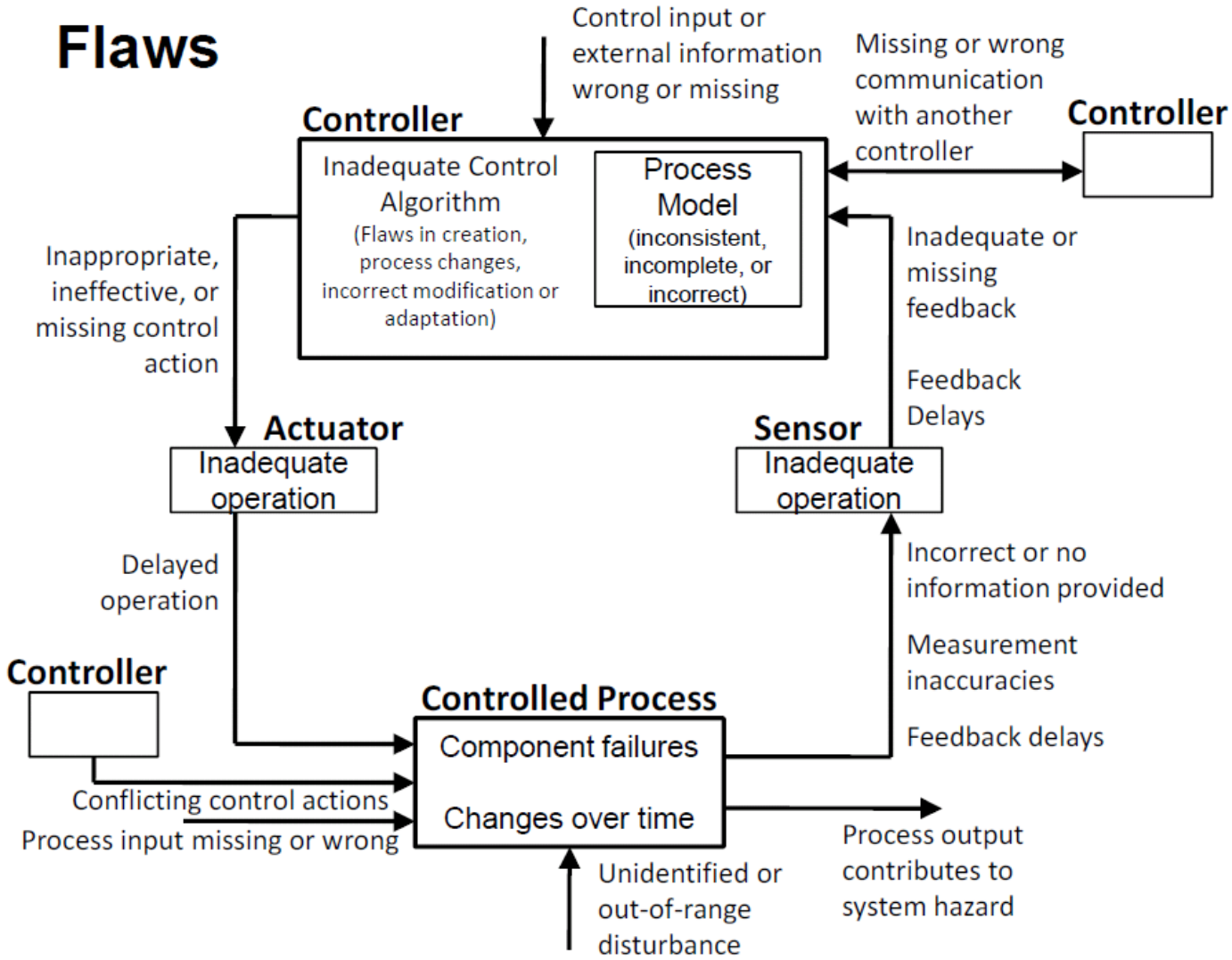
STAMP- Step by step

1. **Reflect** on added value STAMP
2. **Define** accident and system-hazards to be controlled
3. **Identify** relevant controllers
3. **Specify** for each controller
   - Safety responsibilities
   - Safety constraints

Result:
Control Structure

4. **Evaluate** *control structure:* controllers & loops
5. **Investigate** inadequate loops: absent, wrong, too late/early/long/short, ineffective
6. **Recommend** on system improvement

Potential Control Flaws



Recommendations

- Avoid Process Model Flaws in the future?
- Change or remove Contextual factors?
- Add control & feedback paths?
- Remove or modify control & feedback paths?

Macondo case

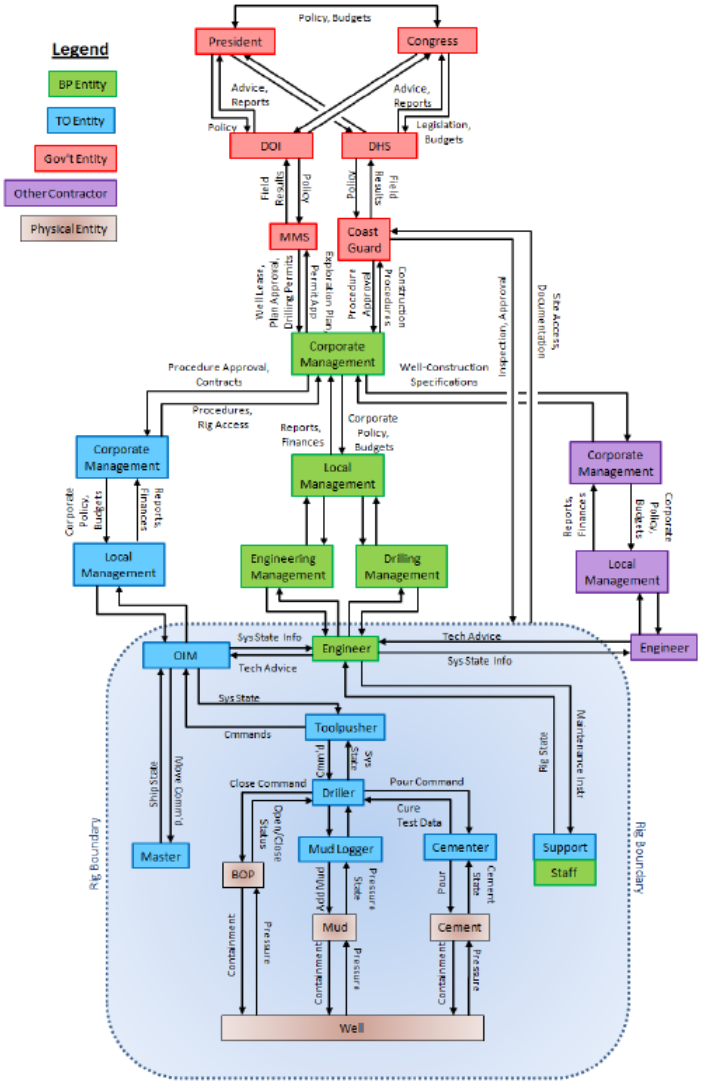
- STAMP analyses
  - Prof. Nancy Leveson
  - Rolf-Arne Haugen Syvertsen

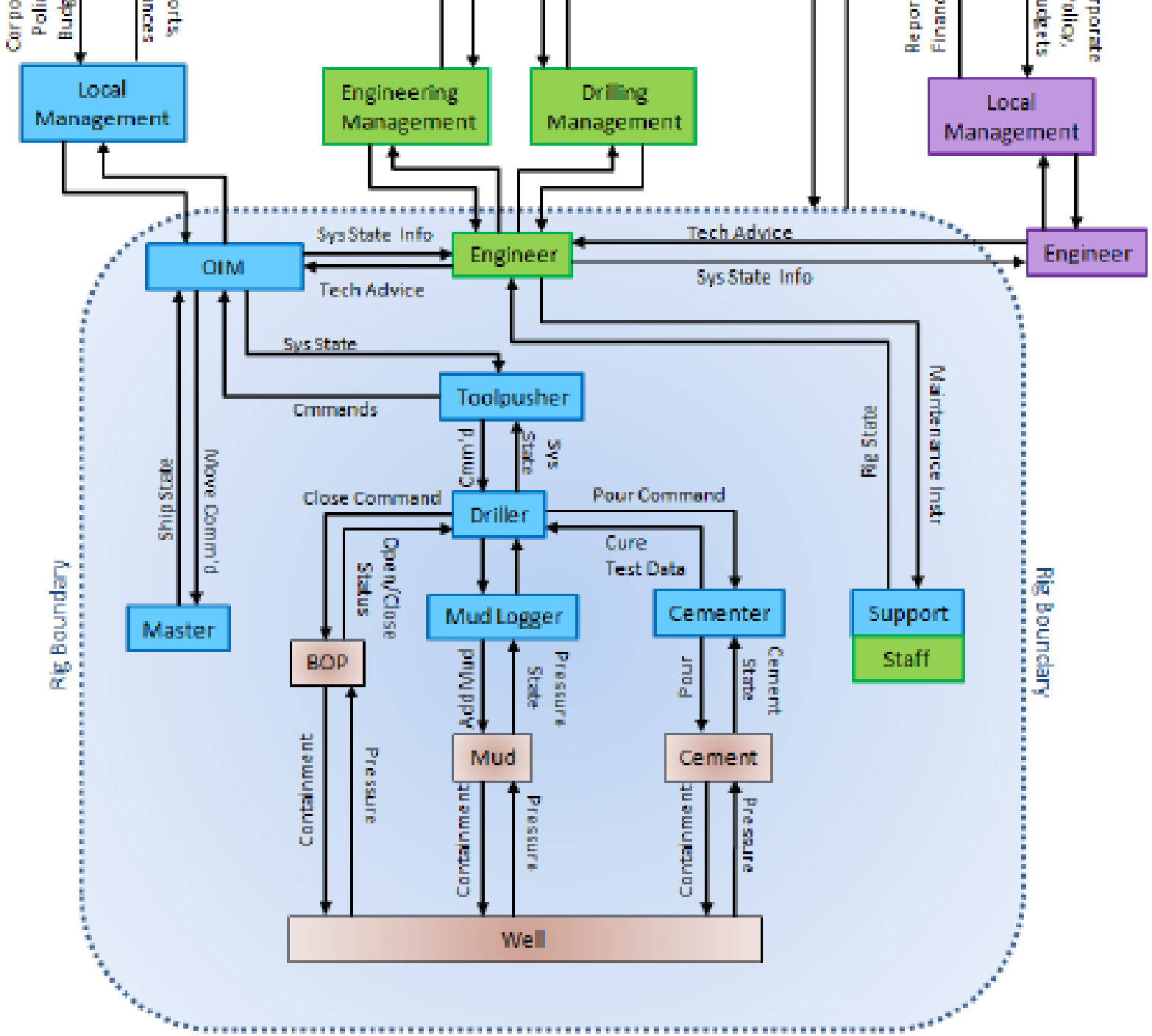
Next slides: selection & work in progress!

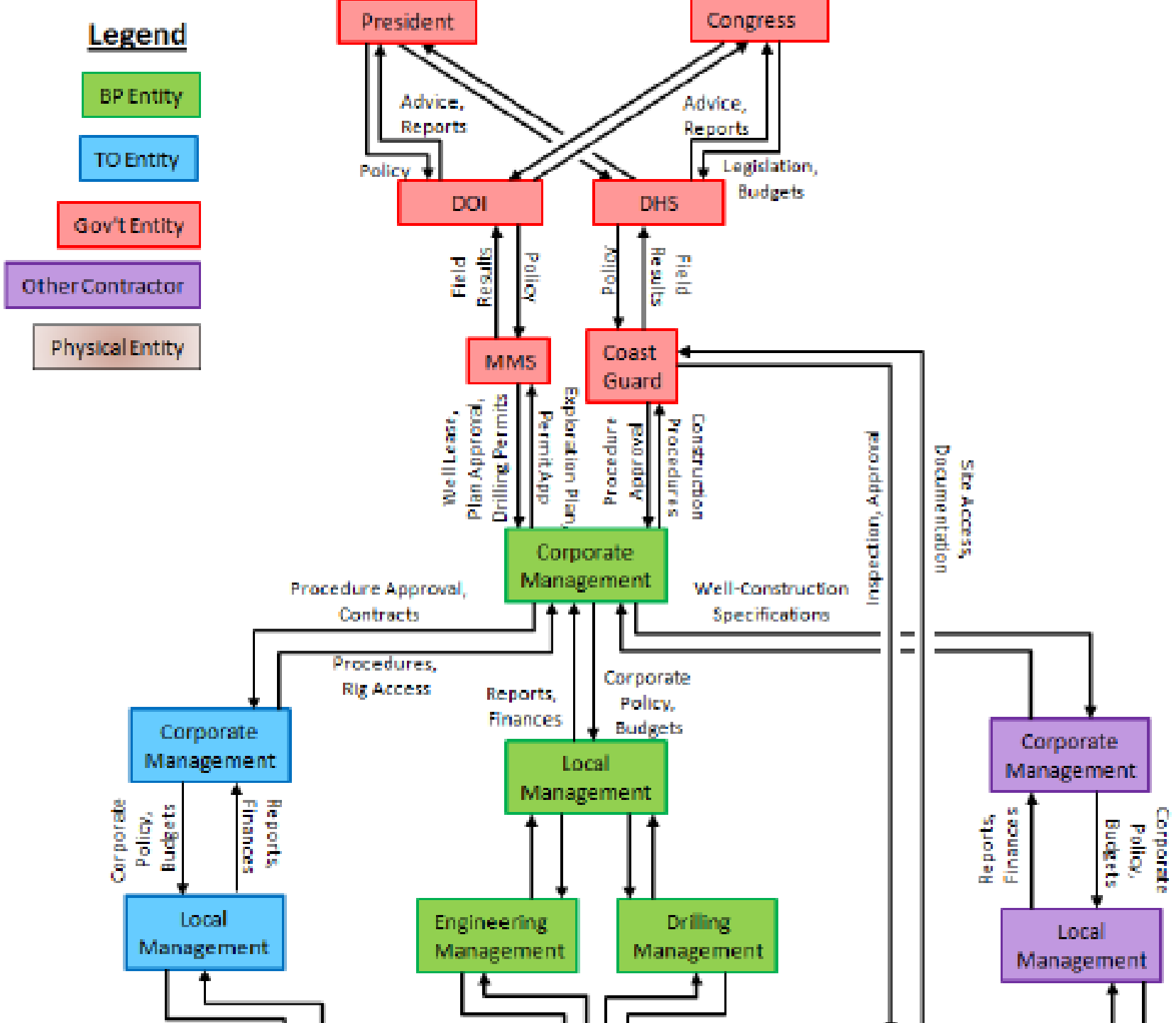
Macondo: system Hazard

- Uncontrolled release of hydrocarbons from the well

Macondo: control structure




Local Management
Engineering Management
Drilling Management
Local Management
OIM
Engineer
Engineer
Sys State Info
Tech Advice
Tech Advice
Sys State Info
Sys State
Commands
Toolpusher
Ship State
Move Comm'd
Cmm'd
State
Close Command
Driller
Pour Command
Rig State
Maintenance Instr
Open/Close Status
Cure Test Data
Master
Mud Logger
Cementer
Support Staff
BOP
Add Mud
Pressure
Pour
Cement
Containment
Pressure
Mud
Cement
Containment
Pressure
Containment
Pressure
Well
Rig Boundary
Rig Boundary


Legend
BP Entity
TO Entity
Gov't Entity
Other Contractor
Physical Entity
President
Congress
Advice, Reports
Policy
Advice, Reports
Legislation, Budgets
DOI
DHS
Field Results
Policy
Policy
Field Results
MMS
Coast Guard
Well Lease, Plan Approval, Drilling Permits
Permit App
Exploration Plan
Procedure Approval
Construction Procedures
Corporate Management
Procedure Approval, Contracts
Well-Construction Specifications
Inspection, Approval
Site Access, Documentation
Procedures, Rig Access
Reports, Finances
Corporate Policy, Budgets
Corporate Management
Corporate Policy, Budgets
Reports, Finances
Local Management
Engineering Management
Drilling Management
Corporate Management
Reports, Finances
Corporate Policy, Budgets
Local Management

For each controller

- Safety related responsibilities
- Safety constraints, control actions & feedback
- Inadequate control & feedback
- Context in which decisions were made
- Process model flaws

Driller: safety-related responsibilities

- Monitor well control and report any potential loss of control situations
- Manually shut down all electrical equipment not rated for hazardous operation

Driller:
safety related MUD responsibilities

- Monitor mud weight
- Communication with Mudlogger
- Monitor for abnormal mud weight
- Monitor for abnormal mud composition
- Adjust mud weight if abnormal mud conditions arise
- Flush mud only after cement test certification

Also for BOP & Cement!

Driller:
inadequate control actions

- increase mud weight when mud composition abnormality was observed (gas in mud)
- recognize the influx of hydrocarbon
- recognize the excess flow from the drill pipe during negative pressure tests
- interpret pressure in the drill pipe
- monitor the well
- Recognize pipe pressure still increased when the mud pump was shut down

Level 1: Deepwater Horizon Drill Crew

Safety Requirements and Constraints

- Ensure well integrity
- Detect and identify a kick
- Respond appropriate to a well control situation (kick, blowout)

Inadequate Control Actions

- Unusual pressure readings were continiously overseen
- Lack of vigilance of flow-out volume monitoring
- Poorly executed flow checks
- BOP activation

Context In Which Decision Was Made

- The DWH was 6 weeks behind schedule
- The drilling had run 58 million dollars over budget
- Shift change
- Lack of training & standard procedures

Process Model Flaws

- Believed the negative pressure test
- Bad habits

Level 2: Transocean OIM & senior toolpusher, and BP well site leaders

Safety Requirements and Constraints

- Instruct rig crew of temporary abandonment procedures
- Perform calculations on expected pressure and flow
- Supervision of temporary abandonment procedures
- Engage EDS

Inadequate Control Actions

- EDS
- Inadequate pressure and flow calculations
- BOP
- Inadequate supervision of drill crew and toolpusher

Context In Which Decisions Made

- The DWH was 6 weeks behind schedule
- The drilling had run 58 million dollars over budget
- Inexperienced well site leader
- Lack of Training
- Lack of Standard procedures

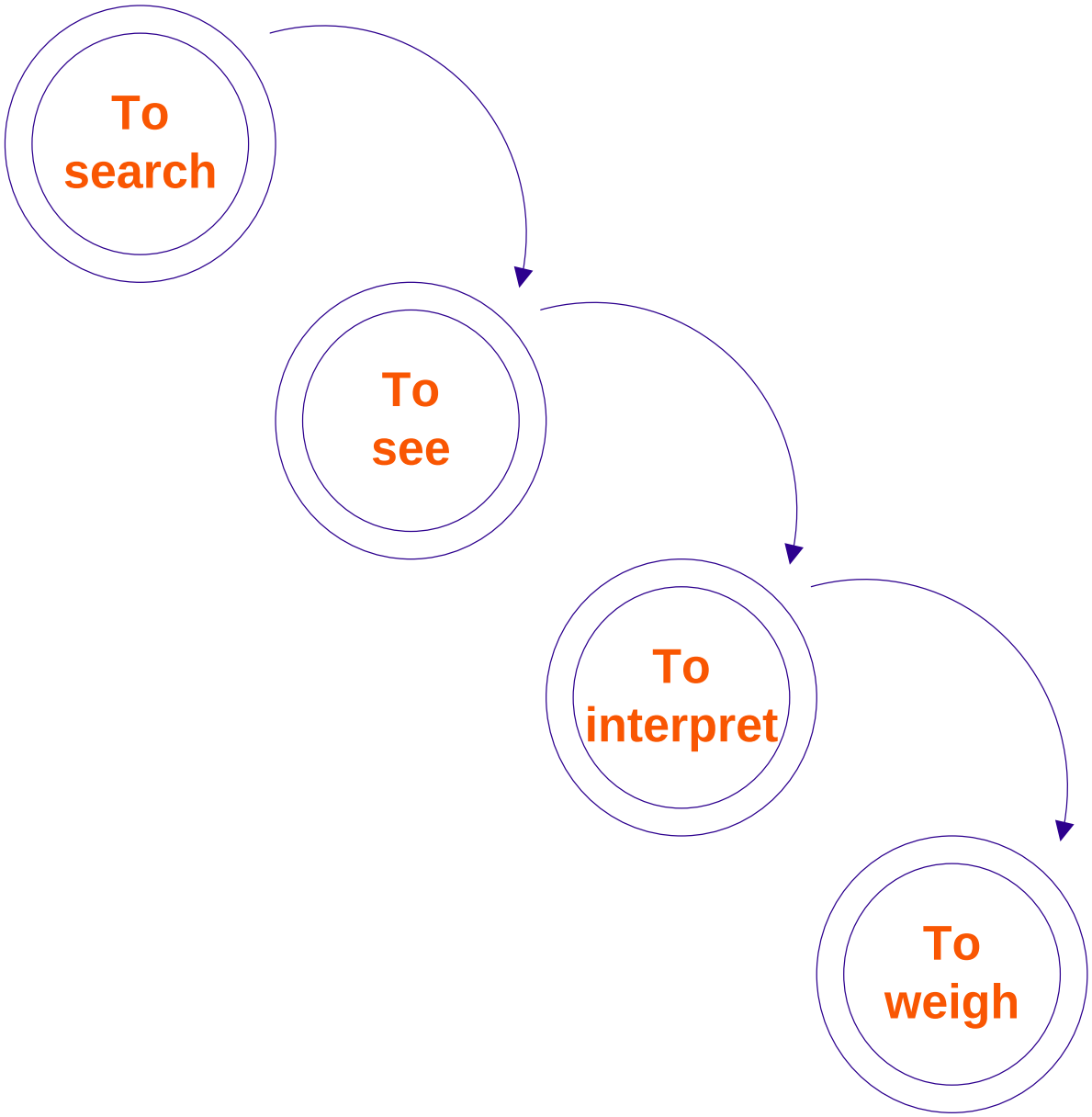
Process Model Flaws

- Unaware of differential pressure investigation
- Believed negative pressure test
- Believed in “bladder effect” explanation of pressure in drill pipe

Recommendations

- Driller was overloaded, had too many things to do at once. Responsibilities should be allocated to prevent this.
- Well status monitored at all times
- All anomalies in pressure readings are logged and explained to next control level
- Safety professionals on site (?)
- More careful structure and assignment of responsibilities
- More careful design to make sure monitoring works
- Make a HF analysis of kind of information that people are given
  - E.g. data observability vs. availability
- Improve Change Management: development, stricter enforcement
- Design and test standards
- Multiple controllers
  - Needed clearer hierarchy in decision chain
  - Improved communication channels along this chain

To summarize


To search
To see
To interpret
To weigh

STAMP – strenghts

- Focus on the system
- Development of control structure
- Evaluation of loops
- Recommendations on improving system performance

STAMP – is not…

- an easy to comprehend, linear reconstruction of the accident
- a ‘cookbook-recipe’

www.incidenteel.com

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