

# How to Incorporate Human Factors in the Design Process

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## What is covered:

- **Motivation: Why Human Factors?**
- **FG 4 Work**
  - **Background.**
  - **The design Process.**
- **Examples: Ignoring Human Factors leads to incidents and fatalities.**
- **Conclusion.**

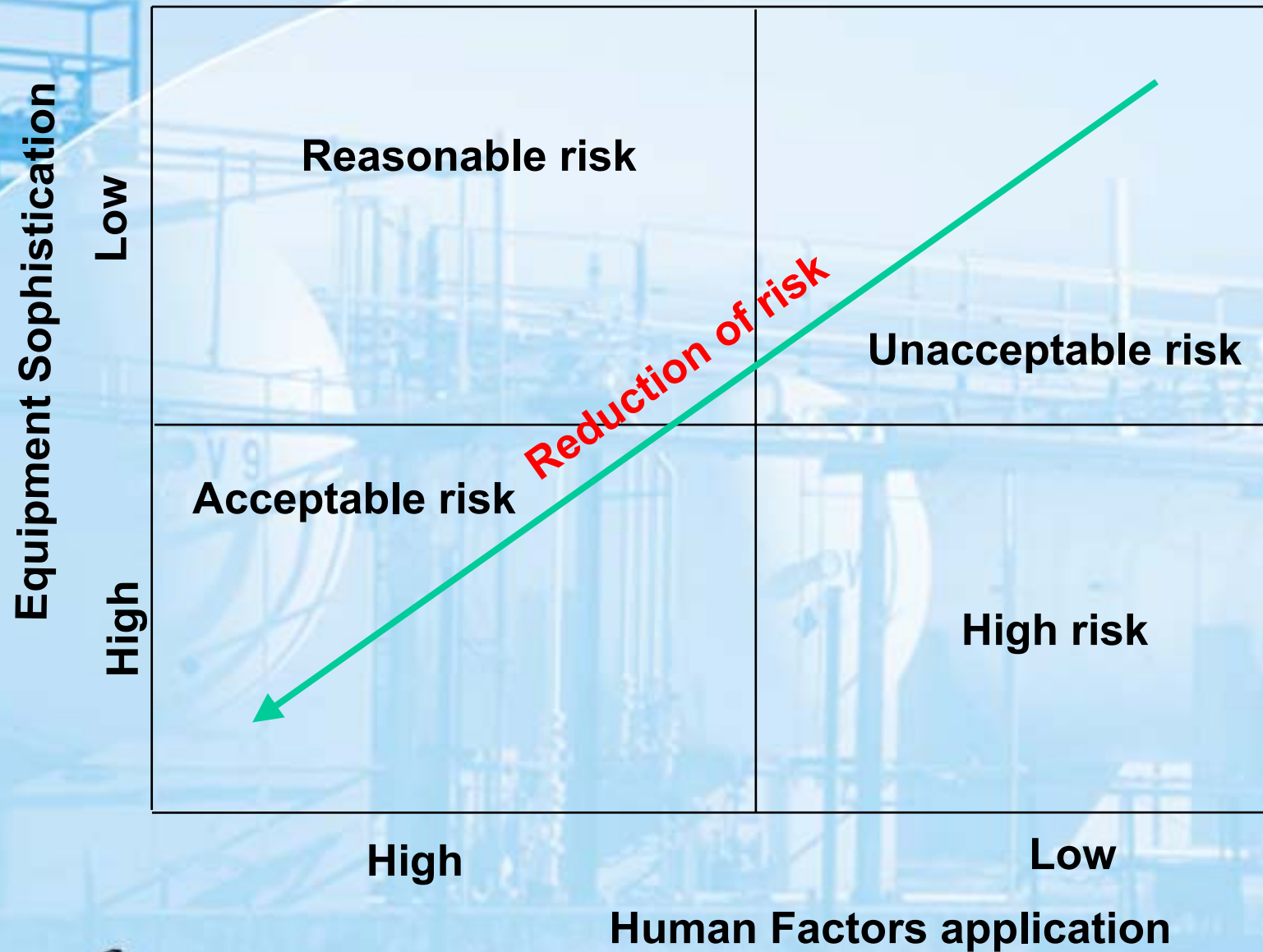
# Why Human Factors?

*Man is a creature made at the end of the week ..when God was tired*

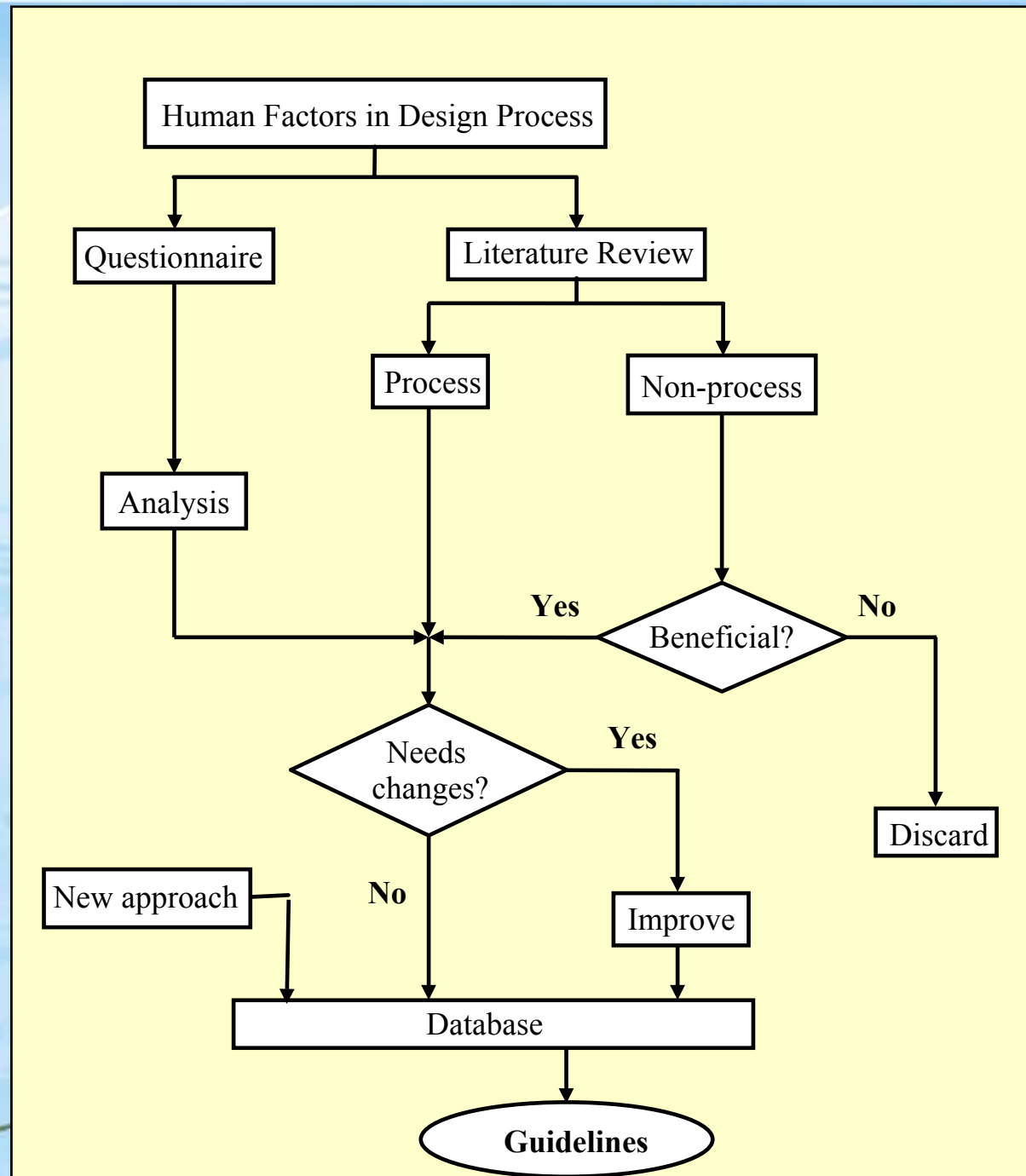
-Mark Twain



# Why Human Factors?



# FG4 - The Task



## FG4 - The Questionnaire

**Large-scale internet-based survey all over Europe:**

<http://tk1.fb10.tu-berlin.de/~loewe/fbogen/Fprism.html>

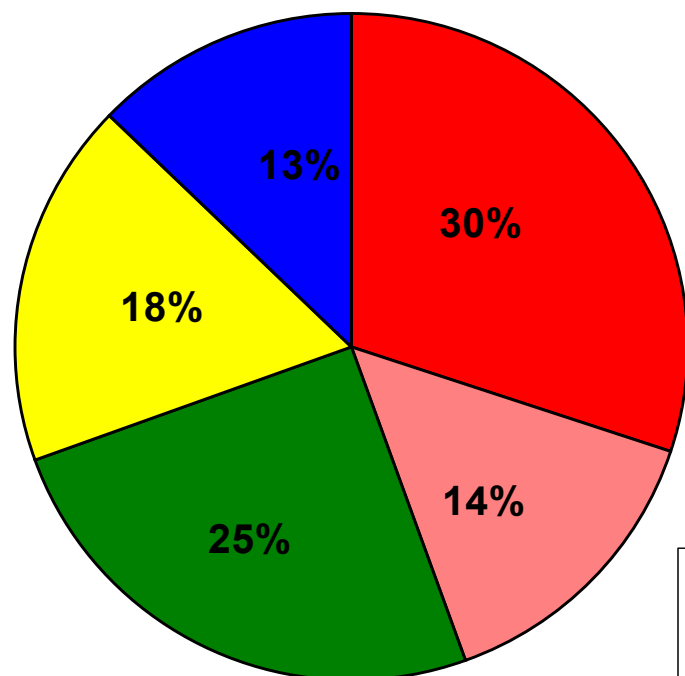
- ↗ **General questions**
- ↗ **Analysis of accidents**
- ↗ **Operator qualification and demands**
- ↗ **Consideration of human factors in  
the design process**
- ↗ **Conclusions**



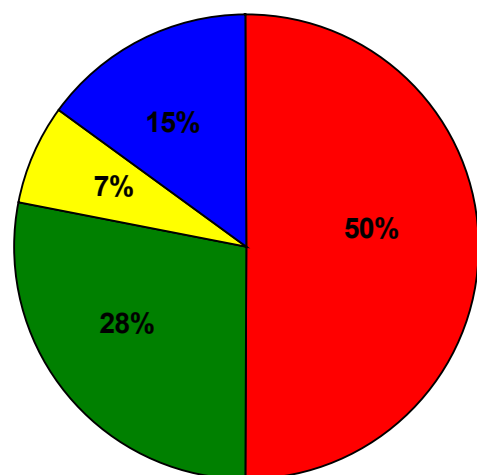
# FG4 - Results example of Questionnaire

## Analysis of accidents

The % of the operating states for event occurrences:



- Normal process
- Loading/unloading
- Maintenance/repair
- Startup/shutdown operation
- Others:

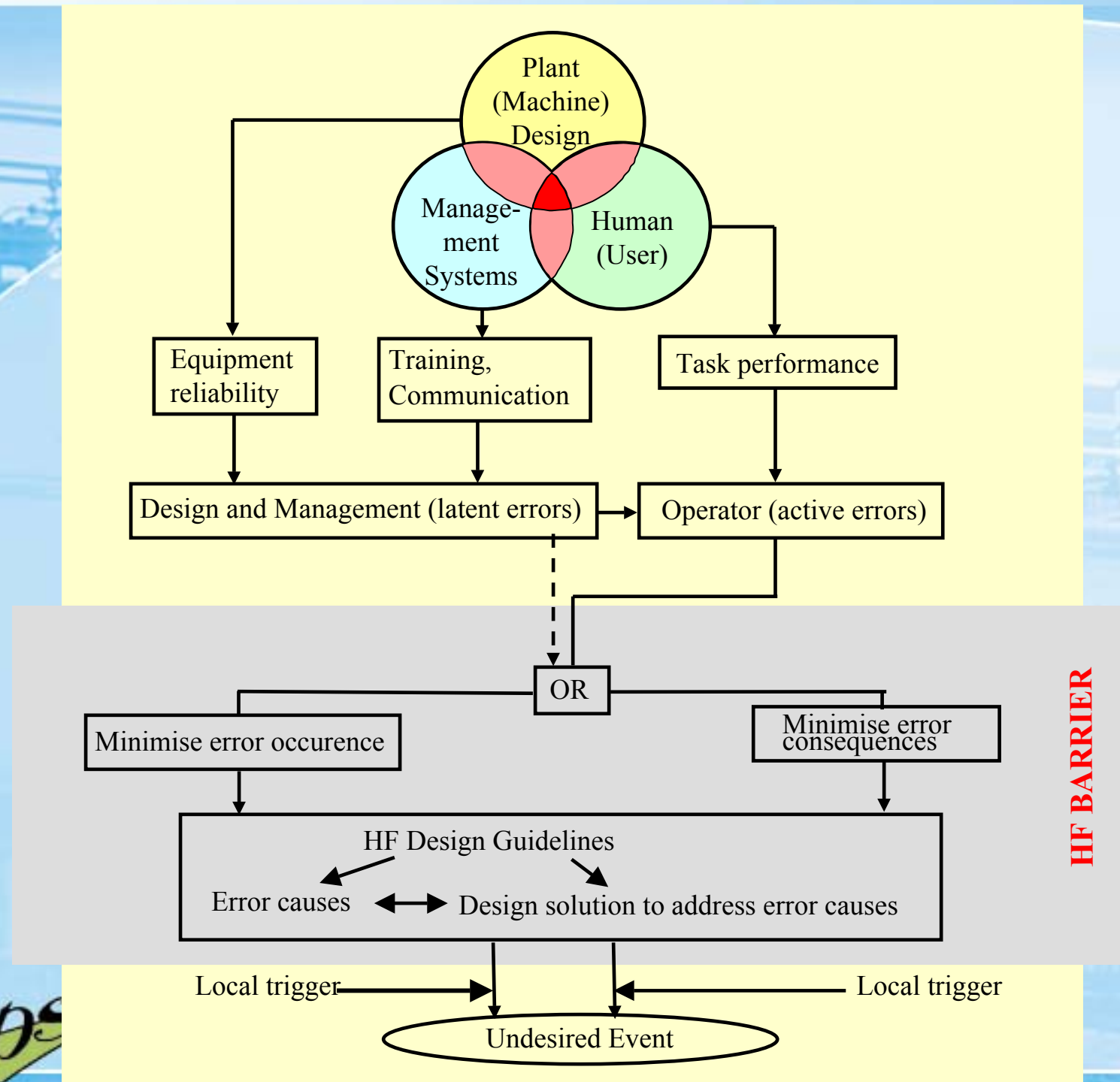


- Normal process
- Maintenance/repair
- Startup/shutdown operation
- Others

Uth 1999



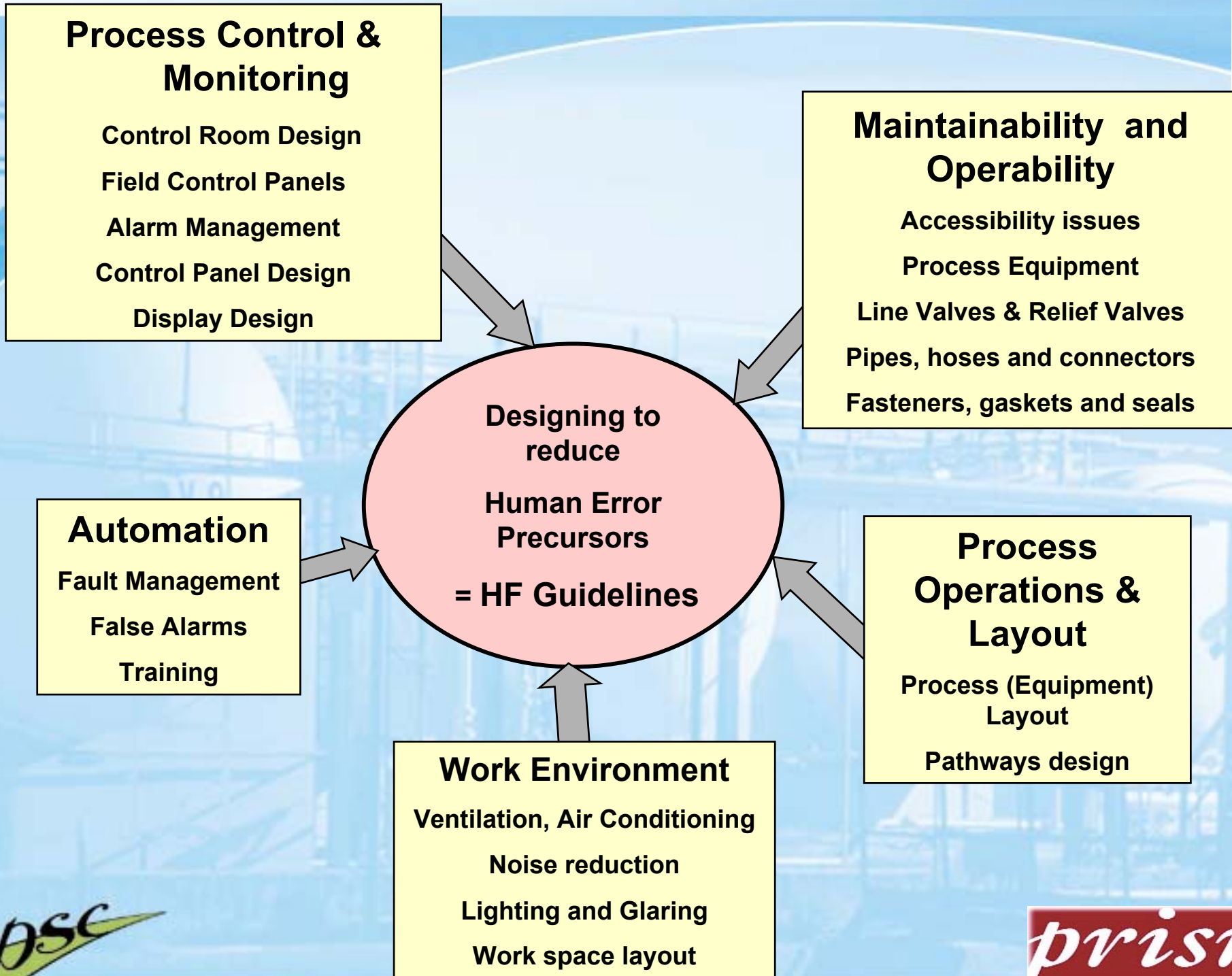
# FG4 - HF Background



**HF BARRIER**







# FG4 - The Design Process



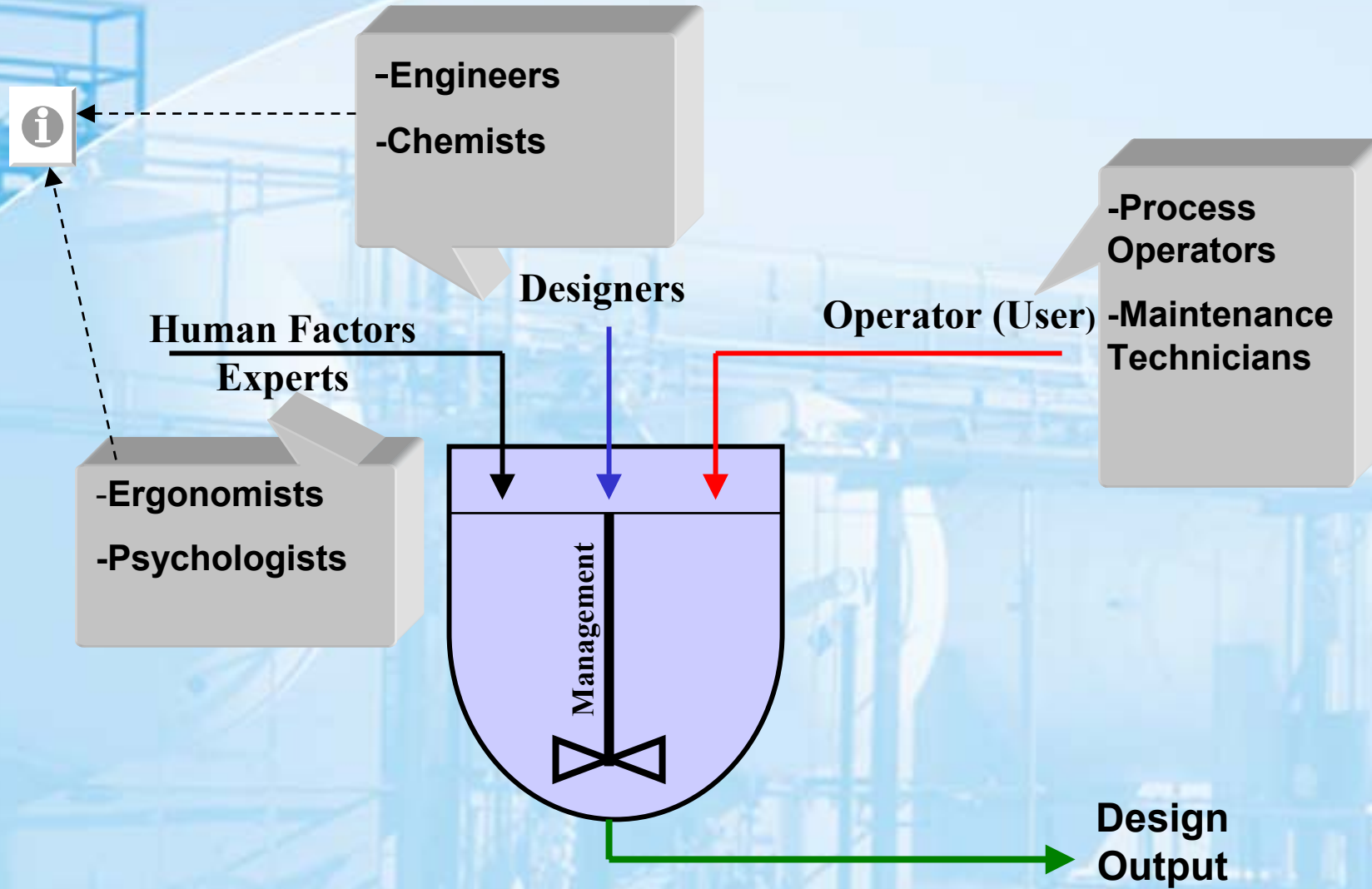
*The Primary function of a design engineer is to make things difficult for the fabricator and impossible for the the serviceman.*

-Murphys law on Technology





# FG4 - The Design Team



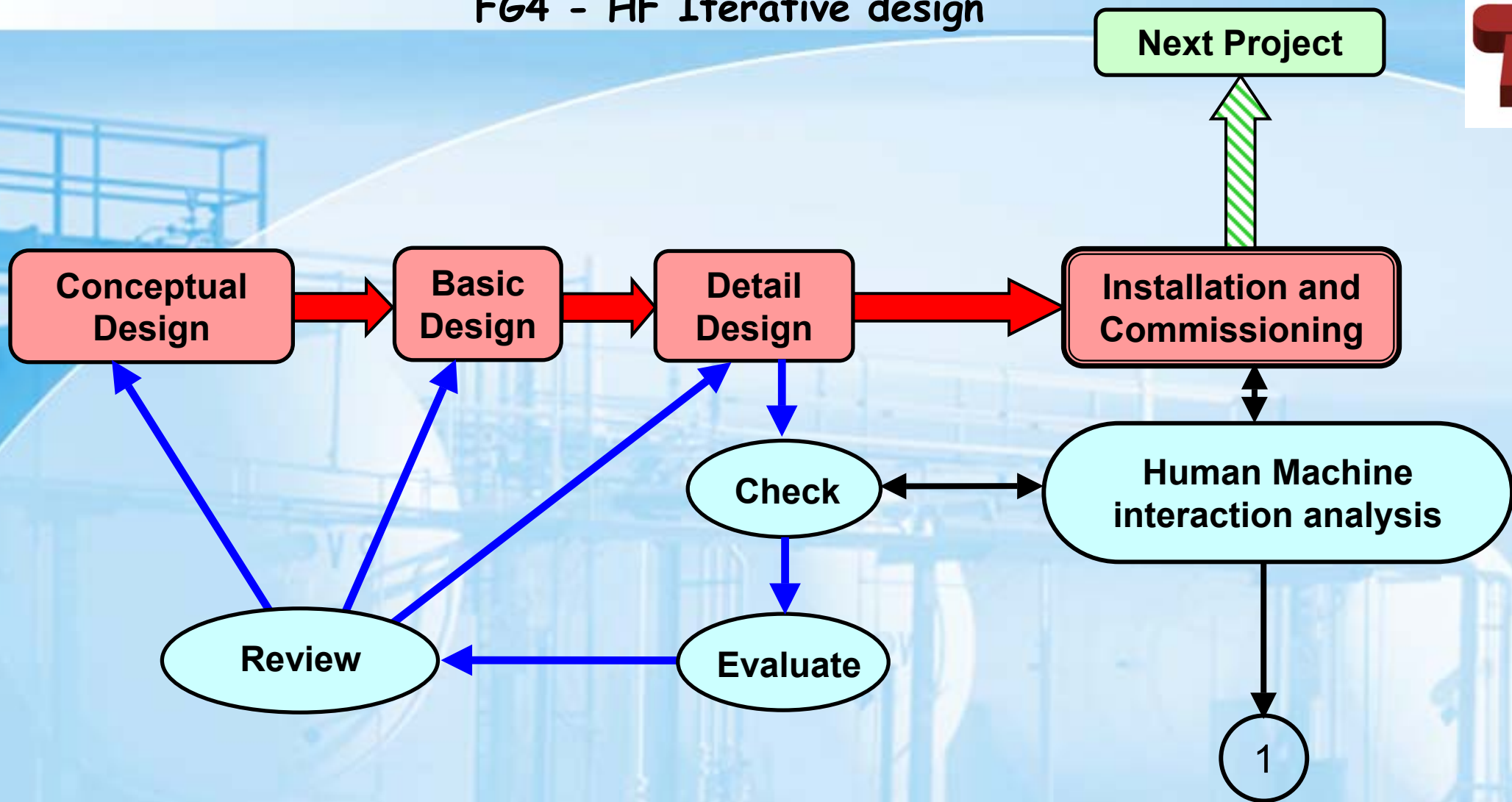


# FG4-The Design Principle

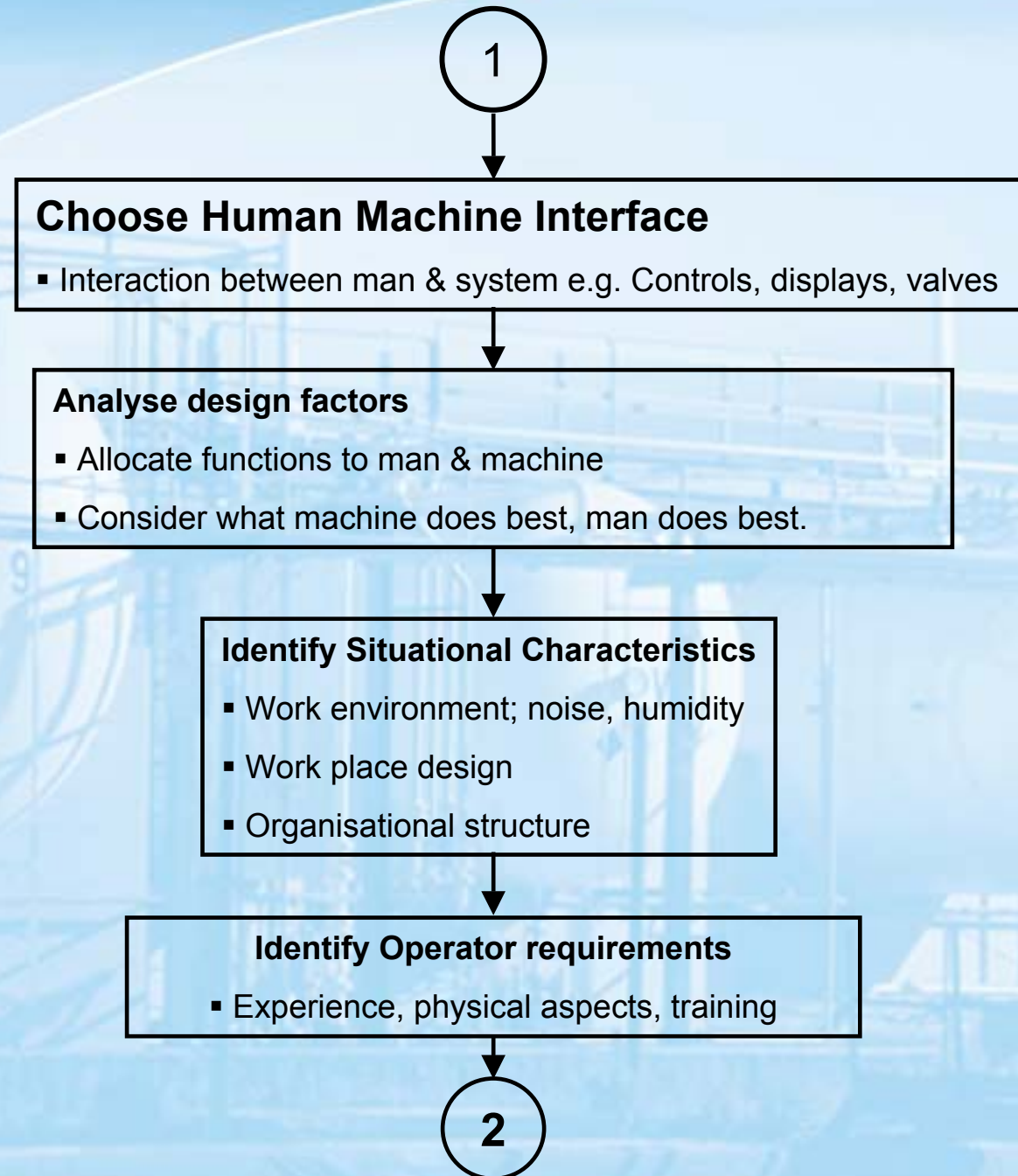
- **Participatory design that involves operator (as the user) participation and task modelling at early stages.**
  
- **To make all departments feel that they own the design process.**
  
- **Human Factors are included from early stages and not to only for cosmetic purposes.**
  - To train Engineers to be HF experts
  - To involve cognitive and physical ergonomists permanently & actively in design projects



# FG4 - HF Iterative design

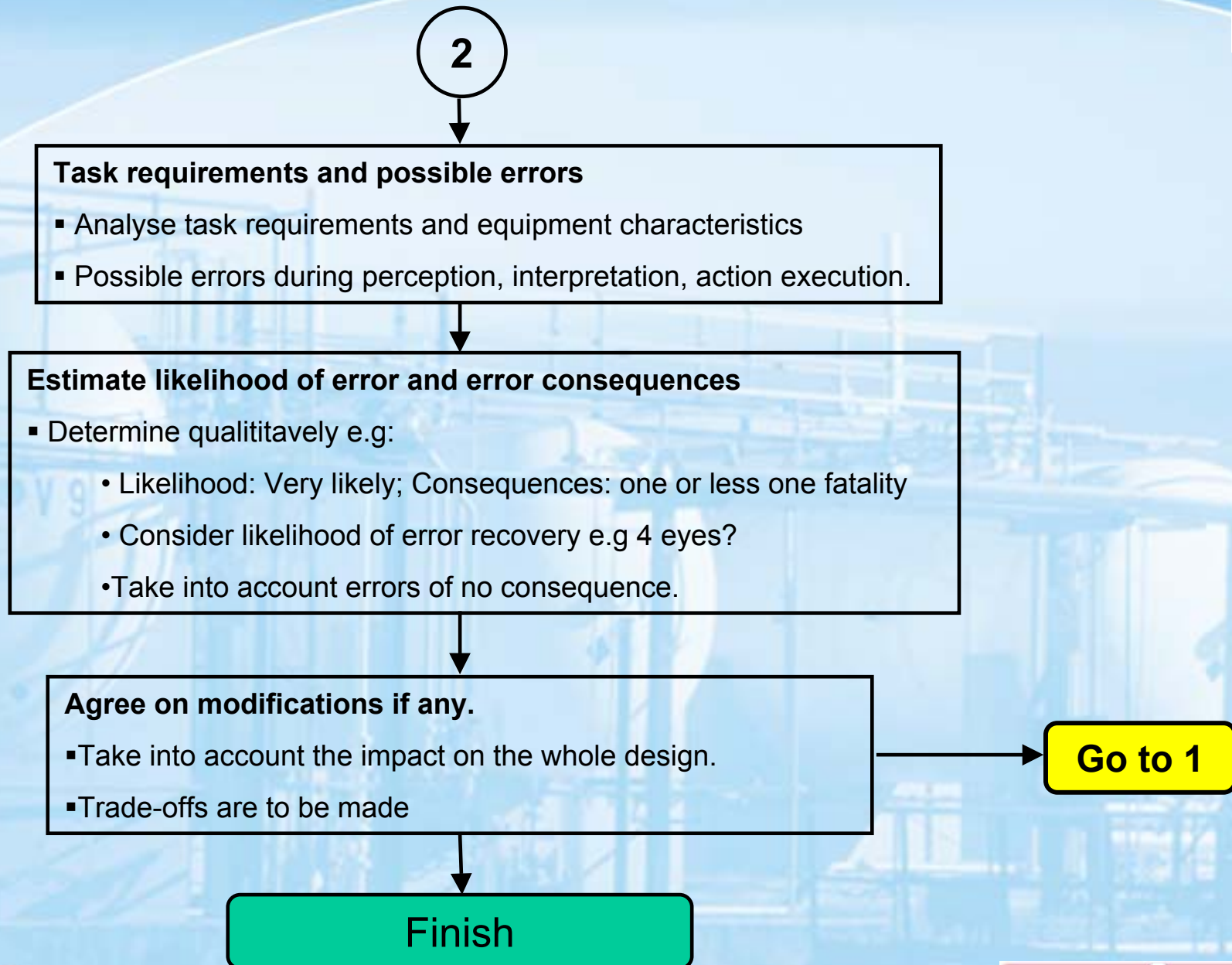


# FG4 - Human Machine interaction analysis



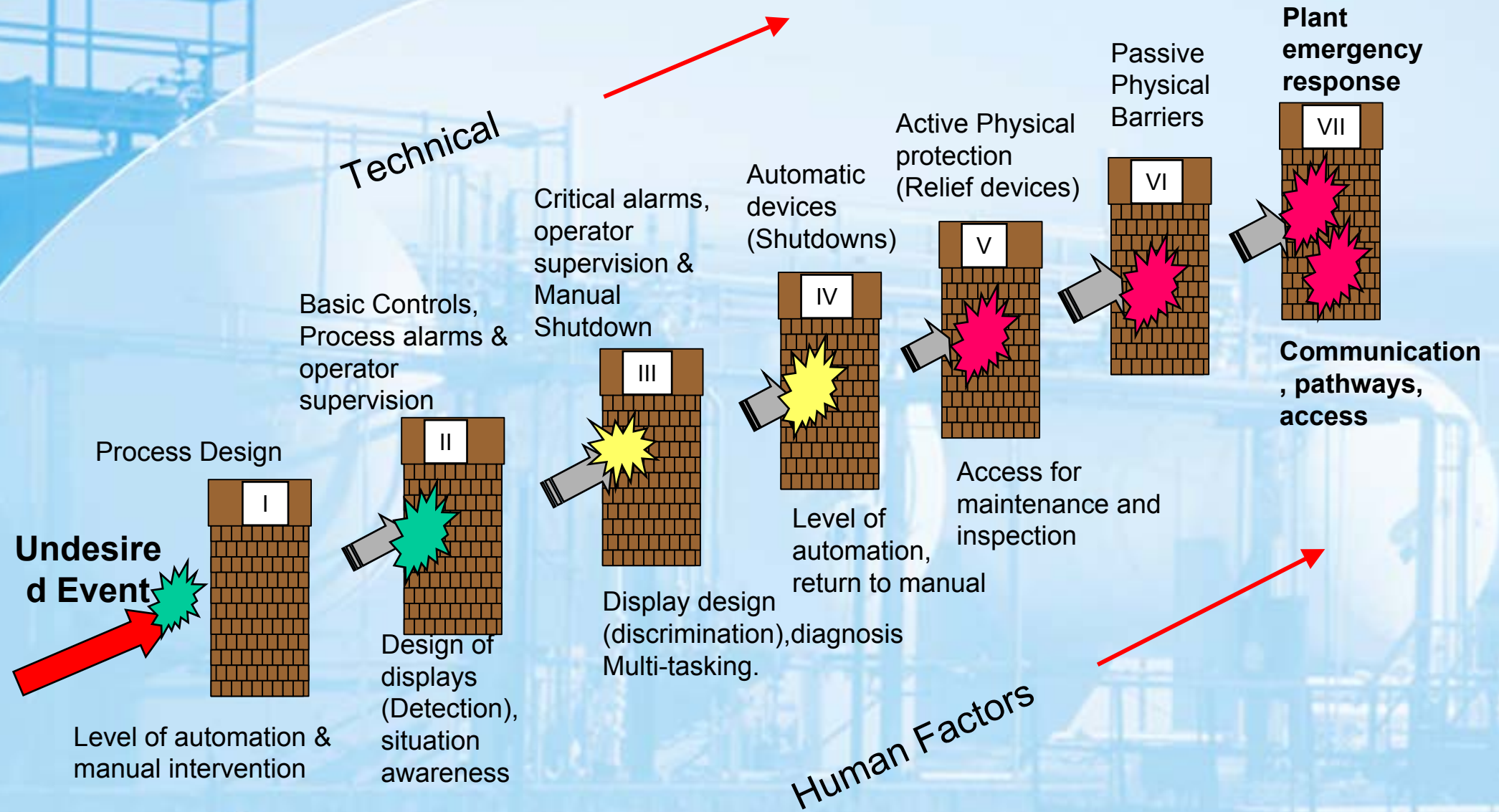


# FG4 - Human Machine interaction analysis





# FG4 - HF Considerations during design of Safety Barriers





# Incident Example: Computer Operated Batch Reactor



*Garbage in garbage out*  
-Anonymous

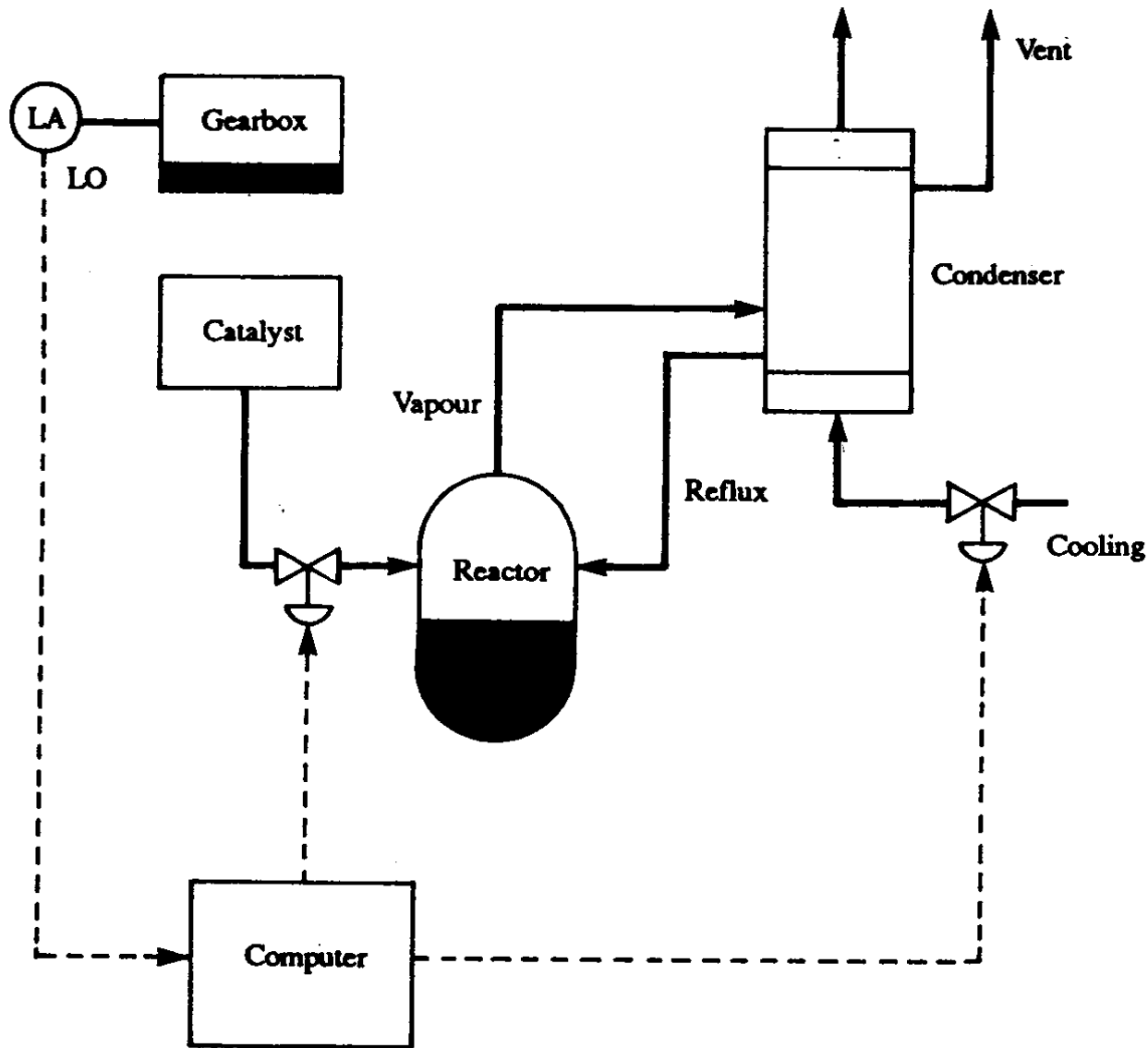
*If builders built buildings the way programmers wrote programs,  
then the first woodpecker that came along would destroy  
civilization*

-Murphys Law on Technology





# Incident Example: Computer Operated Batch Reactor



## The Design Features

- When a fault occurs computer sounds an alarm.
- All operating parameters held constant until operator's intervention.

# Incident Example: Computer Operated Batch Reactor

## The Day of the Undesired event

- Catalyst had just been added.
- Computer receives an abnormal situation signal.
- All operating parameters held constant including cooling water.
- Operator searches for the cause and does not notice the rising temperature
- The reaction gets out of control and contents lost to the atmosphere through the relief valve.
  
- Cause of the alarm:

Information to the operator that there was Low Oil Level in a gear box.

# Incident Example: Computer Operated Batch Reactor



## Human Factors Issues

- Diagnoses – took the operator too long to unravel the puzzle.
- Alarm priority
  - Alarms should be prioritised as informative, warning and critical.
- Software designers were not involved in the initial design tasks like HAZOP studies.





# Example: Petrobras P-36 Sinking March 15th - 20th 2001

## Roncador oilfield Brazil

*.....the project successfully rejected the established constricting and negative influences of prescriptive engineering....*

One of the executives of Petrobras.

# Example: Petrobras P-36 Sinking March 15th - 20th 2001

## Roncador oilfield Brazil

### The incident

- First undesired event on March 15th – no prior indications of upset conditions.
- Followed by many alarms sounding simultaneously.
- Operators try to diagnose the malfunction but alarm system is very complex.



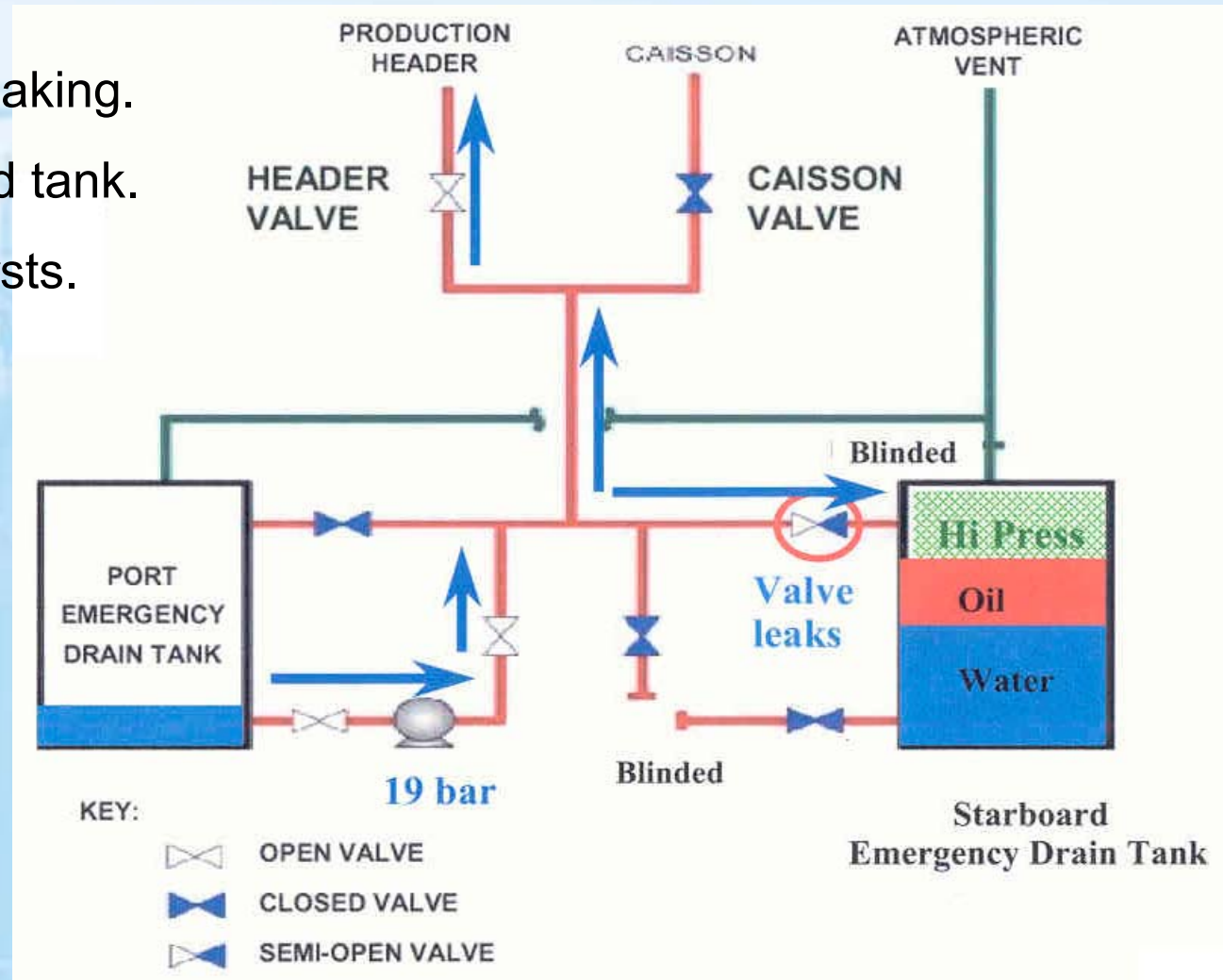


# Example: Petrobras P-36 Sinking March 15th - 20th 2001

## Roncador oilfield Brazil

### What happened:

- 19 bar pump started.
- Starboard drain tank valve leaking.
- Three blinds on the starboard tank.
- Pressure builds and tank bursts.





# Example: Petrobras P-36 Sinking March 15th - 20th 2001

## Roncador oilfield Brazil

### Consequences:

- 11 fatalities
- Over \$500 Million worth of assets
- Huge environmental damage



### Human Factors questions:

- Alarms system reliable?
- Escape routes and emergency evacuation available?

# Conclusions

- ✓ HF should be as old as the conceptual stage of a design process.
- ✓ Iterative design process helps to reduce error causes before the whole design process is concluded.



Thank you for your kind attention

