System Reliability Analysis

Reliability Engineering Lifecycle

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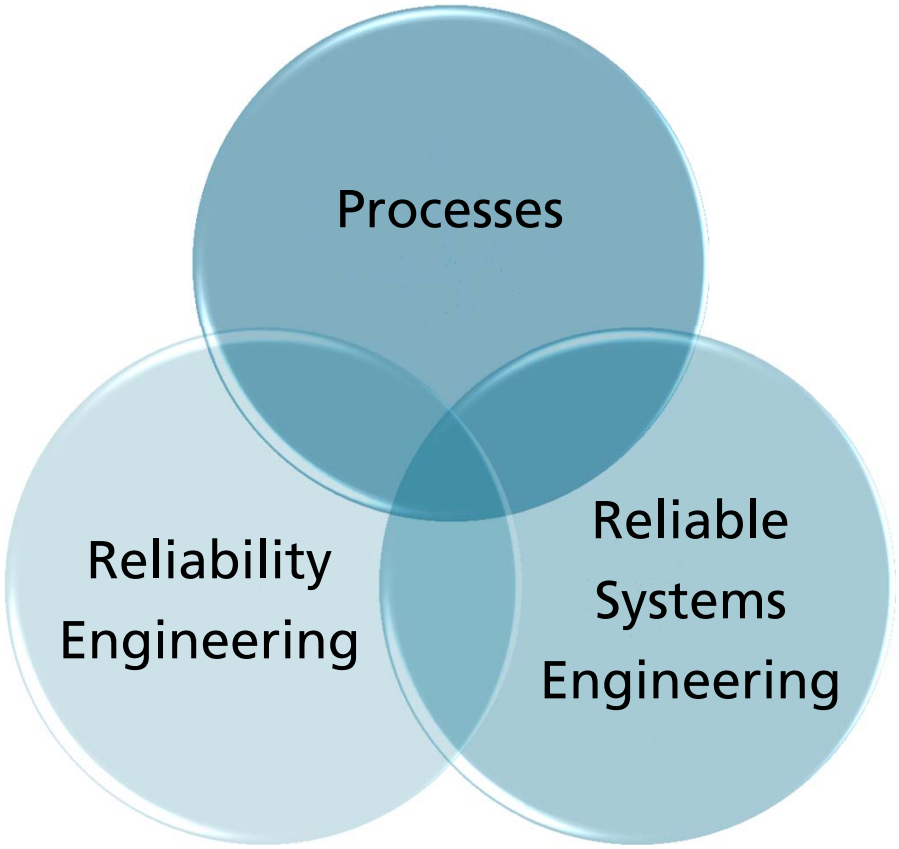
The Elements of Engineering Reliable Systems



Processes

- Developing products following clearly defined processes is a necessary but not sufficient prerequisite
- Processes are the indispensable basis for the engineering of reliable systems

➔ **Fault Prevention**

Without processes you won't have your development under control and thus you won't have your system under control!

➔ Sound project management is an indispensable prerequisite for reliable systems engineering

➔ Assuring sufficient resources for quality assurance is a prerequisite

➔ Clear phases with well-defined quality gates ensure quality

➔ Supporting processes like configuration and change management are indispensable quality over the whole lifecyle

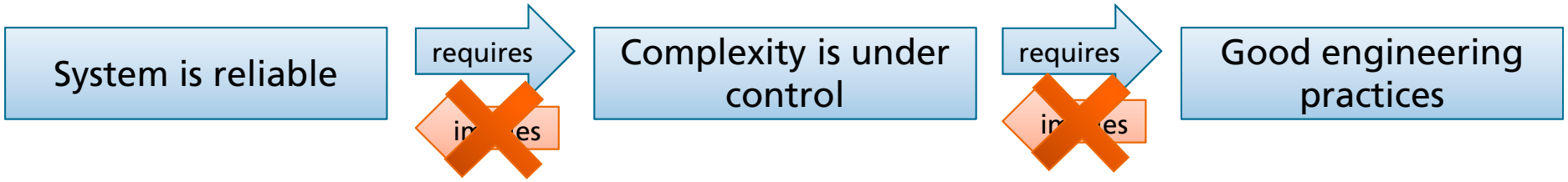
➔ …

Processes won't be considered in detail in this workshop!

Reliable Systems Engineering

Complex systems must be engineered

- From requirements to implementation to validation
- All phases of the development lifecycle must fulfill additional requirements to ensure the development of reliable systems
- In each phase a fault is not discovered, the cost for its removal increases by a factor of 10!
- A good engineering decreases additional effort for reliability
- A good engineering is the prerequisite to ensure system reliability



➔ **Systems Engineering Principles will be part of this section**

Reliability Engineering

- Describes the activities of
  - analyzing and assessing the system's risks
  - analyzing the cause-effect-relationships
  - selecting appropriate counter measures
  - verifying that the selected measures are sufficient
  - using fault forecasting mechanisms
- Direct Impact on Engineering
  - All counter measures are applied in the systems engineering part
  - Fault Removal (e.g., selection of QA-methodologies)
  - Fault Tolerance (e.g., impact of system architecture)

➔ **Will be the main topic of this workshop!**

Engineering reliable systems

- Why Engineering?
- The process point of view
- The methodology point of view – the required minimum

Why Engineering?

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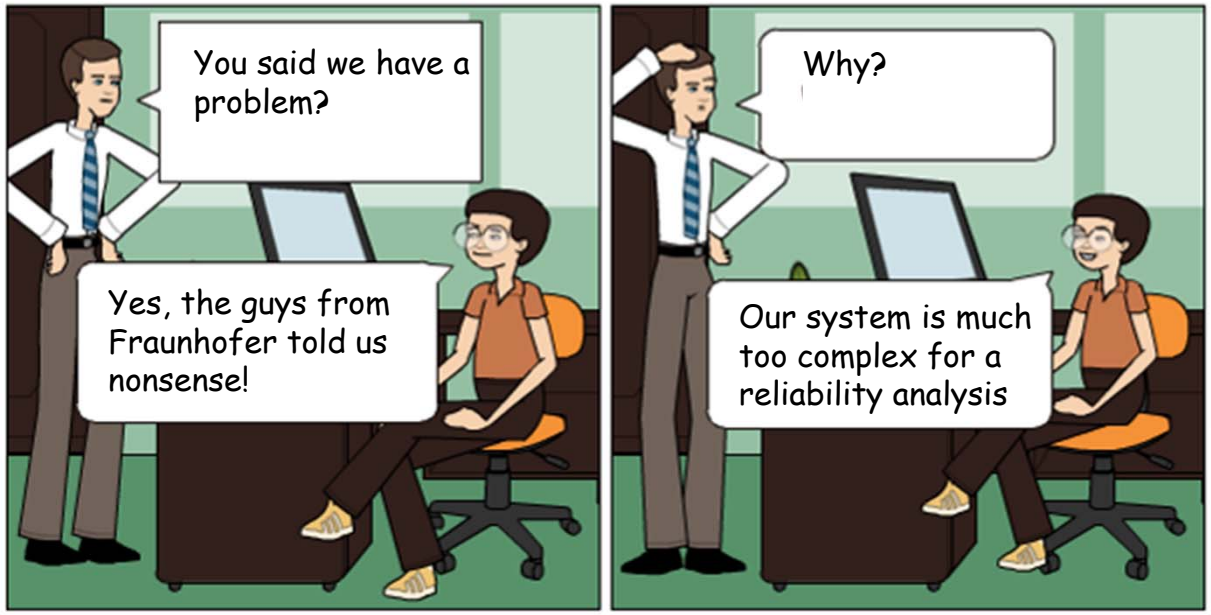

Why Engineering?

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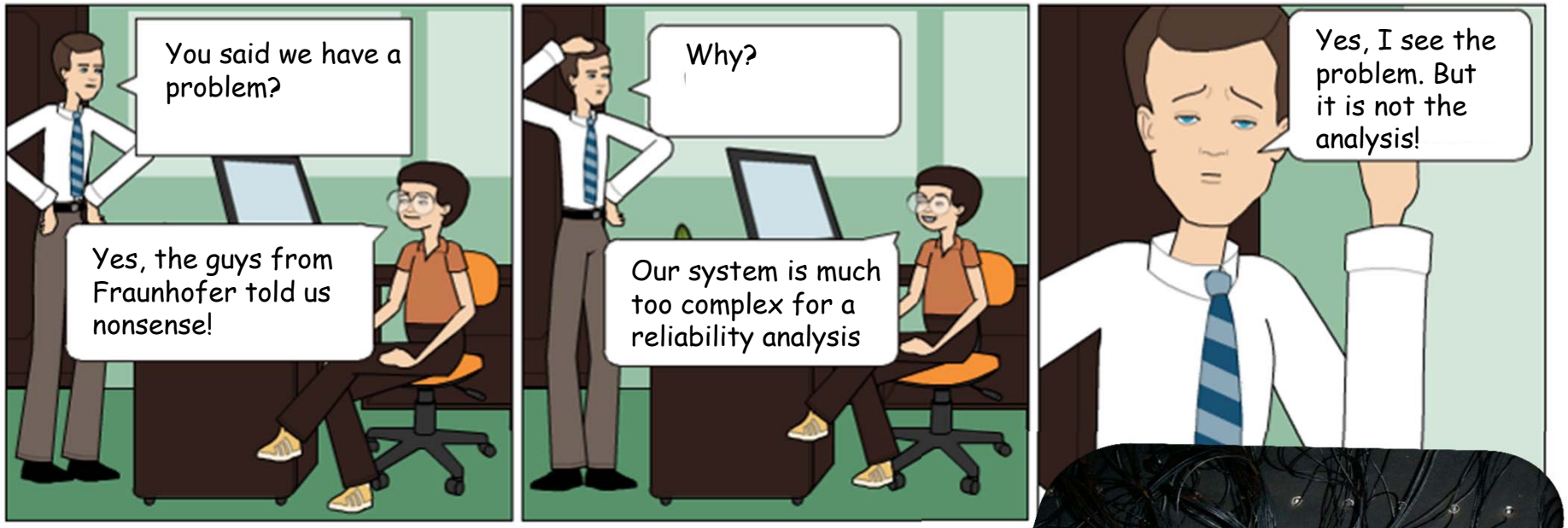
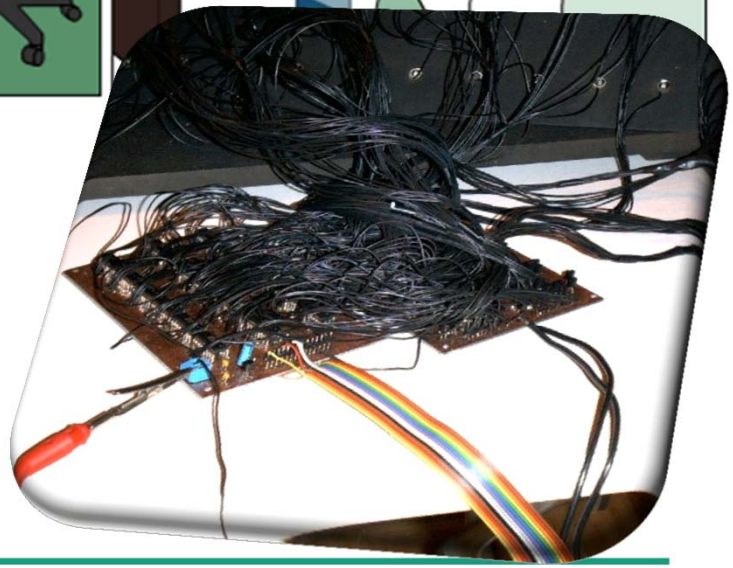
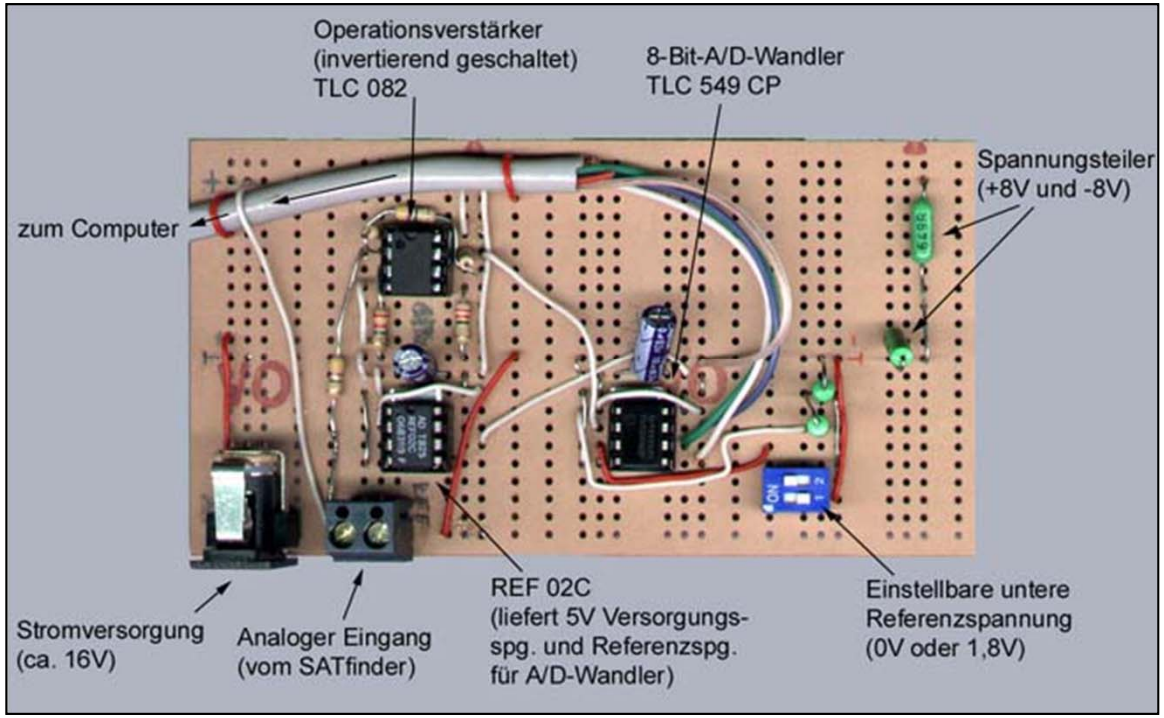


If you are not able to perform a reliability analysis due to complexity reasons, you have a real problem:

You lost control over your system!

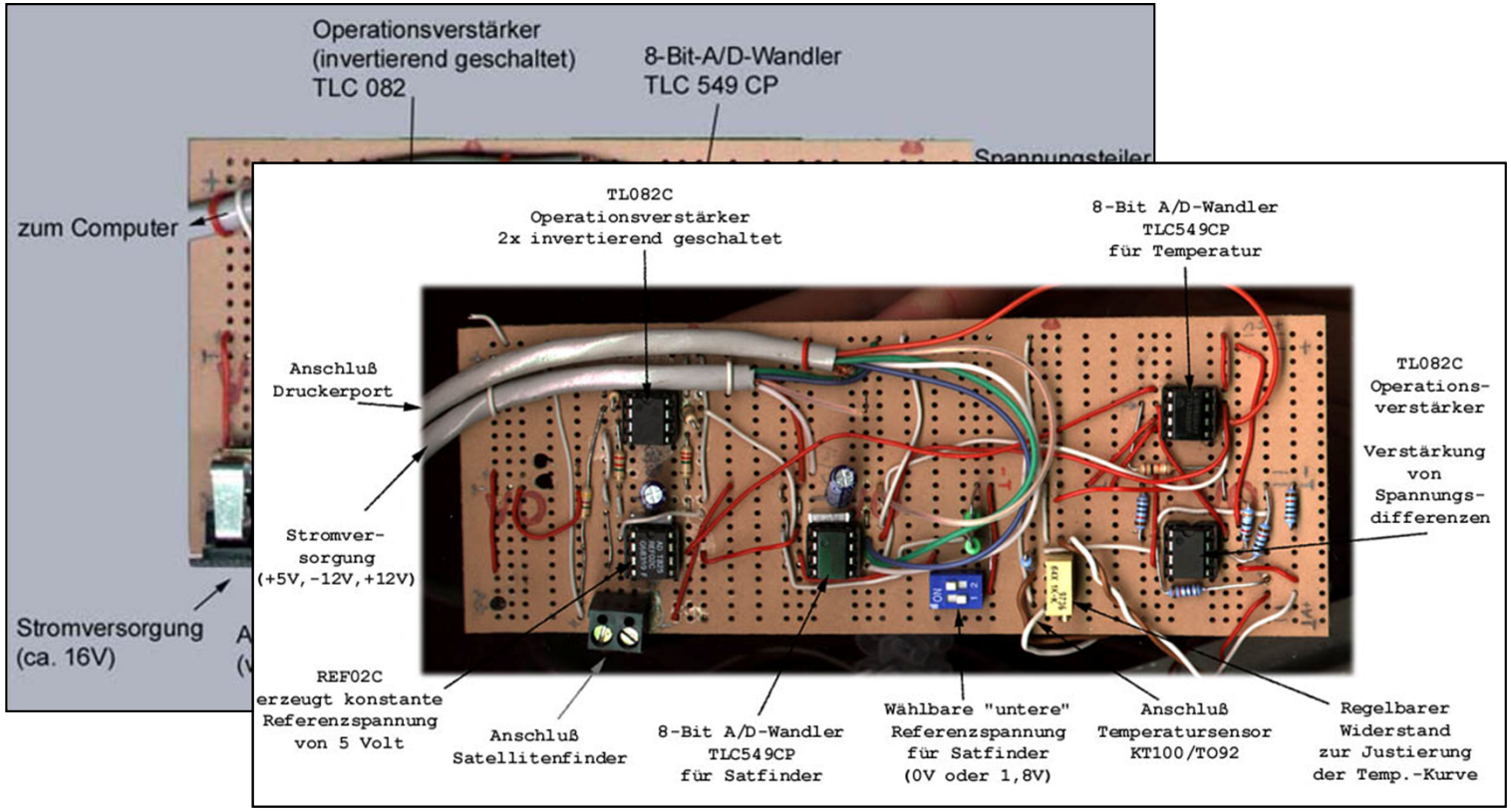


How the story began

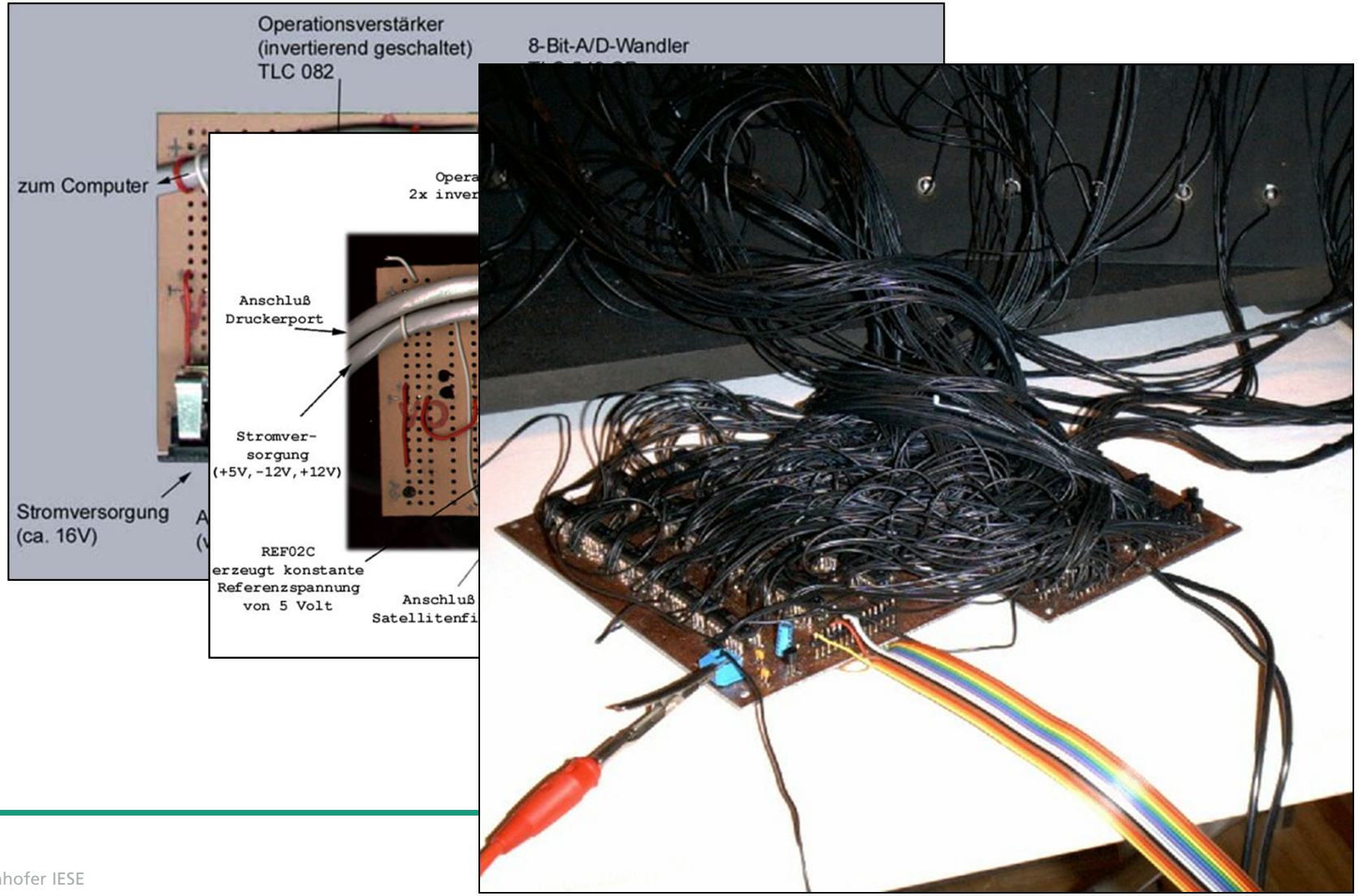


The big mistake

The point of no return



And suddenly it's too late



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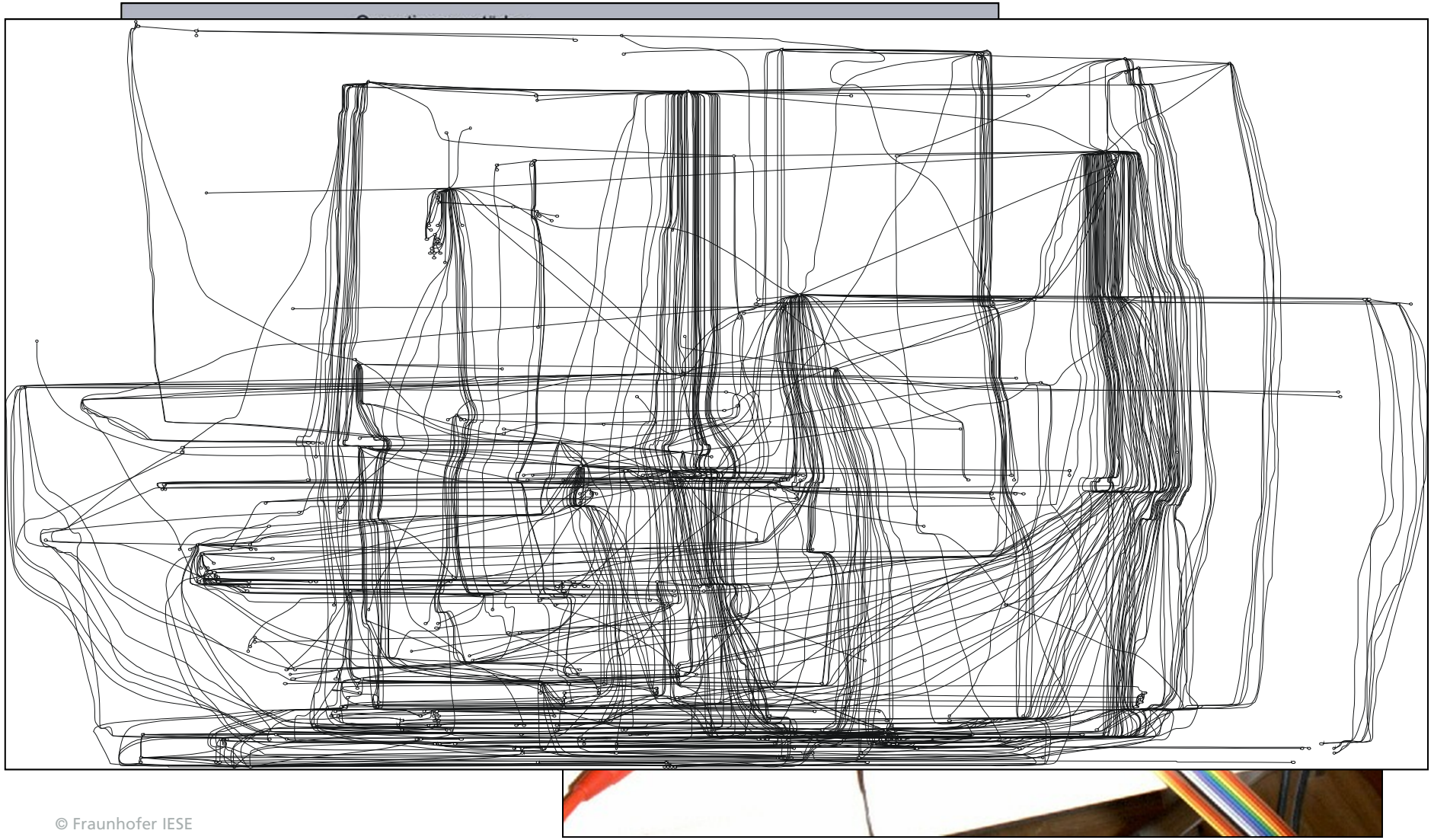
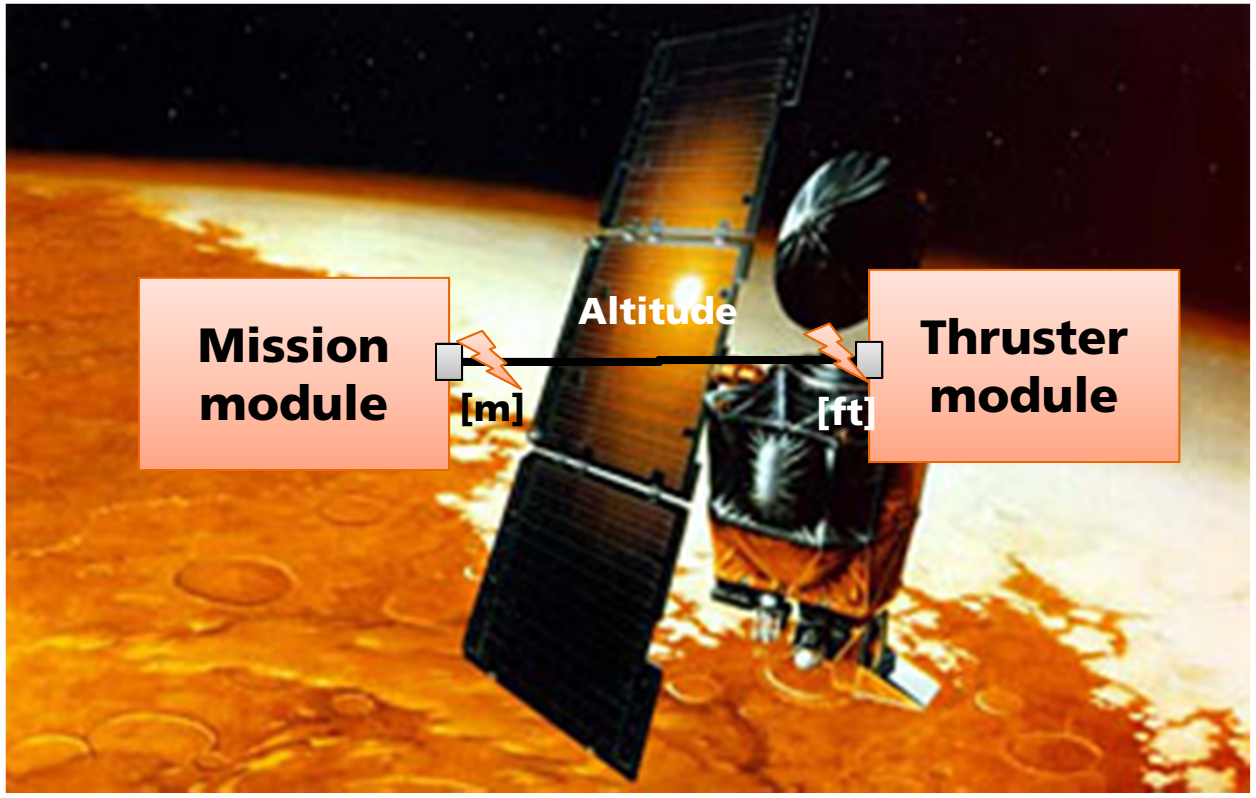


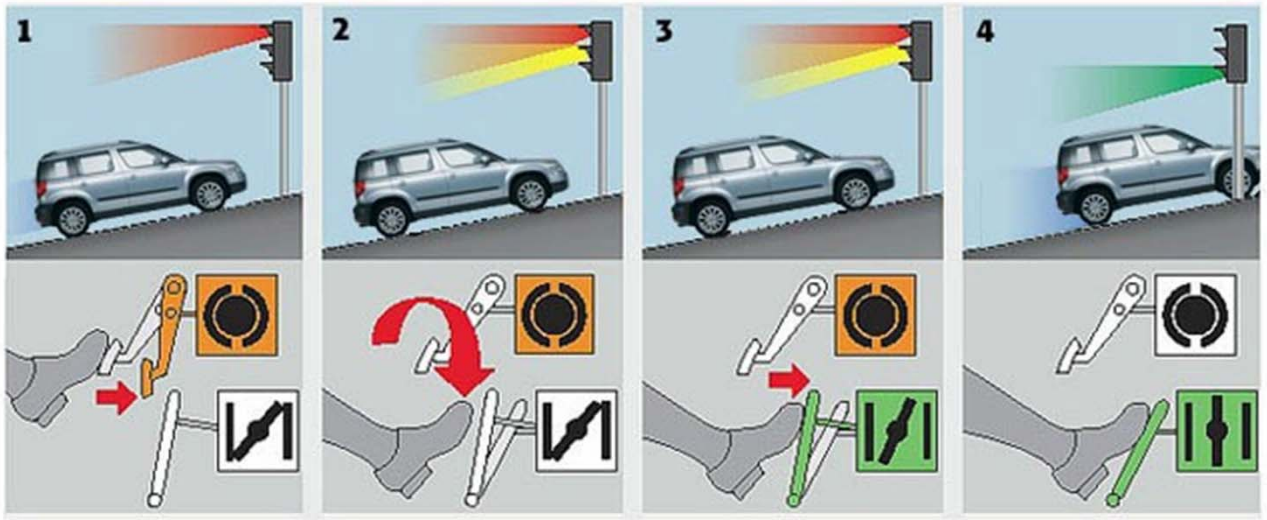
Loss of MARS Climate Orbiter (MCA) - Revisited

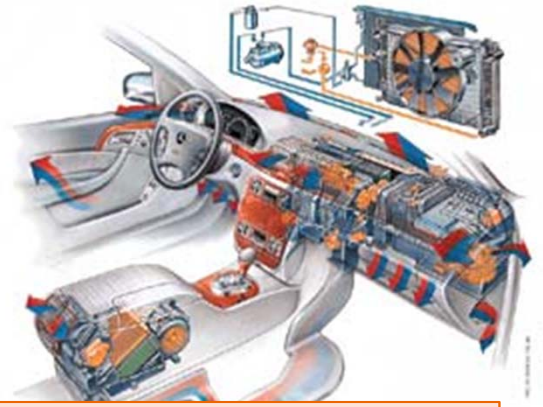


➔ **under /non-specified interfaces**

- → clear reliability impact
- → Obviously no reliability engineering but systems engineering problem

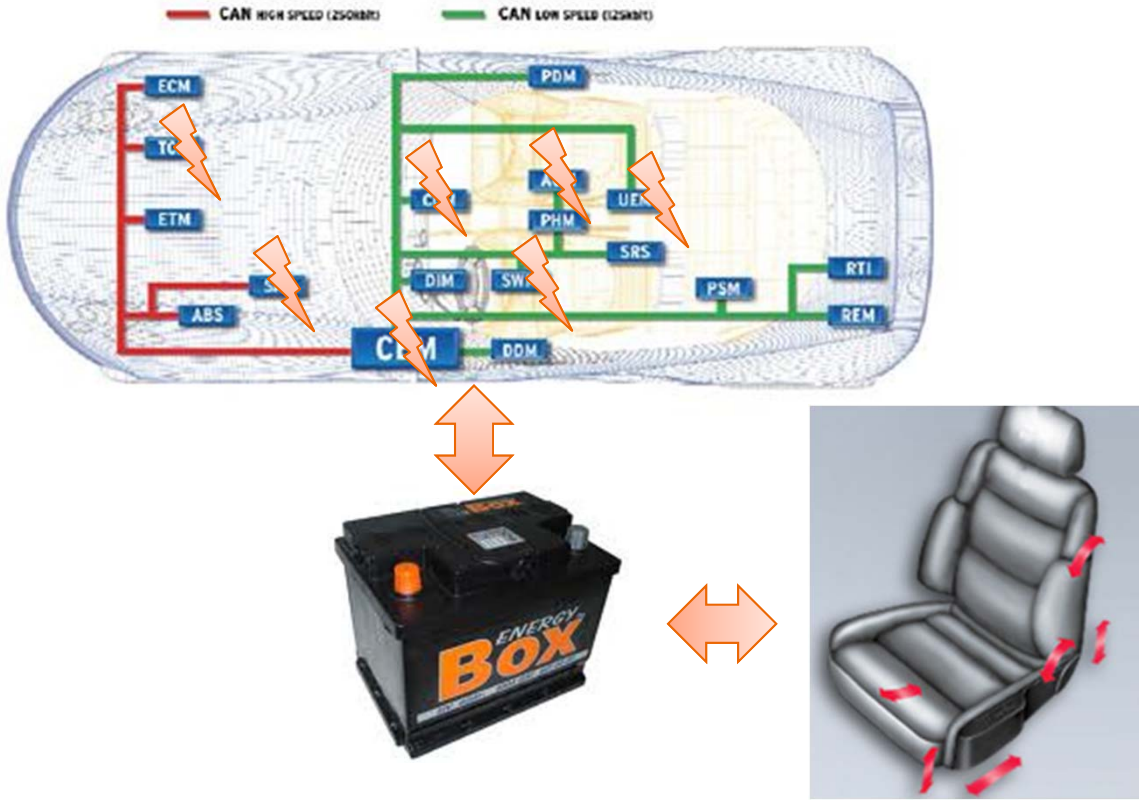
Feature Interaction





➔ **Complexity leads to undesired feature interactions**

Interference



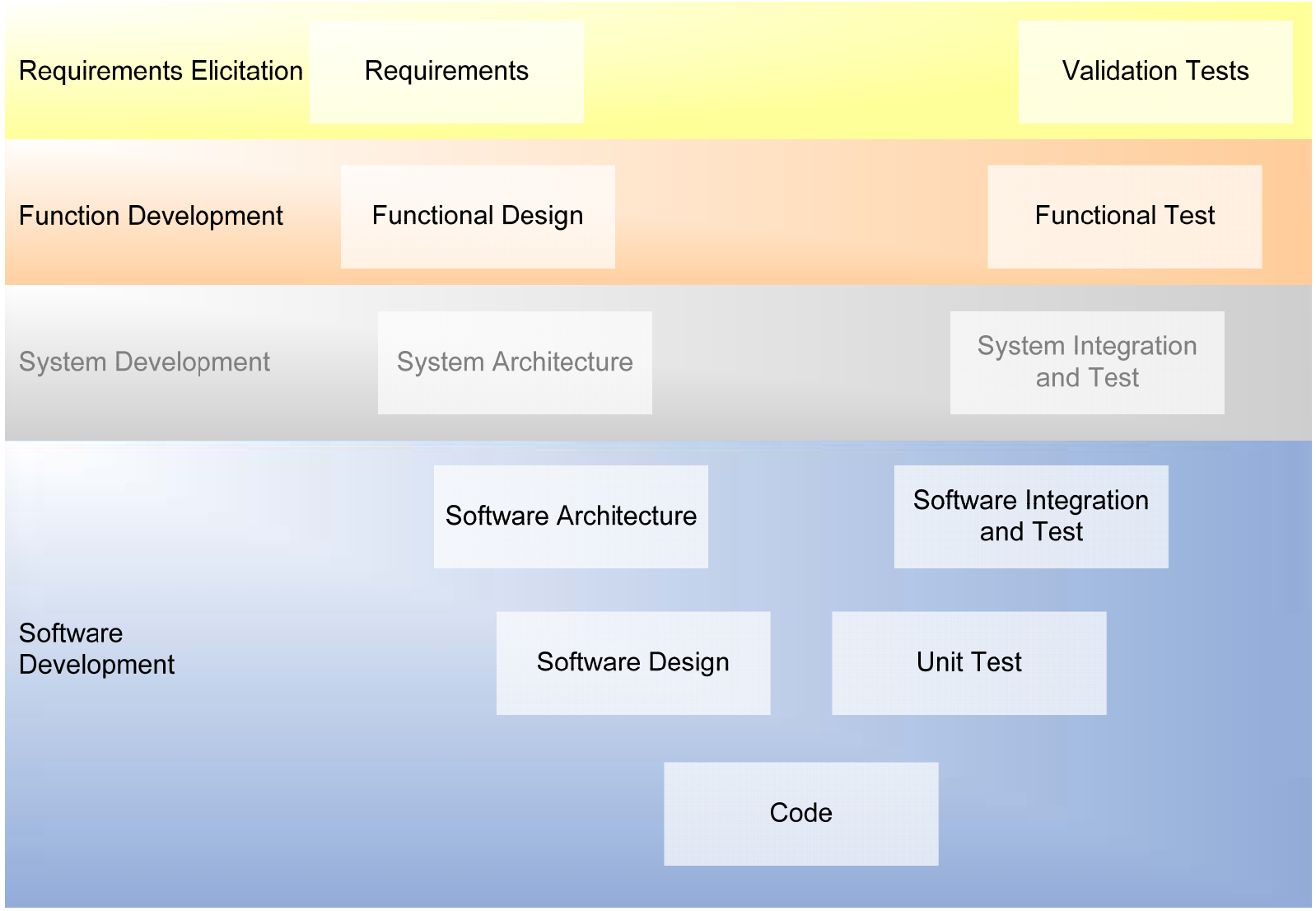
➔ System compexity leads to sub system interference

→ Cannot be manually identified / managed

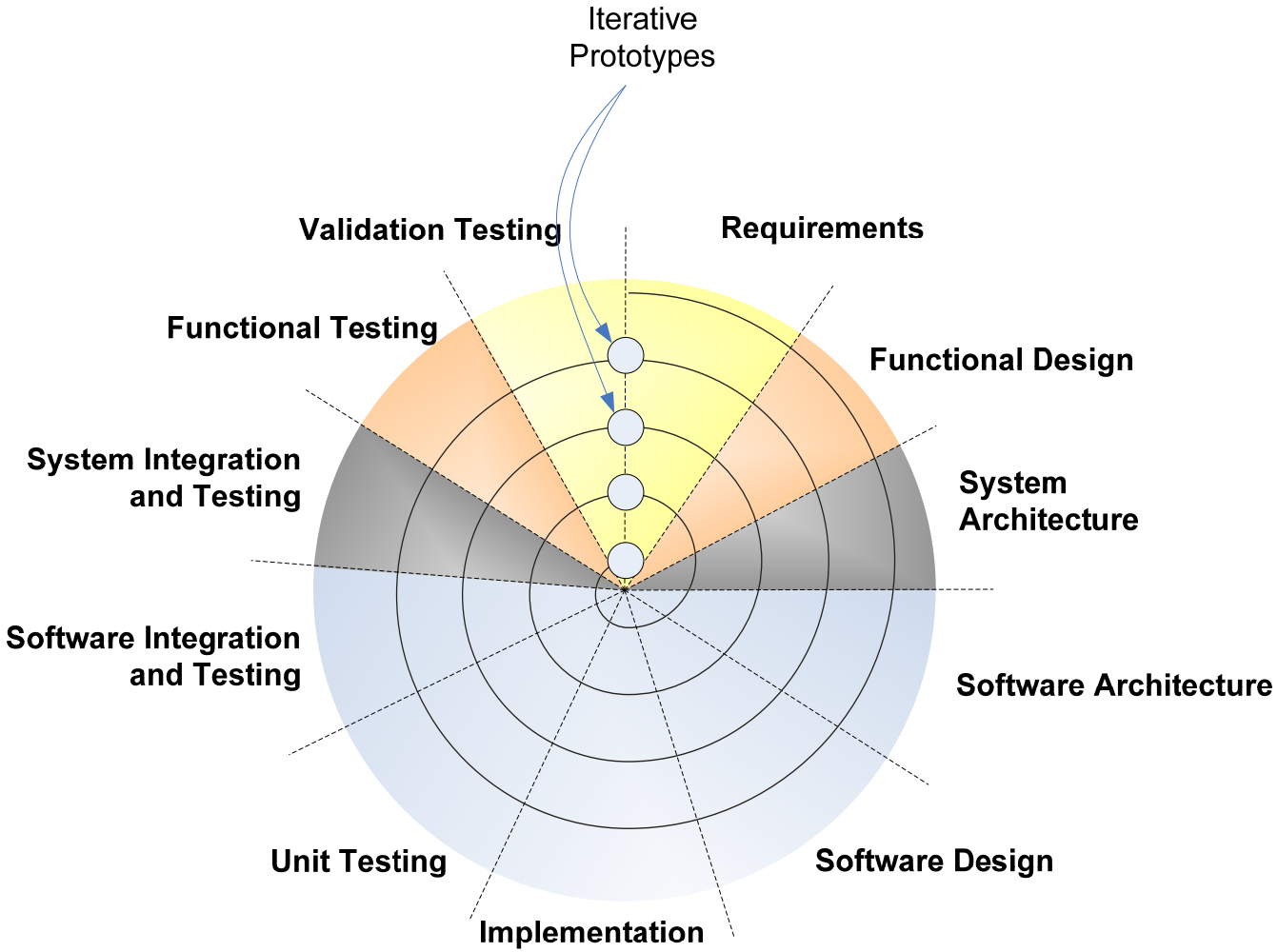
Engineering reliable systems

- Why Engineering?
- **The process point of view**
- The methodology point of view – the required minimum

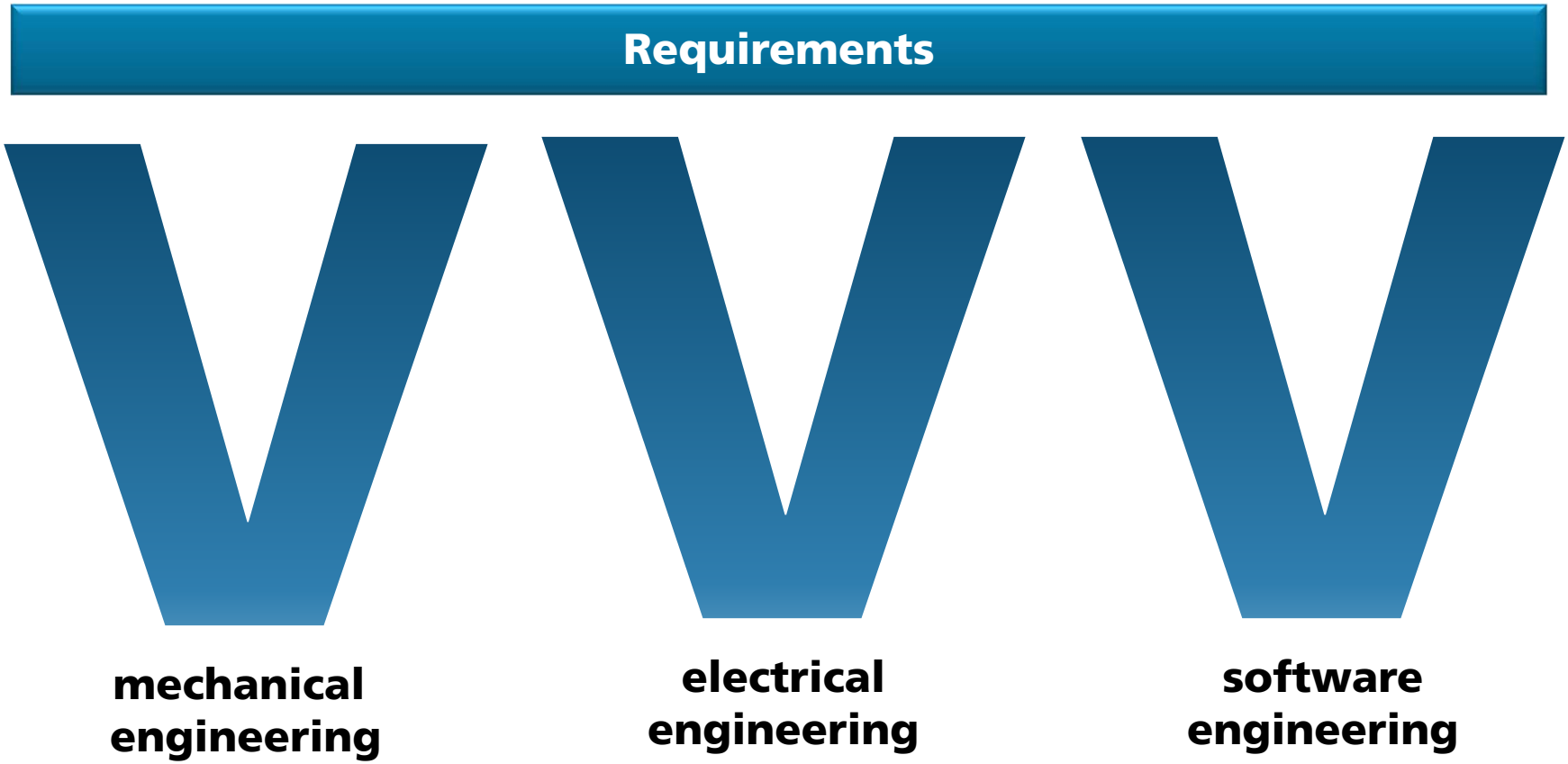
V-Productmodel (the SW-Viewpoint)



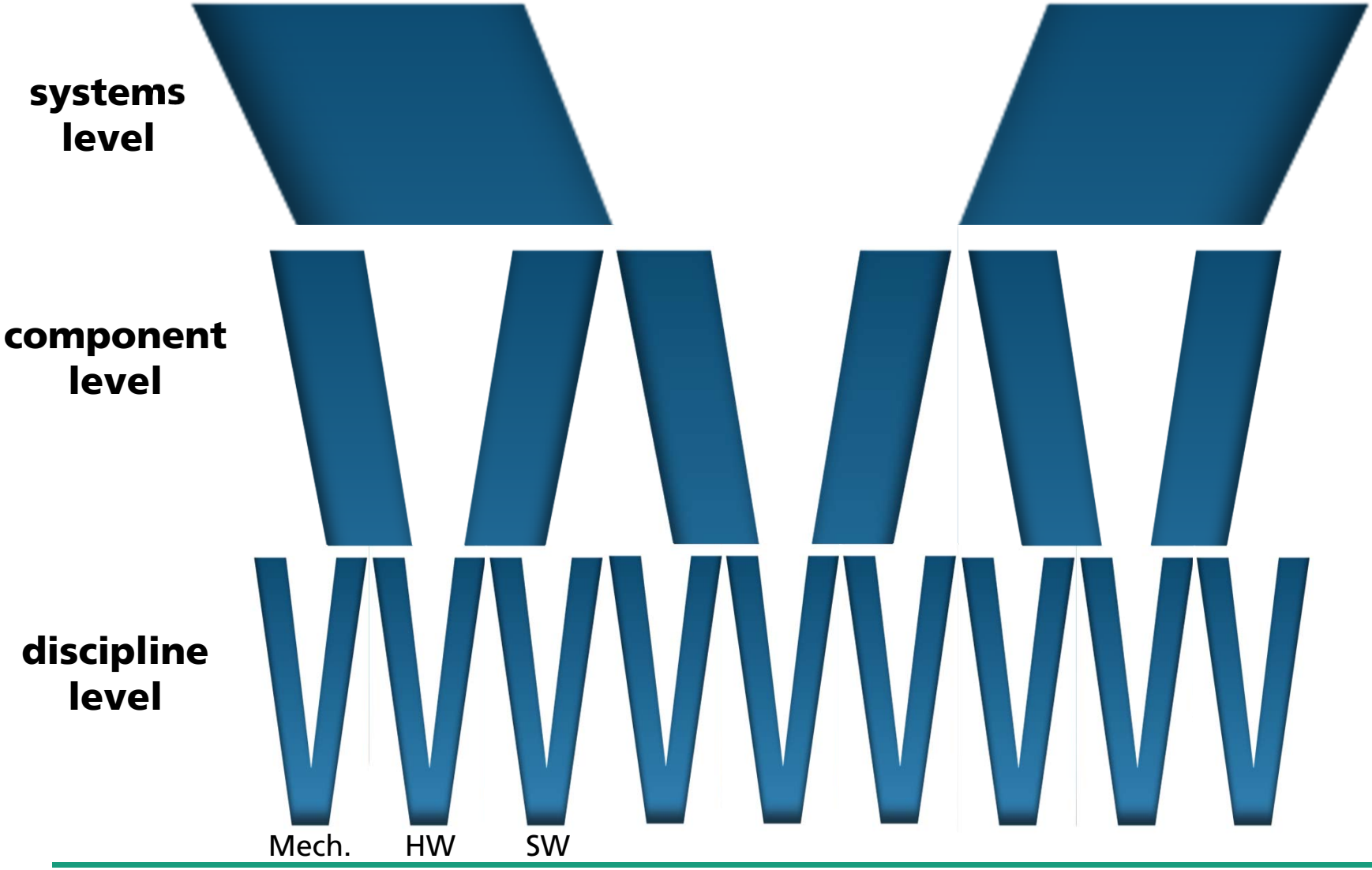
The Development Phases (SW-Viewpoint)



The System‘s viewpoint



From parallel to fractal „Vs“



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Engineering reliable systems

- Why Engineering?
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Required Abstraction levels

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Required Information

- System Architecture
- Clear, precise specification of subsystem interfaces
- Clear, precise yet abstracting specification of subsystem functionality
- Clear, precise specification of composition
- Clear, precise specification of interactions

- the more detailed the specification
  - the less faults will be in the system
  - the easier will be the reliability analysis

- In case of insufficient specification
  - An reliability analysis might not be possible
  - In this case it is not a problem of the analysis methodology
  - But it is a problem of your system (this means you don't have the system complexity under control!)

Recommendation

Use SysML to specify your system

- SysML is intuitive yet formal enough to facilitate automated analyses for fault prevention / fault removal
- models include all information for fault forecasting
- Significantly reduces development complexity by
  - Abstraction
  - Modularization and hierarchy
  - Separation of concerns

- With a sound modeling technique you will
  - Efficiently prevent faults
  - Simplify/enable fault removal
  - Simplify/enable fault forecasting

Conclusion

- With sophisticated reliability analysis techniques we are able to analyze very complex systems,
- but we can hardly be better than the information we get as input!