Model-based Avionics V&V

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Modelling and Simulation

- Starting point:
  - **Modeling and simulation (M&S) is the use of models, including emulators, prototypes, simulators, and stimulators, either statically or over time, to develop data as a basis for making managerial or technical decisions. The terms "modeling" and "simulation" are often used interchangeably.** [DoD Modeling and Simulation (M&S) Glossary]

- Challenge:
  - Better distinction between modelling and simulation function

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What is a model

- A Model is a (simplified) representation of something (device, environment, …)
- Models can represent different aspects / characteristics
    - Physical
    - Functional
    - Mathematical
    - Abstract
    - Data
    - …
- SW technologies are used to create "virtual / digital" models
- Models need to be coordinated and kept consistent to help the (system) engineering process

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What is done with a model

- In the design phase
  - Optimise the design
  - Predict the performance
  - Define architecture and interfaces
  - Specify subsystems

- In the test phase
  - Verify performance
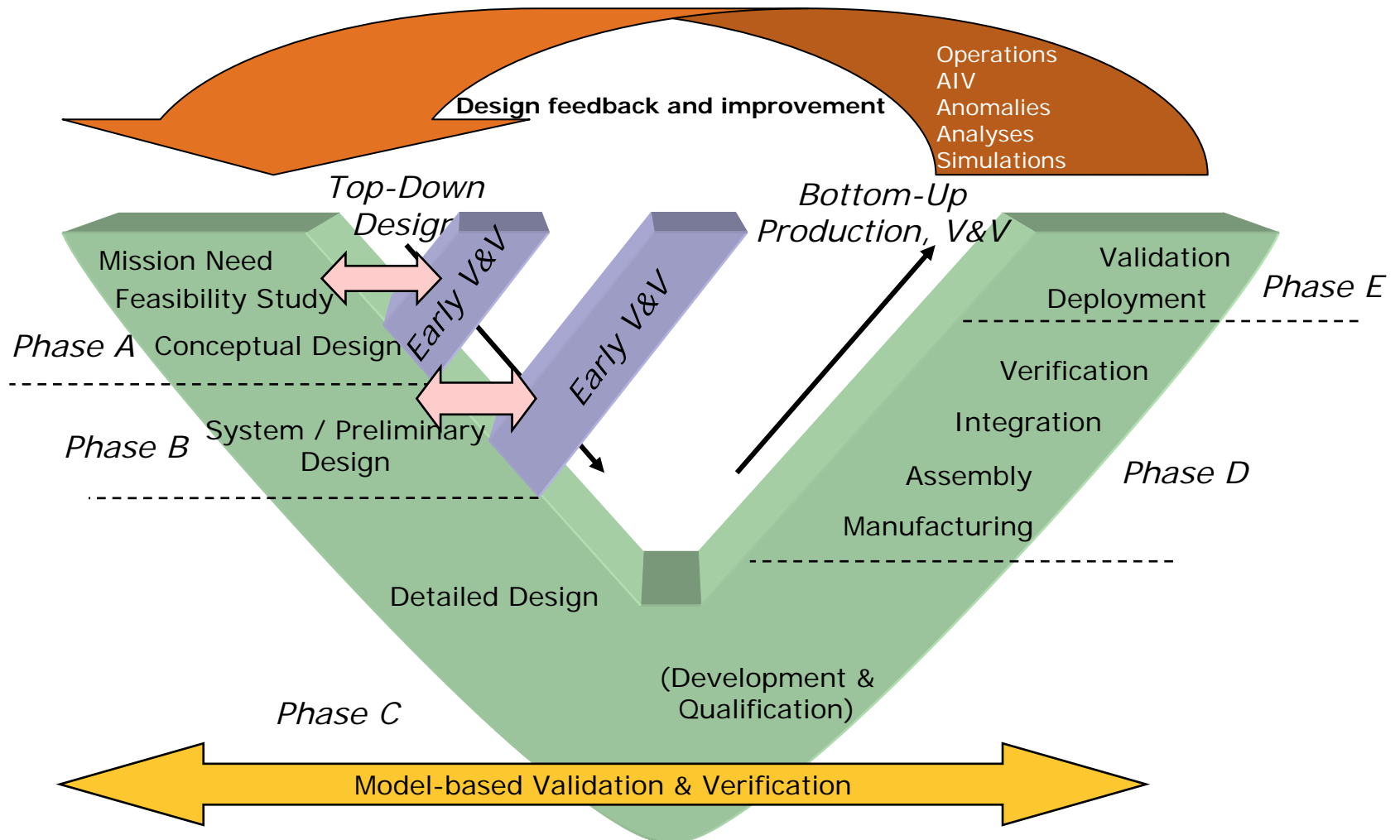 - Test workmanship
  - Confirm "fit for purpose"

Analysis

Verification

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End-to-end System Engineering Process

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Process and models today
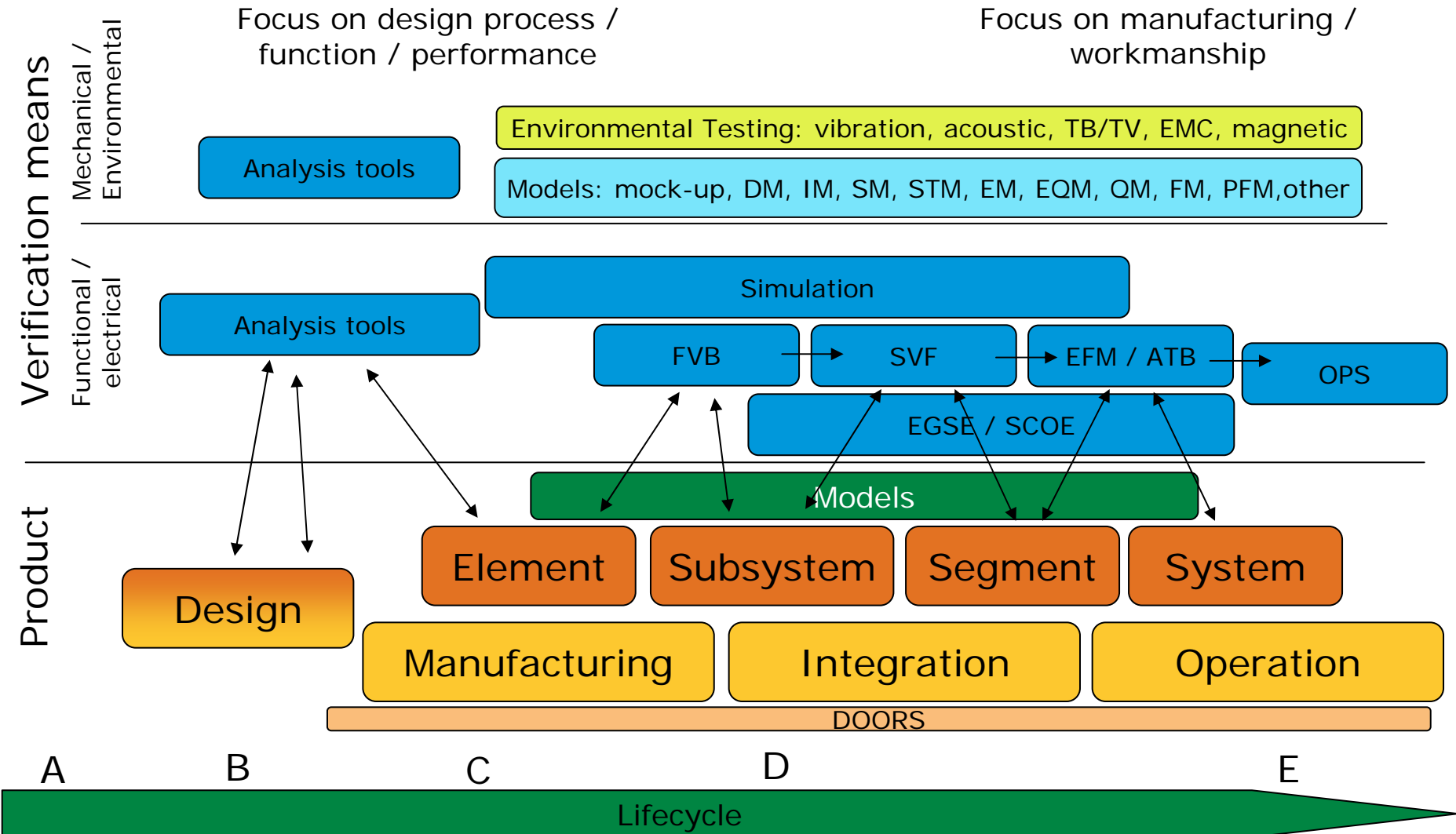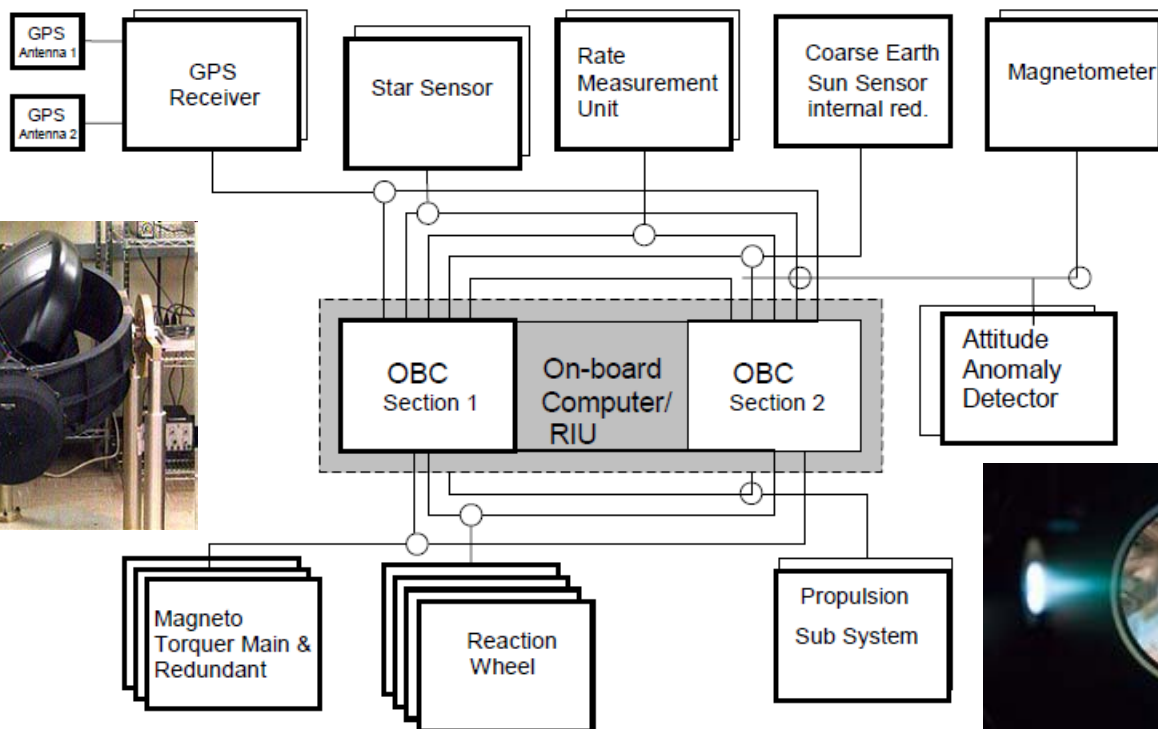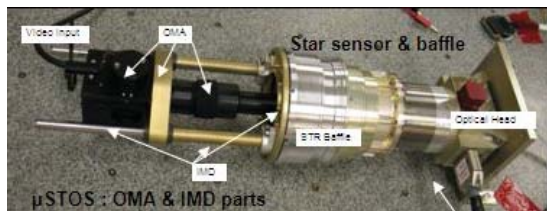
What is at stake ?
Ariane 501: Failure Analysis Report

- r) The specification of the inertial reference system and the tests performed at equipment level did not specifically include the Ariane 5 trajectory data. Consequently the realignment function was not tested under simulated Ariane 5 flight conditions, and the design error was not discovered.

- s) It would have been technically feasible to include almost the entire inertial reference system in the overall system simulations which were performed. For a number of reasons it was decided to use the simulated output of the inertial reference system, not the system itself or its detailed simulation. Had the system been included, the failure could have been detected.

- **t) Post-flight simulations have been carried out on a computer with software of the inertial reference system and with a simulated environment, including the actual trajectory data from the Ariane 501 flight. These simulations have faithfully reproduced the chain of events leading to the failure of the inertial reference systems.**

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- Despite these pitfalls, in may areas HW test equipment and environments are replaced with SW simulations, at least in early phases

- Still required validation of SW models

  - Through physical modelling

  - Through cross-calibration (validation) with experiments or selected physical tests

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Expected benefits

- Potential benefits include:
  - Availability of representation early in the life-cycle
  - Virtual model 'follows' engineering process because they are more flexible – with the caveat that they need to be fit for their intended use
  - Synergies / interfaces between disciplines and phases are easier to exploit earlier
  - Virtual models can be easily replicated with no or low recurring costs
  - Verification can be started early – provided that the model is validated to be representative

- Lower risk (cost / schedule), increase quality and overall performance