The Impact of Modelling and Simulation in Airbus Product Development

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In 1998 Airbus in the UK had less than 5 Matlab licence

Number of Matlab users at Airbus is still growing
Current status: ~4 600 Users at all sites
Introduction

• **Intended** impact of Modelling & Simulation:
  1. Reduction of **cost** by reducing/eliminating physical prototypes
  2. Reduction of **time-to-market** by using readily reconfigurable models simulations
  3. Improved **design maturity** by extensive use of simulations

• **Actual** Impact arises over time
  • It takes time to produce reliable models
    • However, **engineering** the models for **re-use** addresses 1 & 2
    • Engineering the models and conducting simulations **creates knowledge**
      • Knowledge thus created informs design decision-making
      • Informed decision-making addresses 3, and contributes to 1 & 2.

Intended impact takes place over time; benefits may not be fully realised at the first application
Overview: Working Definitions

• Experimentation
  • Discovering the “true” requirements
  • Discovering the possible behaviours (time-based & event-based)
  • Discovering inter-dependencies amongst the system elements

• Design
  • “Sizing” the system of interest, e.g.
    • Form: addresses geometry
    • Fit: addresses interfaces
    • Function: addresses behaviours

• Test – Verification
  • Confirming that the system, at a given design stage, conforms to its allocated requirements
Overview: The MathWorks Tools Used

- Matlab
  - Prototyping design algorithms
  - Automating engineering calculations
  - Data analysis and visualisation

- Simulink
  - Designing control algorithms
  - Simulating on-board systems
  - Auto-code generation for sharing models
  - Specification-in-the-loop; Software-in-the-loop; Hardware-in-the-loop
  - Preparing Real-Time models for training simulators

- Stateflow
  - Modelling logic-based requirements
  - Modelling event-based on-board systems

- SimScape & other Sim-toolboxes
  - Generally, modelling physics-based aspects of on-board systems
Experimentation (open questions)

- Exemplar questions:
  - When I apply <this> stimuli what response do I get?
  - What stimuli generates <this> response?
    - What are the desired behaviours?
    - Under what context are these behaviours exhibited?
    - What interconnections can assure these behaviours?

Example: Library of model components

Knowledge acquisition is an iterative process; new knowledge raises new questions.
Design

Modelling as a “day-job”
System designers developing the models as part of the design
No need for separate “over-the-wall” modelling

Knowledge acquired by the modelling & simulation team members is disseminated, retained and used within the design team
Testing – Verification (closed questions)

• Exemplar questions:
  • When I apply <this> stimuli I shall get <that> response?
  • When I apply <this> stimuli I shall NOT get <that> response?
  • … within a prescribed context

The simulation models encapsulate the behaviours of the “system under design”; therefore approximate the system behaviours.
Challenges – Shared “Blueprint”

- Creating, Engineering & Managing Multi-perspective, Multi-disciplinary design information for sets of products
- Evolving properties, capabilities and behaviours of product families

- Information is distributed across the extended enterprise
  - Pedigree & Provenance
  - Impact on contractual agreements
    - E.g. Managing & Policing Intellectual Property Rights
Challenges – Modelling & Simulation

• Embodying Novel & Emerging technologies with existing ones
  • Understanding their underlying sciences
  • Constructing models to leverage the intended benefits

• Developing Multi-abstraction models for engineering & business decision-making

• Qualifying & Certifying
  • Determining test strategies to verify the desired effects
Addressing Collaboration & Interoperations

Collaboration Standard
- Connect & control global processes
- To be formalised as “SE” DEX mapped to AP233 & AP239/PLCS

Technical Standard(s) enabling exchange of detailed data e.g. AP209, AP242, neutral & vendor formats, ...

Standard specification of BDA* Functions supporting collaboration across companies

Generic BDA* Platform Specification

Specialised BDA* Engineering Methods => Functions/Tools supporting different company roles

Multiple M&S Platforms Deployed

* BDA: Acronym for Behavioural Digital Aircraft
CONGA Project Background

Configuration Optimisation for Next Generation Aircraft

• A 2-year project under the Technology Strategy Board’s “Building the UK Leadership in Aerodynamics” competition

• Led by Airbus, CONGA has 6 other partners:
  • Rolls Royce, EADS-UK, Aircraft Research Association, Eurostep, MSC Software and Cranfield University (School of Engineering and School of Applied Science)

• The main purpose of CONGA is to develop a proof-of-concept for a “System for Creating Valued* Aircraft Configurations” using Set-Based Design Methodology.

* Valued by multiple stakeholders, e.g. Society, Government, Customers & Manufacturers
CONGA: High-Level Concept Diagram

- Market Projections, Needs, Values & Expectations
- Set of possible Aircraft Concepts
- Set of possible Technology Concepts
- Set of possible Operational Concepts
- Product Placement Scenarios
- Multi-disciplinary Collaboration
- Sets of feasible Configurations
- Sets of competitive configurations
- Population sub-sets forming families
- Low Order
- Figures Of Merit
- High Order
Summary

• Impacts of Modelling & Simulation
  • The intended impact takes place over time; benefits may not be fully realised at the first application
  • It takes time to produce reliable models; their reuse contributes to further time- and cost-savings
  • Modelling and Simulations creates knowledge that informs design decision-making leading to design maturity.

• Modelling & Simulation as an integral part of design
  • Knowledge acquired by the modelling & simulation team members is disseminated, retained and used within the design team

• Reuse design models for testing
  • The simulation models encapsulate the behaviours of the “system under design”; therefore approximate the system behaviours.
  • Not aspects of a system can be modelled!
Summary

• Challenges for Modelling & Simulation
  • Collaboration is about working together not just exchanging
    • Interoperability: specially of data, information and rationale
    • “Platform” neutral
    • Standardisation: data model and methods for sharing the information (MoSSEC: Modelling & Simulation collaboration in a Systems Engineering Context)

• Multi-level Models & Simulations
  • Reliable, early analyses for assessing insertion of new technologies
  • Built on scientific principles – abstracted to the level needed depending on the design questions
  • Needed for assessing a large number of design options.
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