Welcome to Volvo Aero!
Model-based development at Volvo Aero

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Today’s topics

• Volvo Aero ...
• Why Modeling
• What to model
• How to model
• Remarks
Volvo Group 2007

Turnover 285 billion SEK
Number of employees: 101,698
Volvo Aero

Model Based Development
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• Combined models
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Increased travelling

Population Growth

Climat Change

Billion RPMs

Population

Based on ICAP Airline Traffic Monthly

Adopted from: U.S. Census Bureau, International Data Base, July 2007
Consequence

- "Information Density" increases
- "Decision Density" increases
- Complexity of contexts increases
  - Both more optimized solutions can be defined and
  - More aspect need to be taken into account
- Business Competition continuously increases
The Modeling Aspect

- Models can be created in before decisions
- Models can be exercised (simulated)
- Models is an important enabler for robust decision making

: Modeling is a necessity to understand behaviour
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What to Model and simulate?

- Functional behaviour (performance, strengths, lifting, performance, aero thermodynamics, noise, …) of the product in operation
- Process behaviour (during development, manufacturing, maintenance …)
- Virtually everything…
Simulation of combuster section malfunction
Models to predict noise

Prediction of noise generated in the Afterburner of RM12
Manufacturing Process Modelling?
Manufacturing Process Modelling

- Welding
- Metal deposition
- Heat treatment
- Sheet metal forming
- Machining

Model Based Development
Example: weld assembly

- Fabricating single components in an assembly operation
- Example of behaviour as a consequence of welding
Models of production cells to plan for production

Can use models of production lines to predict, and optimise, best operating scheme

1. Control Parameters in Excel
2. Run Optimization
3. Result – the best operation scheme
Reflection

• 1998 our Research Manager stated that "what we do not model and simulate 10 years from now – we do not do"

• ... true...
Reflection 2

• Main part of the applications shown relate to understand/simulate physics of mechanical bodies...

• Geometric models (CAD) typically developed using interactive CAD systems
Our mechanical Systems view

• Volvo Aero responsible for components/sub-systems in the whole engine

• Dependencies between component and system drives collaborative design environments
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Model and automate engineering processes

- Understand and represent engineering workflows
- Enable quick iterations and stabilize standard work processes
- Develop Design applications that can be executed to explore & optimise designs
The Global Development Process
- A chain of activities

Mechanical Engineering

Software Engineering

Manufacturing Engineering

Electrical Engineering

... Quality Engineering
Automate the design/Evaluation of Mechanical Behaviour of a design

- Example: Design the best design to resist mechanical loops
Understand and model chains of processes

1 Engineering Process

2 Develop Knowledge Automation Application

3 Use Knowledge Automation Application

Model Based Development
Conceptual Design Automation

1 Engineering Process to Define and simulate one concept

- Design Task
- Generate Solid
- Define Variation
- Idealize Geometry
- Generate Mesh
- Generate Input Deck
- Update Analysis Model
- Simulate
- Evaluate

2 Develop Knowledge Automation Application

3 Use Knowledge Automation Application

Model Based Development
Base for Decision provided by the structural engineering team

Each analysis result is based on a unique 3D design

Each result previously required many days/weeks to derive. Automation enables robust decisions

Model Based Development
Used KBE (Knowledge Based Engineering) tools to define generative design systems

A declarative language – tightly integrated to UG (Knowledge Fusion) was used

Enabled automation support for associated models
Reflection

• Information is processed in a number of steps – involving different systems and competences
Design Problem

Cost of Manufacturing vs. Mechanical Performance

Multi Domain problems - Different competence, skills, systems need to be combined
A systems representation of the workflow
Combining complementary modeling techniques

• Example: Combine Automation Models with Advanced FE based Welding simulation processes
• Effect: Reduce (eliminate) lead time to generate computational models used to simulate. Possible to simulate welding in conceptual design
Define, model, automate the workflow

• Integrated technologies demonstrated Capabilities
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Concluding Reflections

• Can models replace reality?
• No... Physical Validation necessary – but not sufficient...
  • Significant efforts in European Aeronautical Research to move boundaries towards Virtual Certification
What need to be modeled – revisited...

- Manufacturing industry is changing
- Products offered is a combination of hardware, software and services.

- How can be use modeling to take better decisions for such products?
Thank you for listening!