Welcome to Volvo Aero!

Model-based development at Volvo Aero

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Jet Engine Development

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

VOLVO AERO

VOLVO AERO

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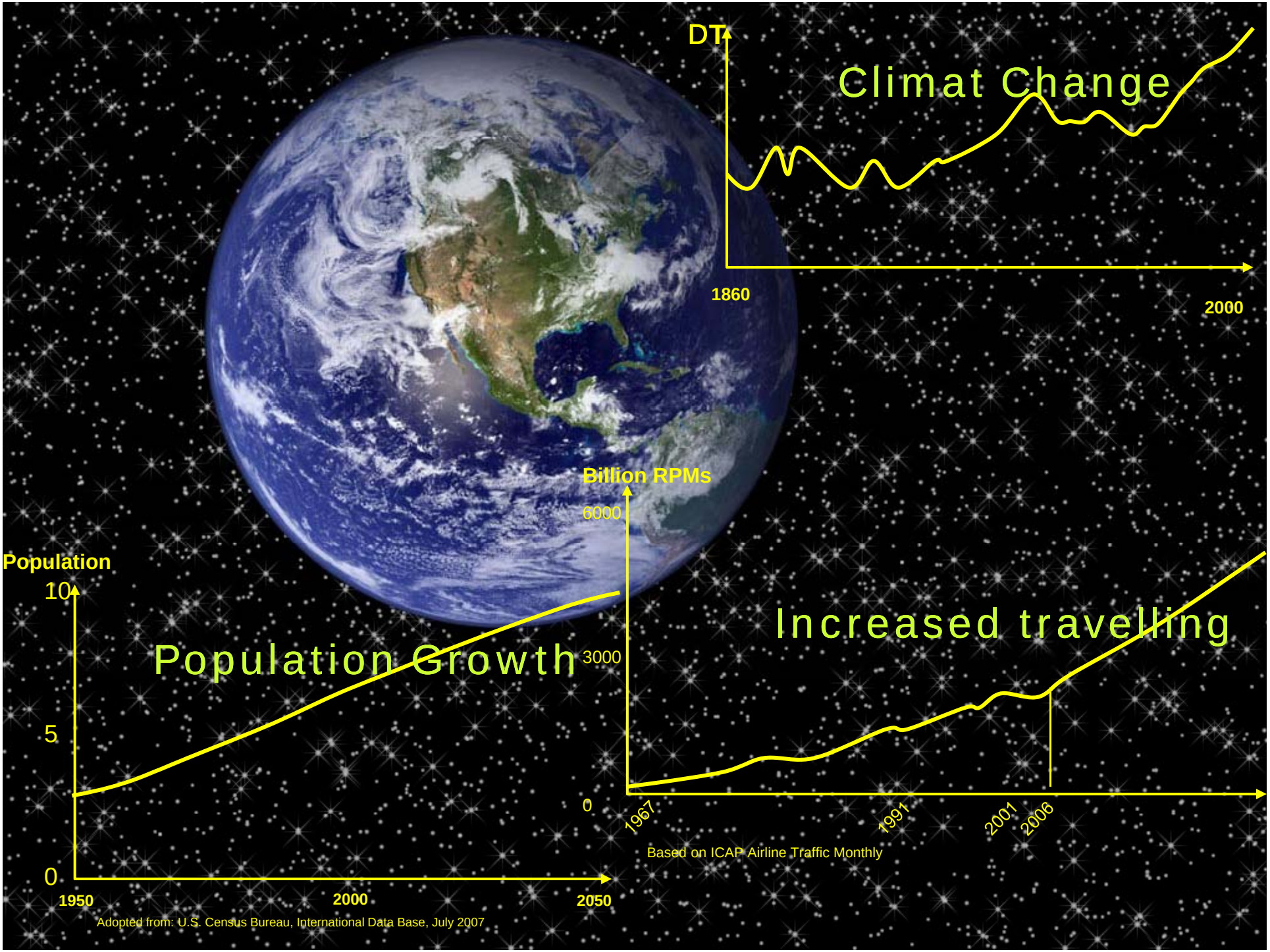
- **Combined models**
- **Remarks**


DT
Climat Change
1860
2000
Billion RPMs
6000
3000
0
Increased travelling
1967
1991
2001
2006
Based on ICAP Airline Traffic Monthly
Population
10
5
0
Population Growth
1950
2000
2050
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 contionously increases

The Modeling Aspect

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

- : Modeling is a necessity to understand behavour

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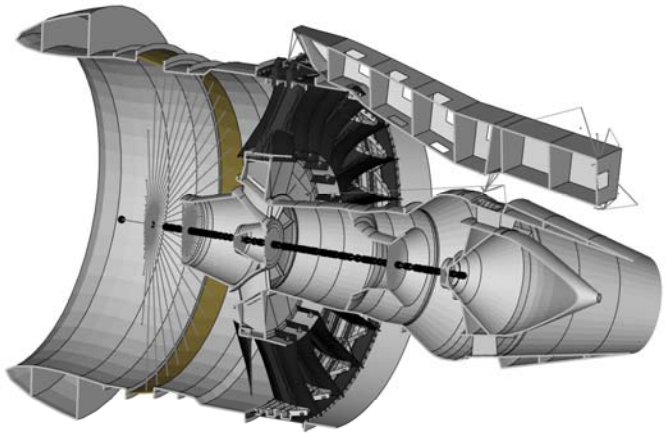
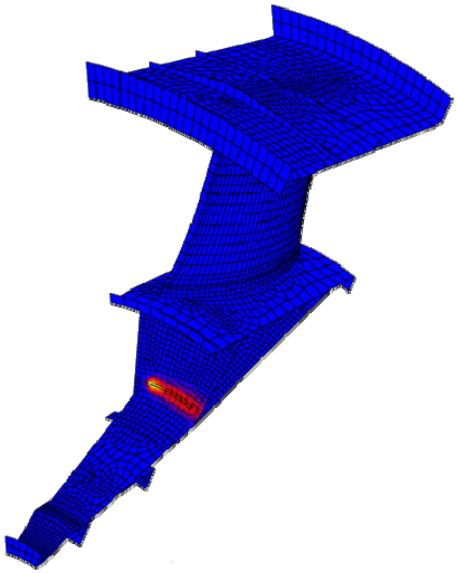
What to Model and simulate?



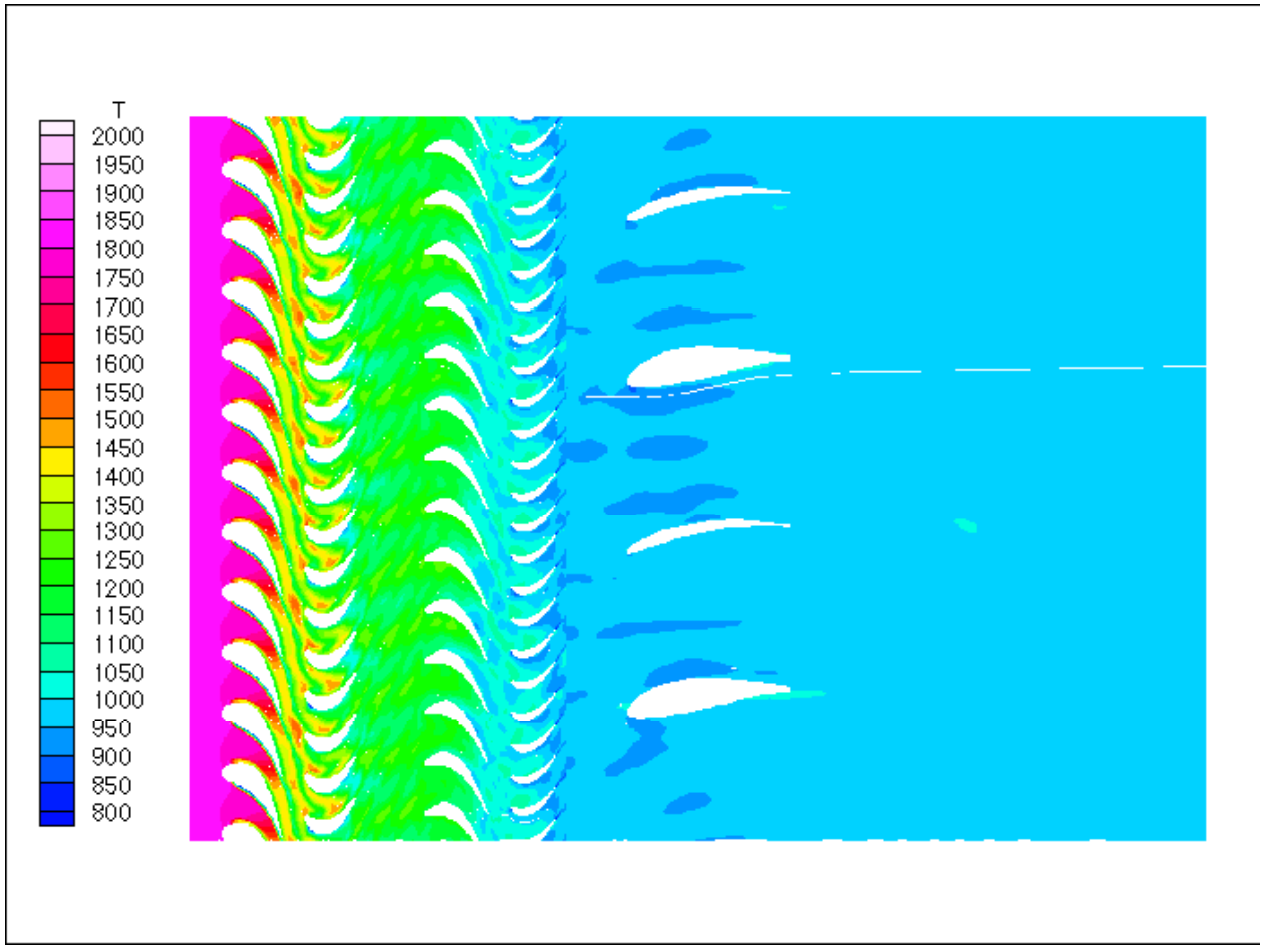
- Functional behaviour (performance, strengths, lifing, performance, aerothermodynamics, noice, …) of the product in operation
- Process behaviour (during development, manufacturing, maintenance …)



- Virtually everything…

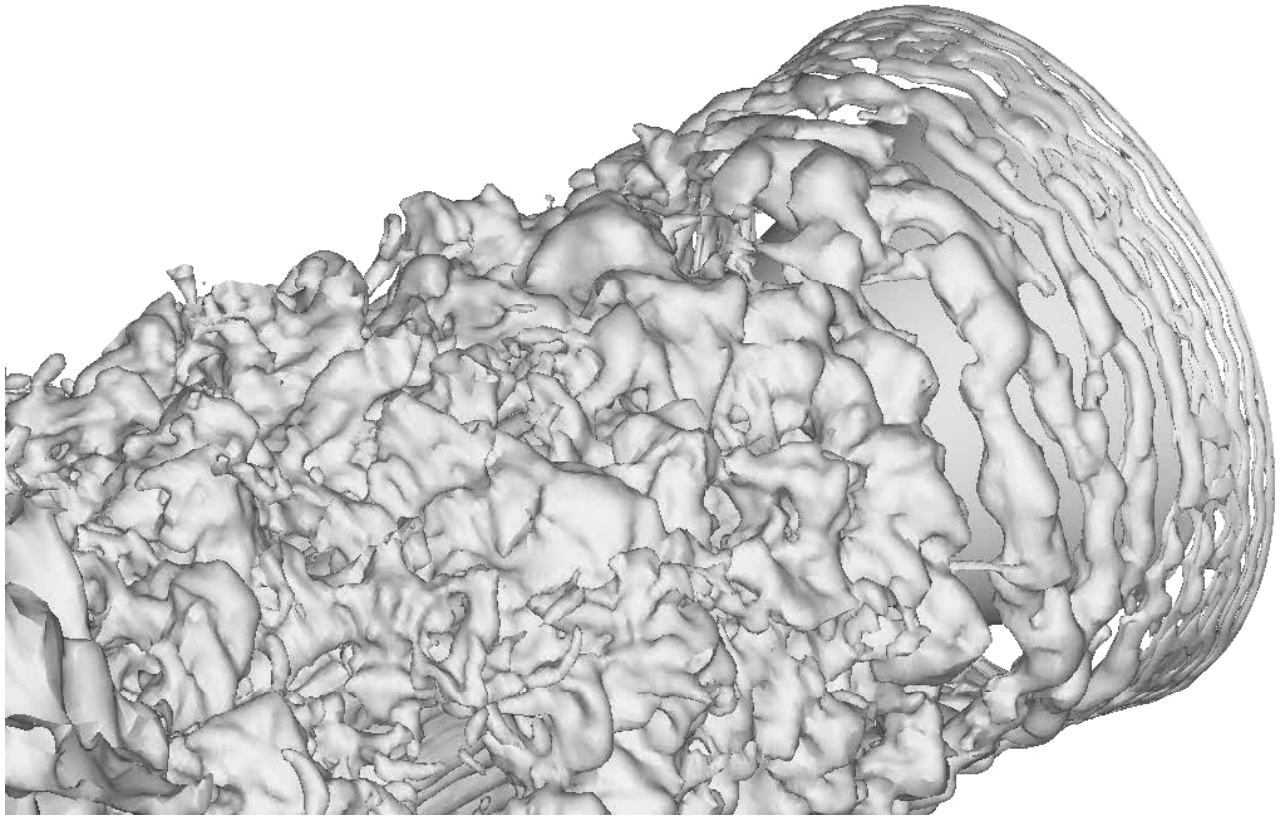
unctional behaviou

Simulation of combuster section mal-function



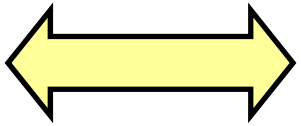
Models to predict noice

Prediction of noice generated in the Afterburner of RM12



Process behaviour

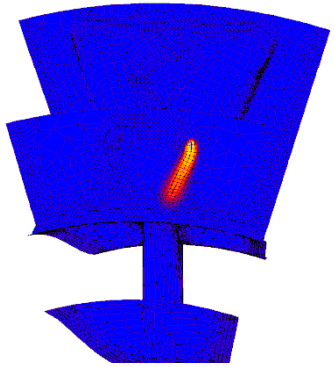
Manufacturing Process Modelling?



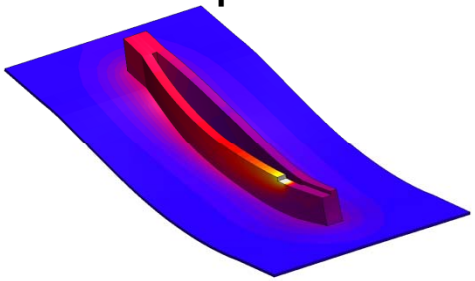
– Manufacturing Process Modelling –

Process behaviour

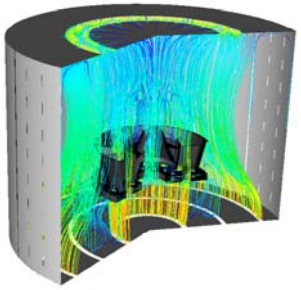
Welding



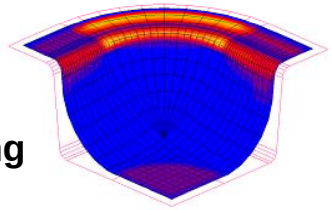
Metal deposition

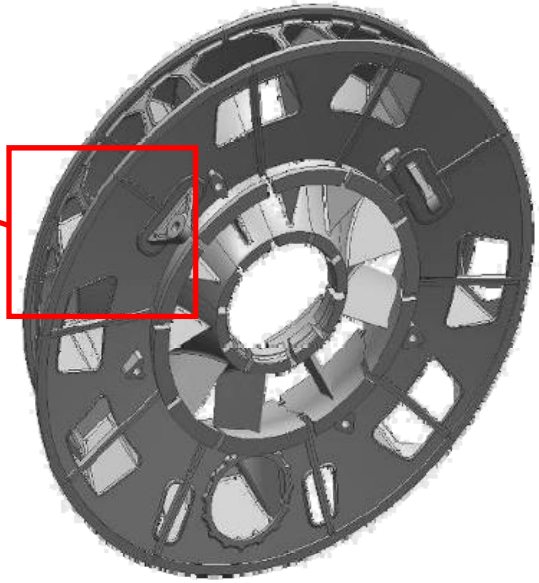


Heat treatment

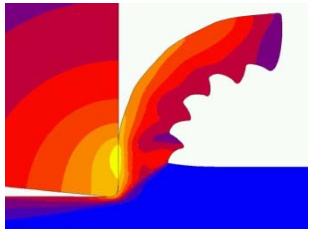


Sheet metal forming





Machining



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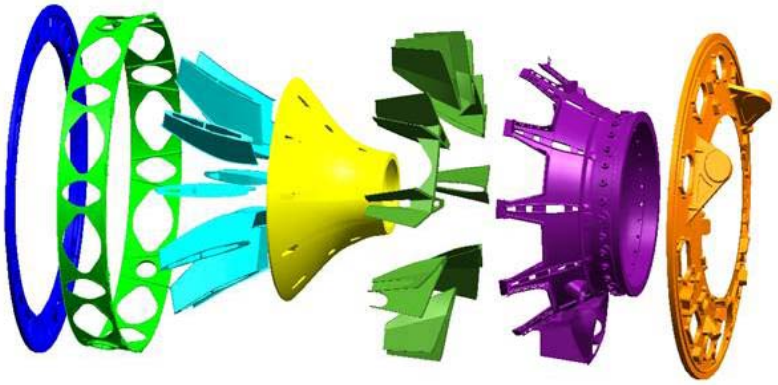
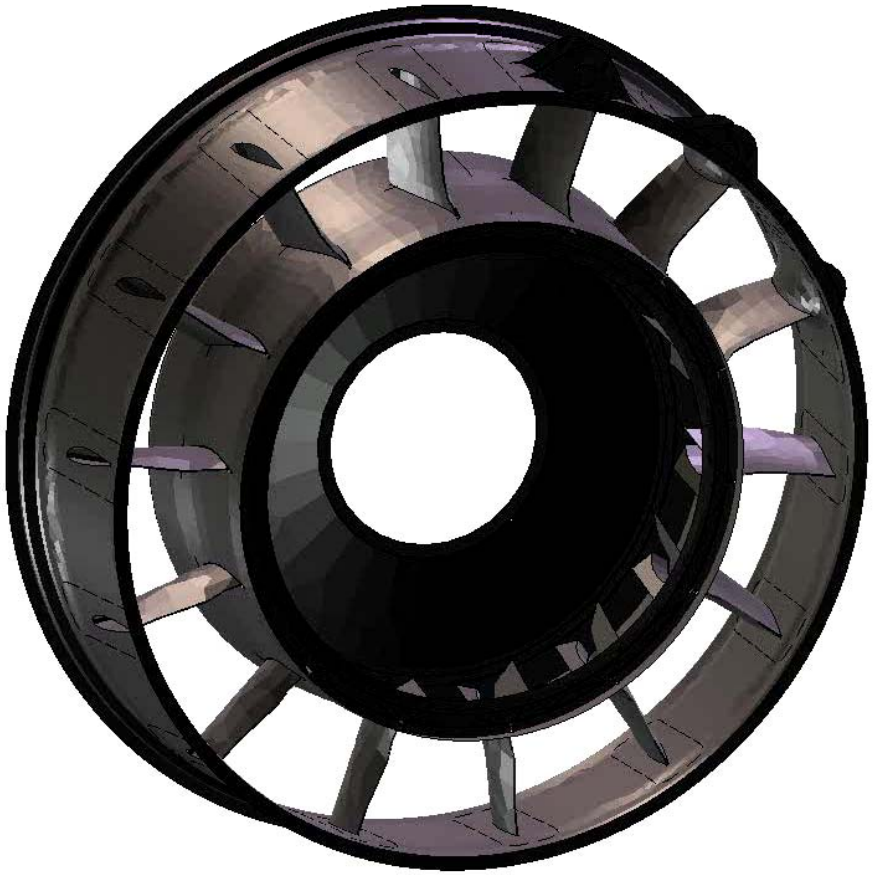
Process behaviour

Example: weld assembly

- Fabricating single components in an assembly operation
- Example of behaviour as a consequence of welding

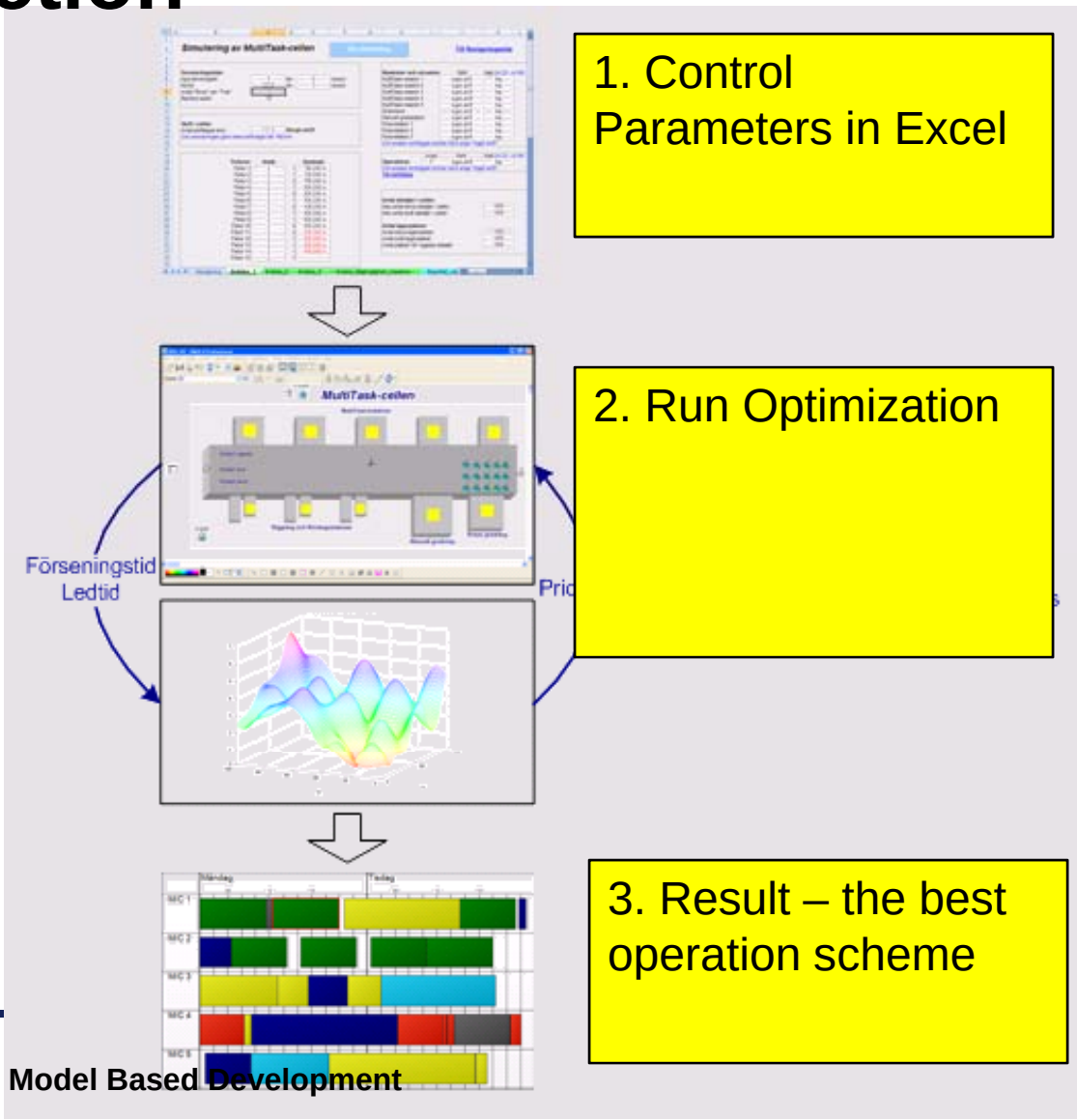




Process behaviour

Models of production cells to plan for production

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



Reflection

- 1998 our Research Manager stated that *”what we do not model and simulate 10 years from now – we do not do”*

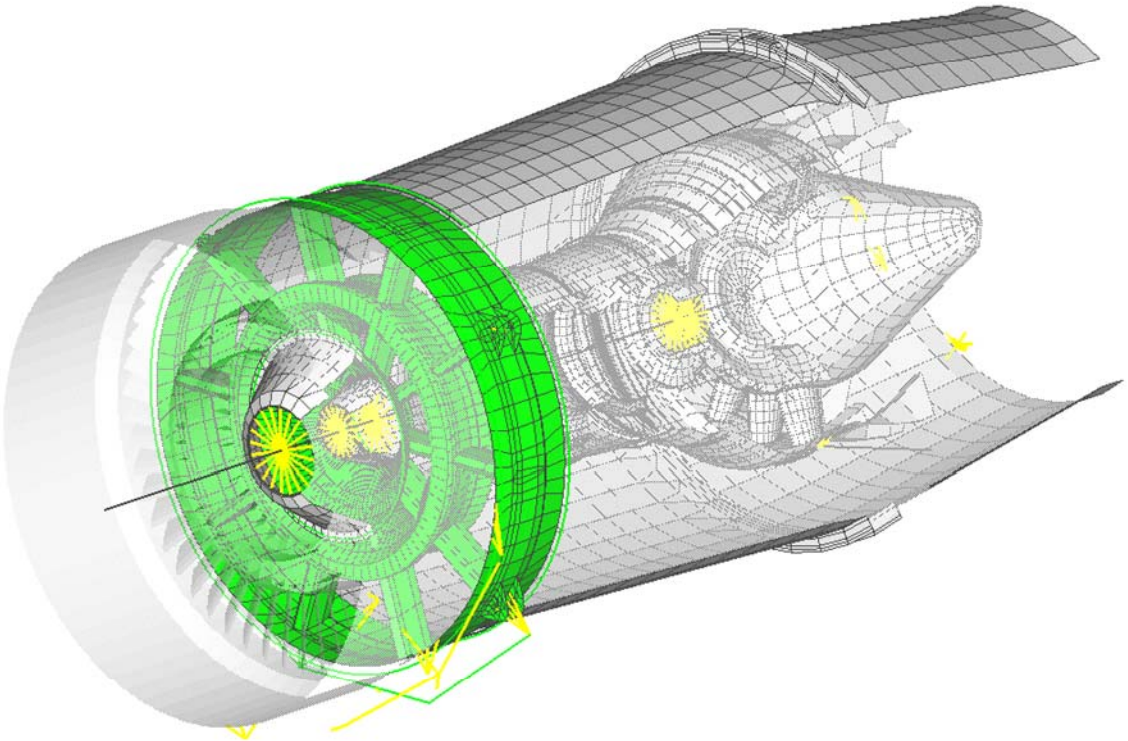
- *... true...*

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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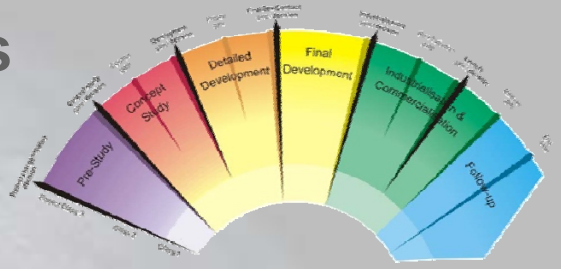
Model and automate engineering processes

- 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

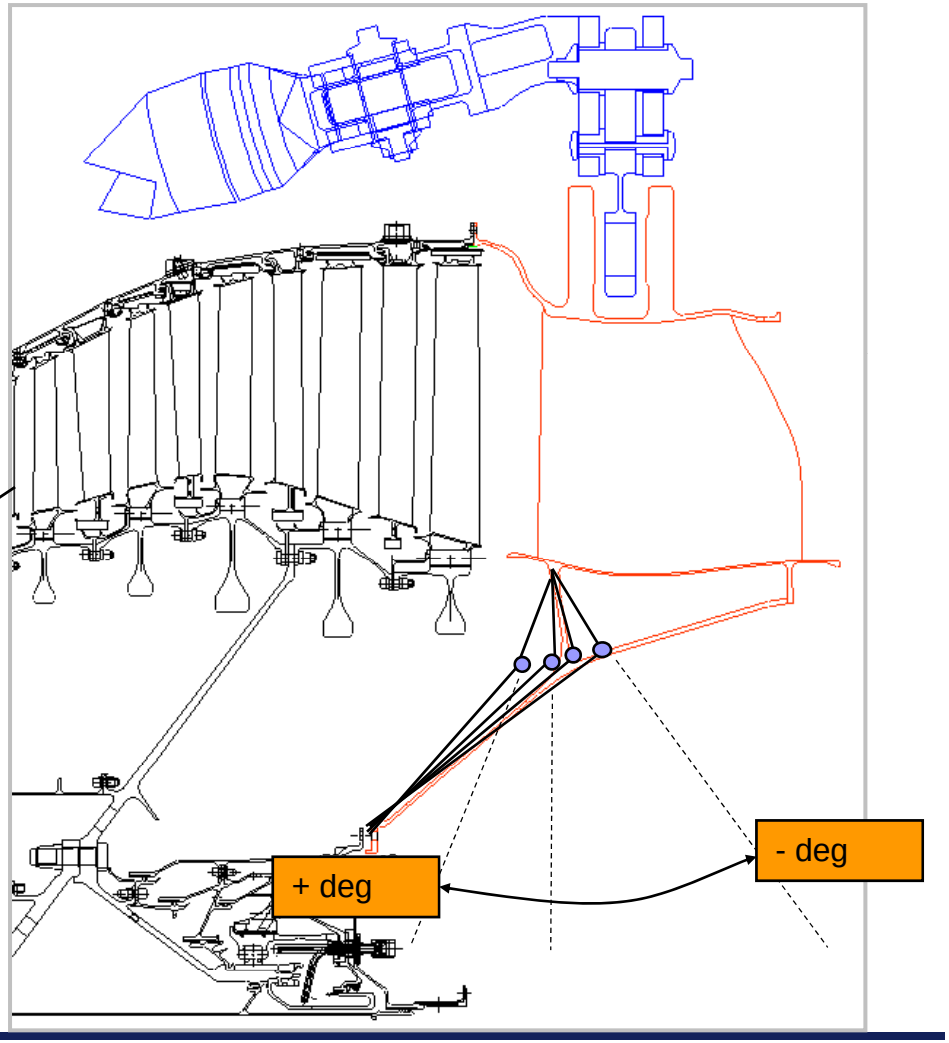
...

Electrical Engineering

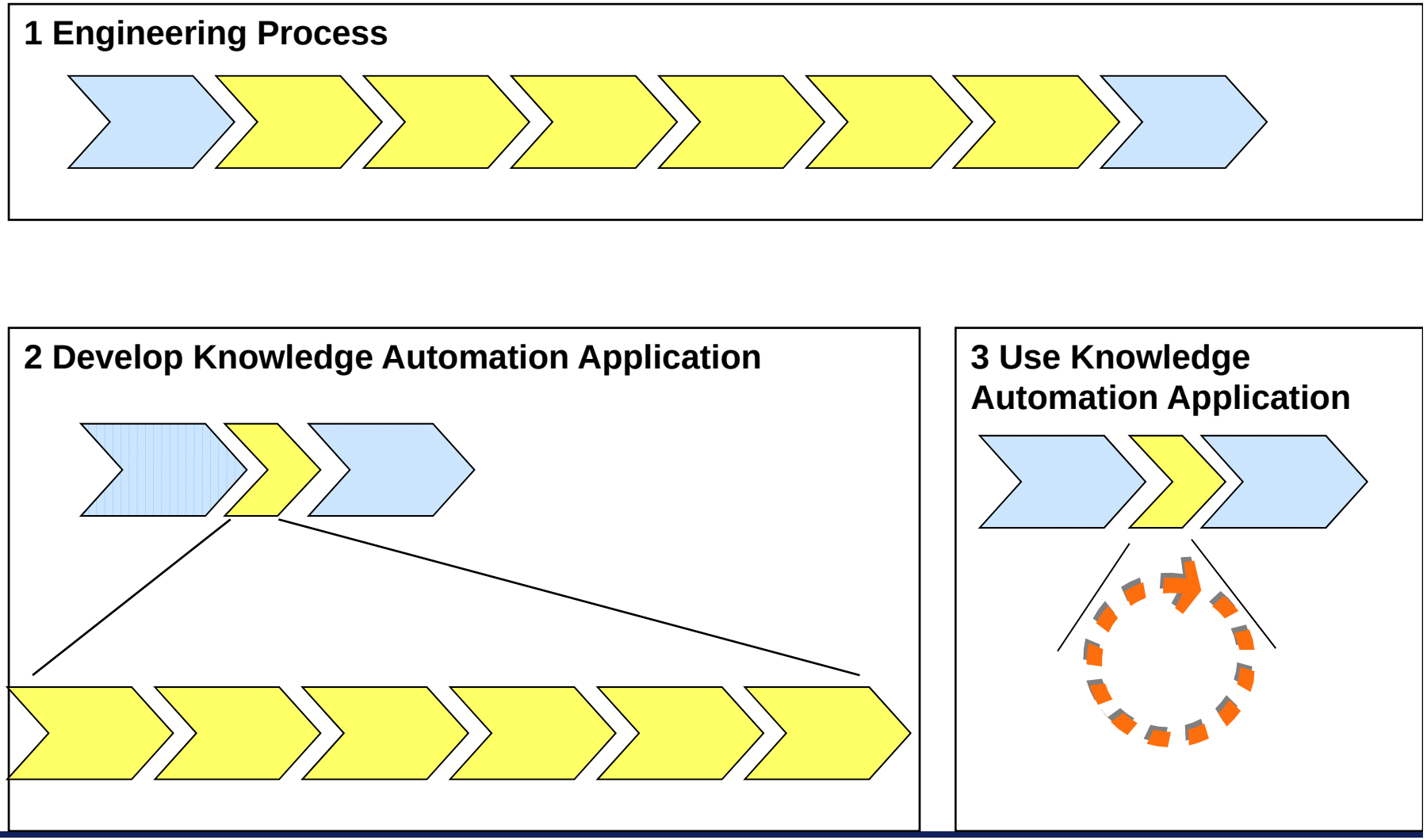
Quality Engineering

Automate the design/Evaluation of Mechanical Behaviour of a design

- Example: Design the best design to resist mechanical loops

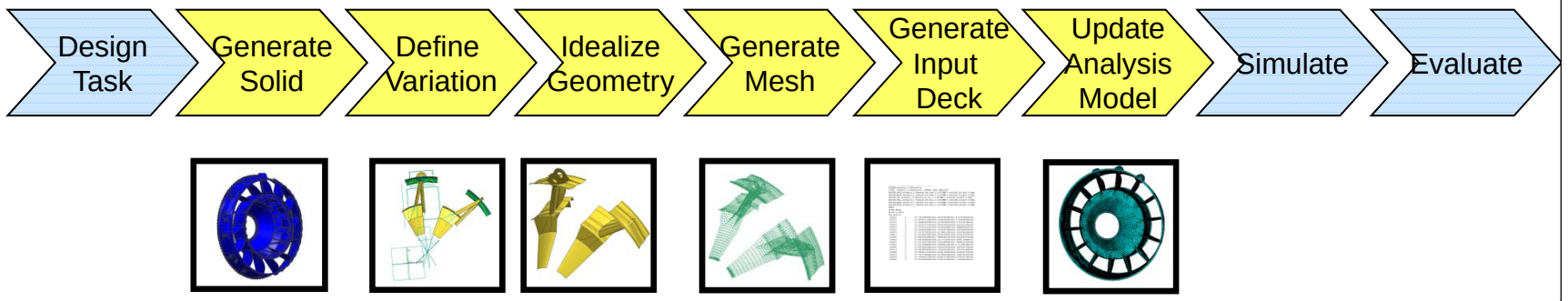


Understand and model chains of processes

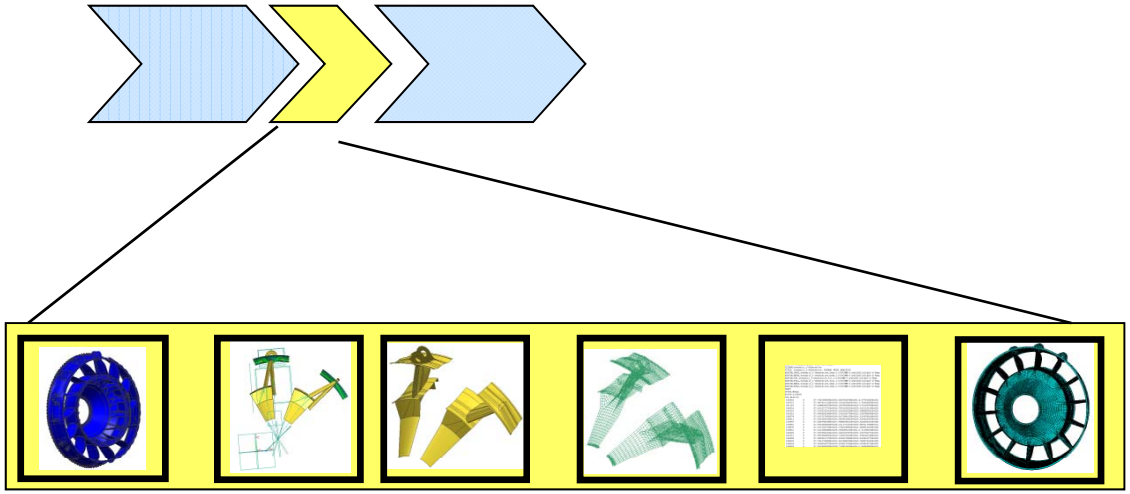


Conceptual Design Automation

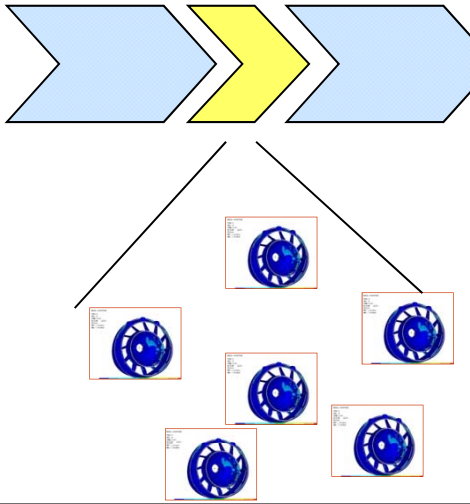
1 Engineering Process to Define and simulate one concept



2 Develop Knowledge Automation Application

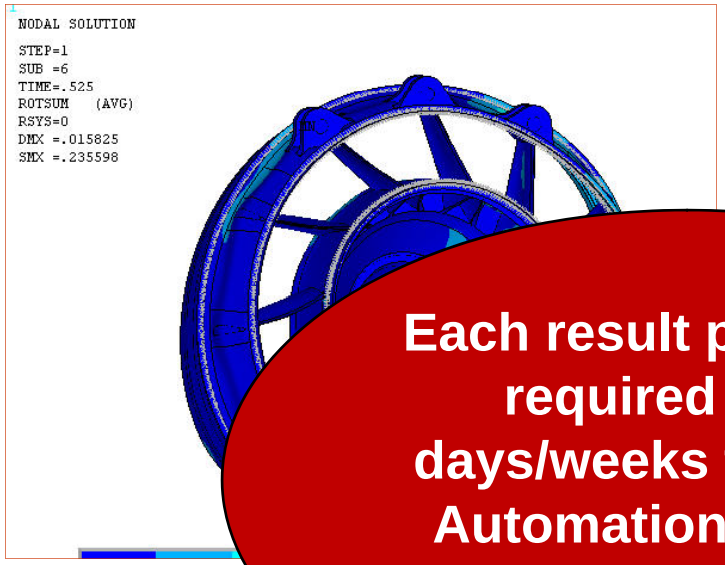


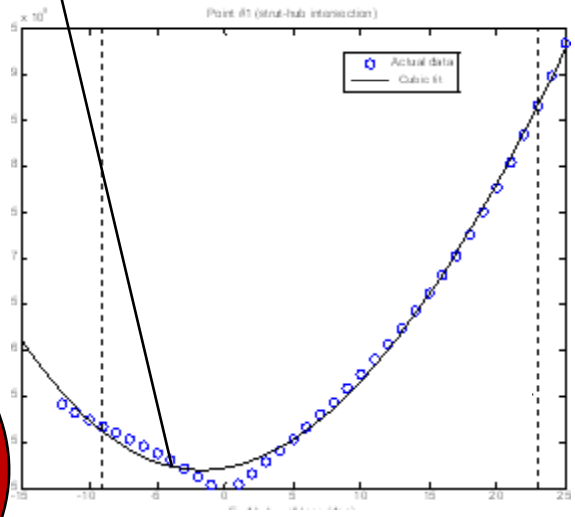
3 Use Knowledge Automation Application



Base for Decision provided by the structural engineering team

Each analysis result is based on a unique 3D design



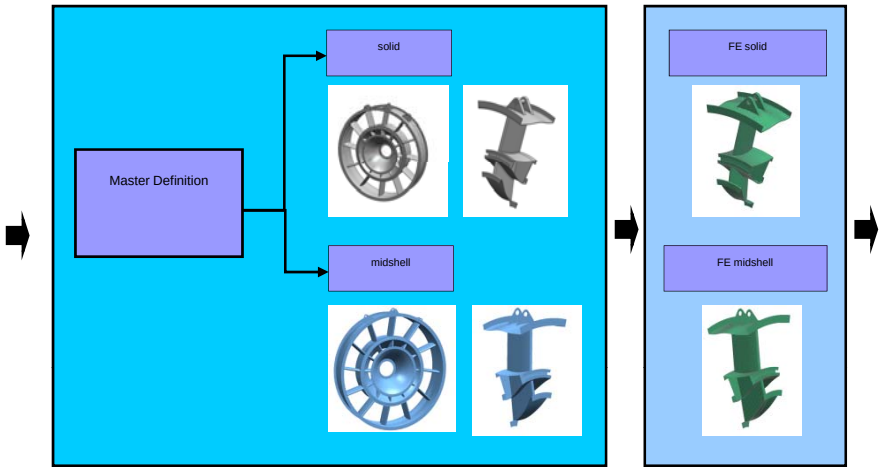


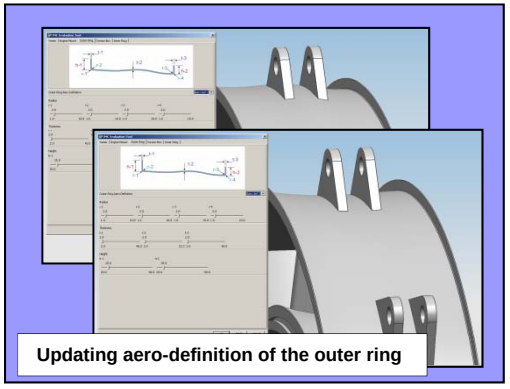
Each result previously required many days/weeks to derive. Automation enables robust decisions

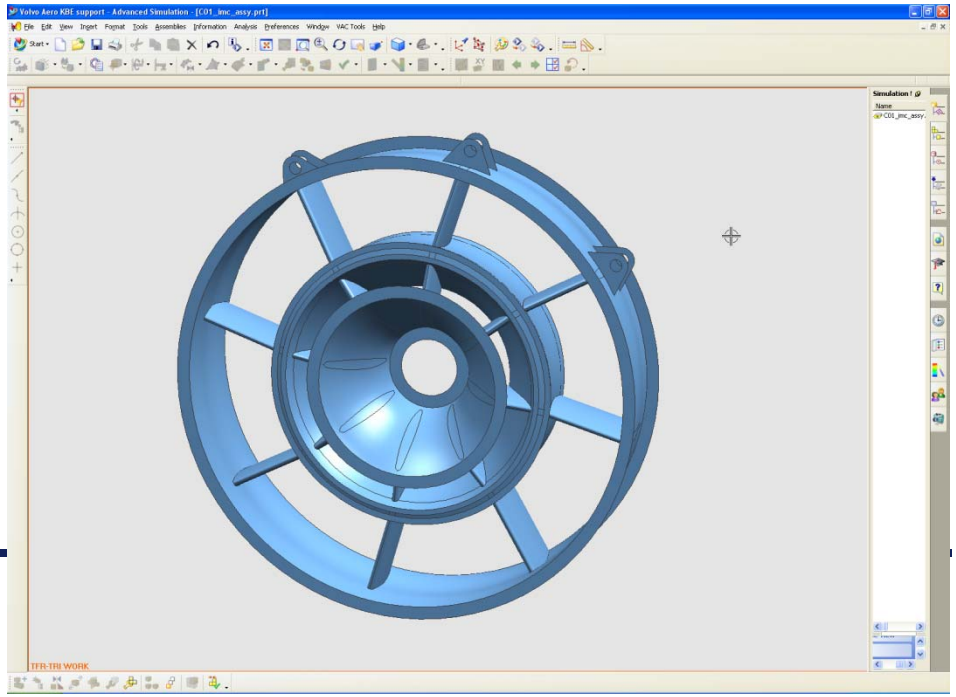
Used KBE (Knowledge Based Engeineering) tools to define generative design systems

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

Enabled automation support for associated models




Updating aero-definition of the outer ring



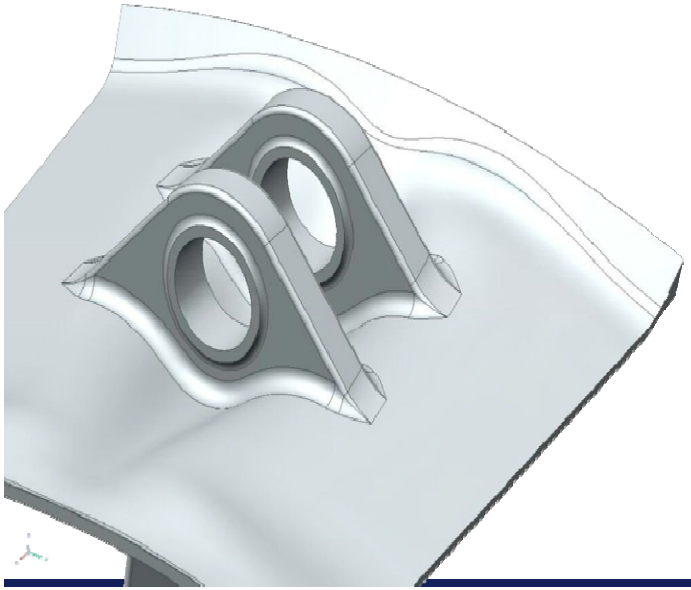
9610, Markus Andersson

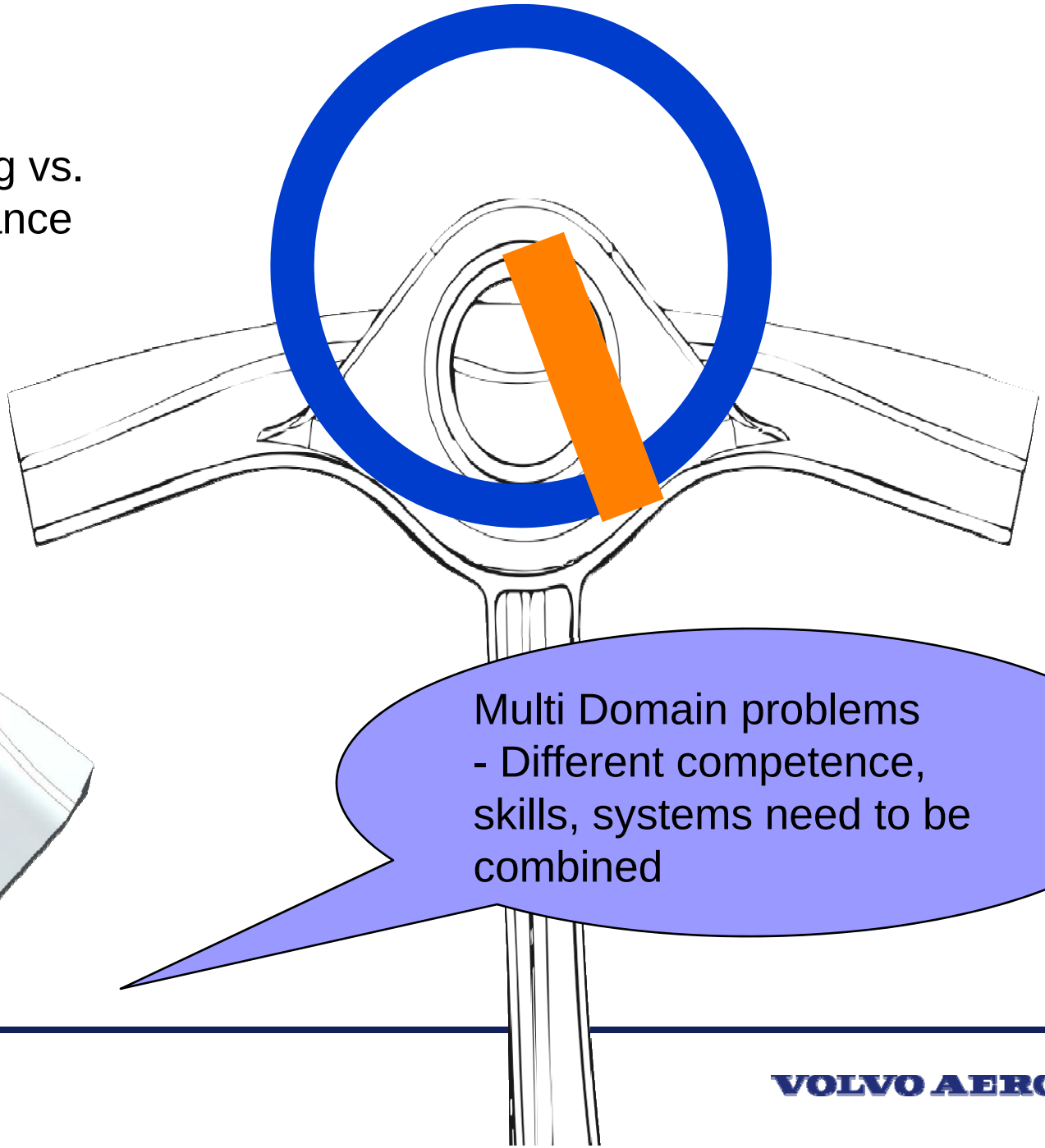
Reflection

- 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

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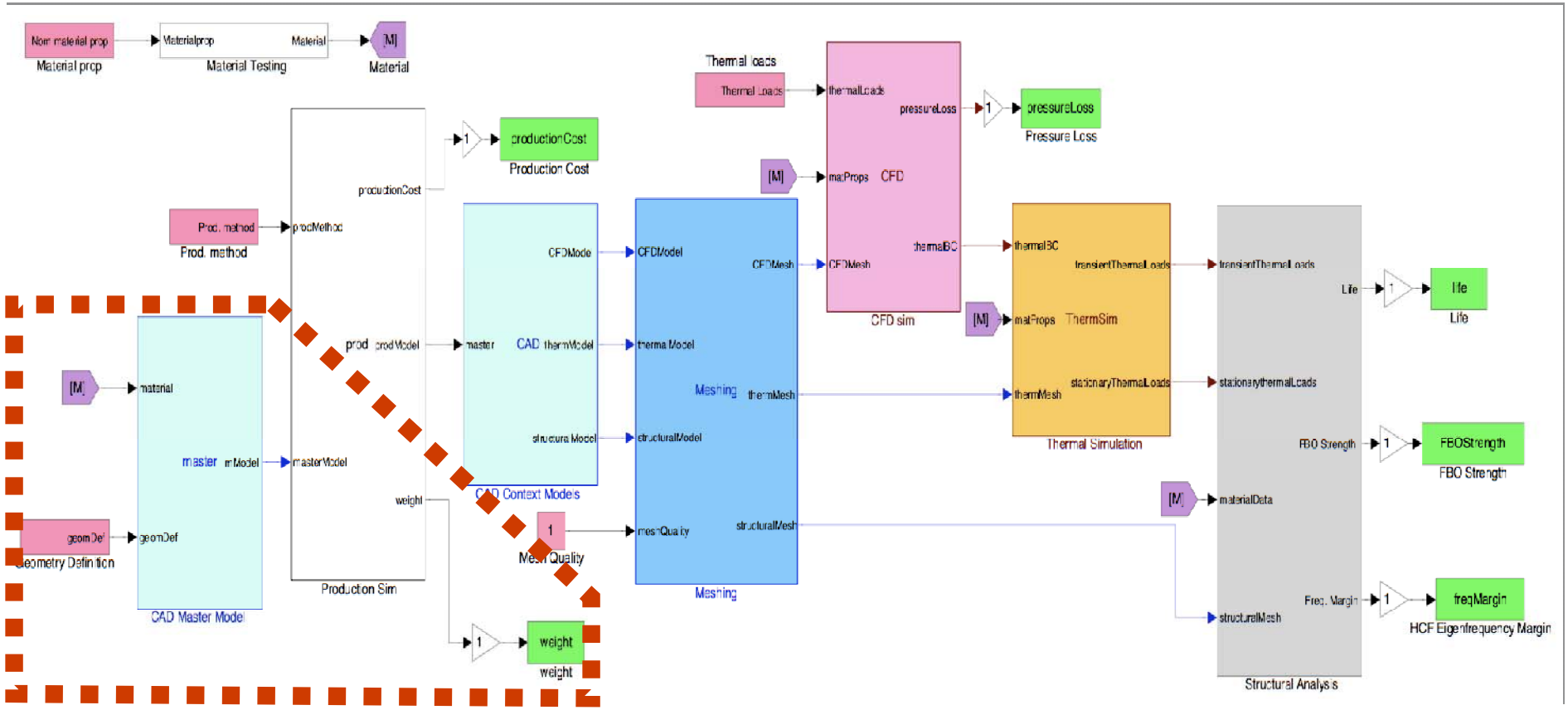
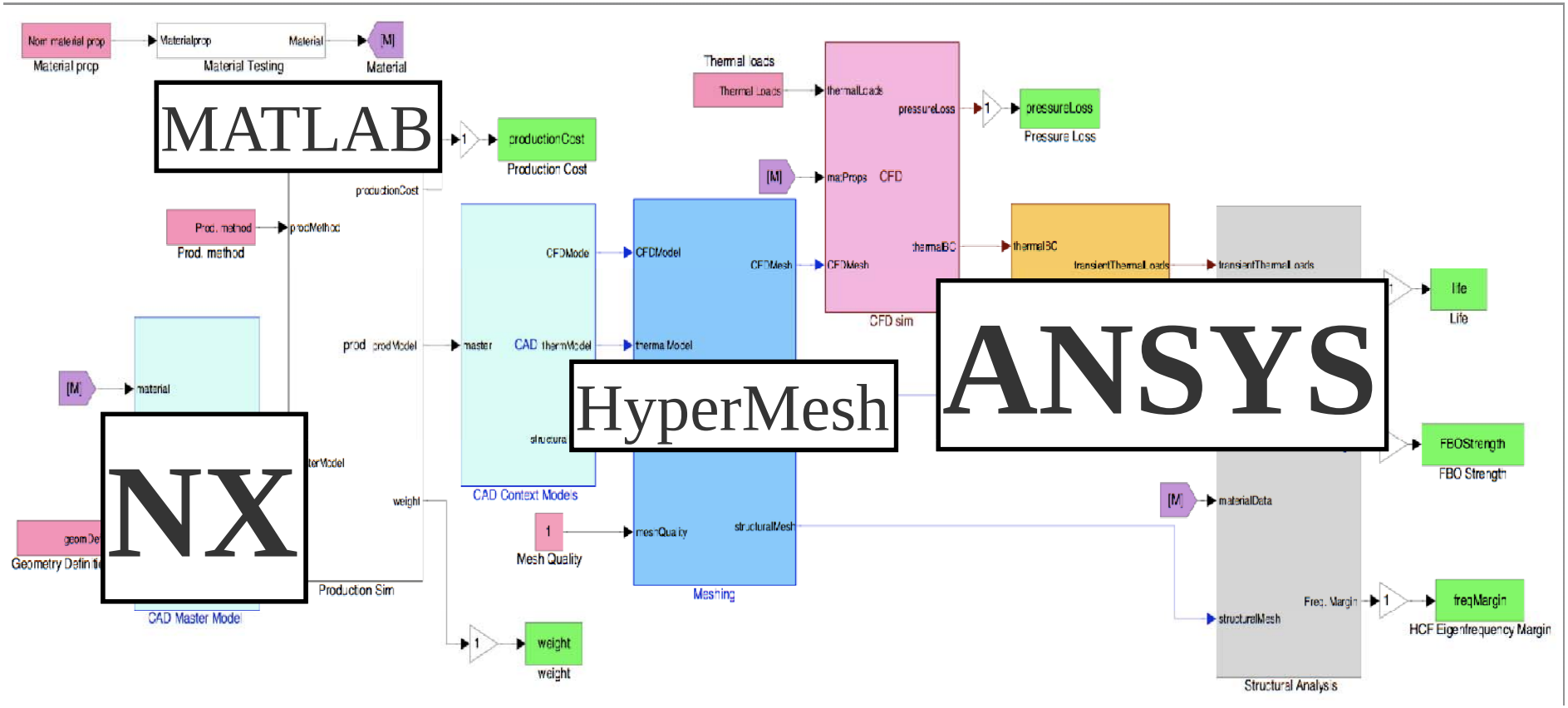
A systems representation of the workflow





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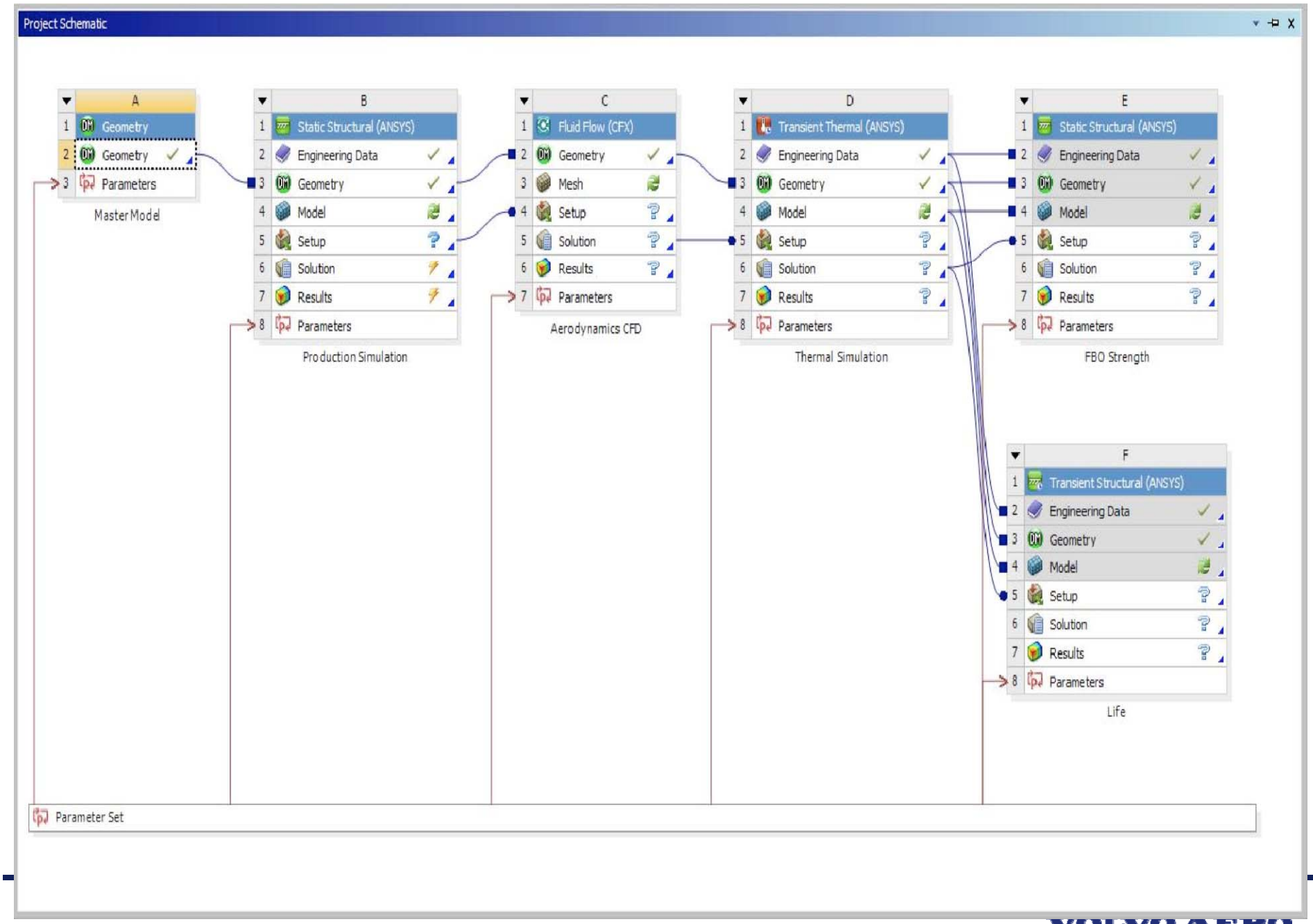
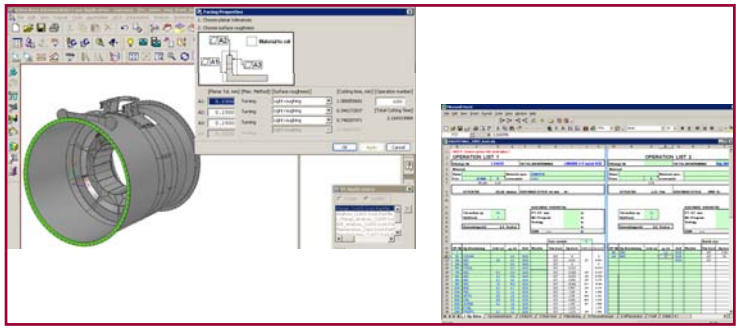


Combining complementary modeling techniques

- 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 conceptul design



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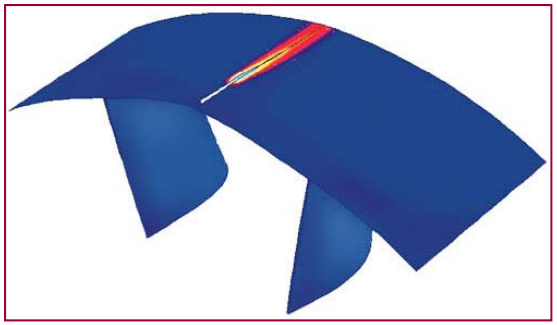
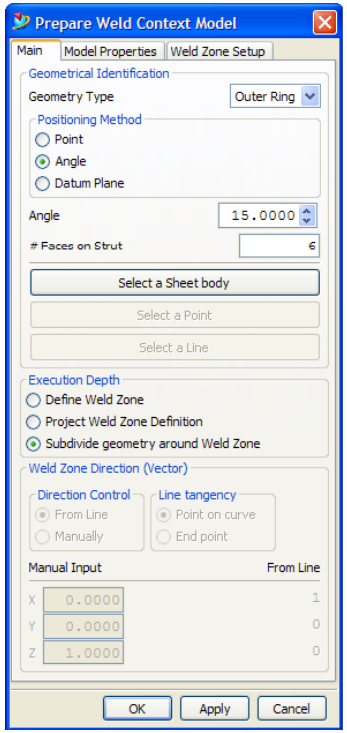
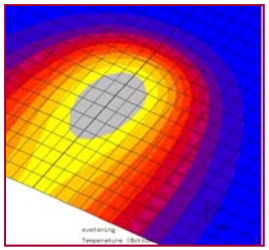
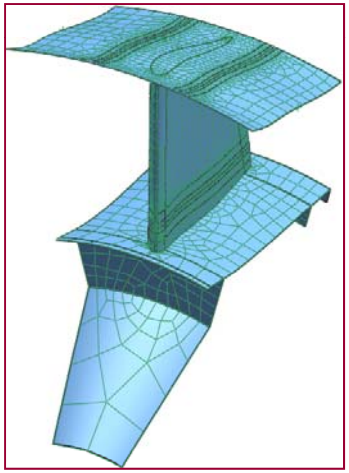


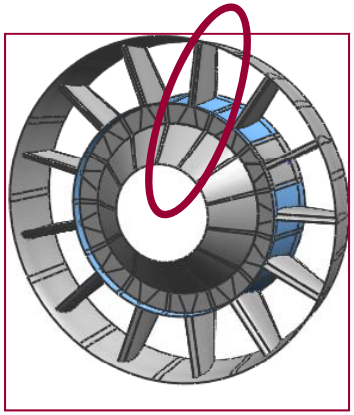
Define, model, automate the workflow

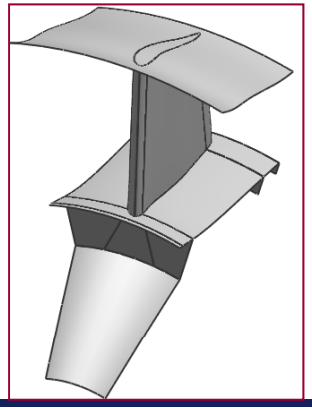


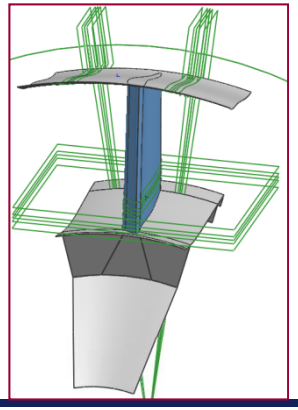
- Integrated technologies demonstrated Capabilities











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Concluding Reflections

- Can models replace reality?
- No... Physical Validation necessary – but not sufficient...
  - Significan 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!