



ASML

Vision on future role of CAE at ASML

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Outline

Introduction

Vision towards role of CAE in development

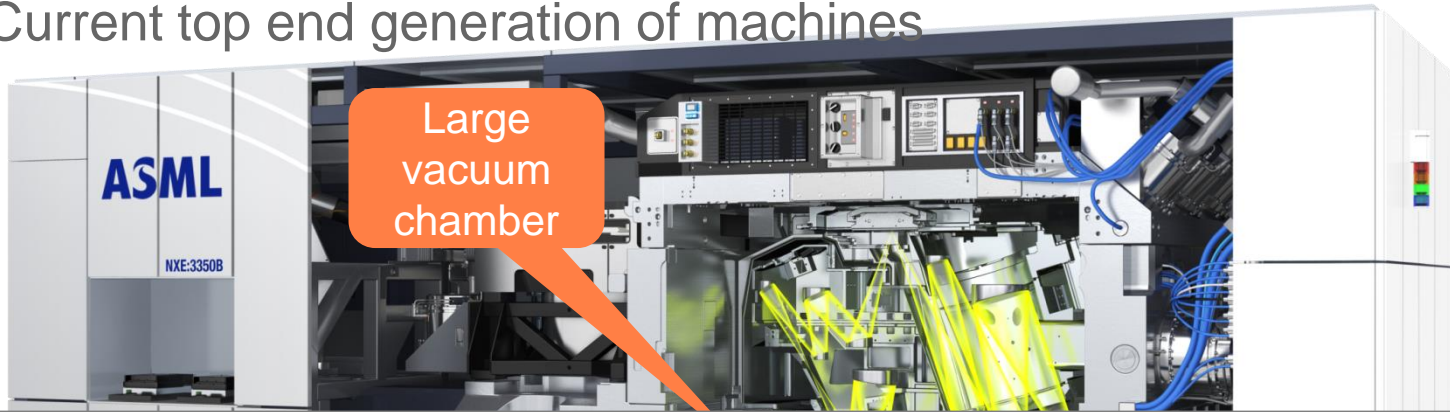
Some examples

Challenges

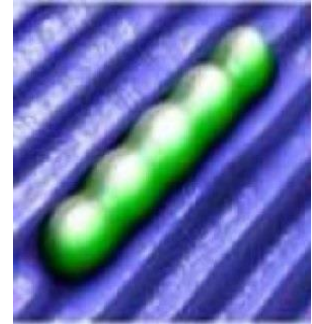
Questions/discussion

Introduction

Current top end generation of machines



- **Accuracy:** ≈ 1 nanometer, less than 5 Si atoms!
- **Expensive:** $> \text{M€ } 200$ (Boeing 787-9 Dreamliner $\approx \text{M€ } 220$)
- Needs to be reliable! 1 full day down: Millions of €'s
- Some parts are both very expensive and have a long lead time to manufacture



Source: Building quantum states with individual silicon atoms, Sciencedaily.com,

Performance to the extremes

Sub-nanometer deformation under operational conditions...



Earth



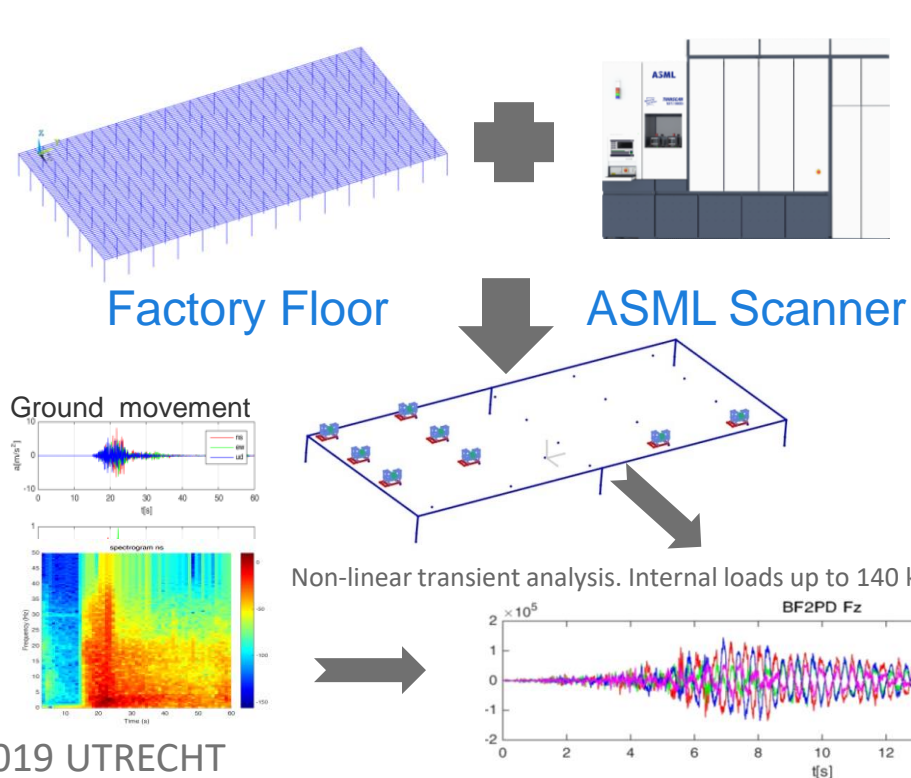
Moon



While the earth rotates, the position of the moon relative to our machine changes during the day

→ total peak-to-peak effect on some parts is **700 pm (0.7 nm)**

and survive earthquakes



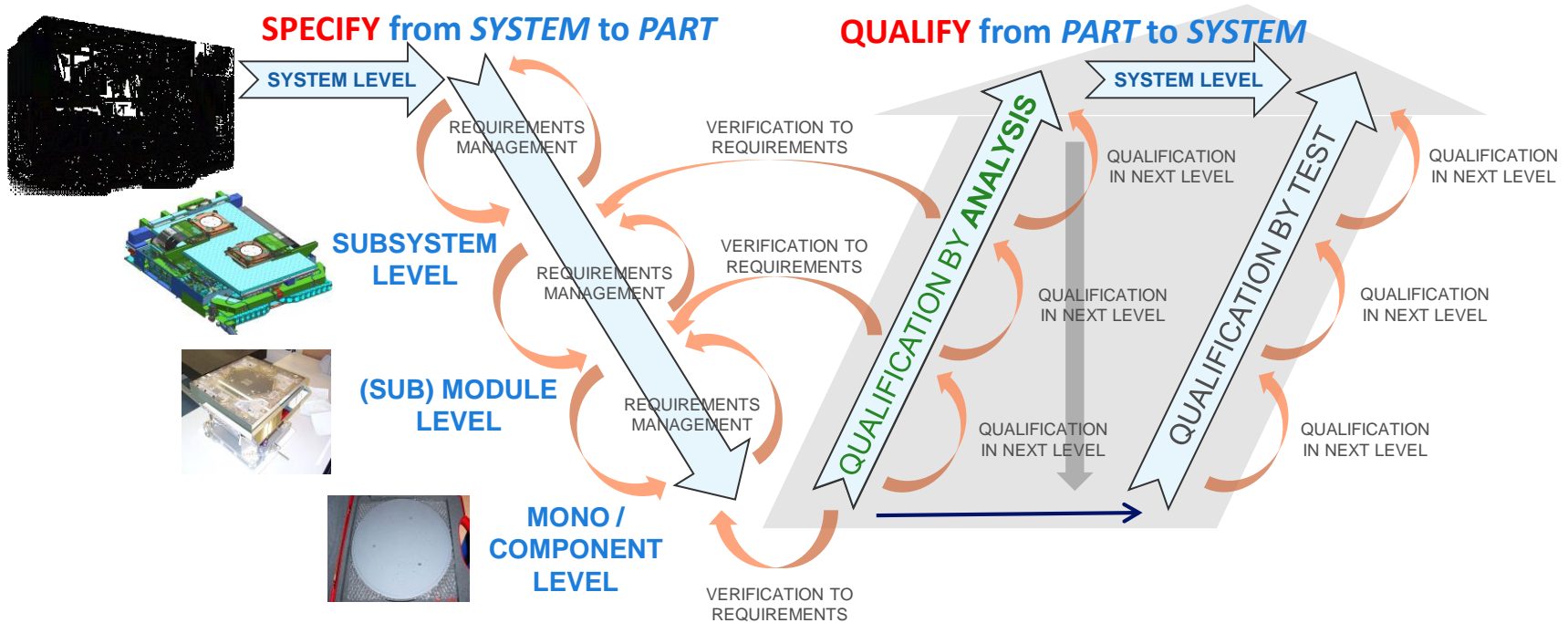
Challenges:

- How to increase the efficiency of development?
“Do more with existing staff and in less time”
- How to increase the quality and reliability of our design?
“right-first-time”
- How to reduce cost?
“less protos, less physical (hardware) testing”

Verification by physical testing is getting more difficult, not feasible or even not possible.

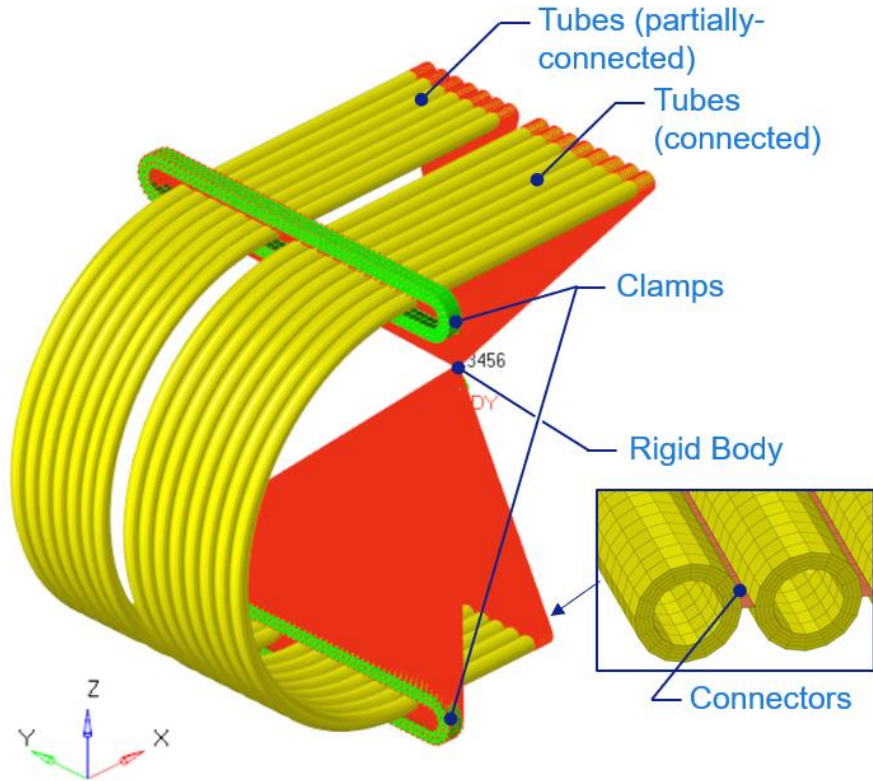
→ Simulation Driven Design

Going through the V-cycle



Examples related to reliability

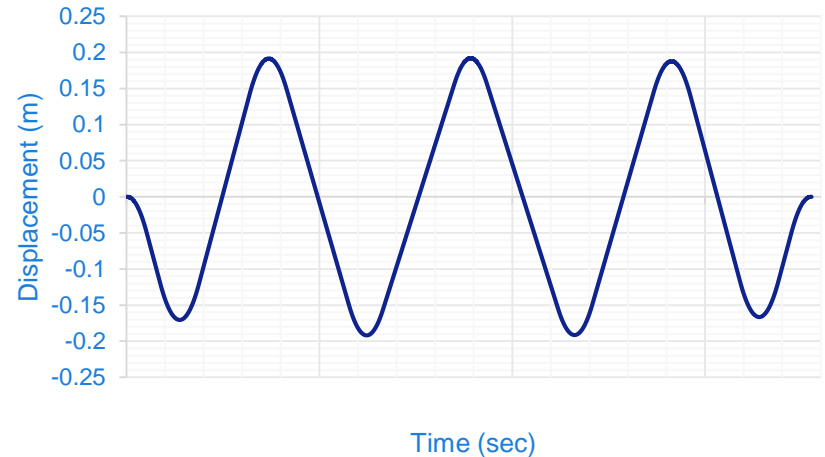
Behavior of a cable slab under high accelerations



Objectives:

- Identify volume conflicts (clashing → particle generation)
- Resulting loads on the system
- Potential fatigue problems

Motion profile (10ths of g's)



Examples related to reliability

Behavior of a cable slab under high accelerations

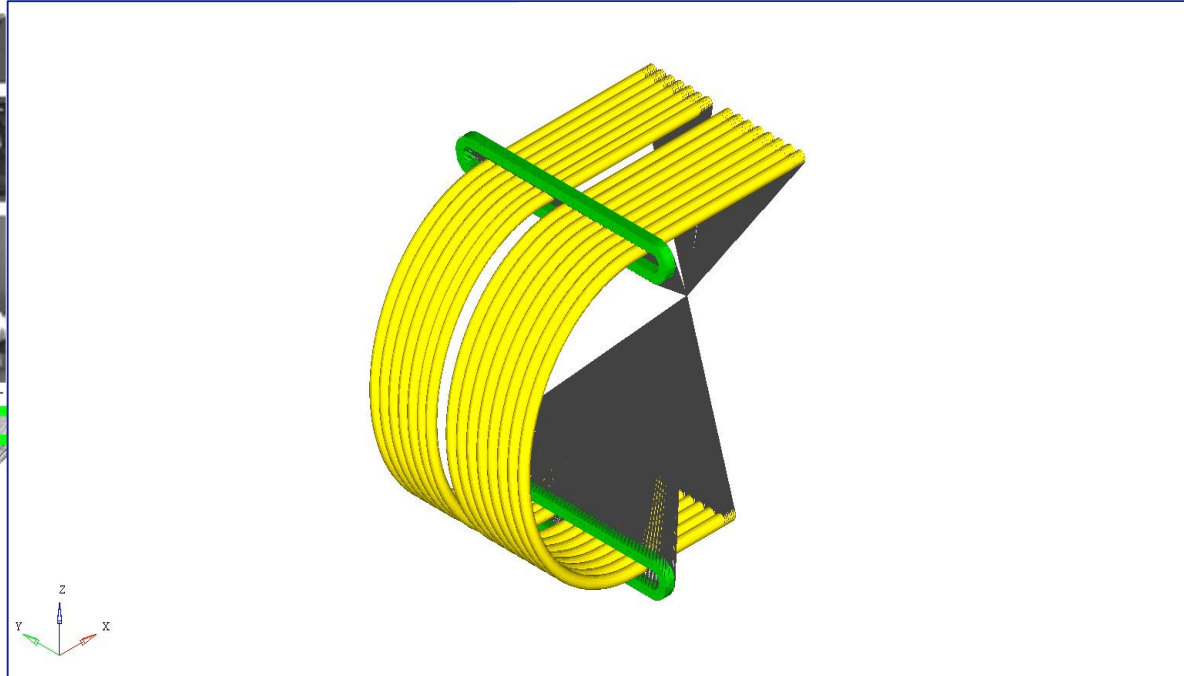
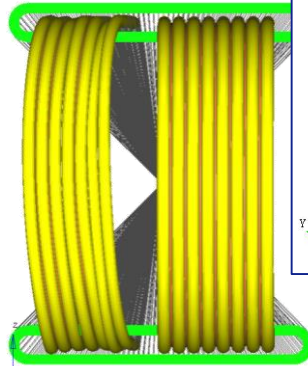
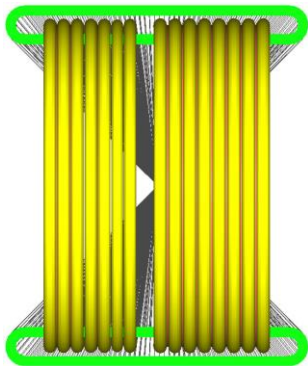
Initial position

Deformed

Experiment



Simulation



Examples related to reliability

Fatigue analysis of laser welded cooling channels

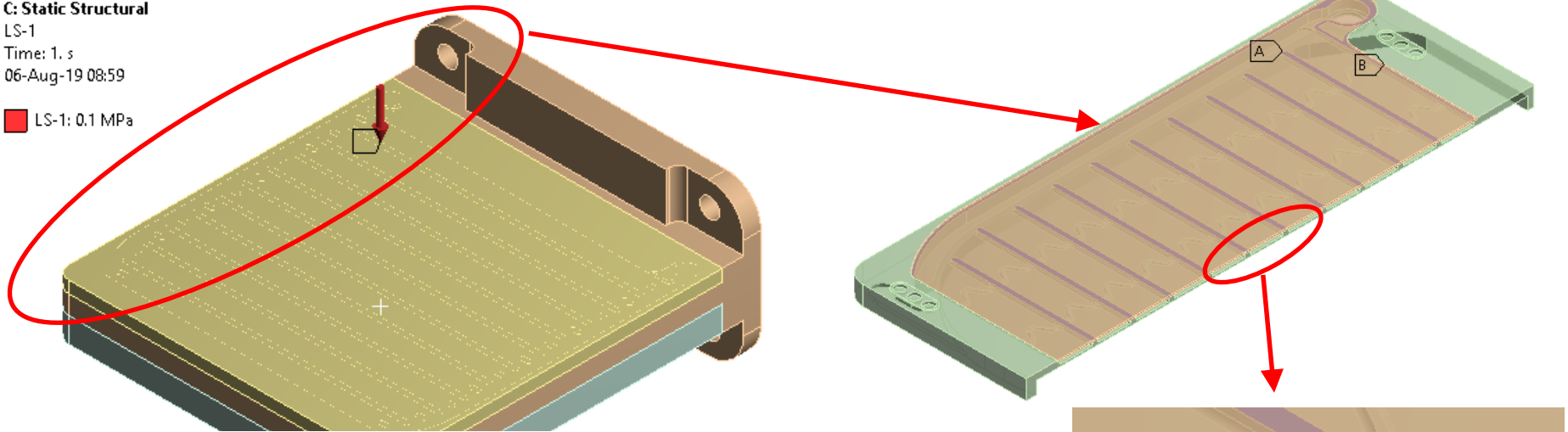
C: Static Structural

LS-1

Time: 1. s

06-Aug-19 08:59

■ LS-1: 0.1 MPa



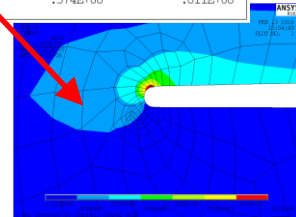
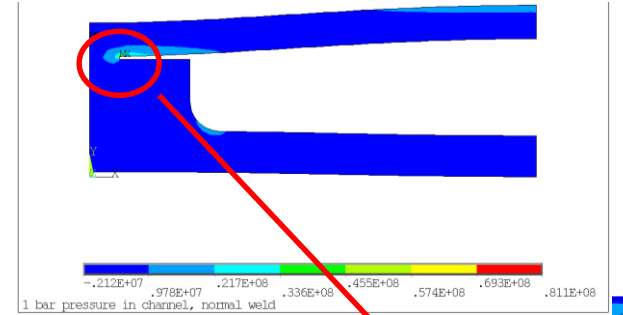
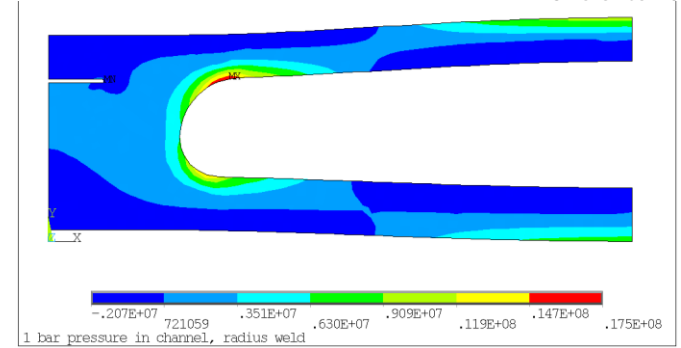
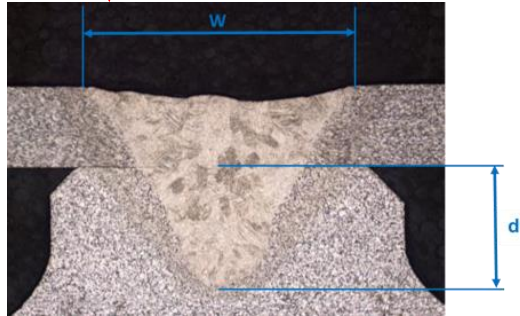
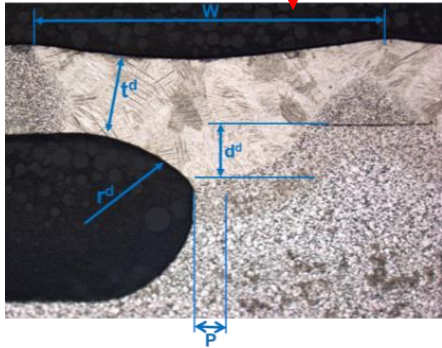
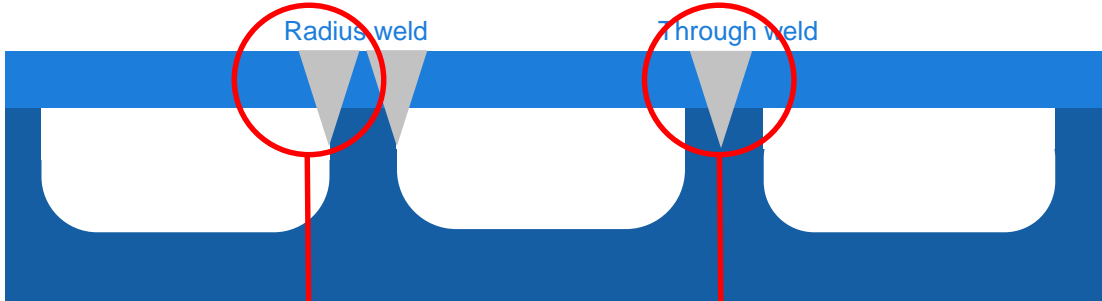
Objectives:

- Ensure reliability (of laser welds) under
 - Pressure loads (pressure pulses)
 - Temperature loads
 - External loads

Examples related to reliability

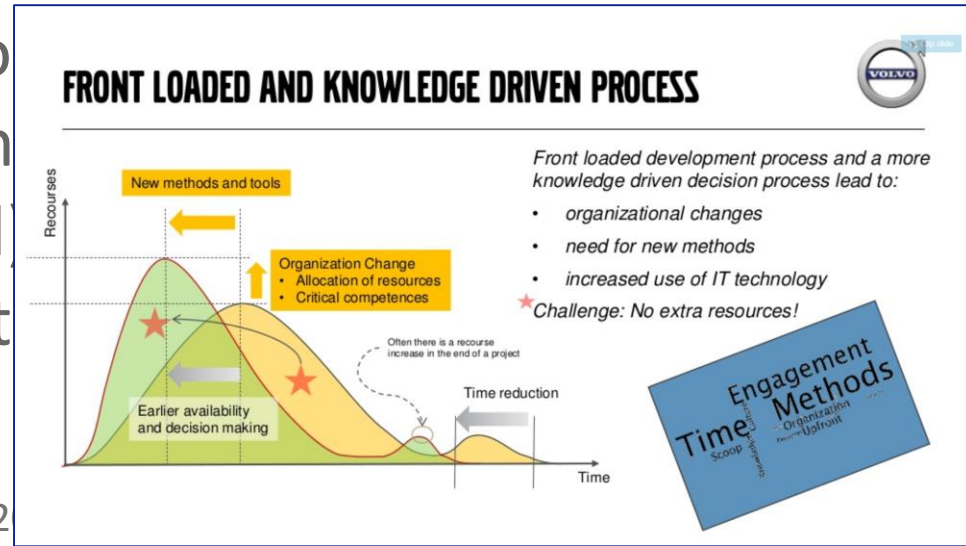
Fatigue analysis of laser welded cooling channels

Material thicknesses in the order of 1/10th of millimeters



Some challenges

- Achieve a change of mindset toward role of simulations
 - Early involvement
 - More simulations “Front loading CAE”
- Have standard simulation
- Verification & Validation
- Simulation (Process and
- How to organize simulation possible way?



- **Achieve a change of mindset toward role of simulations**
 - **Early involvement**
 - **More simulations “Front loading CAE”**
- Have standard simulation processes
- Verification & Validation (V&V) is important!
- Simulation (Process and) Data Management (SPDM)
- **How to organize simulation competences in the best possible way?**

Questions?



The image features the ASML logo in a bold, dark blue font on the left side. The background is a light blue gradient with several decorative elements: a large, semi-transparent light blue arc in the upper left; a series of thin, white, wavy lines that originate from the right side of the ASML text and extend across the lower half of the image; and a solid light blue area in the upper right.

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