Recent Approaches of CAD / CAE Product Development. Tools, Innovations, Collaborative Engineering.

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Agenda

- Company Overview
- Introduction
- Multiphysics Solutions
- Solver Languages
- Master Model Approach
- Designer / Analyst Collaboration
- Design Embedded Analysis / CAE Experts Collaboration
- Data Management

Company Overview

Dr. Binde Ingenieure BINDE Design & Engineering

– Your NX CAE Experts –

Integration Solutions
Training for Engineers
Technical Simulation
Independent Consulting

Solution Partner PLM

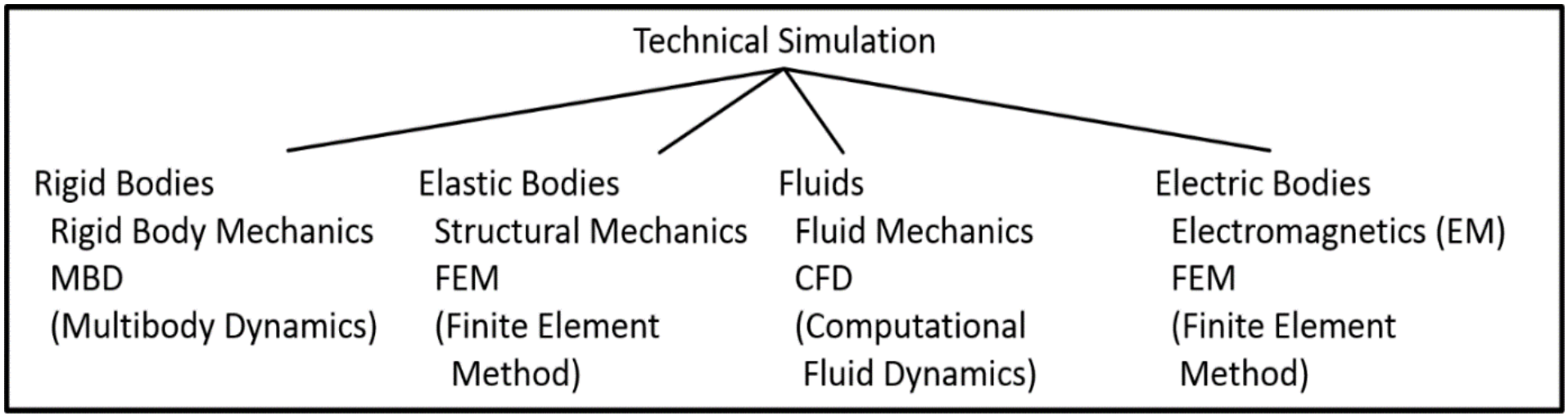
SIEMENS

Fields of expertise

Structural Mechanics	Rigid Body Mechanics	Fluid Mechanics	Thermo-dynamics	Electro-dynamics
FEM	MBD	CFD	FEM/CFD	FEM

Introduction

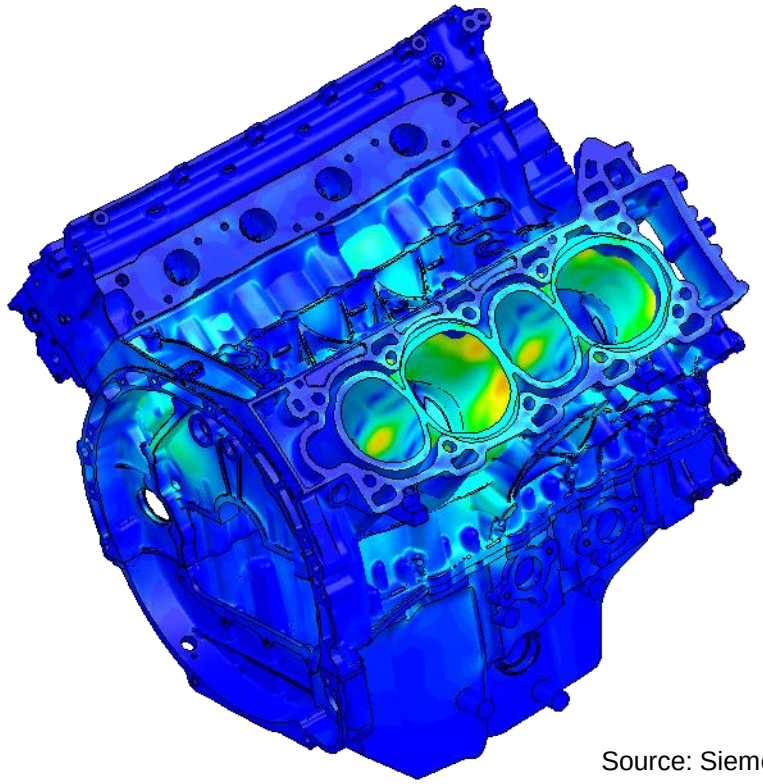
- Integrated CAD/CAE in former times:
  - Limited to linear FEA and kinematic MBD
  - Focus on designers: Easy, fast, less abstraction, A-B comparisons, mechanical only
  - Analysts never used that. Need more abstraction, self made codes. Stand alone codes.
- Today:
  - Broad spectrum of requirements from large OEMs → *Multiphysics*
  - Need for Technology-Integration and PDM → *Interfaces, Collaboration*



Multiphysics Solutions

Thermal / Structural one Way

- First compute for temperature fields and then apply those temperature fields as loads to structural models.
- Needed in all fields of strength analysis cases where thermal expansions plays a role. An example are motor housings.
- not difficult to perform
  if boundary conditions are clear.

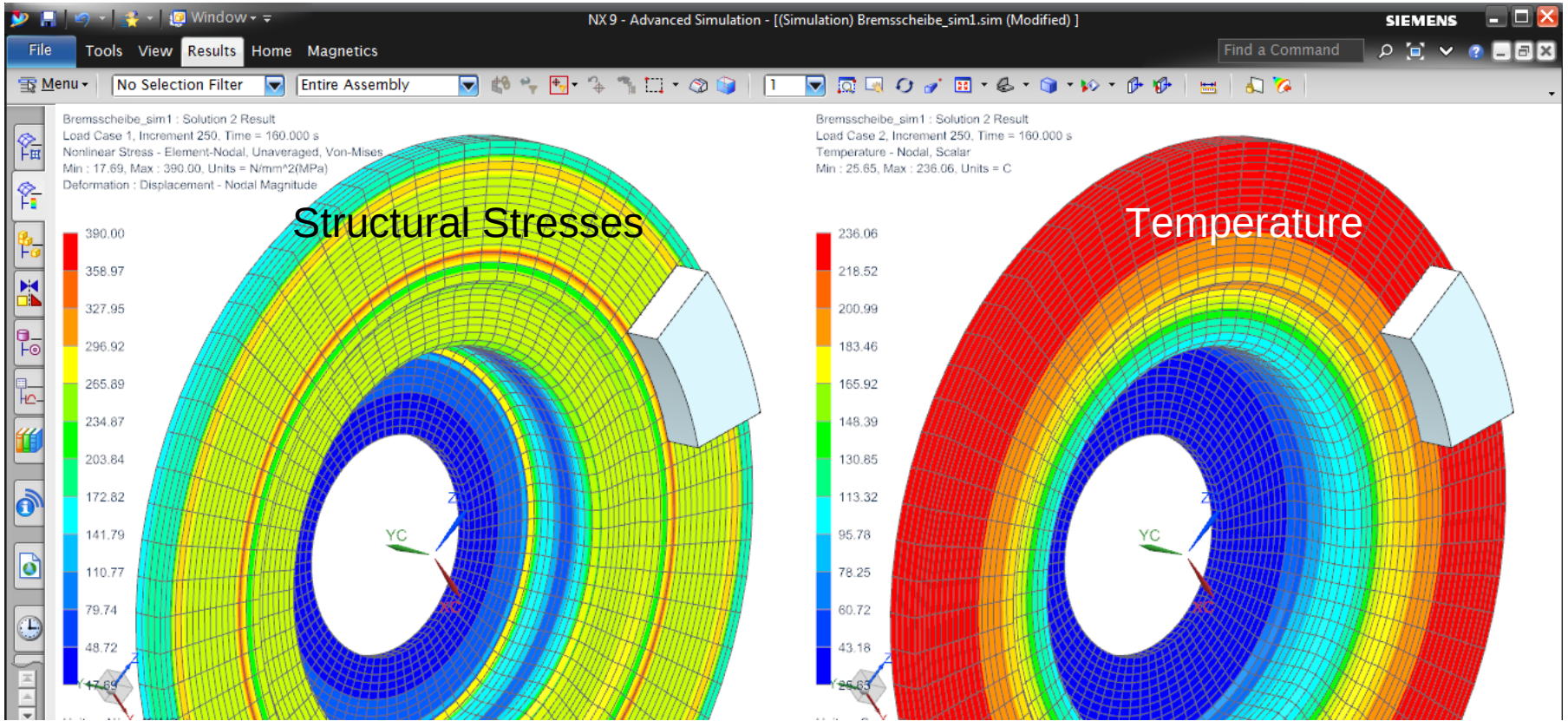


Source: Siemens PLM

Multiphysics Solutions

Thermal / Structural two Ways

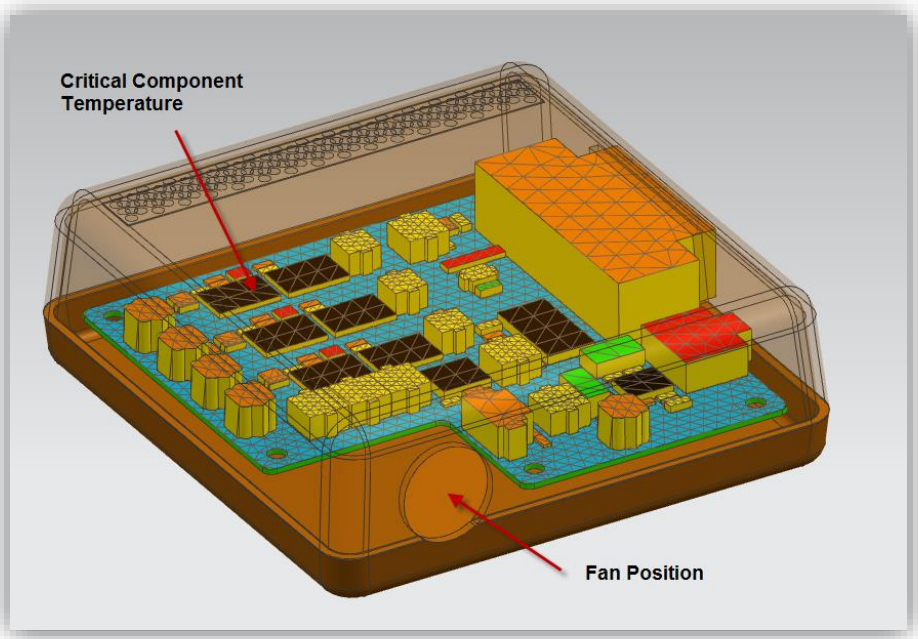
- Temperature loads lead to structural deformation.
- takes into account that deformed models may lead to different thermal conditions.
- Examples: Brake-Disk, Screwed container seals in nuclear plants.
- much more sophisticated to solve.



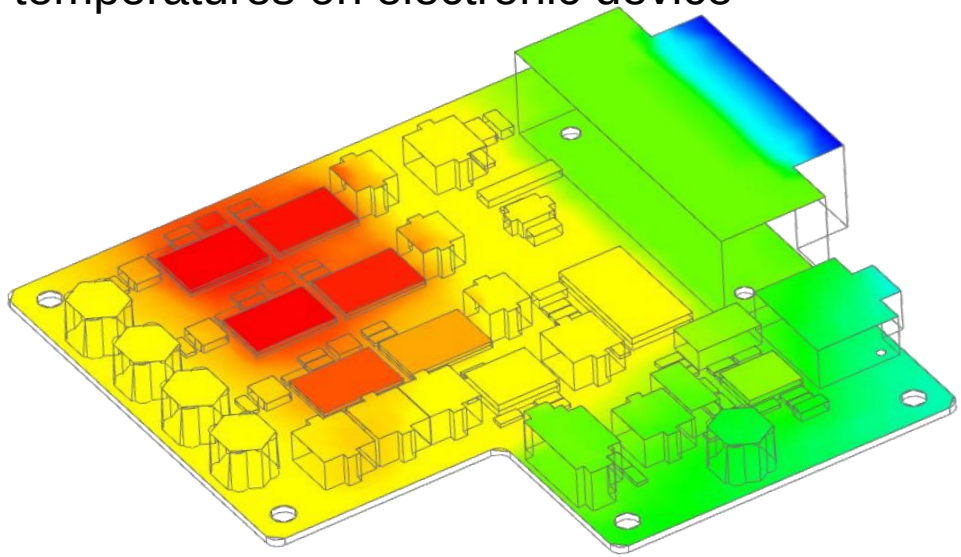
Multiphysics Solutions

Thermal / Fluid two Ways

- combined analysis of thermal and fluid separately in rigid body regions and in fluid regions.
- At all interfaces there must be solved for heat transfer conditions.
- Example applications are coolings of electronic systems.
- Still not common for most CAD CAE systems.



temperatures on electronic device

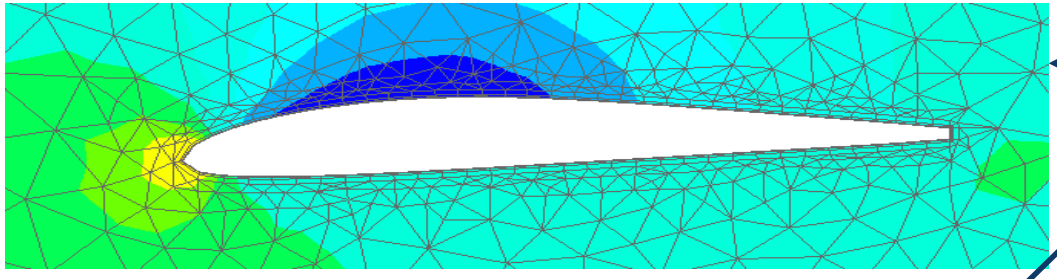


Source: Maya HTT

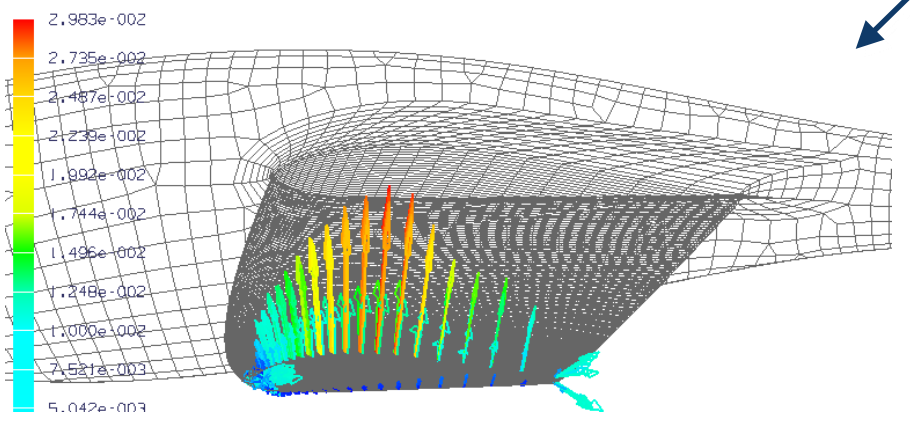
Multiphysics Solutions

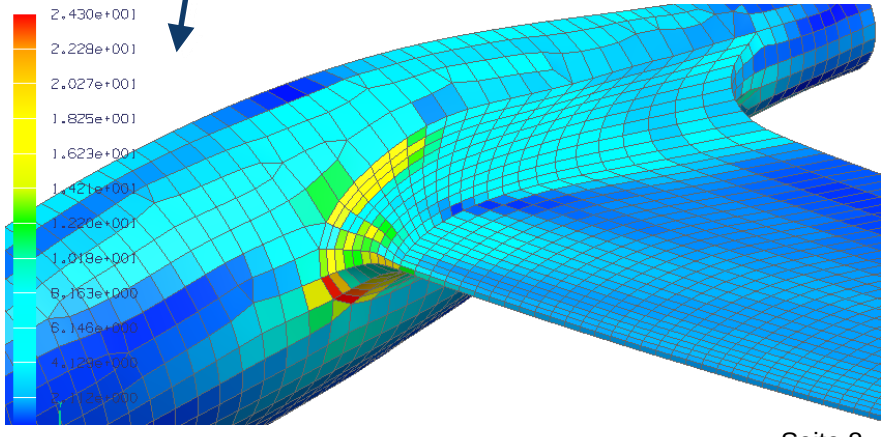
Fluid / Structure one Way

- Forces and pressures arising from fluid lead to deformations.
- First analyzing for flow, then mapping pressures to following structural analysis.
- Mapping between different meshes must be carried out.
- Application: stationary aircraft wing investigations.
- Some of the integrated CAD/CAE systems allow this analysis type.



1. CFD flow analysis
2. mapping
3. FEA structural analysis



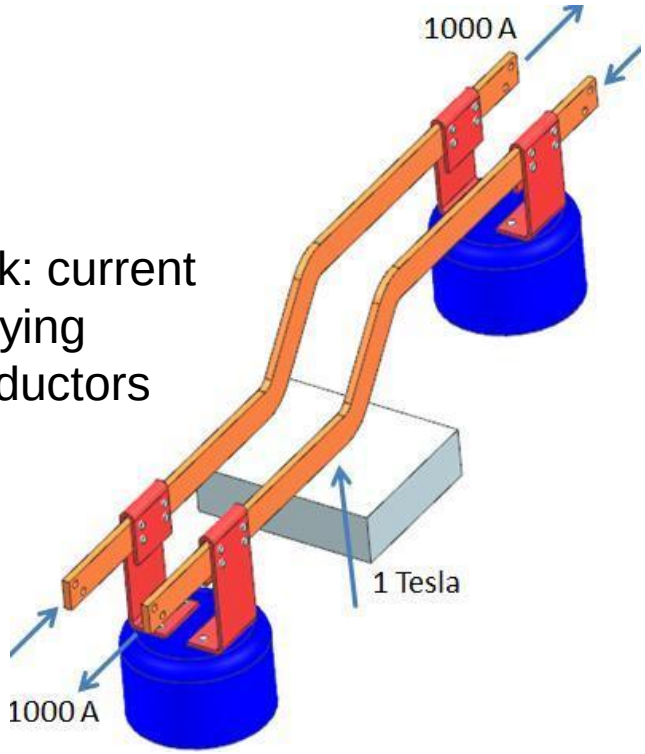


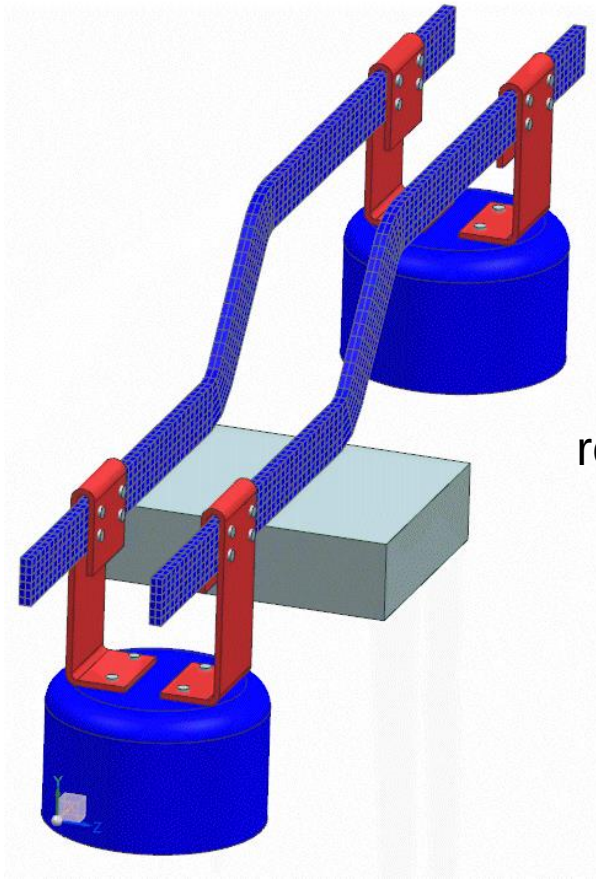
Multiphysics Solutions

Electromagnetic / Structural one Way

- Electromagnetic forces, for example Lorentz-forces, are computed in the EM solver and transferred to structural models to be solved for deformation, stress and strength.
- Applications are high-voltage conductors at short circuit.
- possible in few systems only.

Task: current carrying conductors



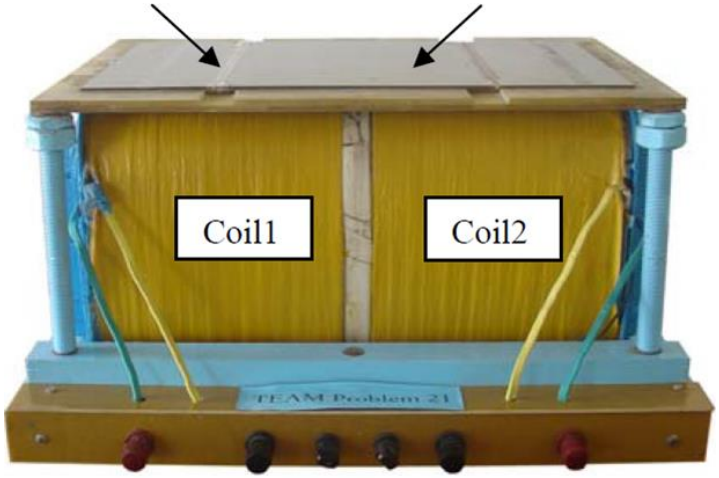


result: deformation

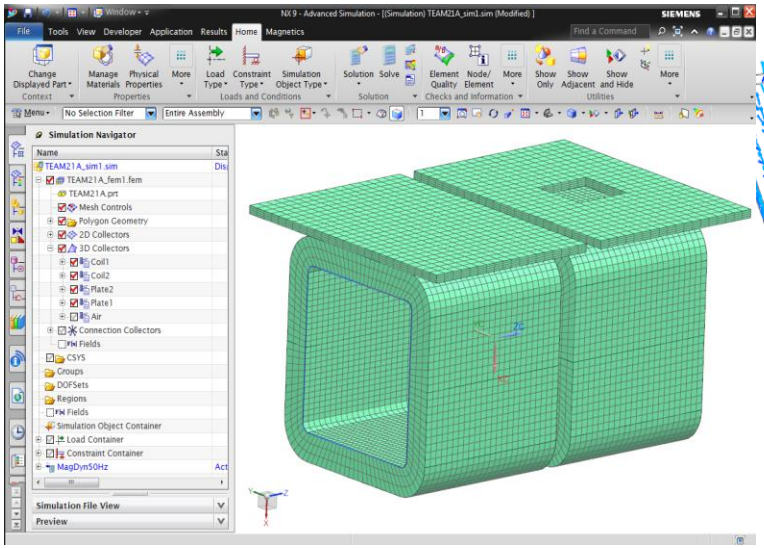
Multiphysics Solutions

Electromagnetic / Thermal one Way

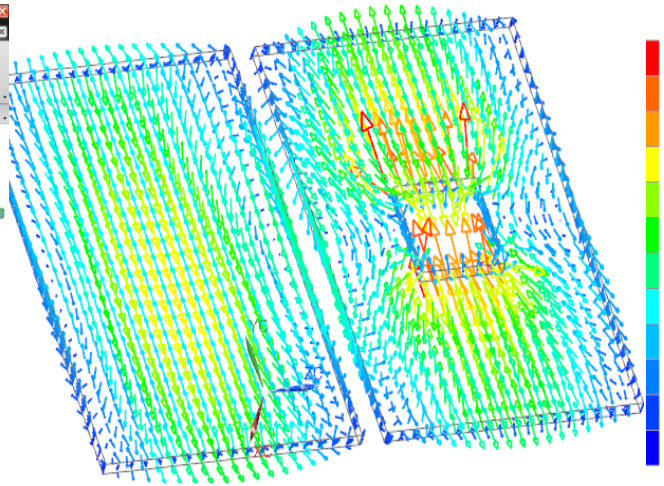
- Losses that result from electromagnetic eddy-currents and hysteresis effects, are computed in EM solvers and then used as thermal loads in following temperature studies.
- Application is transformer thermal analysis.
- possible in few systems only.



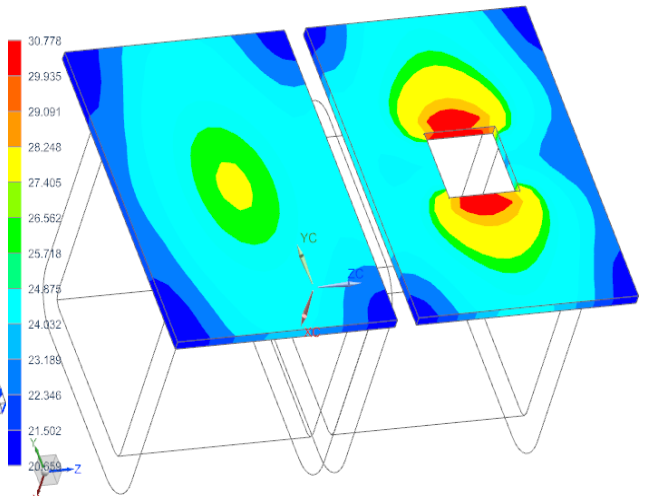
CAE-model



eddy currents



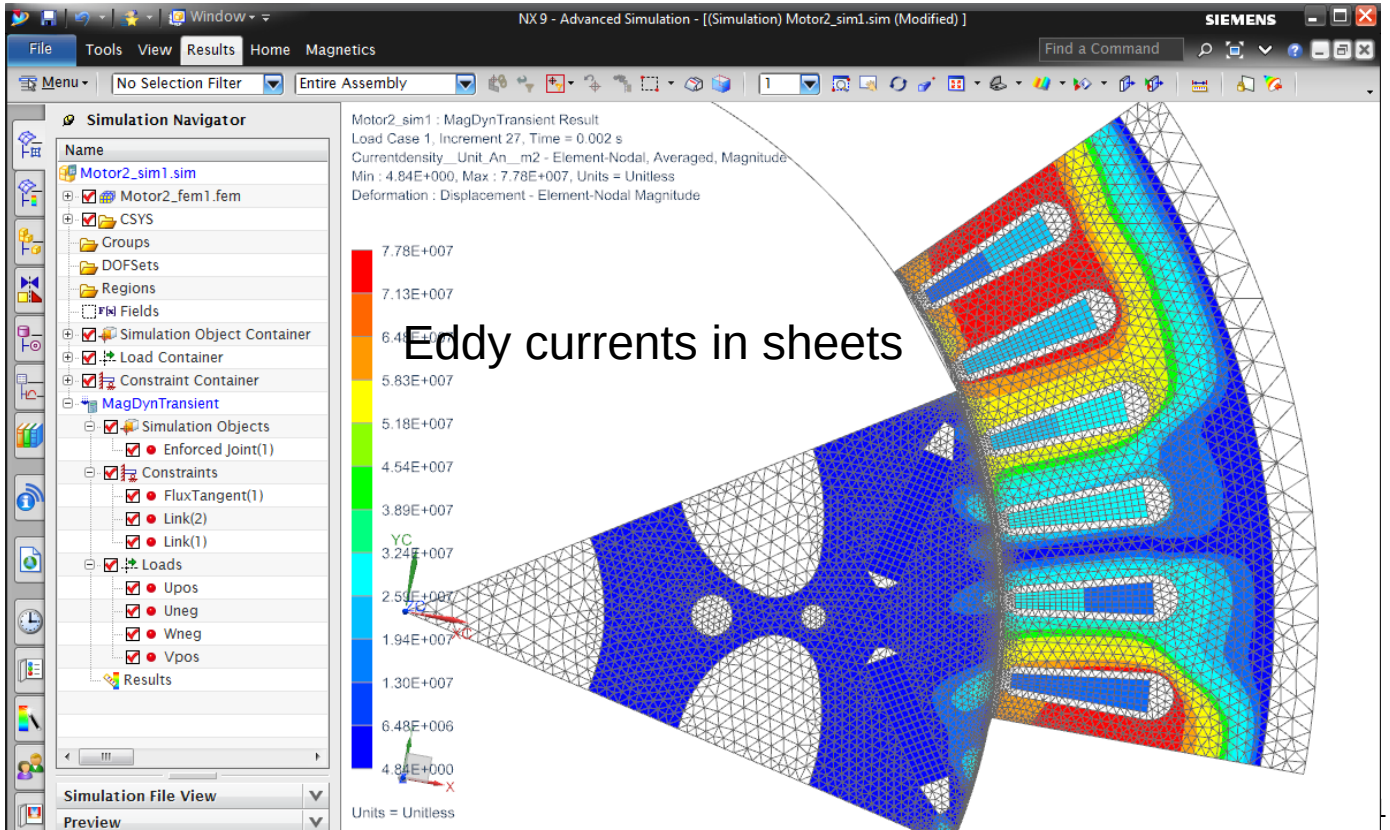
temperature



Multiphysics Solutions

Electromagnetic / Thermal two Ways

- Again losses are computed by EM and used to find temperature fields in the second step. But now those temperatures lead to different material-properties and back influence the EM result.
- Application is electric motor. Particularly the electric conductivity in electro-sheets of motors varies heavily with temperature.
- possible in few systems only.

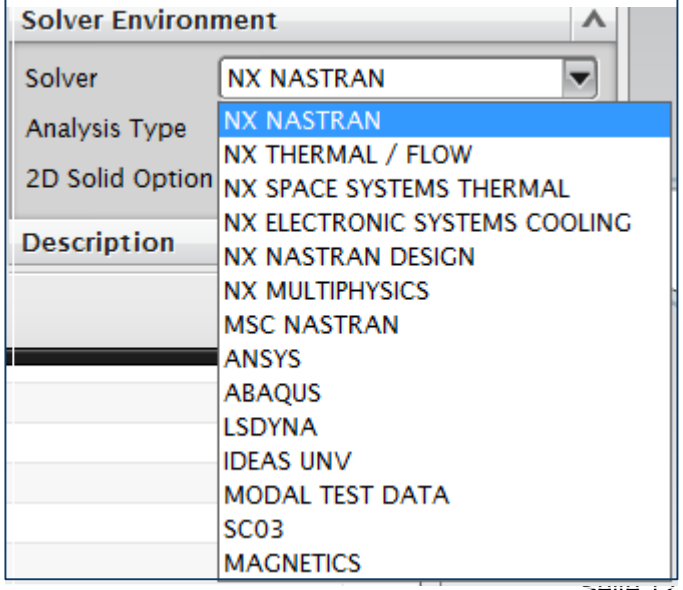


Solver Languages

Neutral Language for Solvers

- special technologies must be implemented in large CAD/CAE systems
- General Method how to implement new solver technologies in CAD/CAE systems.
- All input data for any FEA solver is classified via XML by the following set of objects:
  - Solution Class: Description of all solutions that characterize the solver, for instance Thermal or Structural or Electromagnetic.
  - Solution Type: Detailed description of the physical solutions that the solver can perform
  - Elements: The various finite element types a solver can handle.
  - Physical Property Tables: All physical properties like material data.
  - LBCs: Loads, boundary conditions, constraints and related data.
  - Sections: One-dimensional elements may need various sections.
  - Modeling Objects: Additional data blocks.
  - Element Quality Checks: Special quality checks for the considered solver.

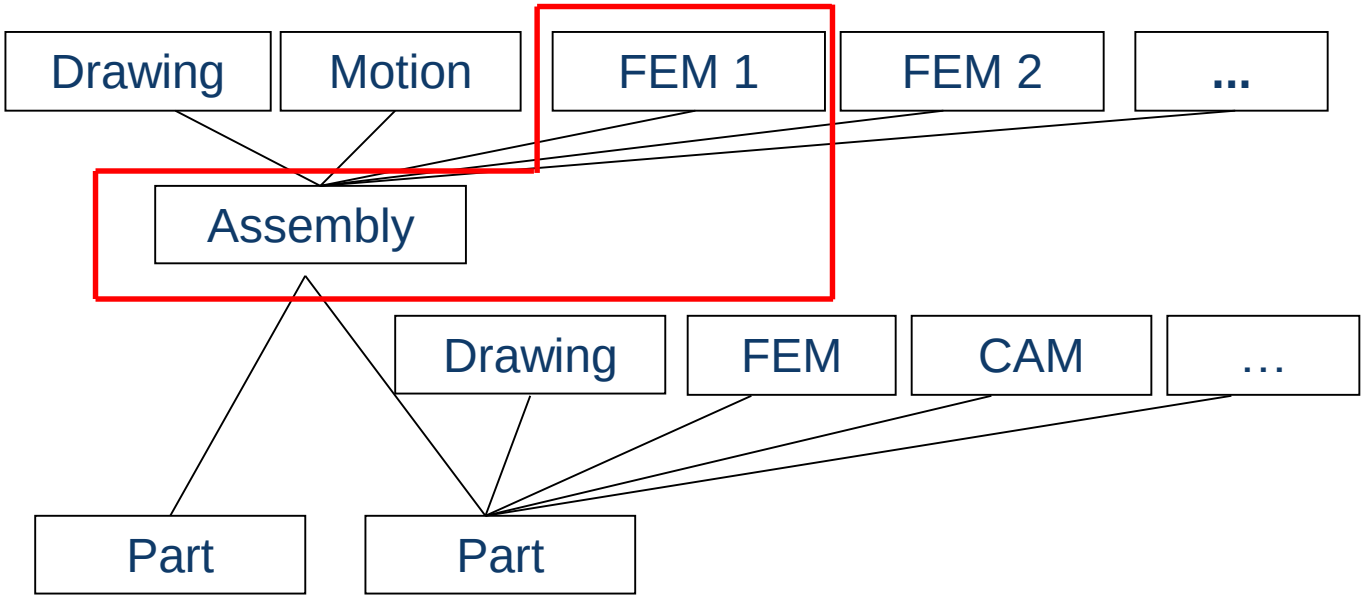
Example: Solvers in NX



Master Model Approach

Advantages

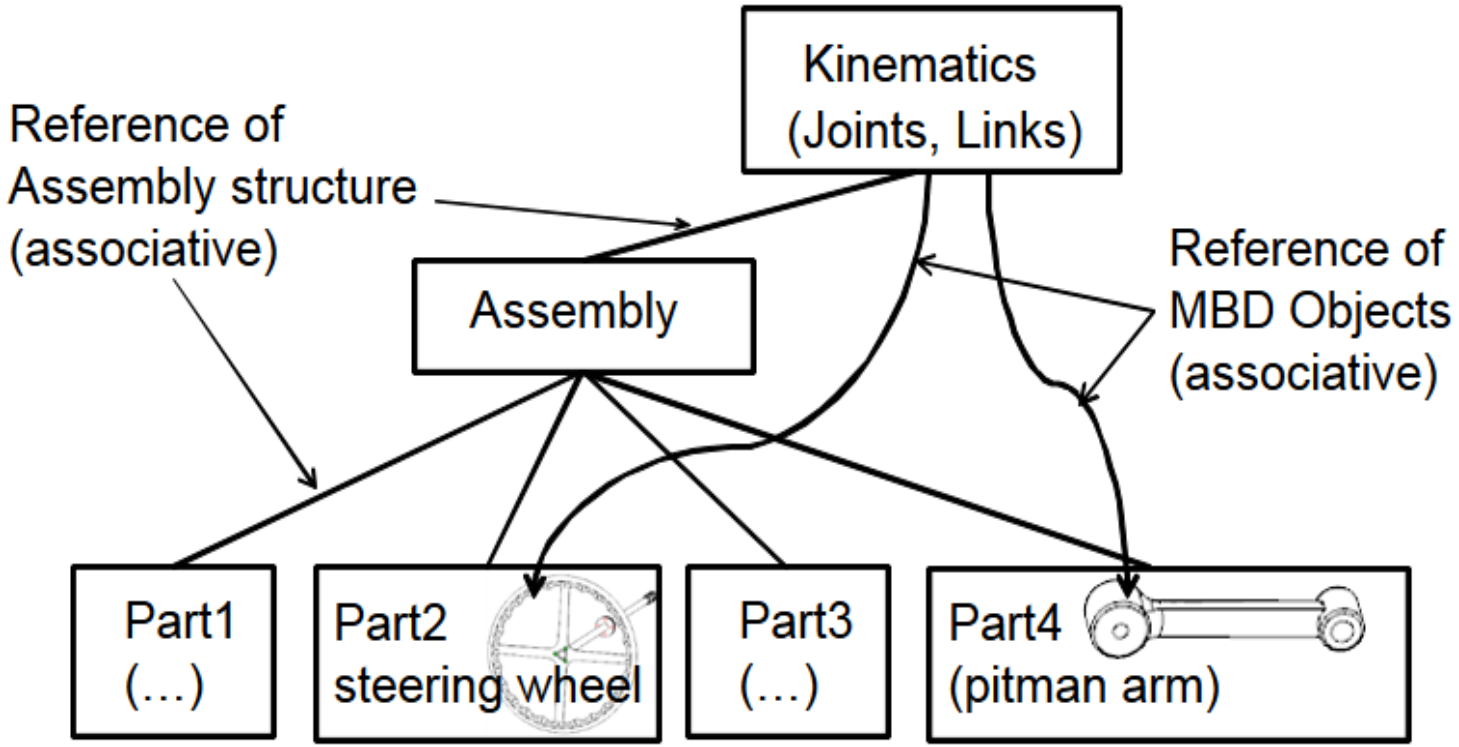
- different engineers can develop together
- Handling of large assemblies easier



Designer / Analyst Collaboration

CAE Objects are linked to CAD objects

- fully automatic updates after geometry changes are possible
- Handling of large assemblies easier



Designer / Analyst Collaboration

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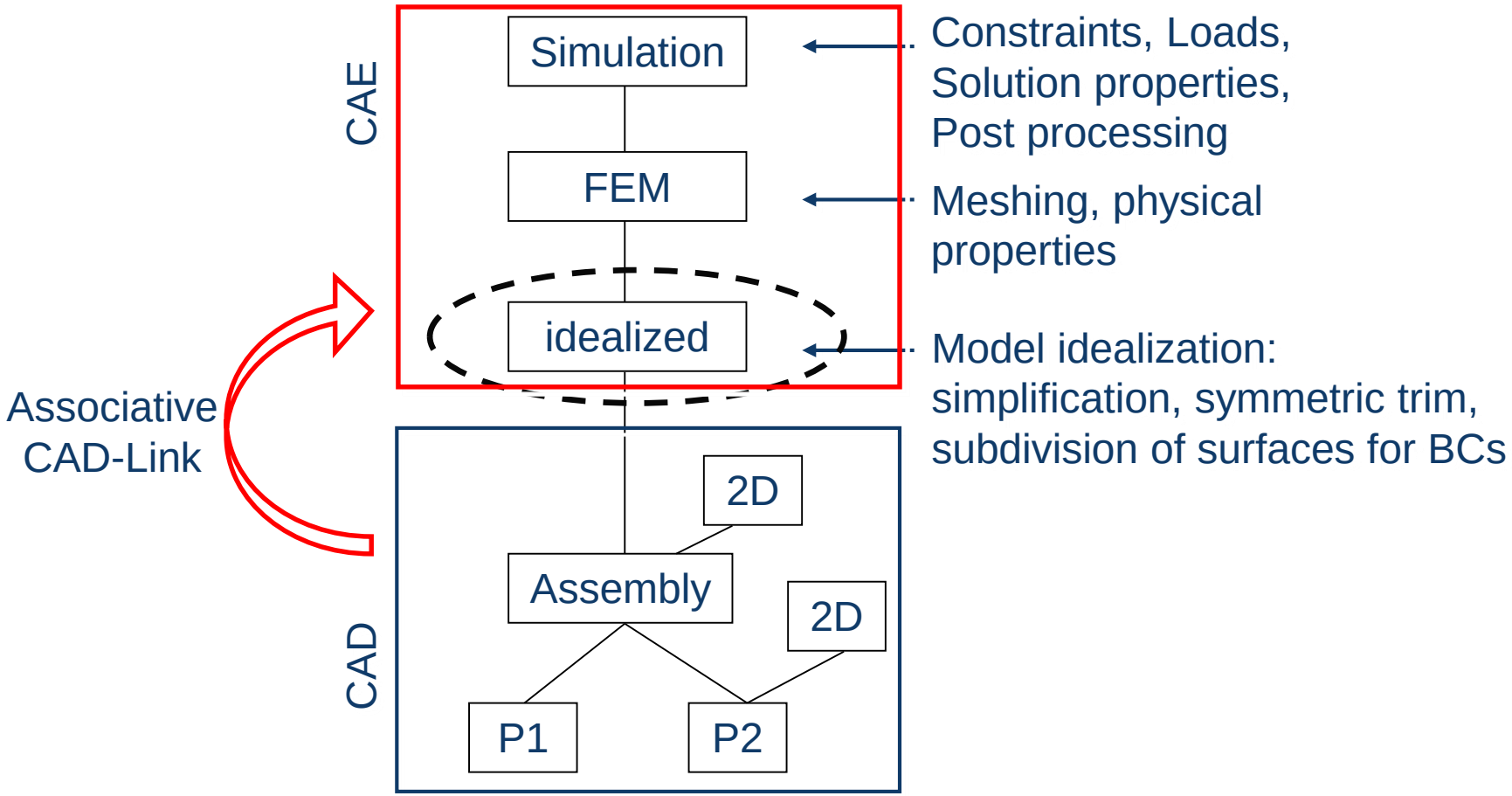
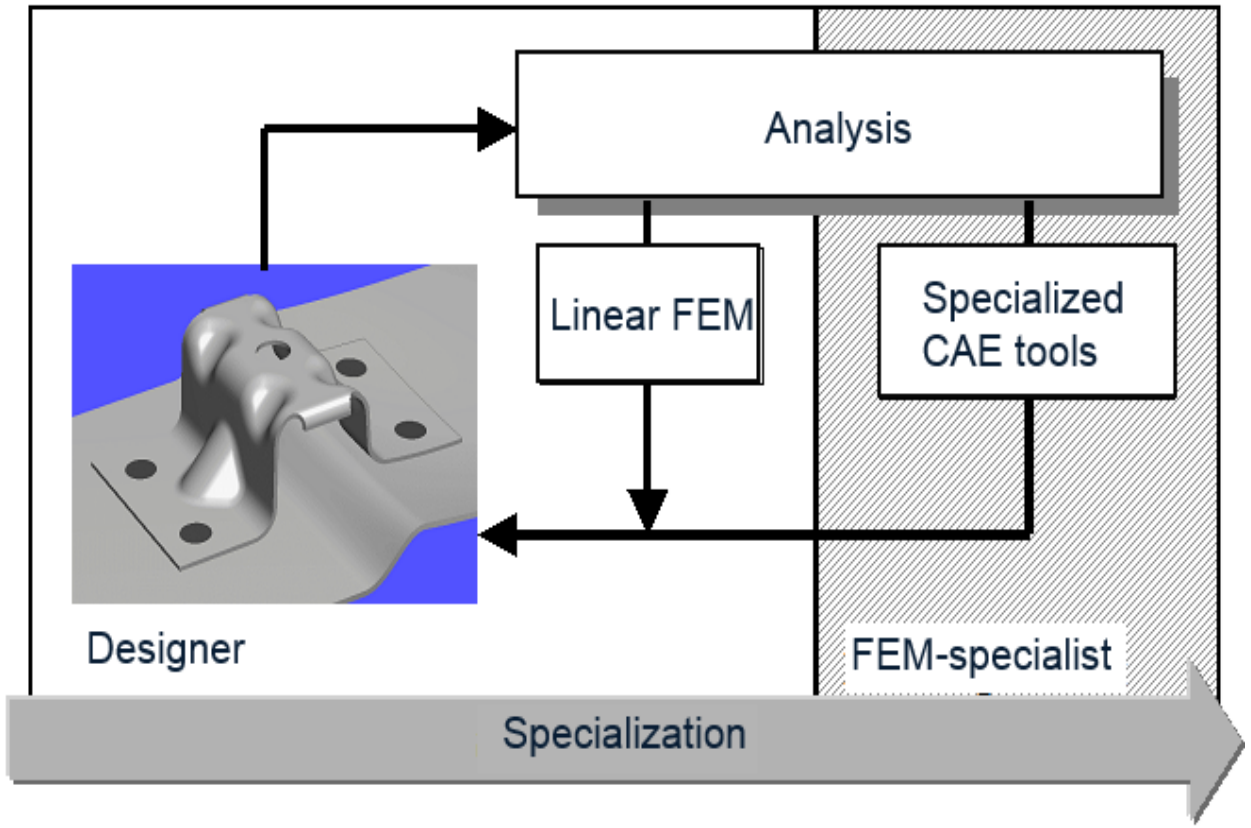
Analysis Engineers need access to CAD Methods

- additional CAD model placed between CAD master and CAE
- changes in the CAD master lead to updates of CAE
- CAE engineers do also have possibilities to modify geometry



Design-Embedded Analysis / CAE-Experts Collaboration

- Designers can perform simple analysis types efficient, but need support from CAE-experts.
- If designer CAE tools are compatible to experts tools many advantages can arise.



Data Management – The Challenges

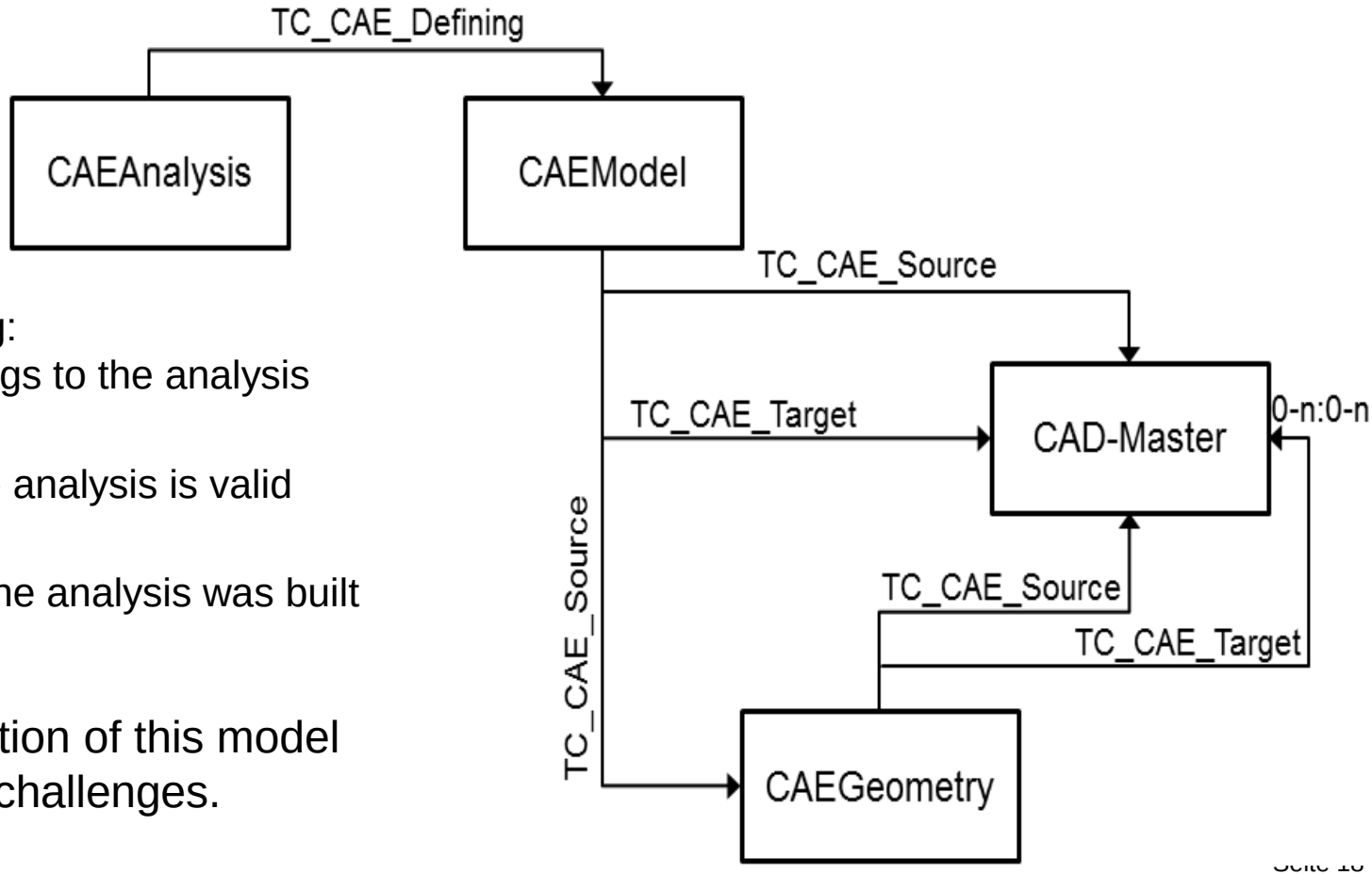
- Personnel separation of modeling from the analysis,
- Many different CAE software systems,
- Many analysis variants,
- Lack of relationship of CAD to CAE models,
- Lack of process orientation,
- Inadequate data protection,
- Insufficient supplier integration.

Data Management – Data Model used in Teamcenter

- Database Items contain CAD and CAE Data:
  - CAEAnalysis: Simulation file
  - CAEModel: FEM file
  - CAEGeometry: idealized file

- Relations:
  - TC_CAE_Defining:
    which mesh belongs to the analysis
  - TC_CAE_Target:
    for which CAD the analysis is valid
  - TC_CAE_Source
    from which CAD the analysis was built

- Consequent application of this model allows facing those challenges.



Questions?