Harmonic drives with high accuracy and service life, working in different fields

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Internship plan

№	Events	Results
1	Education methodology for solving engineering problems in the ANSYS environment	new skills with software from ANSYS
2	Methods and technology of multi-physics problem-solving	solution for conjugated problems related to my thesis, improve the overall "skill"
3	The analysis of large assemblies using finite element method;	analysis of harmonic drive in three-dimensional statement
4	payment problems with a large number of contact pairs;	Calculation harmonic drive given the large of number of contact pairs
5	automation software package Ansys Workbench	Creating a module of automated construction of the computational model in ANSYS software Harmonic drive
6	Visit to the university centers in Germany	Increased general "skill", experience exchange

CADFEM International can be split into three different categories:
First, the ANSYS Channel partner, who are working with ANSYS in their countries (Core Business Partner). **Second**, partners who offer complementary solutions in the field of numerical simulation (Complementary Business Partner). **Third**, Start-Up companies, working on innovative ideas.

Implementation of the plan

1. Structural Mechanics with ANSYS Mechanical
2. Topology and parametric Optimization
3. Introduction to ANSYS Application Customization Toolkit (ACT)
4. High-perfomance computing
5. Contact Modeling with ANSYS Mechanical

About What I'm doing in the Grafing near Munich (week 2)

ANSYS Workbench / Software handling
- Introduction to FEM
- Demonstrator (live)
- Workbench Project page
- Material Definition
- Objects and their properties
- Coordinate Systems
- Mechanical software handling
- Named Selection Worksheet
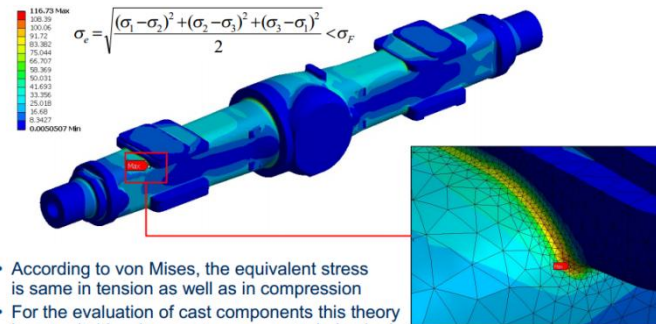
Discretization / Theory
- Meshing (Theoretical Introduction)
- Element size of thin Structures
- Geometry Preparation
- Global Mesh Settings
- Local Mesh Settings
- Mesh based simplification
- Connecting bodies

**Boundary Conditions / FE Idealization**
- Introduction to Boundary Conditions
- Deformation-Boundary Conditions
- Remote Points
- Nodal Coordinate Systems
- Introduction to Nonlinear Statics
- Load-Boundary Conditions
- Inertial Loads
- Nonlinear Boundary Conditions-Contact

Evaluation of Results
- Evaluation of Results
- Adaptive Mesh Refinement
- Singularities
- Evaluation in Cylindrical Coordinates
- Construction Geometry - Path Evaluation
- Probes
- Submodeling
- Computation of large Models (HPC)

$$\sigma_e = \sqrt{\frac{(\sigma_1 - \sigma_2)^2 + (\sigma_2 - \sigma_3)^2 + (\sigma_3 - \sigma_1)^2}{2}} < \sigma_F$$

- According to von Mises, the equivalent stress is same in tension as well as in compression
- For the evaluation of cast components this theory is not suitable, since cast components behavior is

- Module 1: Material along the load paths
  - Motivation
  - Concept of the topology optimization
  - ACT Extension
  - 2D michell-structure (Hands-on)

- Module 2: Without restrictions it will not work
  - Design constraints
  - Maunfacturing constraints
  - Generic engine mount (Hands-on)

- Module 3: Different ways to get the optimal design
  - Objective functions
  - Comparison of different objectives (Hands-on)
  - Single Compliance vs. Multiple Compliance (Hands-on)

- Module 4: Redesigning
  - ANSYS Topology Optimization → ANSYS SpaceClaim (Hands-on)

WS_04_generische_Motorhalterung_Recovery_and_Verification_clean.wbpz
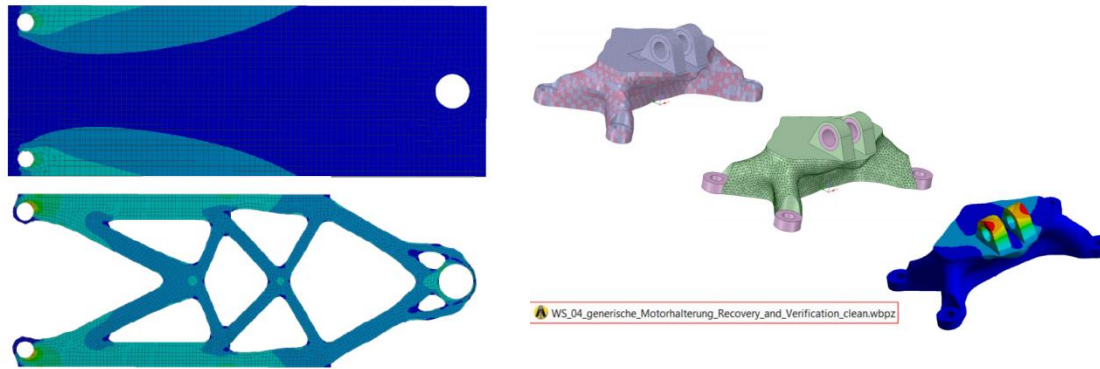
About What I'm doing in the Echtendinger near Studgardt (day 1-3) (week 2)

First day
- Introduction ACT
- (Iron)Python
- XML format
- Toolbar
- Journaling (project schematic)

Second day
- ACT console
- Change and insert standard features
- Pre-processing feature (reuse APDL)
- Post-processing feature
- Graphic
- Create report

Third day
- Excercise: fix displacement
- Compiling an extension
- Wizard
- Libraries
- Optional topics
  - DesignModeler
  - Insert meshfeature
  - Rename by class
  - Debugging_with Visual Studio
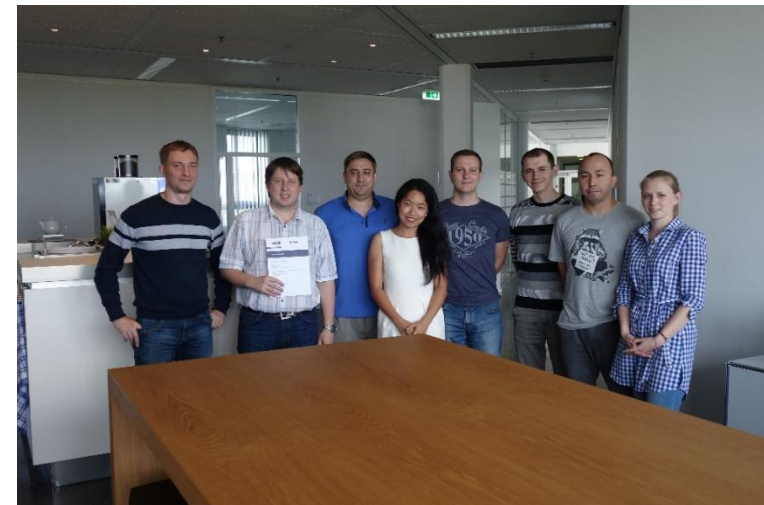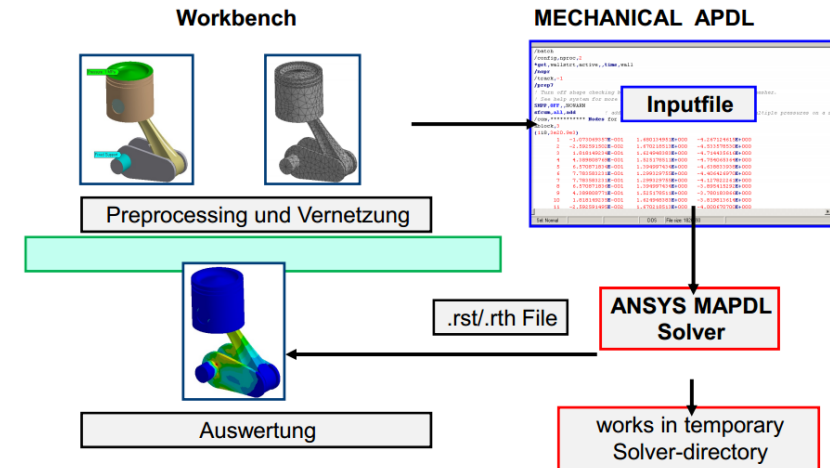
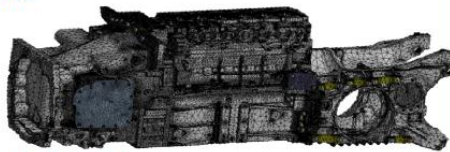# About What I'm doing in the Echtendinger near Studgardt (day 4-5) (week 2)

Day 1 – Modelling techniques
1. Purpose
2. Submodelling and External Data
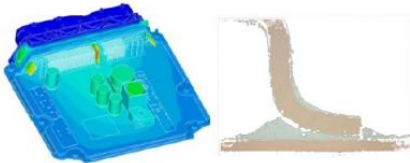3. Substructuring, CMS

Day 2 – High Performance Computing
1. Solvers (structural, thermal, Eigen-,)
2. Components and aspects of HPC
3. „Do …" and „Don't …, if you can do it in another way"

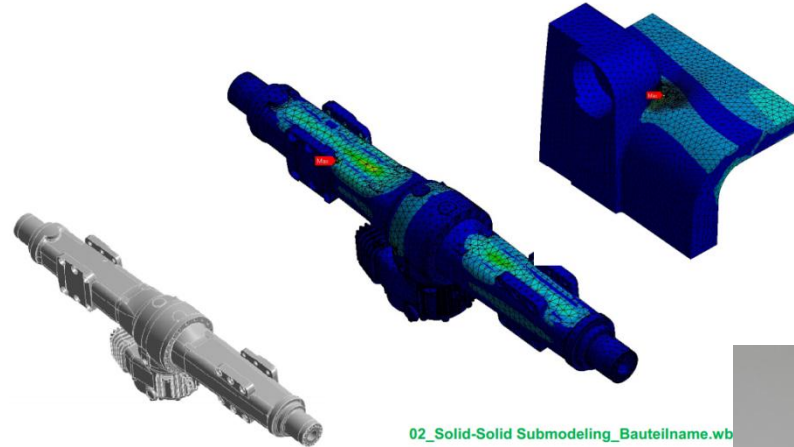02_Solid-Solid Submodeling_Bauteilname.wb

ents

Quelle: AGCO Fendt

Quelle: Microconsult

About What I'm doing in the Hannover (week 3)

- Day 1
  - 2.) Illustrative Introduction
  - 3.) Connection Groups
  - 4.) Contacts between Surface Bodies
  - 5.) Analysis Settings
  - 6.) Input and Output Files
  - 7.) Contact vs. Target
  - 8.) Force Control vs. Displacement Control
  - 9.) Evaluation of Results
  - 11.) Trim Contact
- Day 2
  - 10.) Contact Elements

- 12.) Types of Contact
- 13.) Detection Method
- 14.) Pinball-Region

- 15.) Contact Algorithm
- 16.) Contact Stiffness
- 17.) Penetrations

- Day 3
  - 18.) Bending Example
  - 19.) Rigid Body Motions
  - 20.) Bonded Contact

- 21.) Contact Treatment
- 22.) Convergence Treatment

CADFEM

Examples Overview

- 02_Introduction_to_Contact_Analysis_Mechanical
- 03_Connection_Groups
- 04_Contact_between_Surface_Bodies
- 07_Contact-vs-Target
- 09_Evaluation_of_Results
- 10_Elements_for_Contact_Analysis
- 13_Detection_Method
- 14_Pinball_Region
- 16_Contact_Stiffness
- 17_Penetrations
- 18_Bending_Example
- 20_Bonded_Contact
- 21_Contact_Interface_Treatment
- 22_Convergence_Treatment

- Contact_Closed-Open.wbpz
- ContactTreatment_Bolt_Hole.wbpz
- ContactTreatment_Gap_Penetration.wbpz
- Improper_Geometry_ICONT_CNOF_adjustment.wbpz
- Flange_S8_adjustment.wbpz
- Flange_S8_Mortar_Solved.wbpz

- 02-Hertzian_Stress.wbpz
- Group-Search.wbpz
- Contact-Search_Tolerance.wbpz
- Pipe_Connection.wbpz
- Surface_Contact.wbpz
- Punching-on-Bend_Solved_Discussion.wbpz
- Contact-vs-Target_refined-enough.wbpz
- Results_Evaluation_of_Screw & Flange.wbpz
- Closed_Contact.wbpz
- Connecting_Rod_with_Rigid_Target_elements.wbpz
- Detection_Method_Workshop_1.wbpz
- Detection_Method_Workshop_2.wbpz
- Pinball-Region_Workshop.wbpz
- Study_of_kN-kT.wbpz
- Three_Point_Bending_Test_Stiffness_study.wbpz
- Hertzian_Stress_Mesh_Study_Solved.wbpz
- Hertzian_Stress_Mesh_Refinement_Study.wbpz
- Penetration_treatment.wbpz
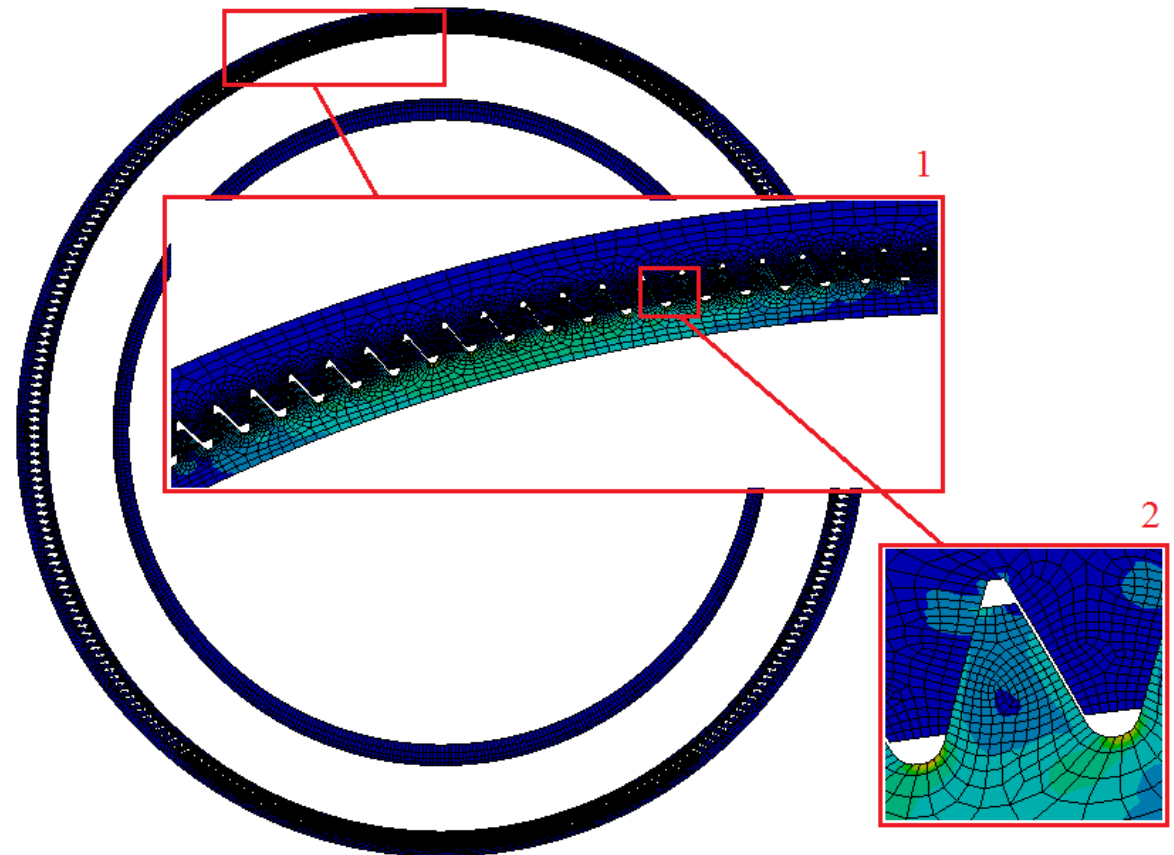- Bending_Example.wbpz
- Bell_Modal-Analysis.wbpz
- Contact_Volume_Surface_body.wbpz
- Pipe_Cantilever-Beam_RemotePoint.wbpz
- Bonded-Penalty_vs_MPC.wbpz
- Bonded-contact_Surface-bodies.wbpz
- Bonded_Contact_Workshop_1.wbpz

What is being done at the moment as a result of the internship (problem)
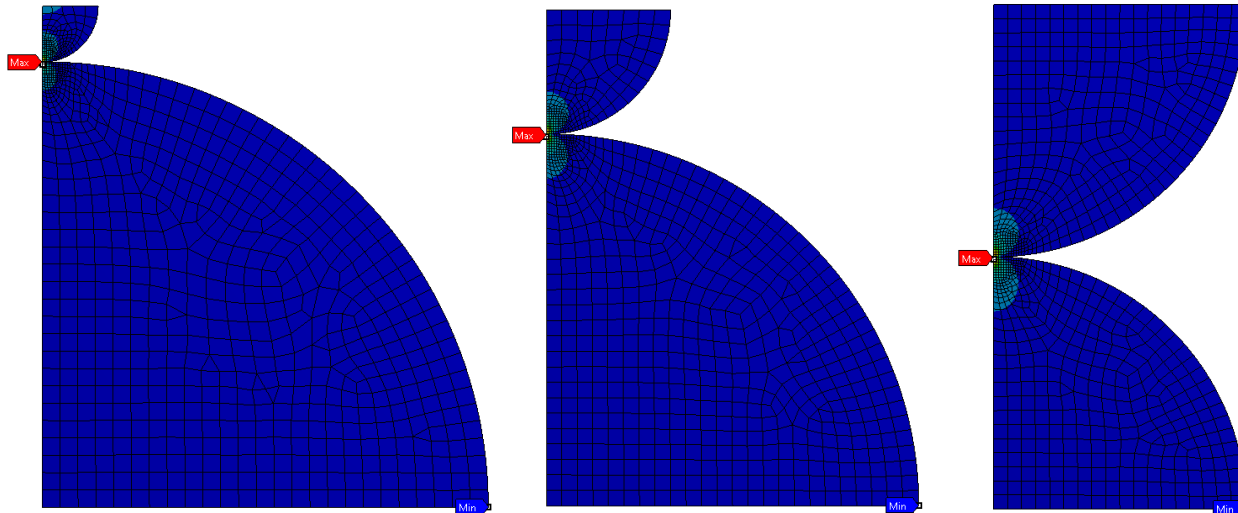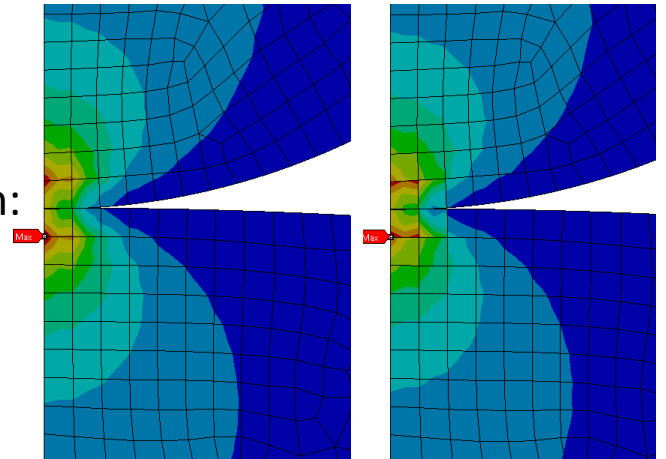
Standard gear
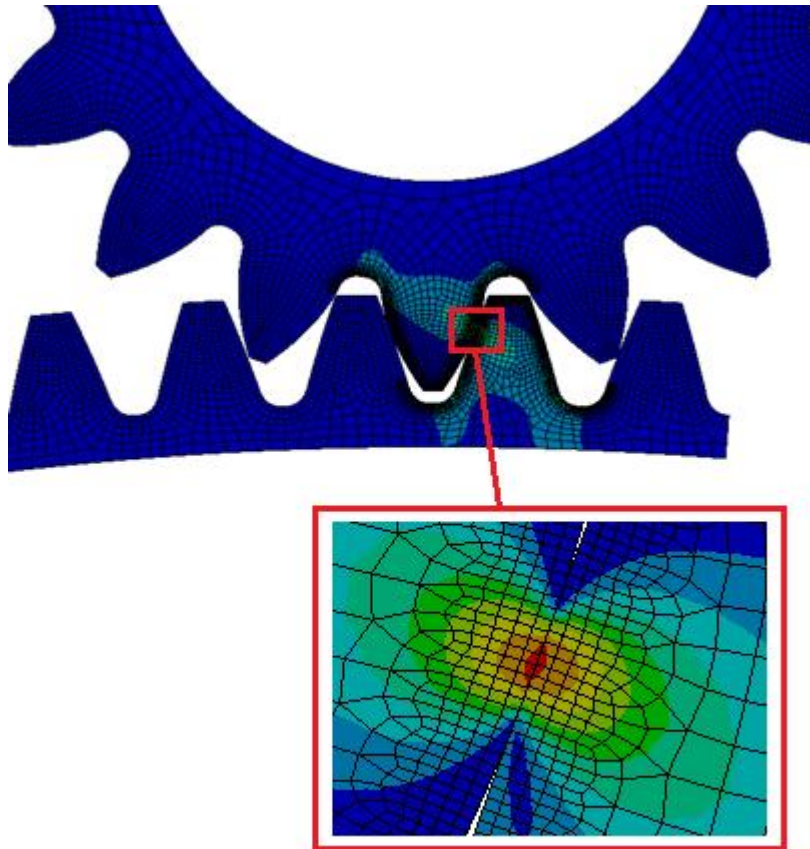
Harmonic drive

What is being done at the moment as a result of the internship (solution process)

Compare different radius of contacted cylinders

Course mesh:

Fine mesh: