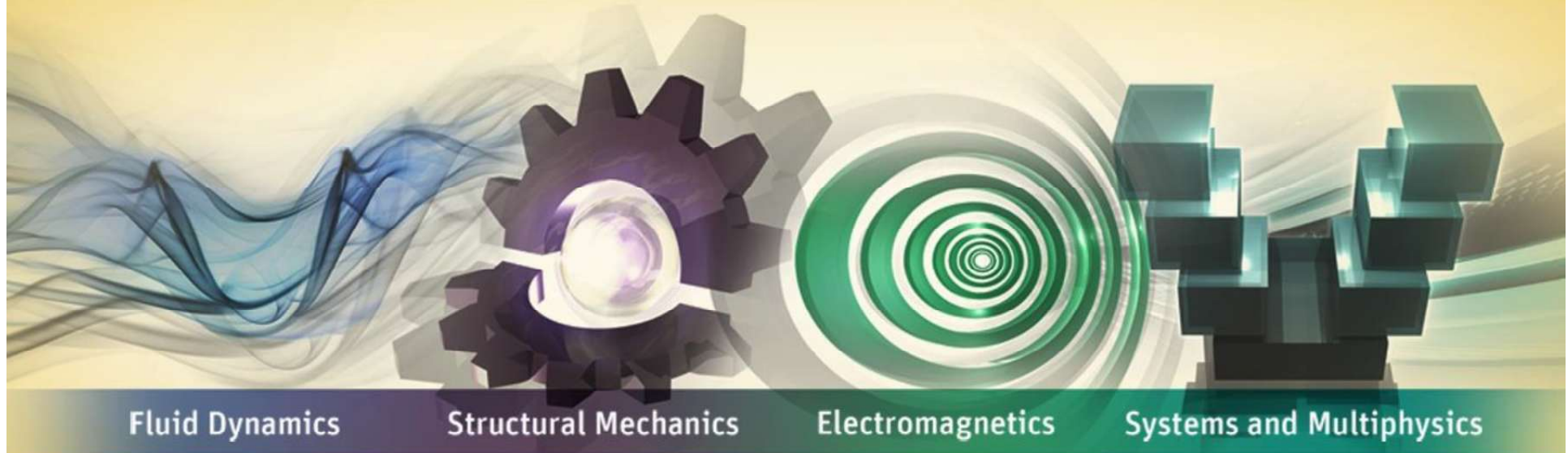


Auslegung und Dimensionierung eines Rotorkopf- Sterns in Composite-Solidbauweise



Fluid Dynamics

Structural Mechanics

Electromagnetics

Systems and Multiphysics

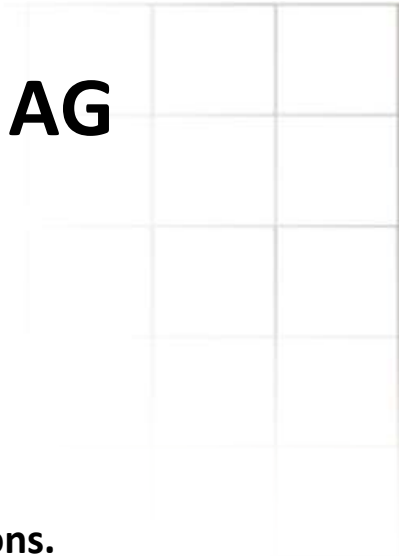
EVEN AG
Technoparkstrasse 1
8005 Zurich
Switzerland

Name: Dr. René Roos
Phone: +41 44 500 93 60
Fax: +41 44 500 93 61
Mail: rene.roos@ansys.com
Web: www.even-ag.ch

- **Über uns**
- **Einleitung: Baugruppe Rotorkopfstern**
- **Lasten**
- **Finites Elemente Modell**
- **Ansys Composite Prep/Post**
 - **Pre-Processing**
 - **Post-Processing**
- **Fertigung**



**In Zusammenarbeit mit
Marengo Swiss Helicopter**



- Spin-Off der ETH-Zürich
- Gründer:
O. König Dr. sc. techn.
Dissertation: Evolutionary design optimization: Tools and applications.

M. Wintermantel Dr. sc. nat.
Dissertation: Design-encoding for evolutionary algorithms in the field of structural optimization

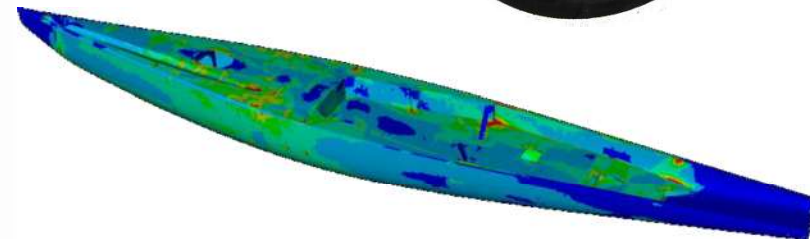
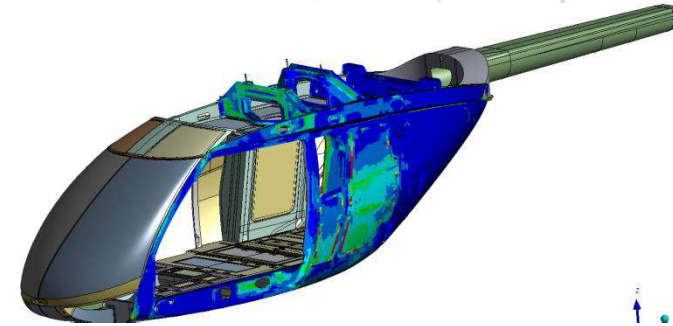
N. Zehnder Dr. sc. techn.
Dissertation: Global Optimization of Laminated Structures

- Mitarbeiter: 12
- Gründung: 2004
- ANSYS Switzerland: since April 2013



Kernkompetenzen I: Ingenieur Dienstleistungen

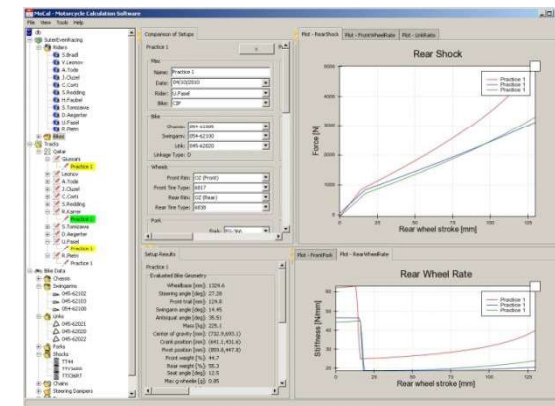
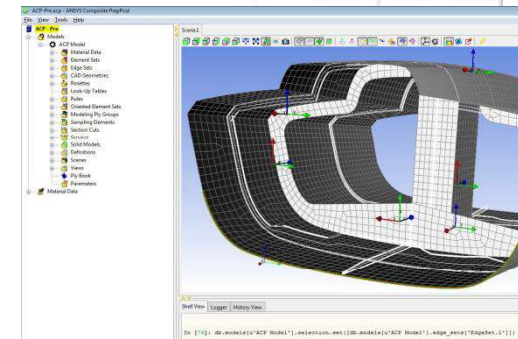
- **Dienstleistungen**
 - Optimierungstechnologien
 - Finite Element Simulationen und Analysen
 - CAD-Technologien
 - Entwurf und Analyse von Faserverbundstrukturen
 - Iterative Fluid-Struktur-Kopplung (FSI)
- **Einige Referenzen**
 - United Internet Team Germany (Americas Cup) (D)
 - BMW Oracle (Americas Cup) (USA)
 - StarragHeckert AG (CH)
 - BBS Kraftfahrzeugtechnik AG (D)
 - VESTAS (DK)
 - Ferrari Gestione Sportiva (I)
 - REpower (D)



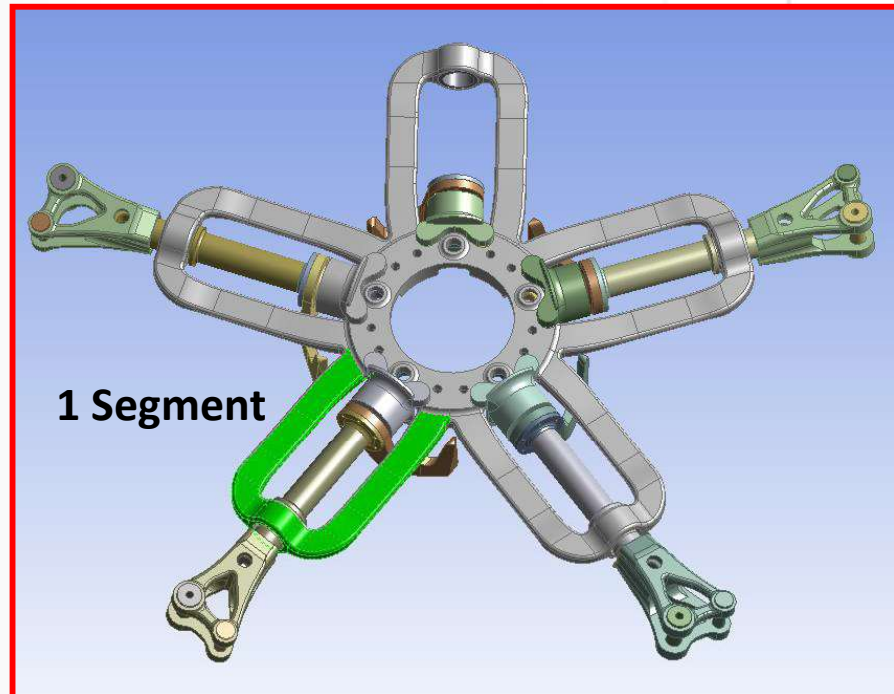
Kernkompetenzen II: Software Entwicklung

- **Products**
 - **ACP - Ansys Composite PrepPost**
 - **Pre- und Postprozessor für die Finite Elemente**
 - **Analyse von Faserverbundstrukturen**
 - **OpLyX - Generische Optimierungsumgebung**
 - **CoLyx - The Coupling Library eXperiment (FSI)**
 - **MoCal - Geometrische Analyse von Rennmotorrädern**
 - **Mehr Produkte finden Sie unter: www.even-ag.ch**

- **Einige Referenzen**
 - **ANSYS (USA)**
 - **Sauber F1 Team (CH)**
 - **Advance AG (CH)**
 - **Suter Racing Technologies (CH)**

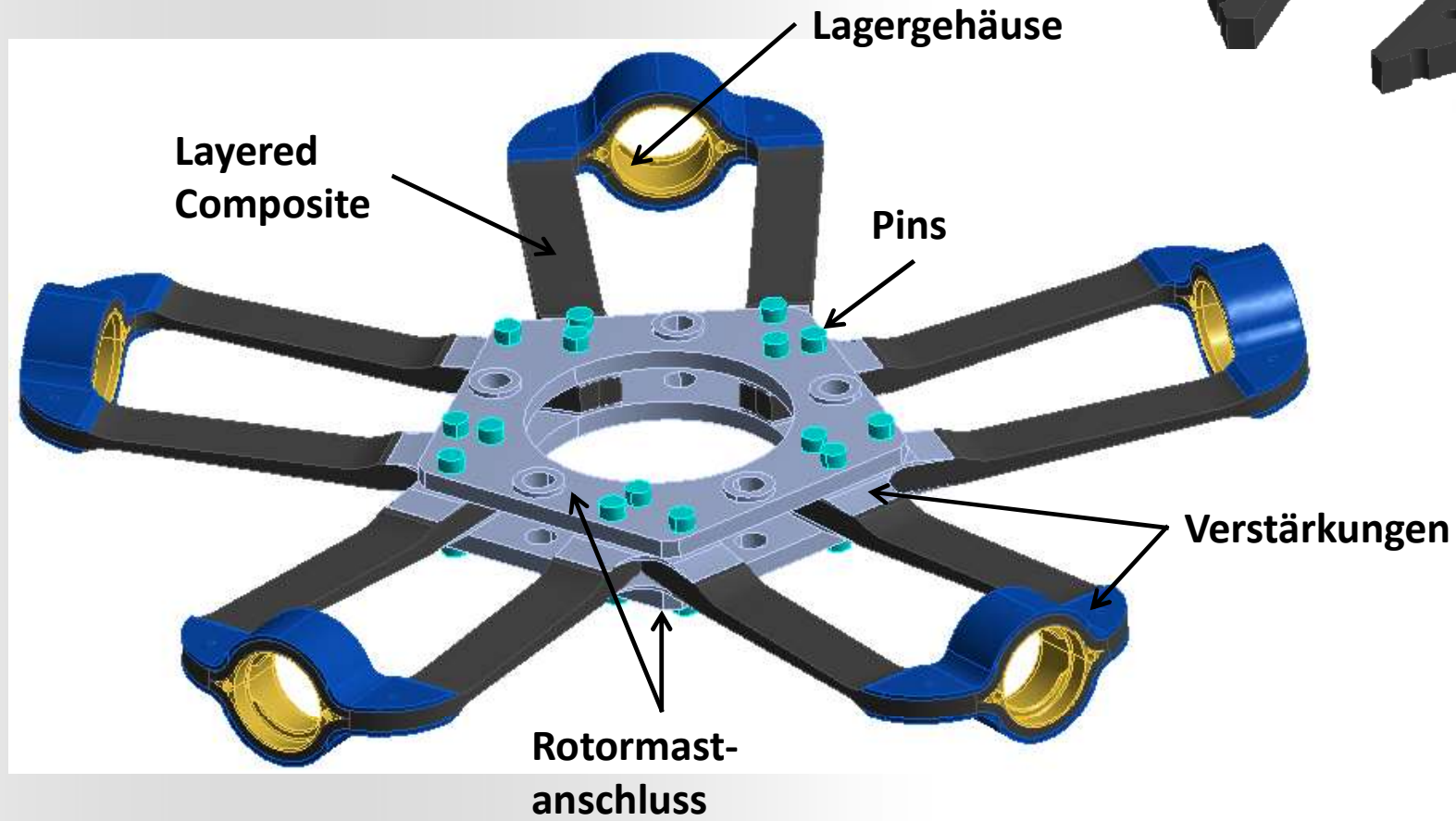
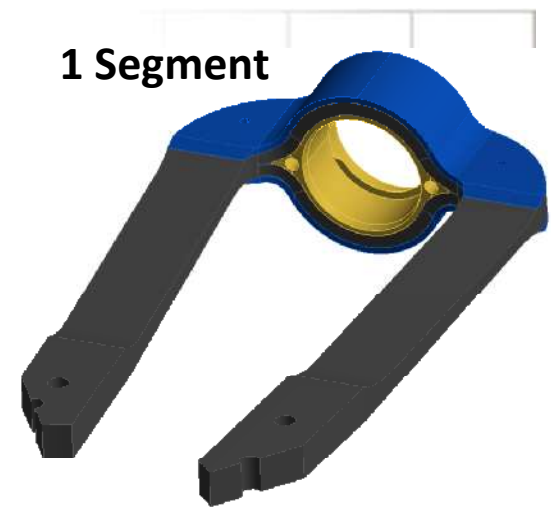


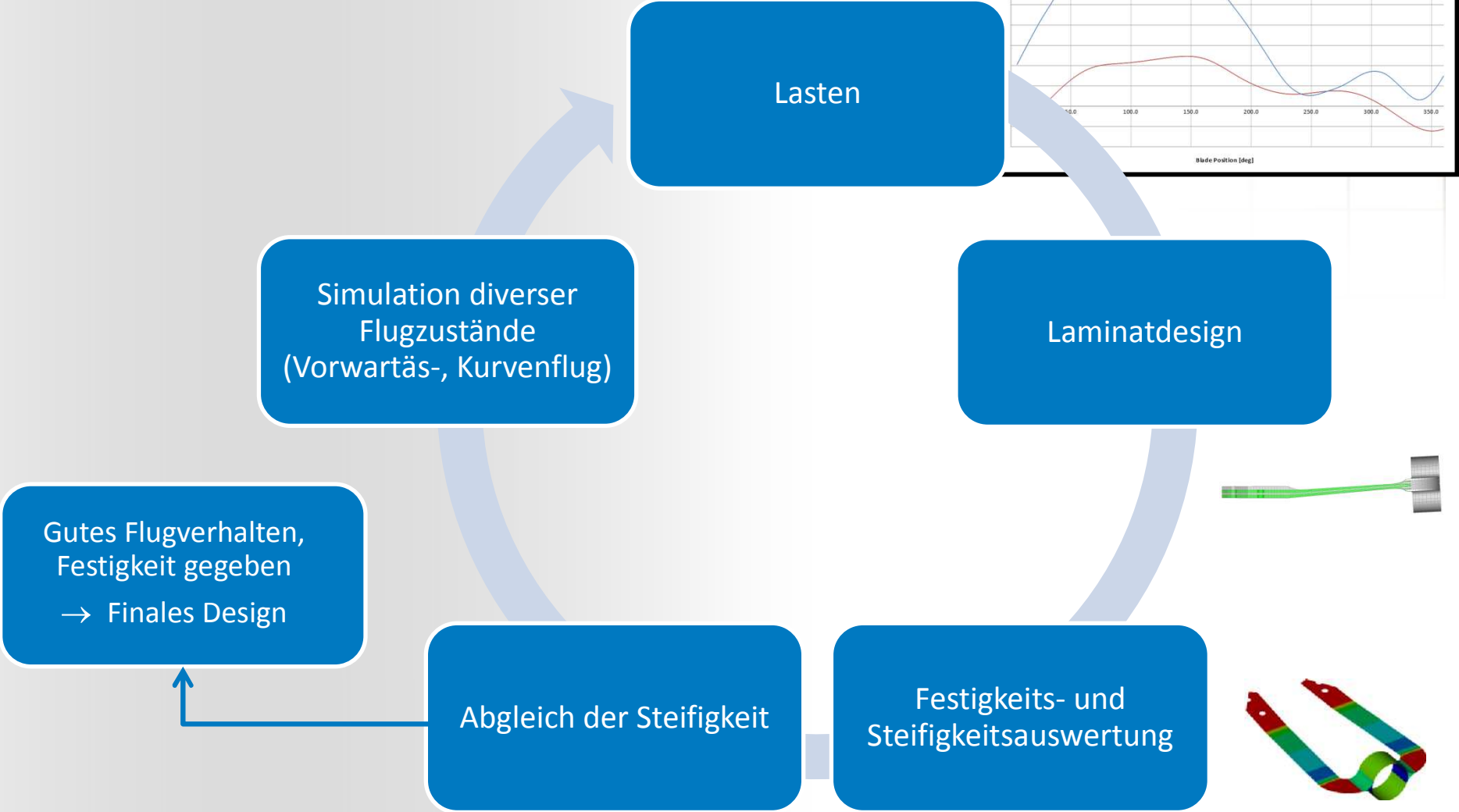
- Anforderungen
 - Virtuelles Gelenk – “wartungsfreier” Rotorkopf
 - Steifigkeit beeinflusst die Flugeigenschaften
 - Sicherheit (redundantes System)
 - Fertigung und Wartung



Sternassembly

1 Segment

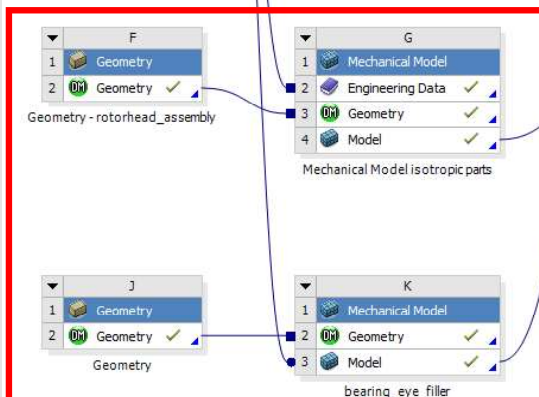
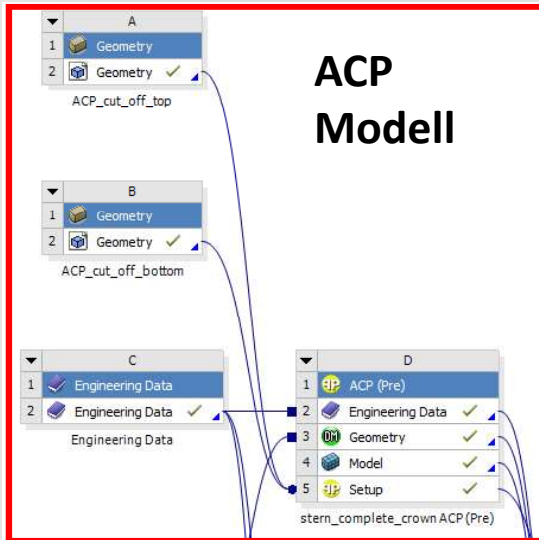




Design Workflow

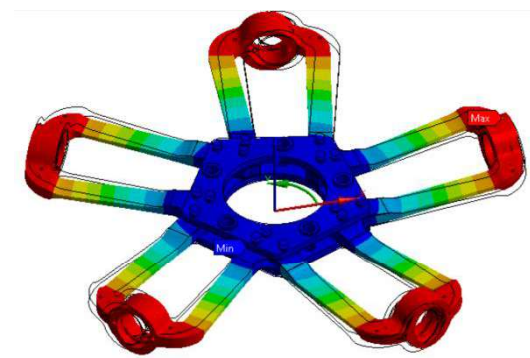
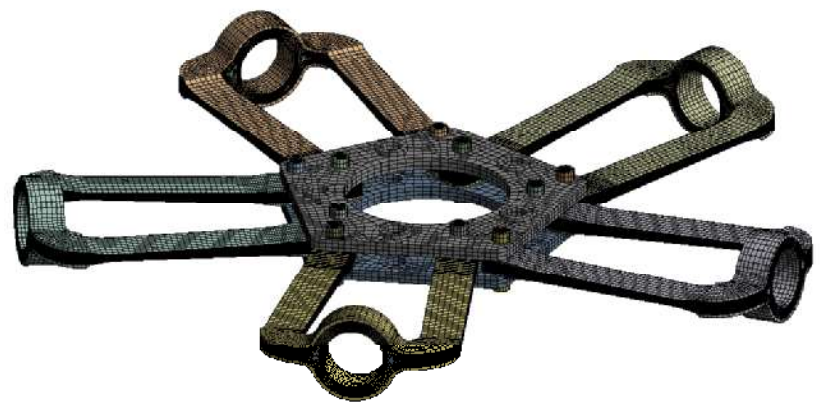
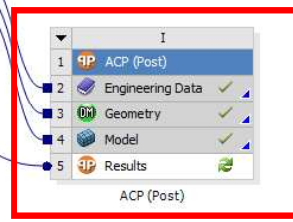
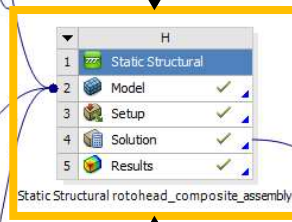
- **Machbarkeitsstudie**
 - **Volumenmodell**
 - **Homogenisierte Materialeigenschaften**
 - **Ermittlung kritischer Punkte**
- **Ausarbeitung**
 - **Laminatoptimierung**
 - **Konstruktive Anpassungen**
 - **Optimierung der Steifigkeiten: Kompromiss zwischen Flugeigenschaften und Festigkeit/Masse**



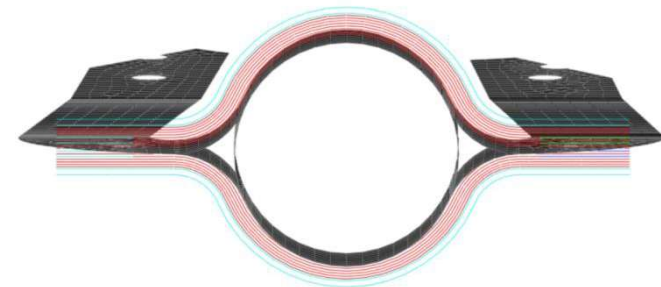
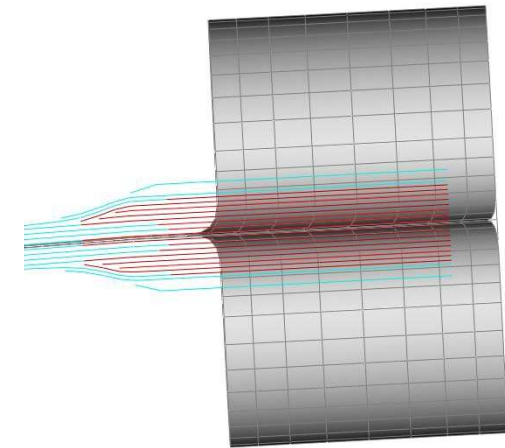
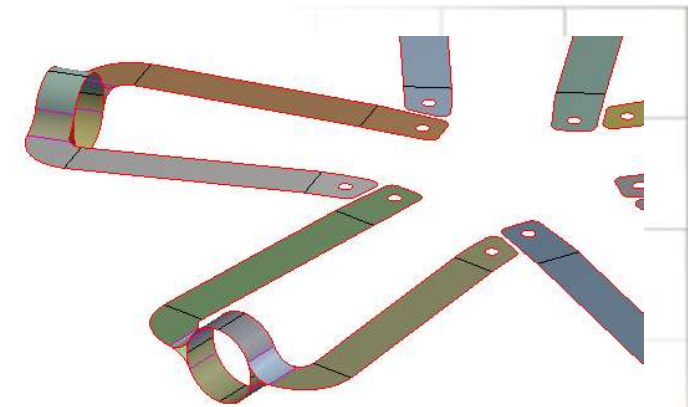
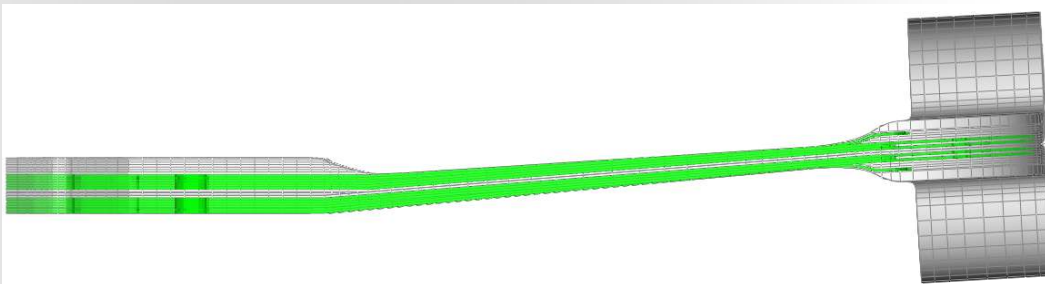


Composite Volumenmodell

Composite post-processing

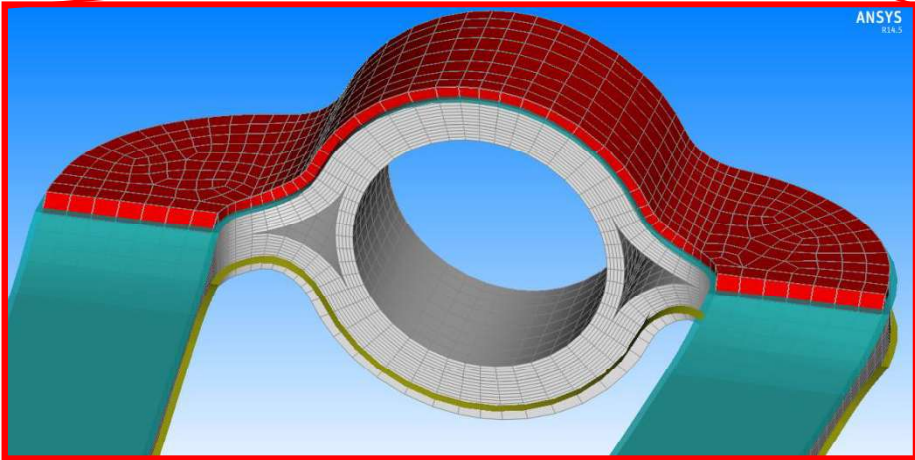
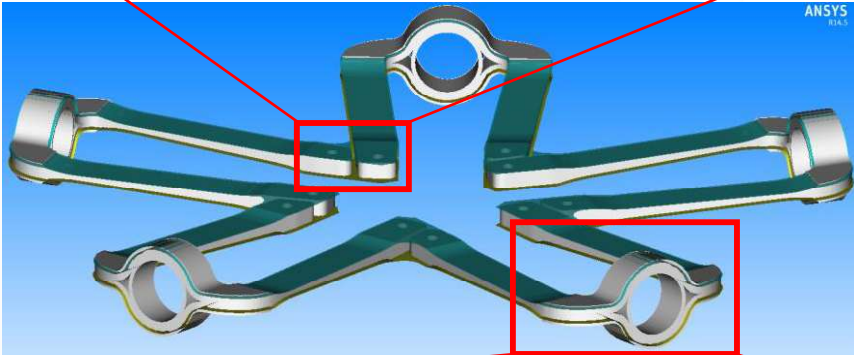
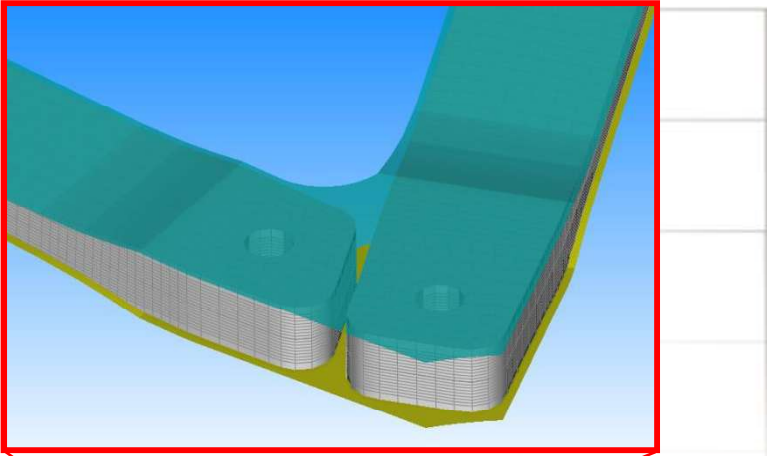
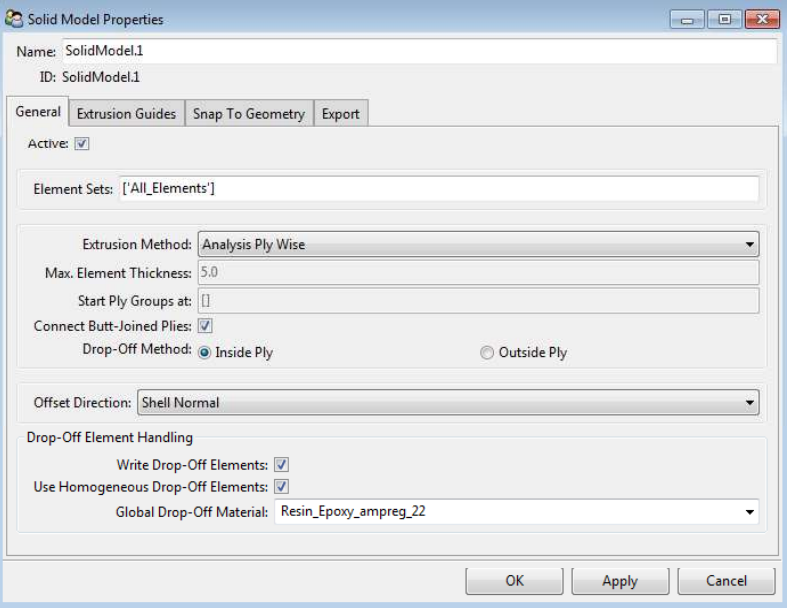


- Schalen Referenzfläche
- Aufdickung im Wurzelbereich
- Composite – Metall Hybridstruktur
 - Zusätzliche Verstärkungsplatten
- Überlappungen / Tapering
- Symmetrie: Python Skript um das Laminat zu spiegeln

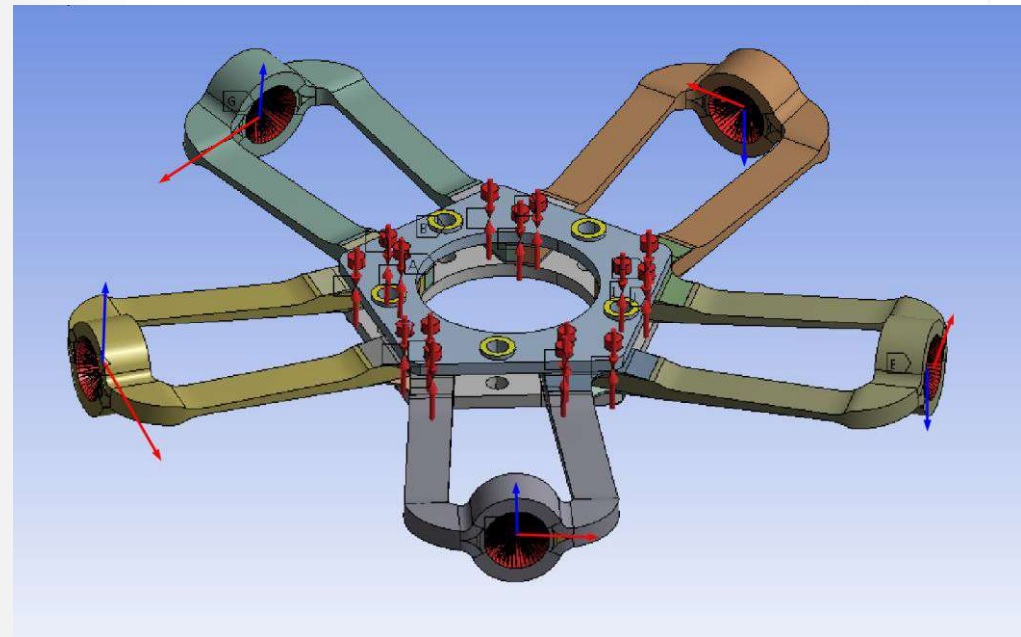


ACP Volumenmodell

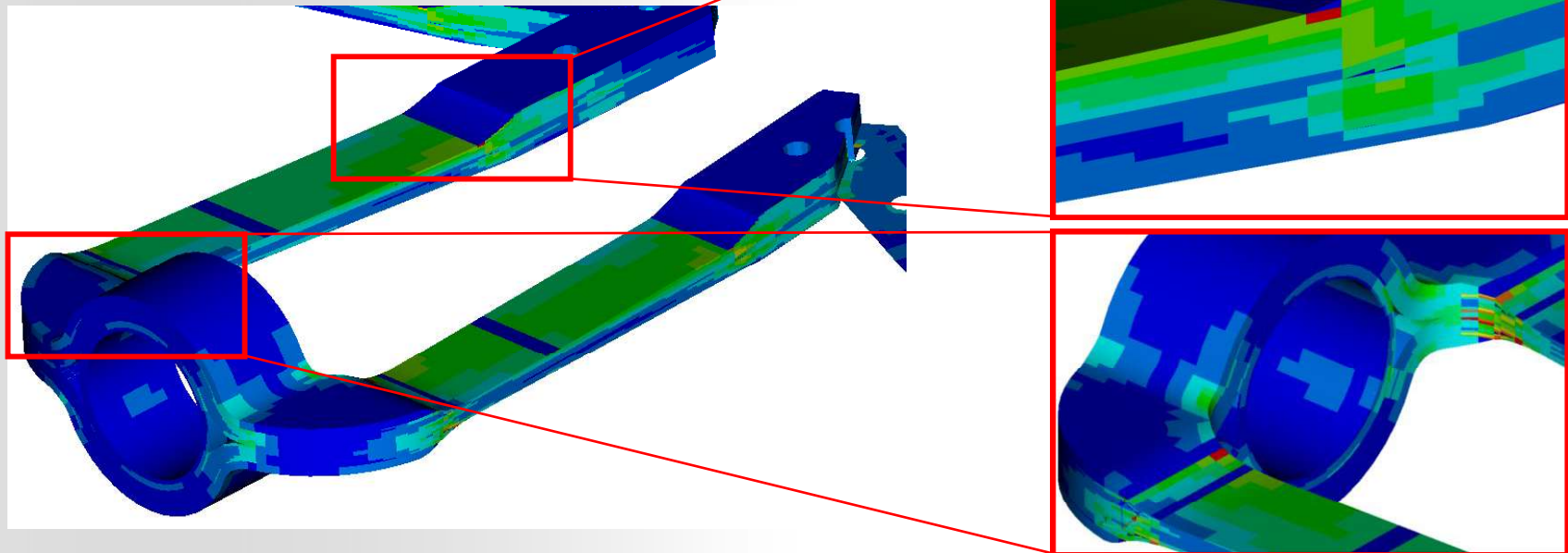
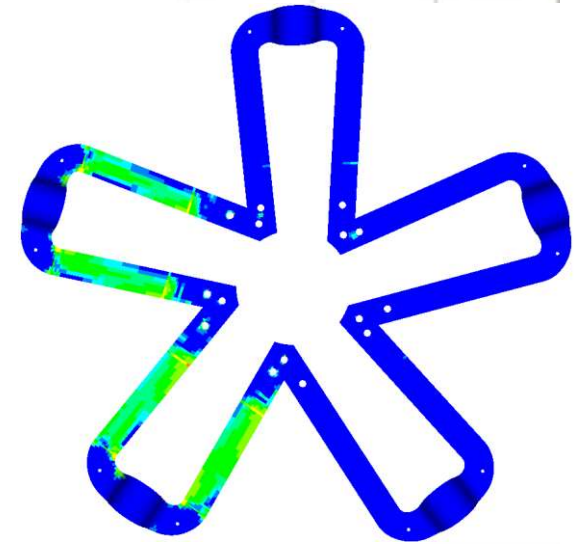
- Genau definierte Kontaktflächen zu den Rotormastplatten und Lagerbuchsen
- Volumenextrusion mit «SnapTo» und «CutOff»



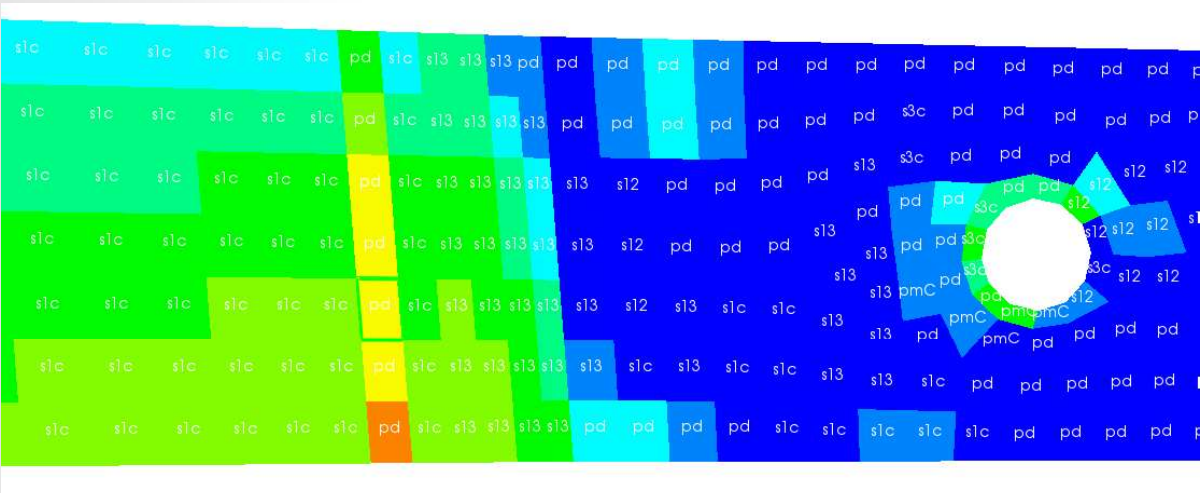
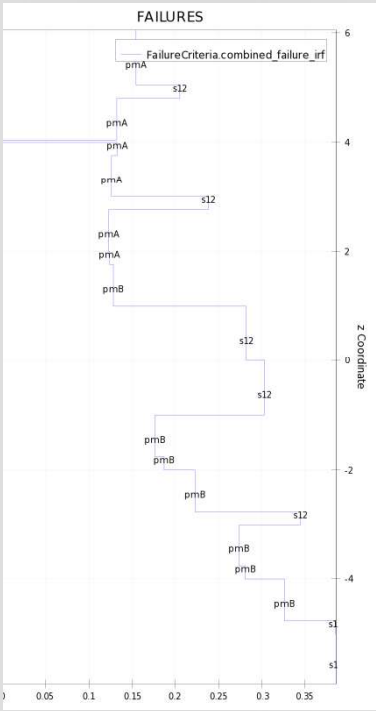
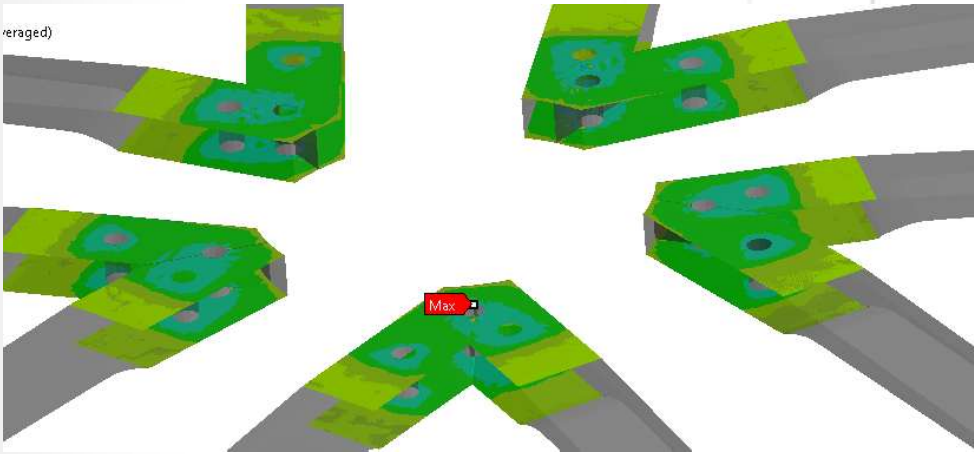
- **Volumenmodell**
 - 3D Spannungen
 - Delamination
- **Genauere Kontaktbedingung zu den Anschlussstellen**
 - Auswertung der Klebe- und Kontaktflächen
 - Flächenpressung
- **Lastfälle**
 - Steifigkeiten
 - Bolzenvorspannung
 - Limit Load
 - Ultimate Load
 - Fail Safe



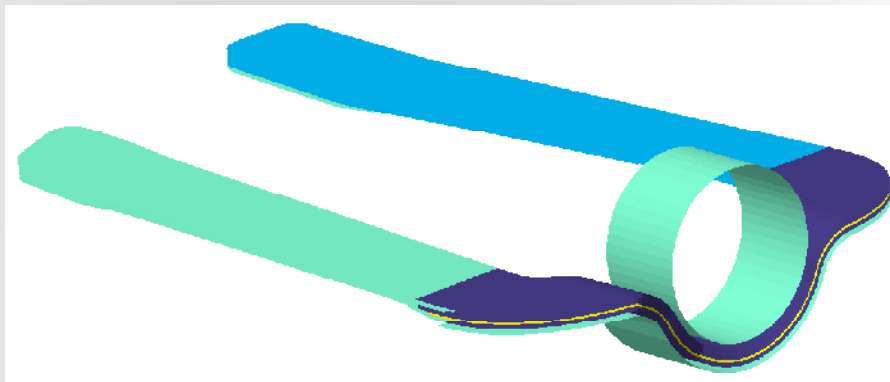
- Steifigkeiten
- Kritisch Versagensarten
 - Delamination
 - Faser Zug-Druck
 - In-plane Schub



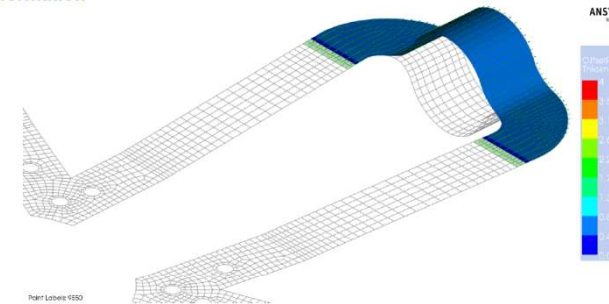
- Laminatübergänge
- Kontaktspannungen
- Kleberfestigkeiten



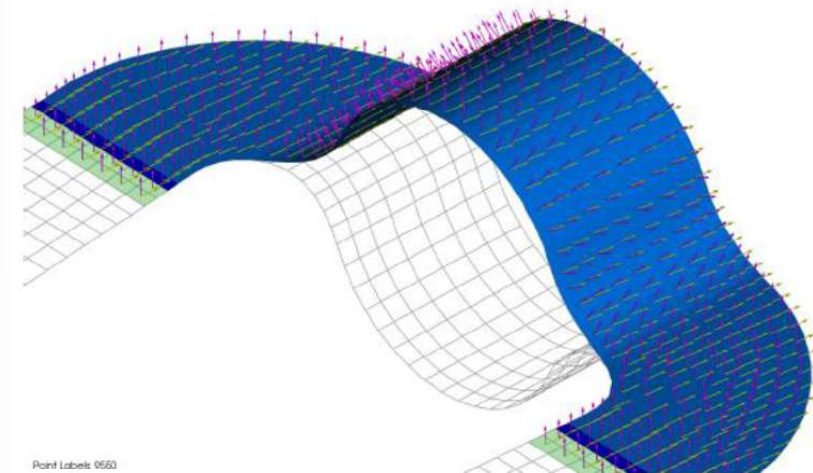
- Automatisiertes erstellen der Laminatpläne und Zuschnitte
- Plybook: PDF
- Lagengeometrien inkl. Offset und Outline: STEP (oder IGES)



Workshop Information

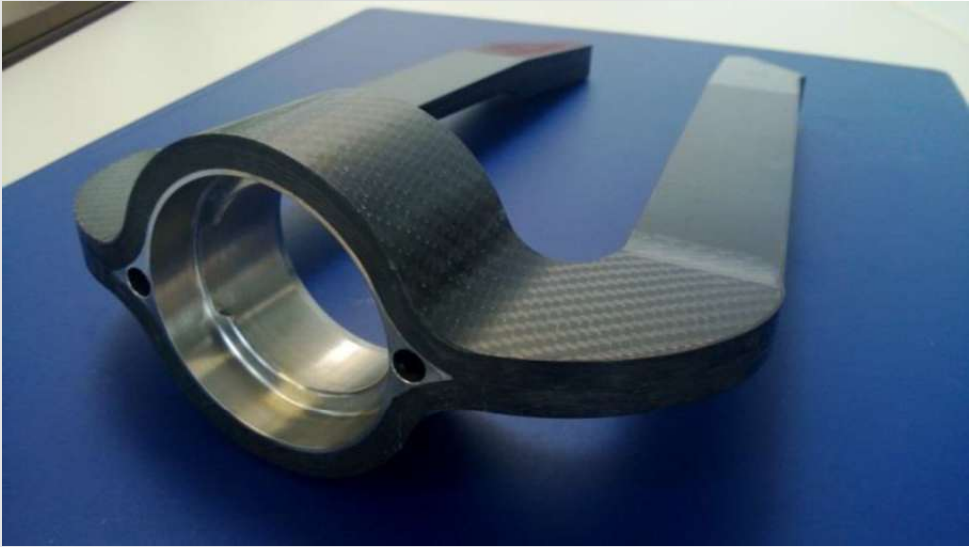


Parameter	Value	Unit
Orientation	0.0	[degree]
Material	Epoxy_Carbon_woven_230GPa_Prepreg_1mm	[-]
Thickness	1.001	[mm]
Area	16444.6513853	[mm ²]
Weight	1.10542963627e-05	[tonne]
Cost	0.0	[\$Fr]





Erste Bauteile



Vielen Dank für Ihre Aufmerksamkeit

