

Effiziente und effektive Composite-Entwicklung mit SIEMENS FIBERSIM

Boris Vetter, Siemens PLM Software, 20.3.2014, 3. Fachkongress
Composite Simulation, VDC (Virtual Dimension Center), Fellbach

Vistagy is now business segment SES (Specialized Engineering Software) of SIEMENS PLM

SIEMENS

Vistagy Inc.

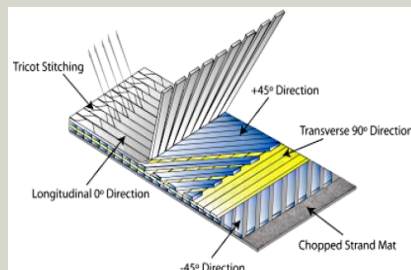
- Founded 1991
- Headquarters:
Waltham, MA, USA
- 300+ Global Customers
- Acquired by
SIEMENS PLM in
Dec. 2011



Specialized Engineering Software Portfolio

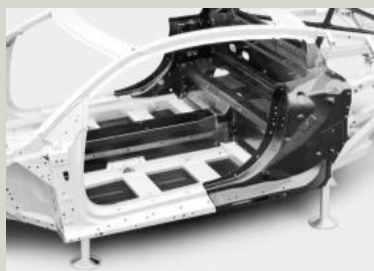
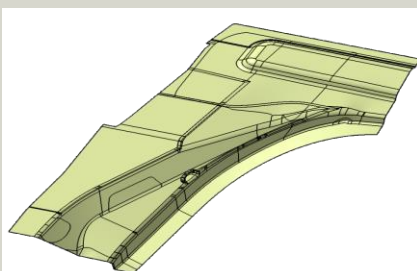
FIBERSIM

Designing and manufacturing innovative, durable and lightweight *composite structures*



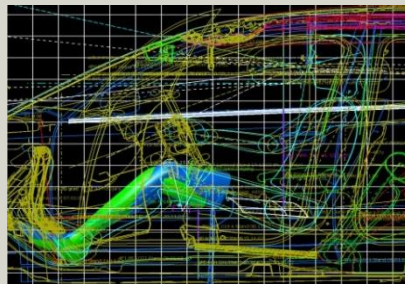
SYNCROFIT

Designing and manufacturing *complex assemblies* and large aero structures



SEAT DESIGN ENVIRONMENT

Developing seat cover systems and covered *interior components*

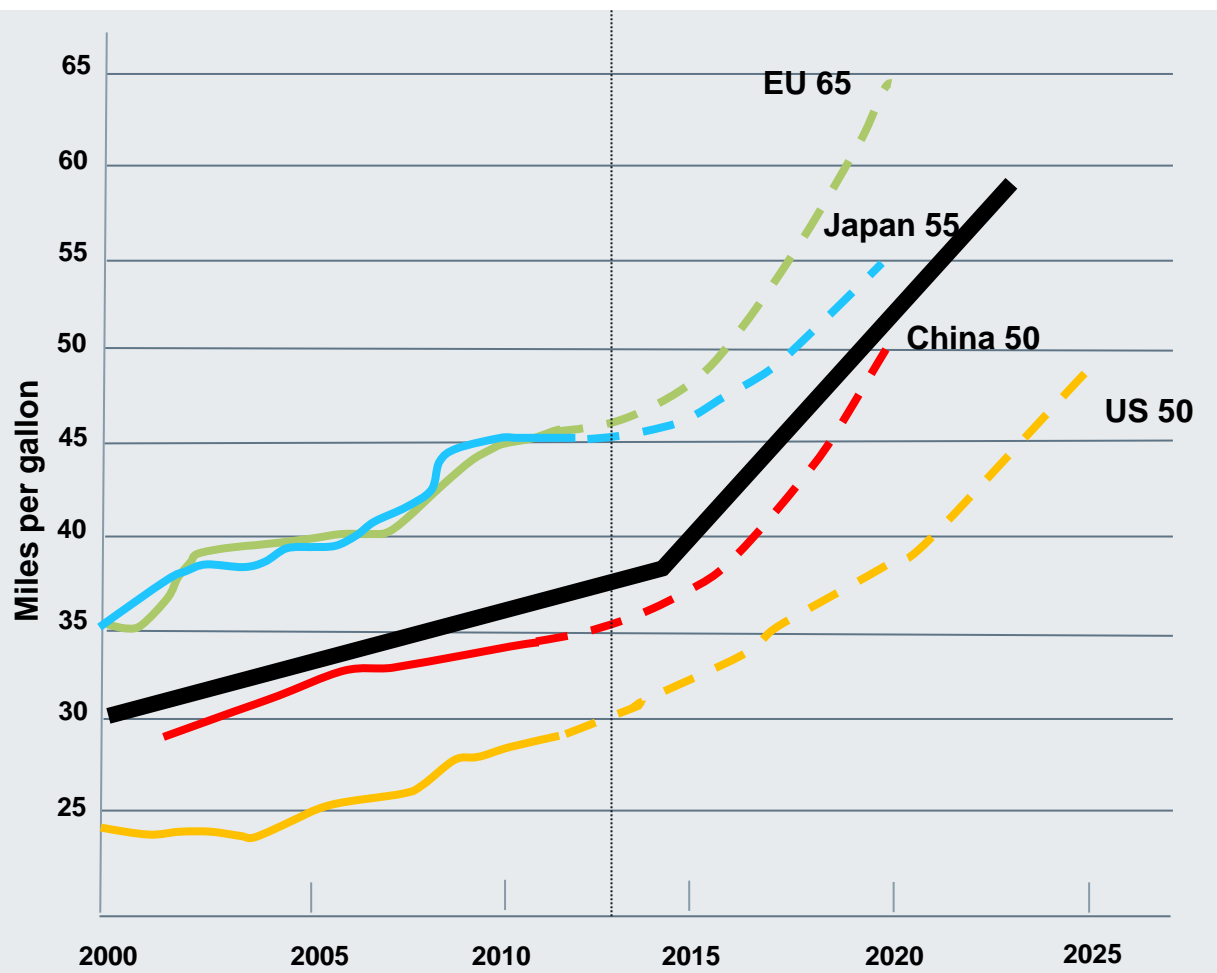


Agenda



1. Challenges of composite design in High Volume Automotive Structures
2. Engineering Software for the cost effective design of High Volume Composite Structures
3. Examples

Fuel Economy & Emissions Reductions Are Driving Innovation to New Levels for the Automotive Industry



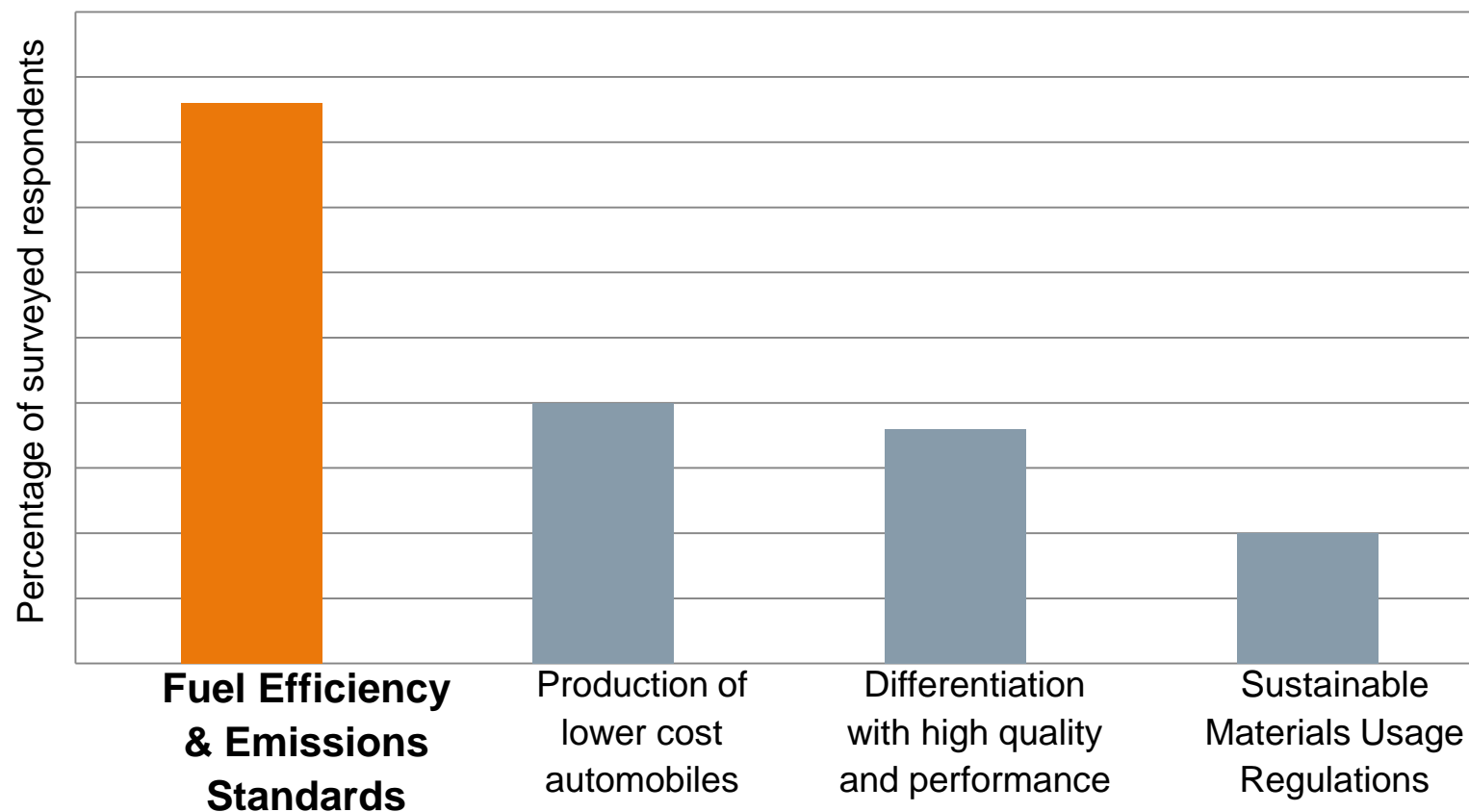
Huge improvements
to fuel economy
required by 2025!

Past ~0.5 mpg per year

Future ~2.0 mpg per year

Source An, F., and A Sauer.

Top Pressures Impacting Change in Automotive Industry



Source Aberdeen Group, Harte Hanks Research Study, 2013

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Biggest Challenges in Automotive Industry

Powertrain

Plug-in Hybrids
Electric Vehicles
Combustion
Powertrain Efficiency
Transmission & Drives

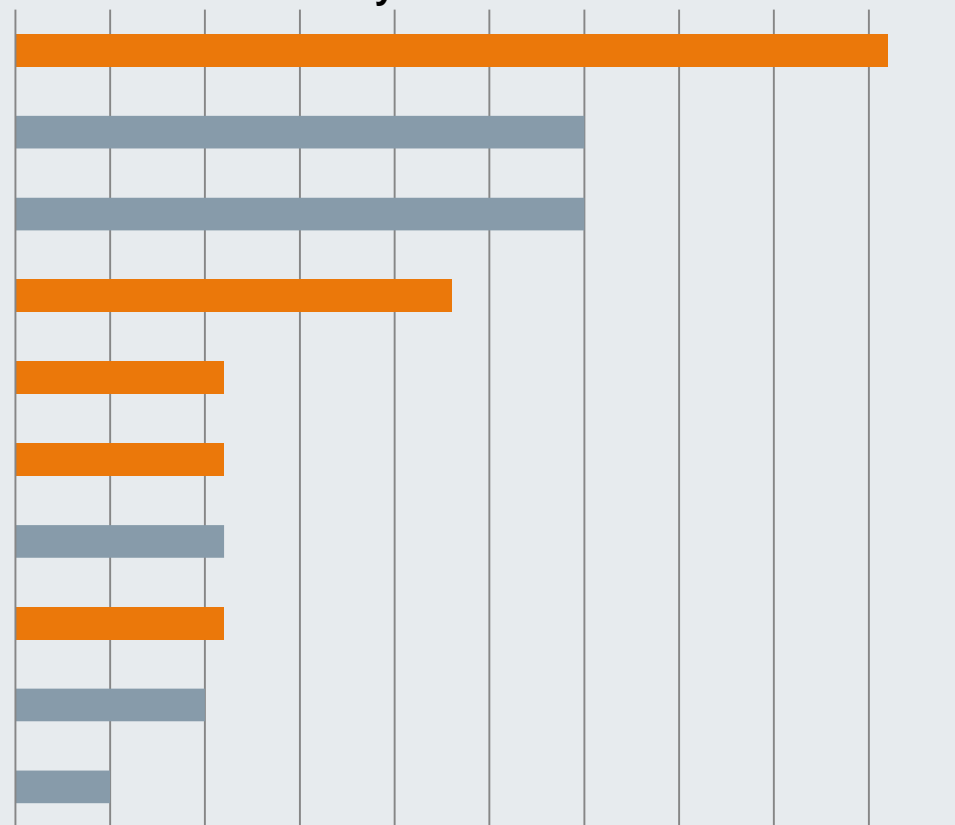
Weight

Vehicle Architecture
Weight Efficiency
Tradeoff weight/attributes
Joining technology
Materials

Performance

Aerodynamics
Driving Behavior
Rolling Resistance
Energy Management
Climate Systems

Top Two Challenges of Achieving Fuel Efficiency/Reduced Emissions



Source Aberdeen Group, Harte Hanks Research Study, 2013

Automotive Lightweighting | Cause and Effect

DECREASING WEIGHT



Lighter Body



Smaller Engine



Lighter Chassis

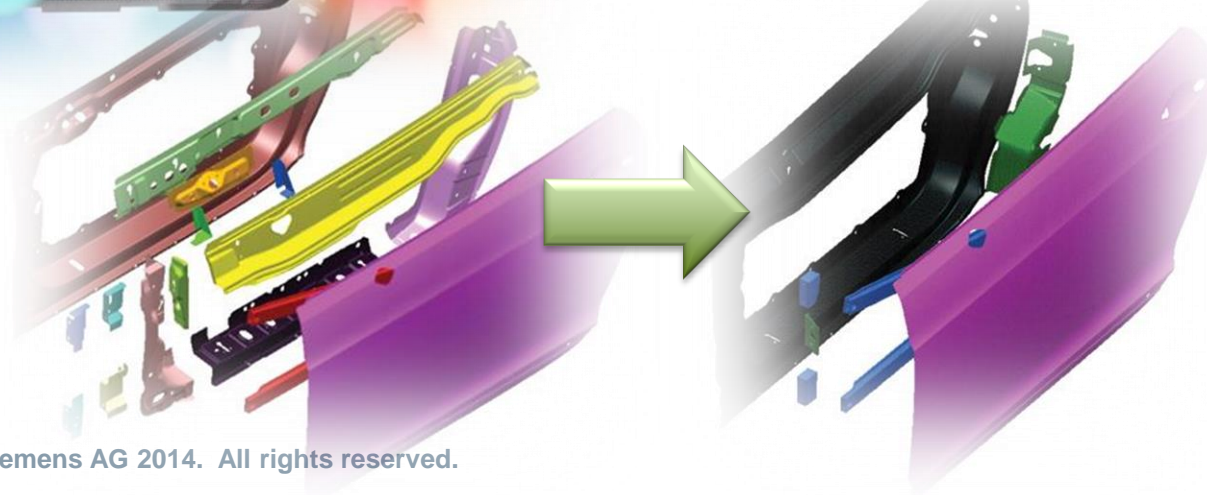
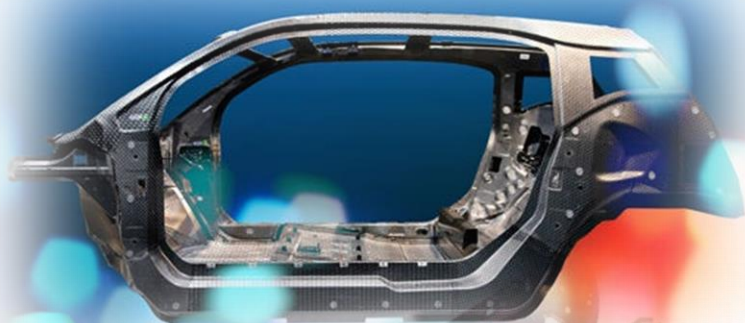
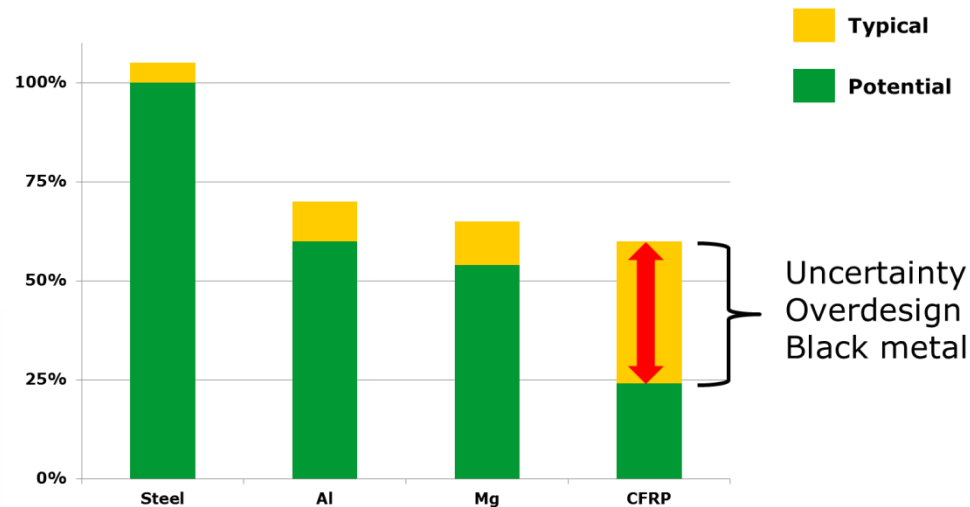


**Reduced fuel tank capacity,
fewer batteries**

Additional Body Weight Reduction

The composites potential

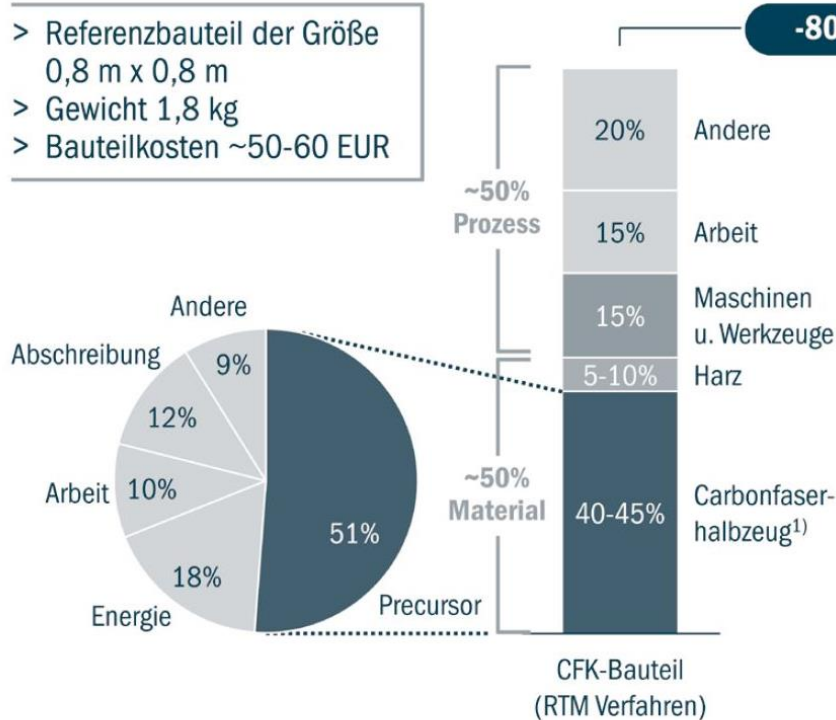
- Saving weight
- = Saving material cost !



What is typically driving cost in composite applications ?

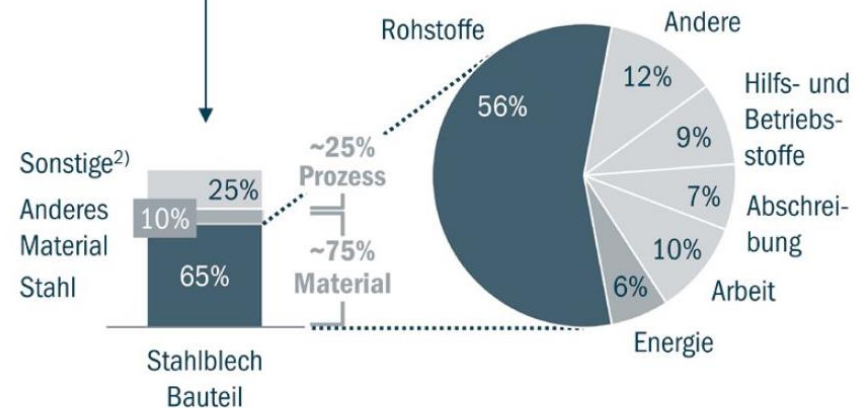
KOSTENSTRUKTUR CARBONFASER-REFERENZBAUTEIL (RTM)

- > Referenzbauteil der Größe 0,8 m x 0,8 m
- > Gewicht 1,8 kg
- > Bauteilkosten ~50-60 EUR



KOSTENSTRUKTUR STAHLBLECH-REFERENZBAUTEIL

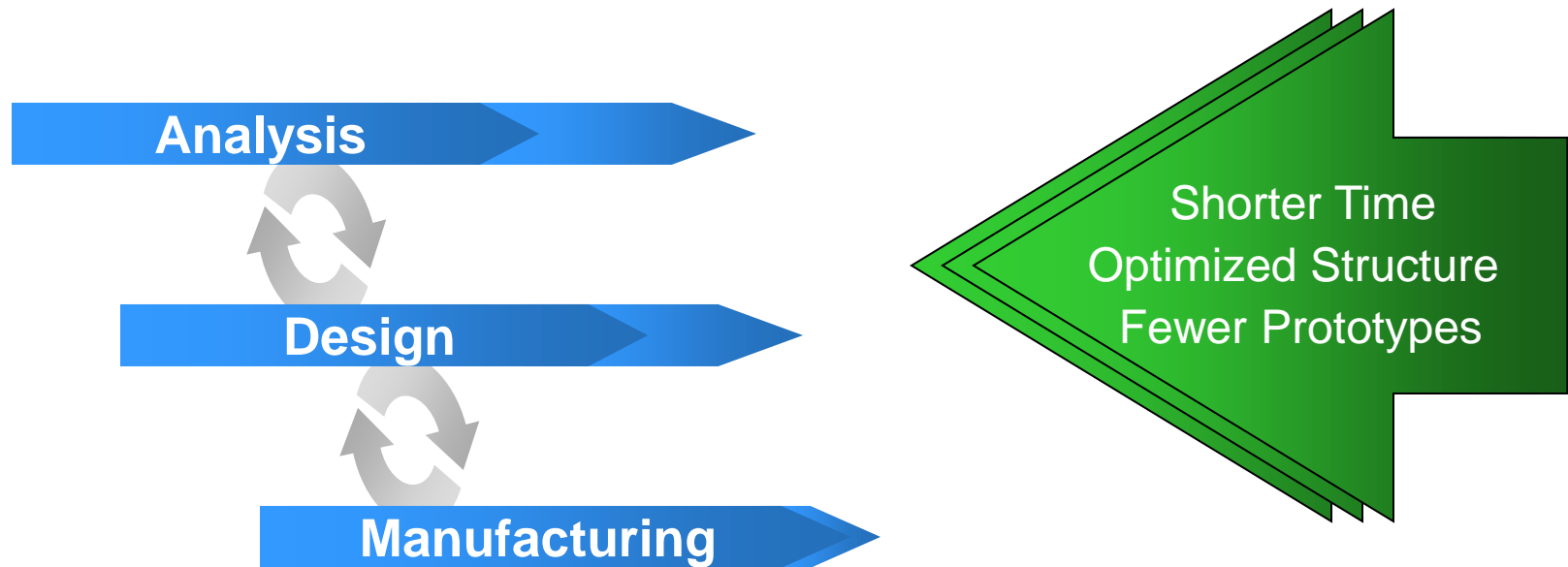
- > Referenzbauteil der Größe 0,8 m x 0,8 m
- > Gewicht 4,5 kg
- > Bauteilkosten <10 EUR



1) Textile Rollenware ohne weiteren Zuschnitt etc. 2) Split: Maschinen und Werkzeuge ca. 5%; Arbeit ca. 12%; Andere ca. 8%

Quelle: Desk-Research; Experteninterviews; Roland Berger

Automotive Composites are Unique | Tight Integration Analysis, Design Manufacturing



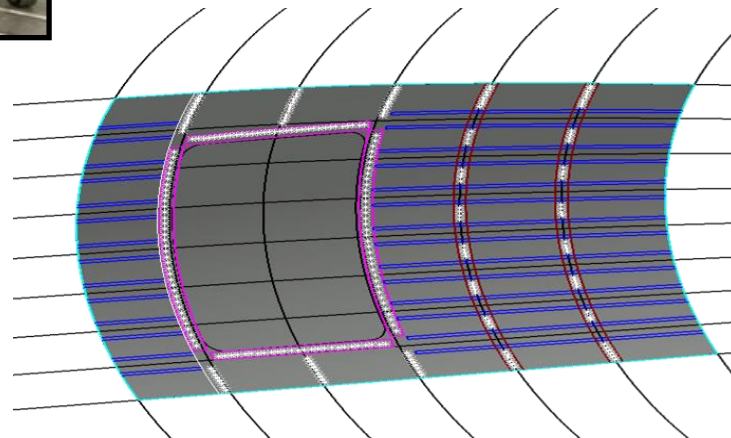
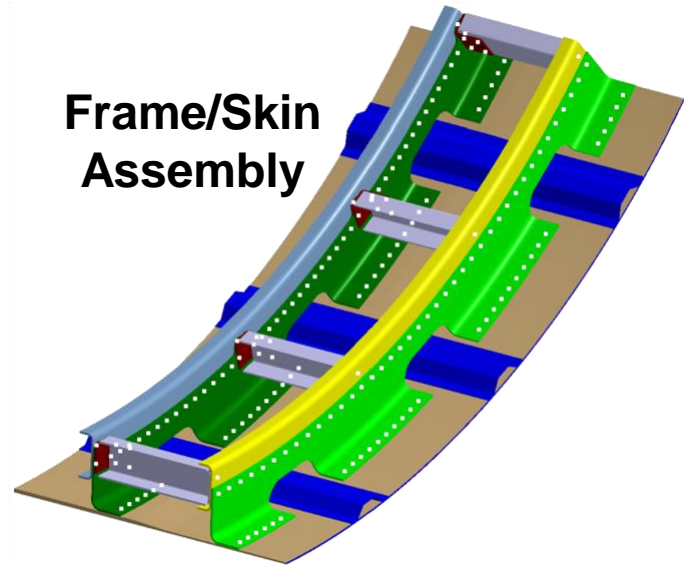
- Performance strongly influenced by material, process, geometry
- Requires tight integration between analyst, design/manufacturing engineers
- Accommodate early and frequent changes
- Bi-directional communication between analyst, designers and manufacturing

Aerospace Composite Configuration and Shape

Boeing 787



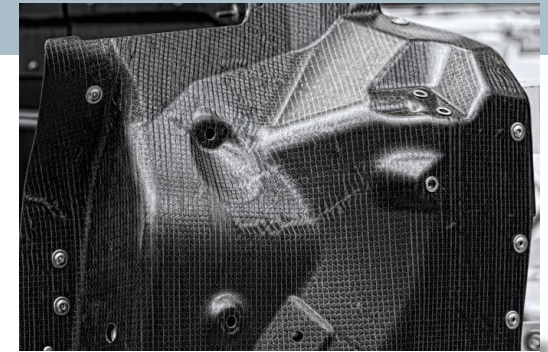
Frame/Skin Assembly



Grid Based Design

High Volume Automotive Composites Unique Challenges

- Time to market and design cycles are shorter
- Complex part shapes / limited space
- Strong emphasis on weight and cost reduction
 - Crash sensitive to stiffness, not as tolerant to over designing
- Unique CAE and Design data exchange requirements
- High Production volumes necessitate new materials and reliable automated processes



Automotive Composite Process Choices

Resin infusion

- RTM
- RFI

Automated deposition

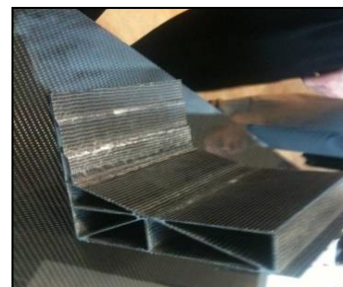
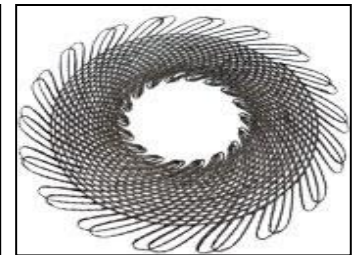
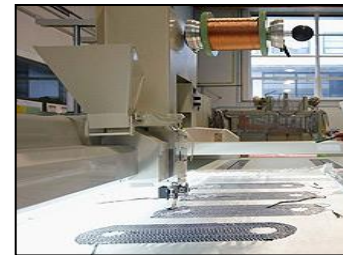
- Braiding
- Tailored Fiber placement
- Winding
- Spray Fiber

Forming

- Dry Preform
- Wet/Infused
- Hot TP

Pultrusion

**Each process imposes
unique constraints**

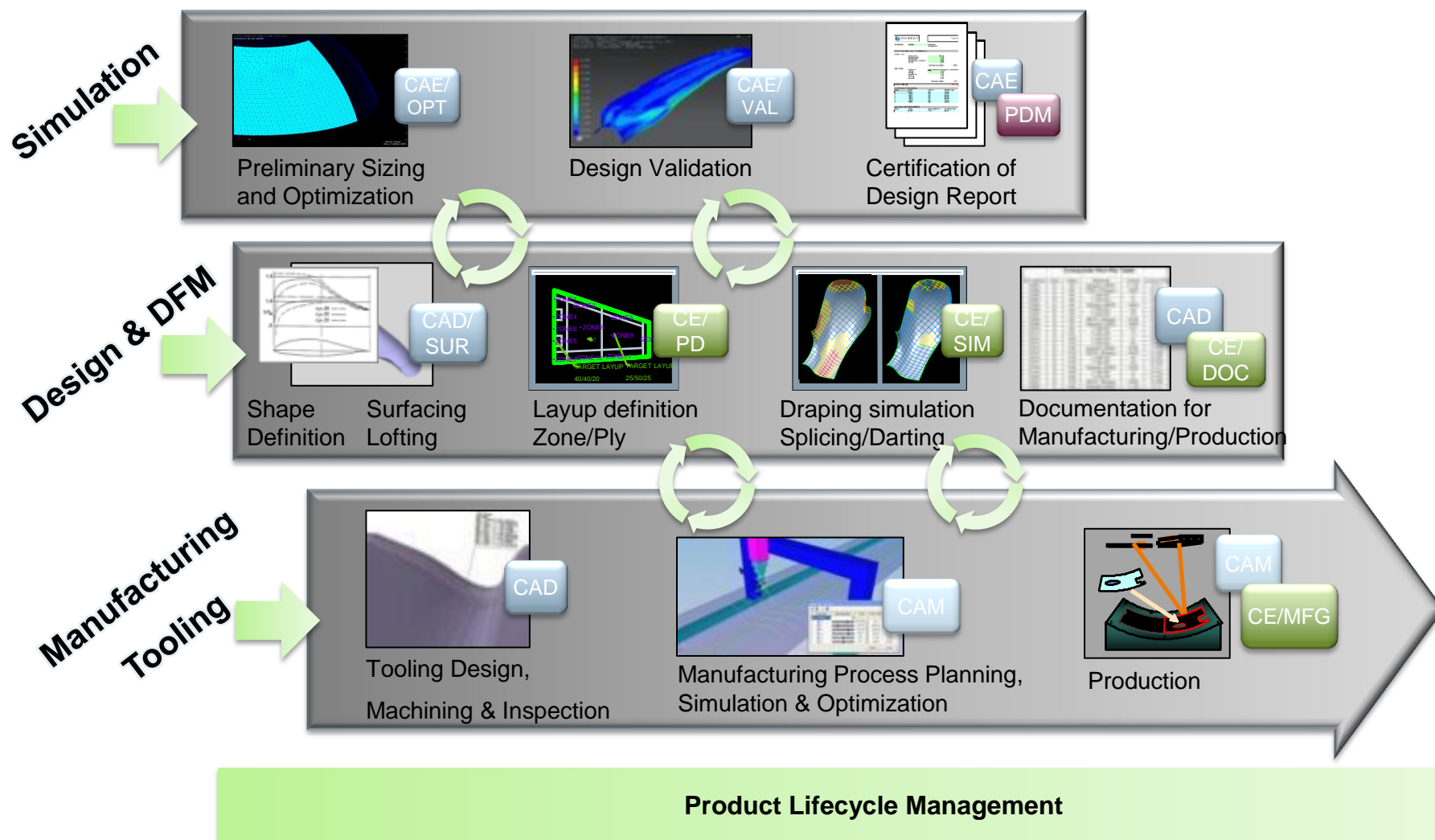


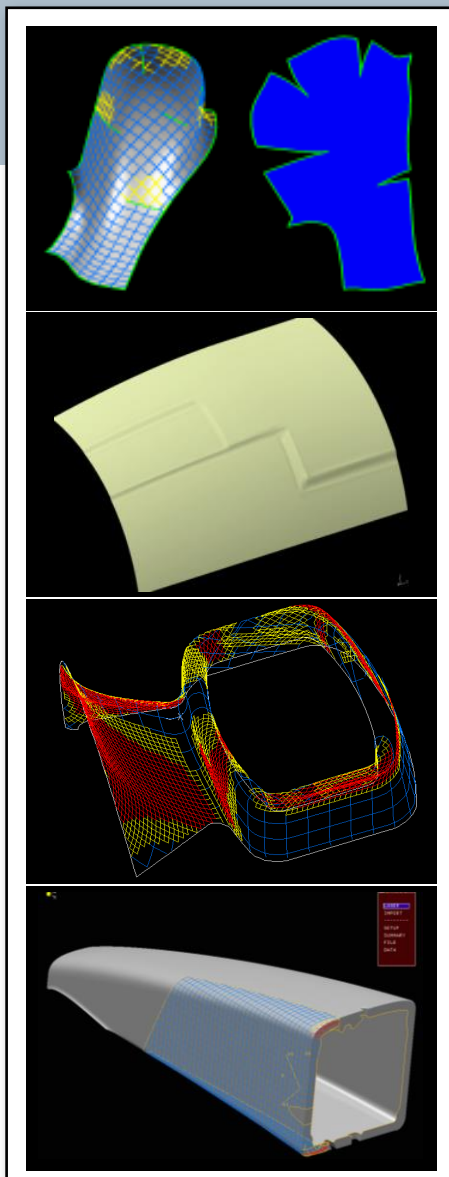
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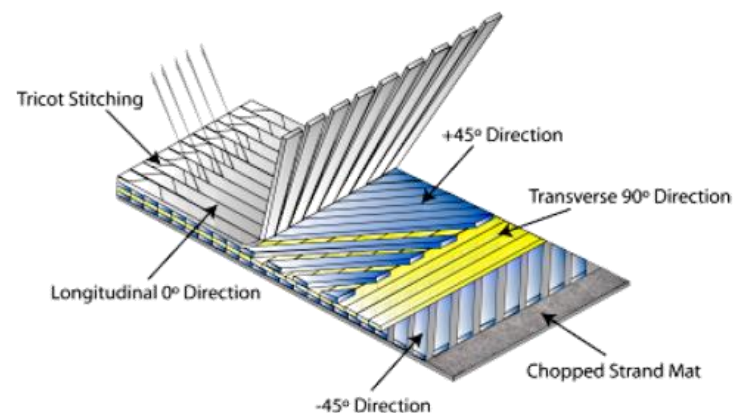
The Composite Engineering Process



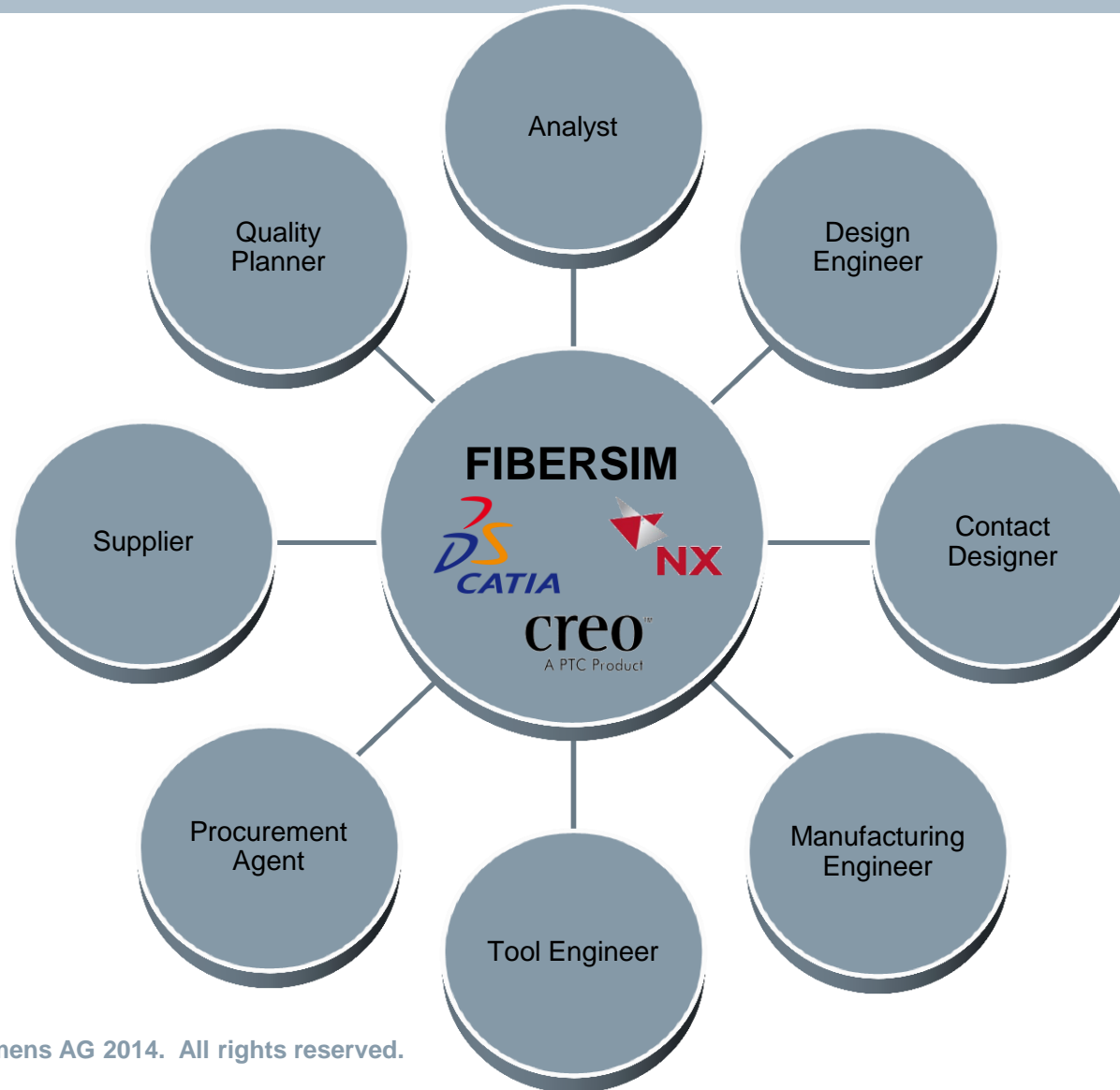


FIBERSIM

Software for designing and manufacturing innovative, durable and lightweight composite structures

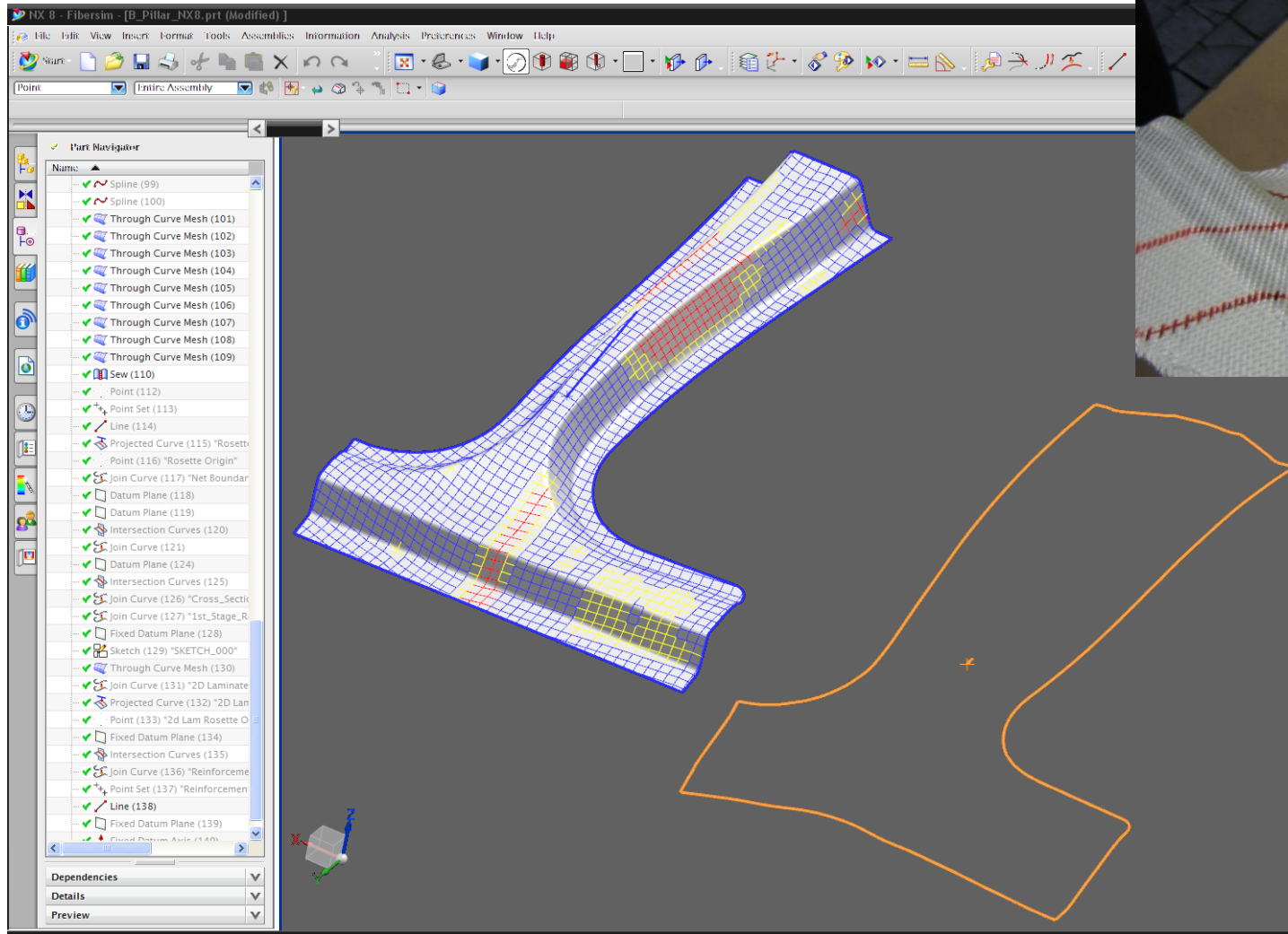


Collaboration Across Disciplines – FIBERSIM as “Collaboration Platform” for Composite Design



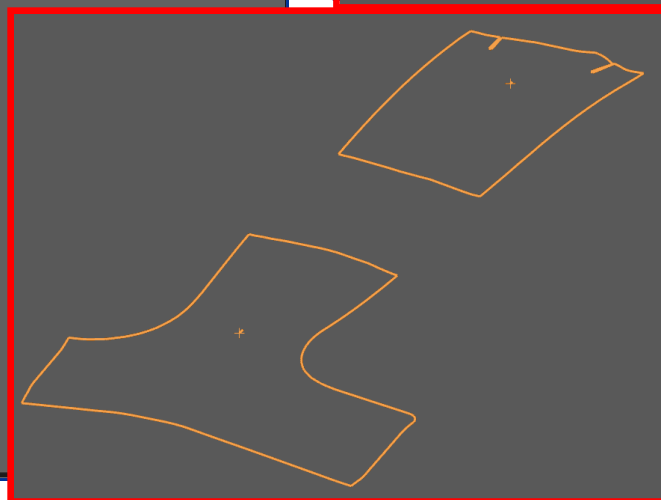
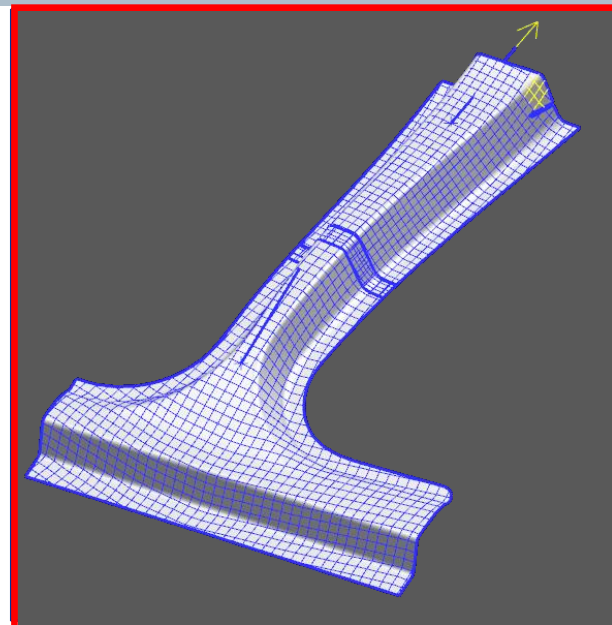
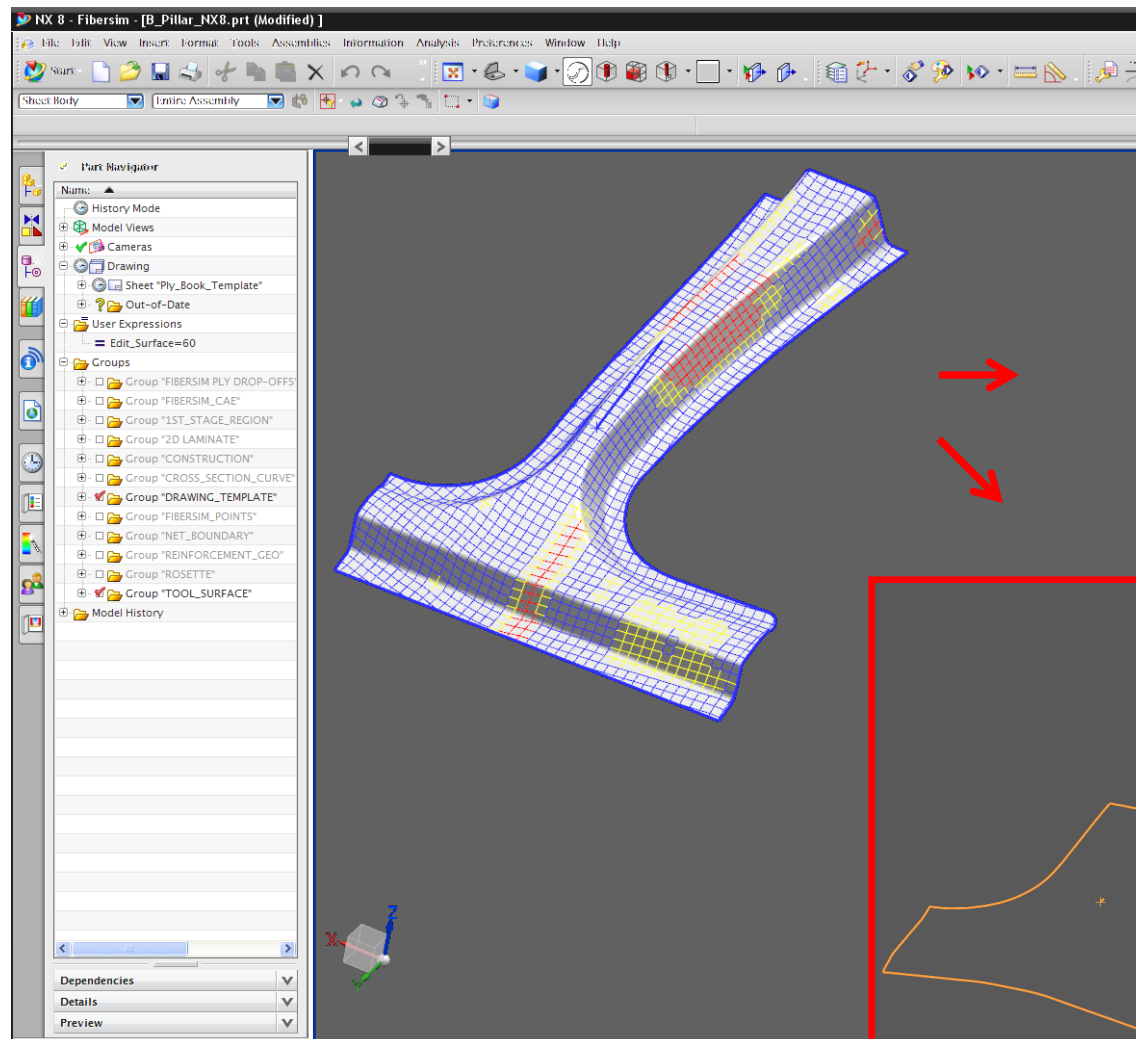
FIBERSIM

Producibility Simulation & Flat Pattern Generation



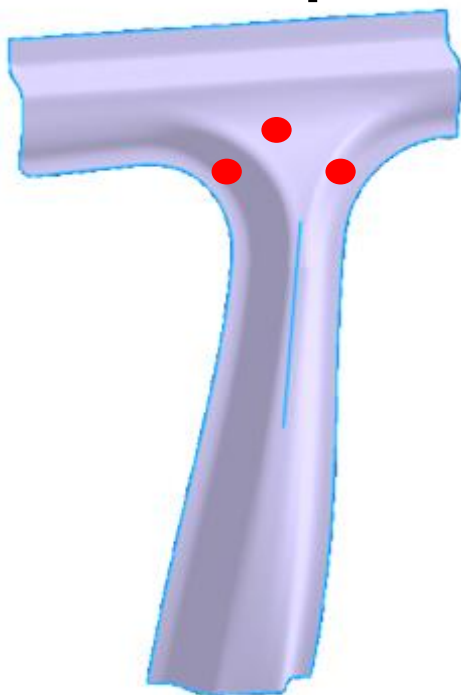
FIBERSIM

Manufacturable Composite Designs



Test Coupon Property Variation

**Metallic
Isotropic**



Properties Equal

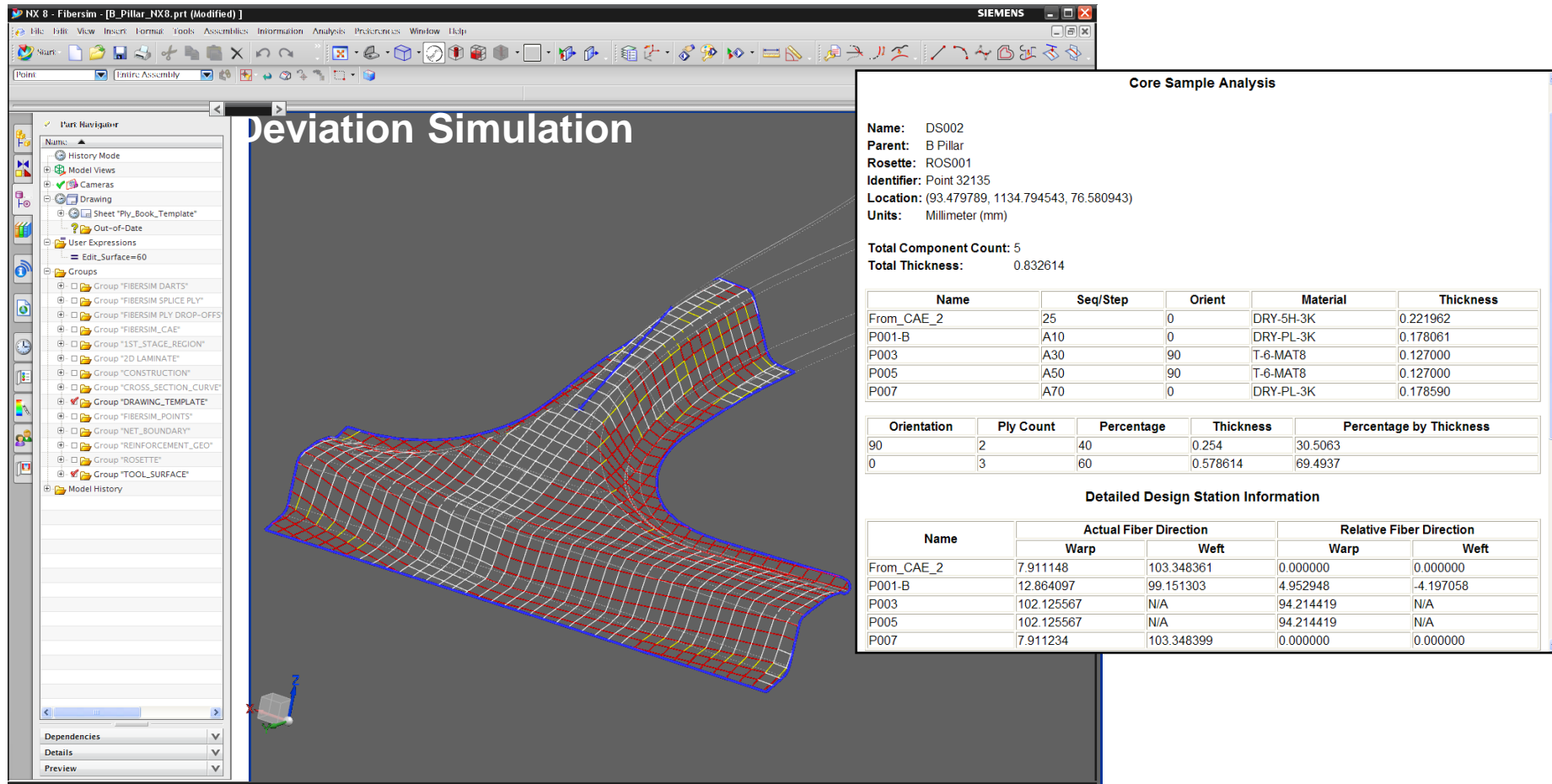
**Composite
Non-Isotropic**



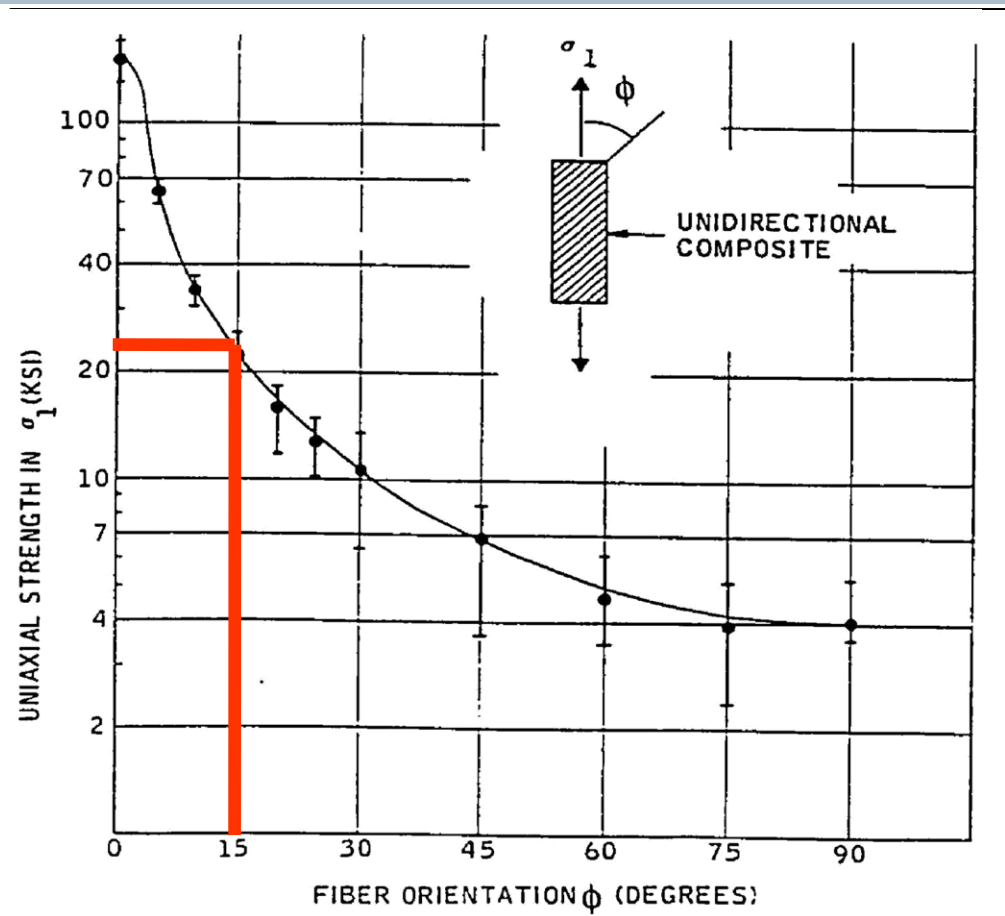
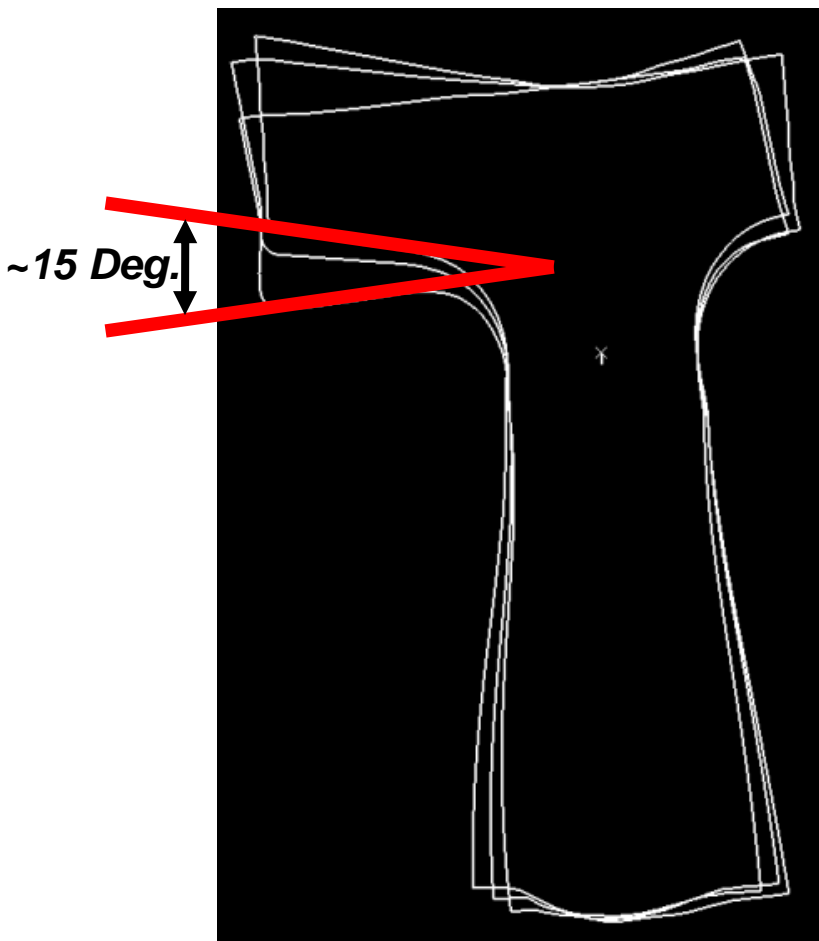
**Properties vary based on
Material, Process, Geometry**

FIBERSIM

True Fiber Orientations

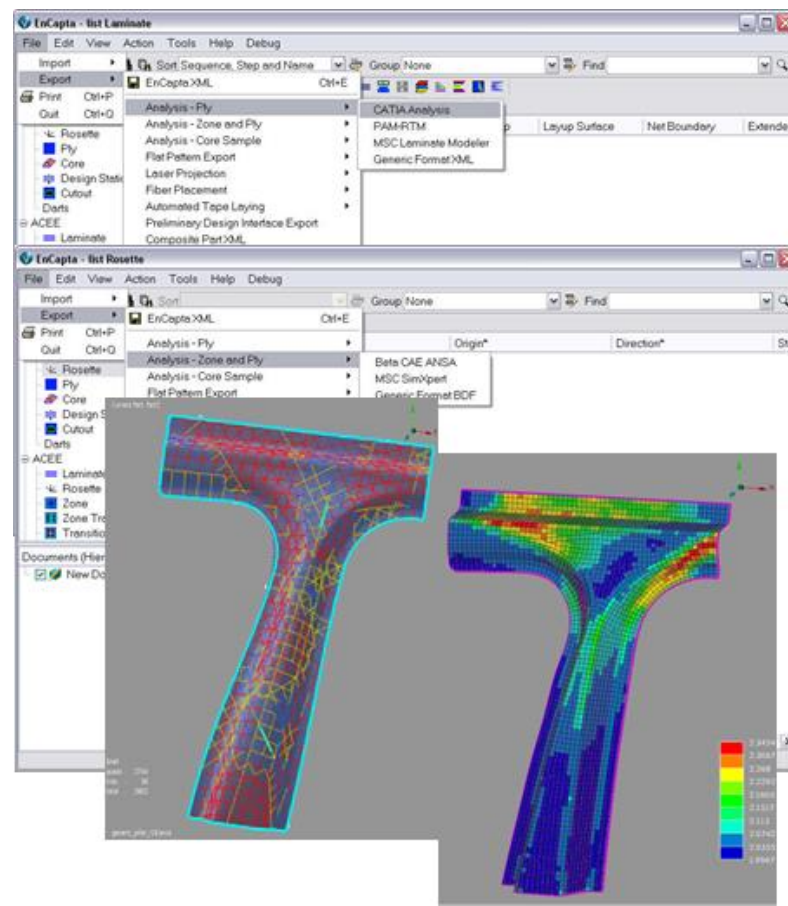
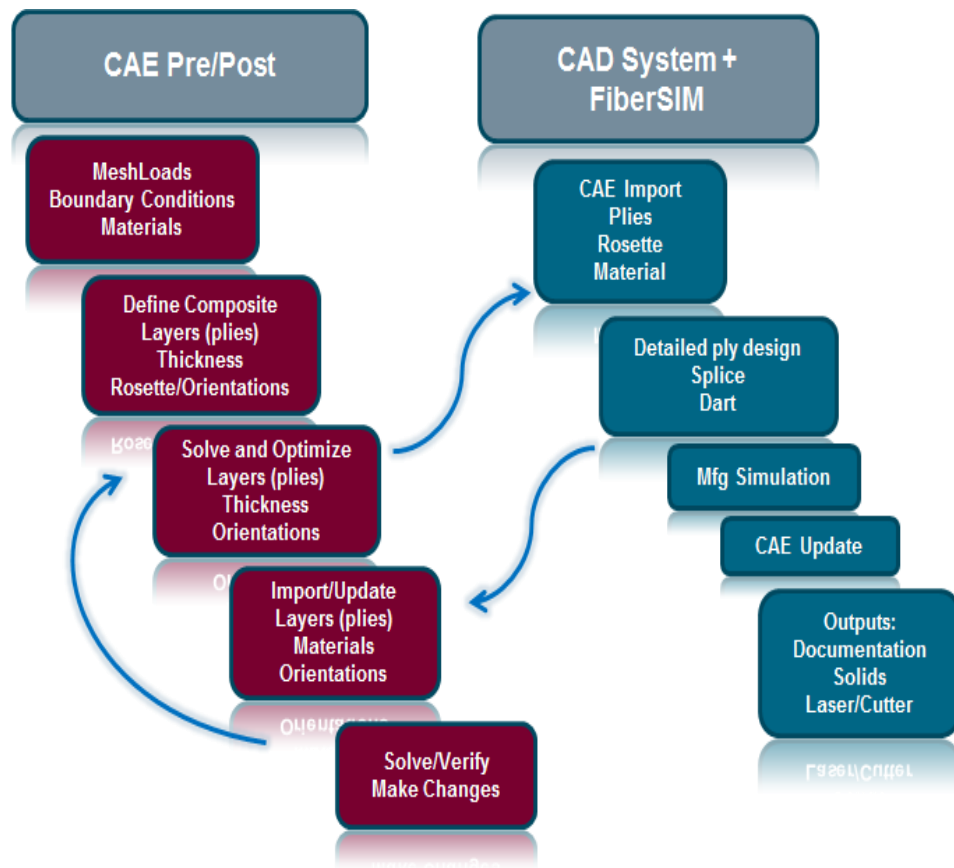


Improve Forming Producibility Feedback



**15 degree misalignment results in
75% reduction in strength**

Open Bi-Directional Analyst ↔ Designer Interface

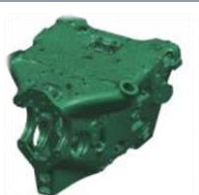


NX CAE

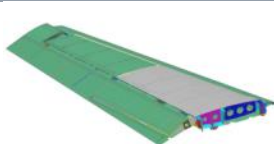
Multi-CAD
Geometry Editing



Advanced
Meshing



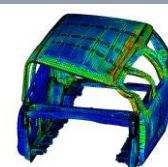
Assembly
Management



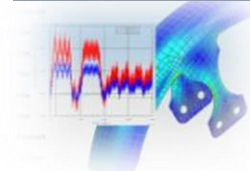
Linear
Structures



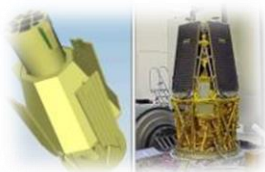
Nonlinear
Structures



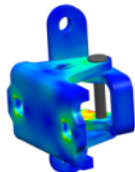
Response
Dynamics



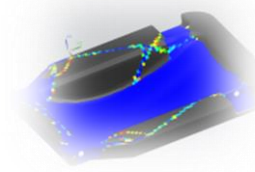
FE Correlation
and Update



Durability



Optimization



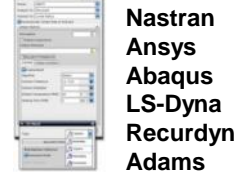
Laminate
Composites



Motion and
Controls



Multi-Solver
Support

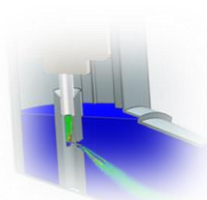


Nastran
Ansys
Abaqus
LS-Dyna
Recurdyn
Adams

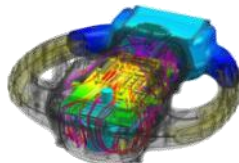
Thermal



Flow



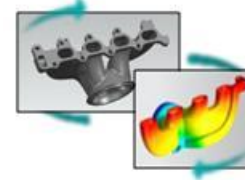
Electronics
Systems Cooling



Space Systems
Thermal



Knowledge
Automation

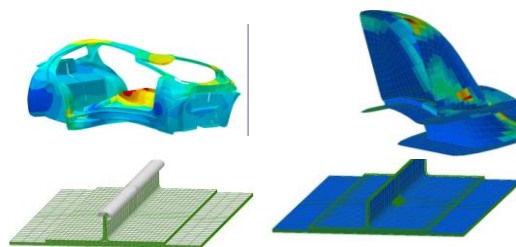


Integrated Data
Management



LMS - Multi-attribute Structural Performance Validation and Optimization

Strength



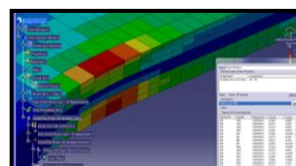
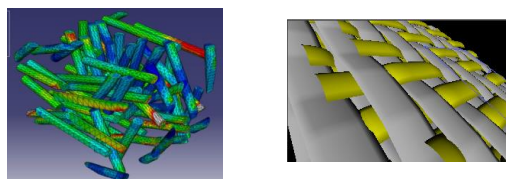
Classic Failure Analysis

Tsai-Hill, Tsai-Wu

Progressive Damage

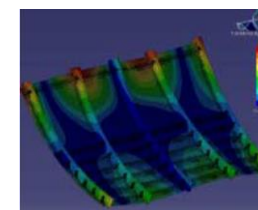
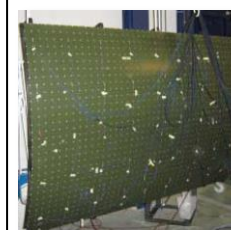
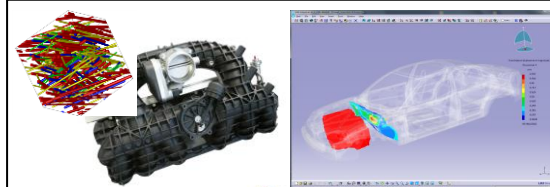
Intra-laminar & Inter-laminar

Durability



Stiffness Degradation under cyclic loading

Vibro-acoustics



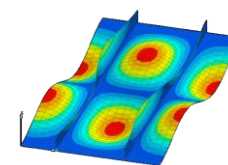
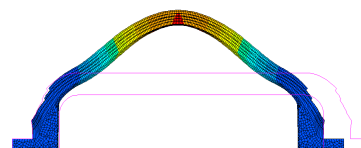
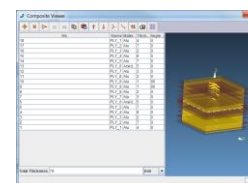
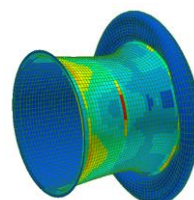
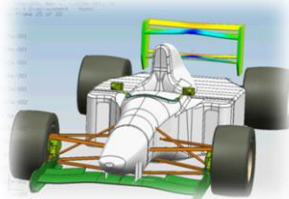
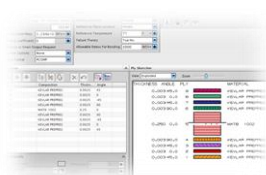
Lightweight composite affects NVH



**SIEMENS
FIBERSIM**

**PART
Engineering**

**Manufacturing
Process**



Core Composite Modeling

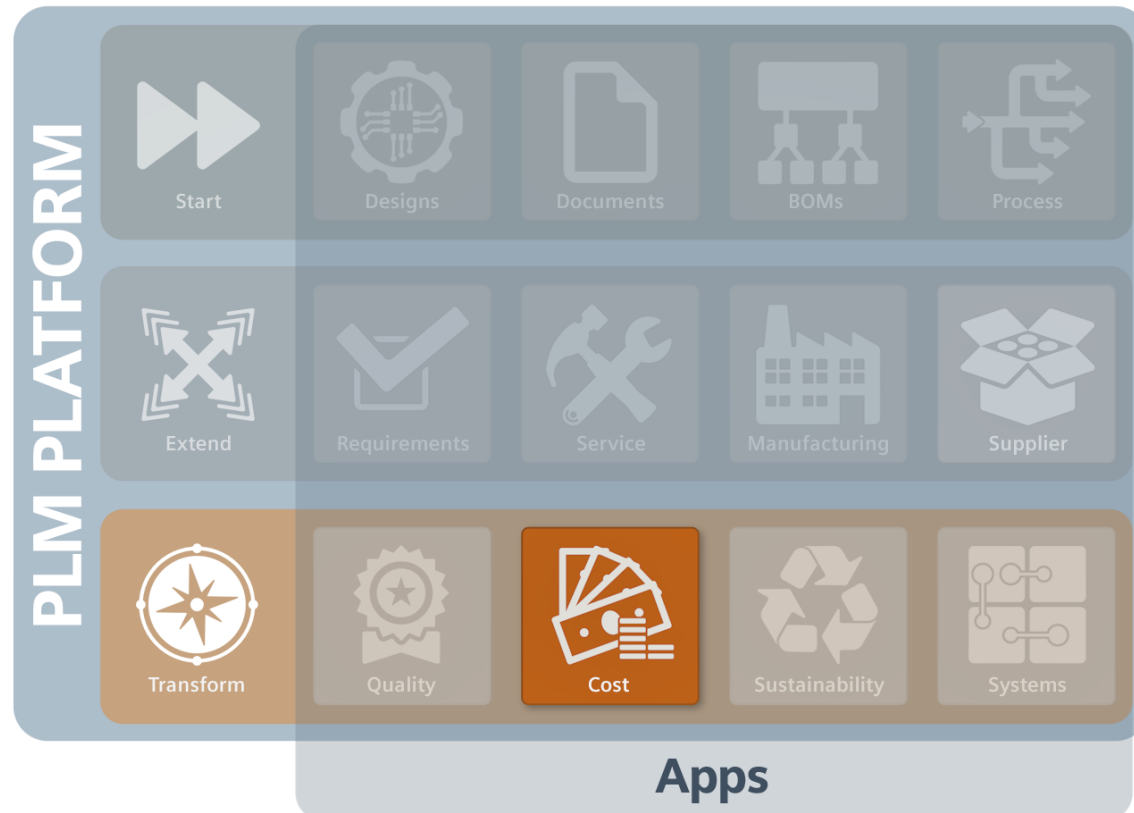


KU LEUVEN



**Technology
Partners**

TEAMCENTER



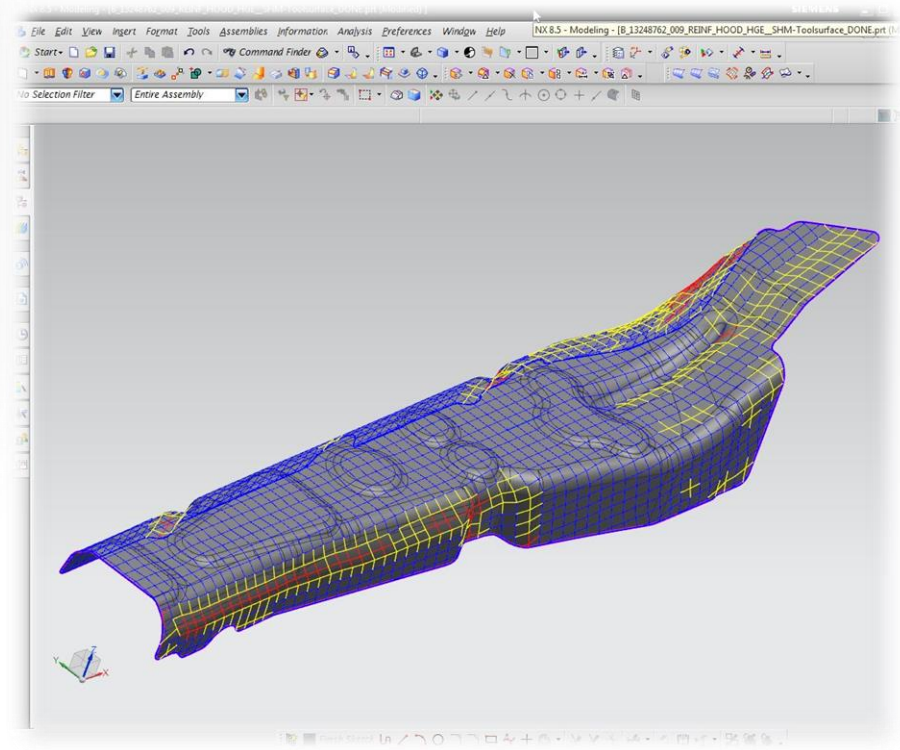
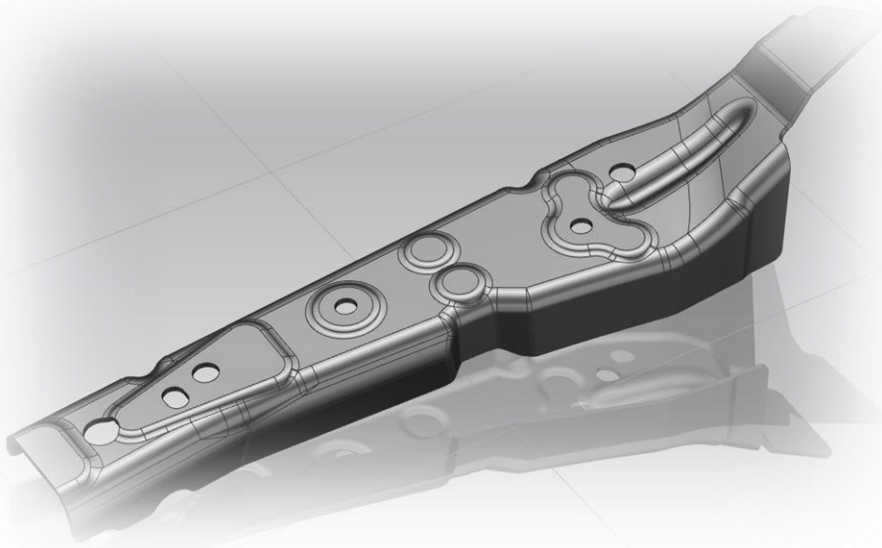
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2. Engineering Software for the cost effective design of High Volume Composite Structures
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Quickly Analyse different designs & materials (Draping Simulation < 1 minute)

- Example for “black metal design” – is it feasible?
- Get results and decision criteria in a few minutes using FIBERSIM!



Technischer Ablauf

CFK in der Automobilindustrie



NX Nastran Design Optimization – SOL 200

C-CON Door: What is an appropriate ply stack to satisfy the following requirements?

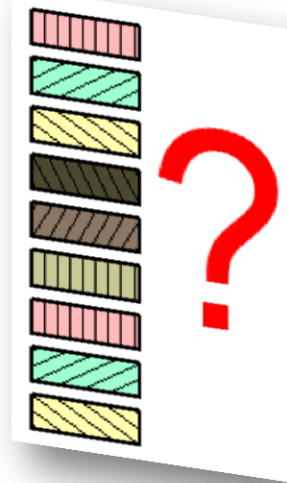


Minimum Weight

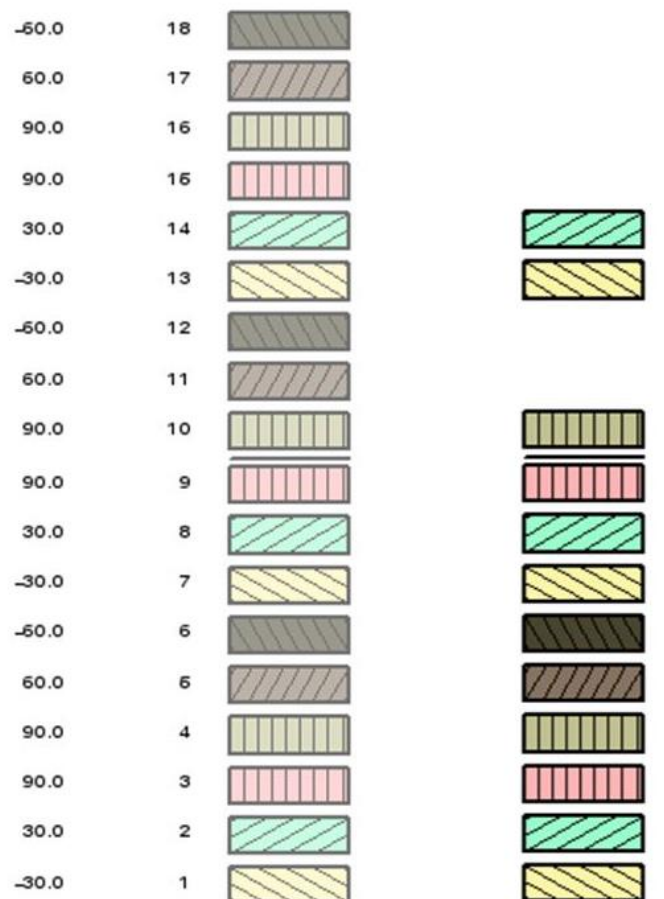
without violating design constraints

- **Vertical displacement** < 2.5 mm
- **Failure indices** (in critical areas) < 0.9

500 N



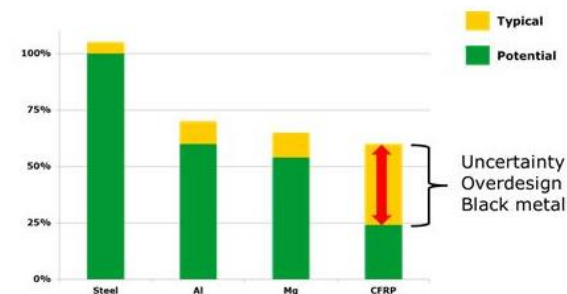
NX Nastran Laminate Design Optimization – SOL 200



(Overdesigned) initial

Optimized

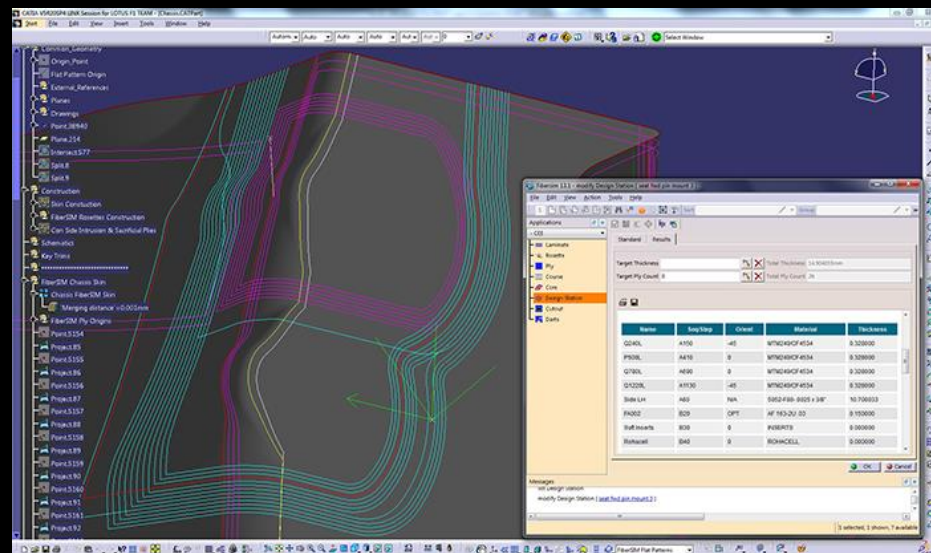
NX Nastran Design Optimization SOL 200



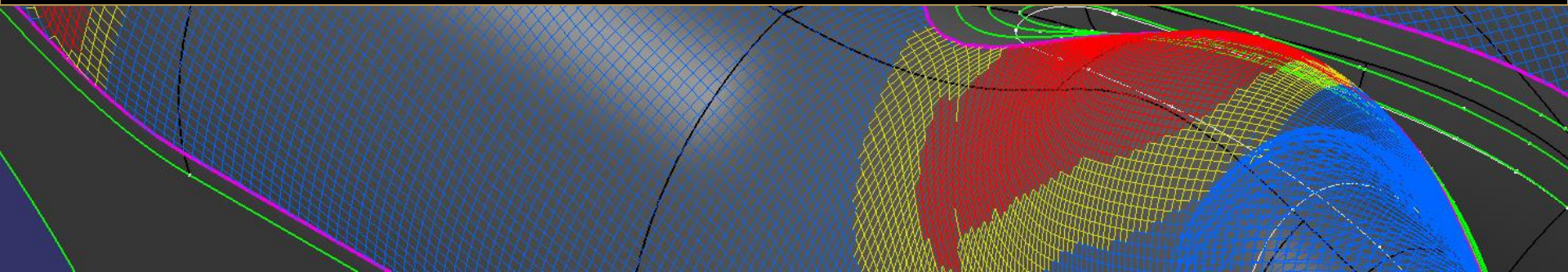
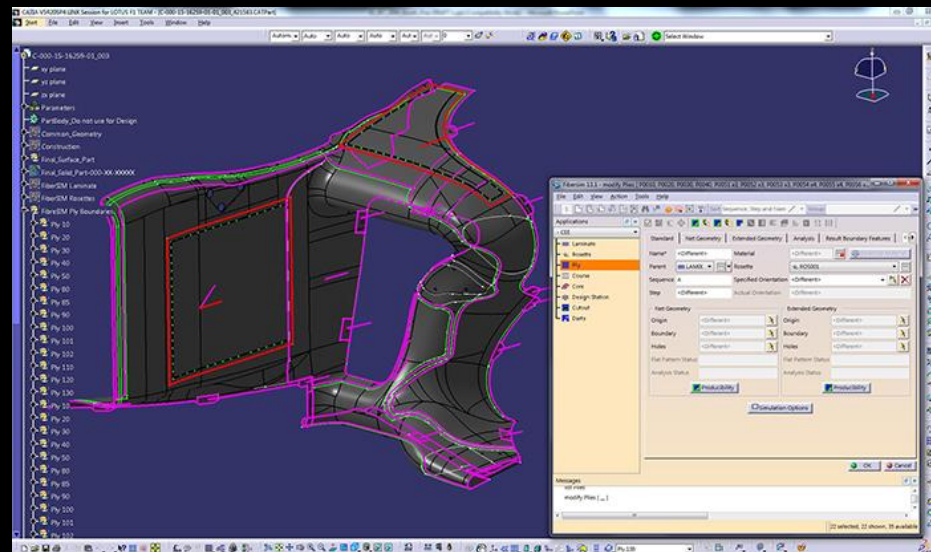


Fibersim & Lotus F1 Team

- Technical Partner for over 10 years
- Proven software for composites design with established procedures
- Enhanced precision and manufacturability of parts
- Cutting edge new functionality in every new release to stretch our capabilities and creativity



- Chassis
- Structural Bulkheads
- Front and Rear Wing parts
- Floor/Diffuser
- Body work, fairings, covers
- Suspension (wishbones, trackrods)
- Crash structures (nose, side impact, RCS)





Quantifying the design driven methodologies and Fibersim benefits

- Accelerated overall development time by 60%
 - Reduced design time by 20-30% typically
 - Reduced layup time by 75% over traditional methods
 - Reduced laminate templating time by 80%
- Optimized and verified part performance
 - Automatically transferred analysis data to design, increasing speed & providing more analysis testing cycles
 - Verified optimal part performance by sending composite design definitions back to analysis
- Delivered 100% accurate data
- Optimized part strength and weight
 - Weight variation of only 1.5%

“Engineers make million dollar decisions and don’t know it.”

Steve Luby
Sr. Vice President
Specialized Engineering Software, Siemens PLM Software
(Founder and Former CEO of Vistagy)



Thank You!

Questions, Comments, Suggestions?



Contact me:

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Siemens Industry Software

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Smarter decisions, better products.