Virtual process chain for the additive fiber layup technology Fiber Patch Placement

Dr. Neven Majic | JEC World 2019 – Altair Conference

cevotec
milestones in composites

Complex composites still manufactured by hand!

- Long production cycles
- No effective quality control
- High scrap rates >30%
- High cost

Need for automation solutions?

Fiber Patch Placement

Additive 3D fiber lay-up platform for complex composites

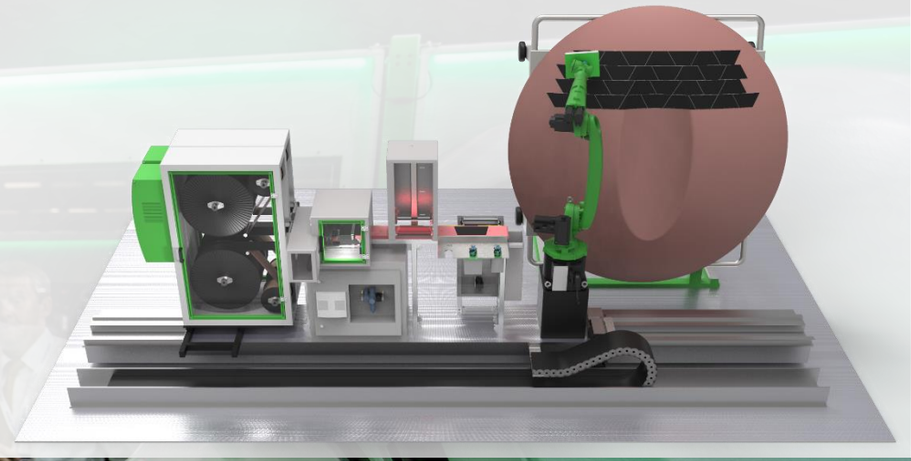
Benefits

- Digitized, automated process chain
- 100% in-process raw material control
- Multi-material layup capability
- > 50% material and cost savings

www.cevotec.com/en/fpp-technology/

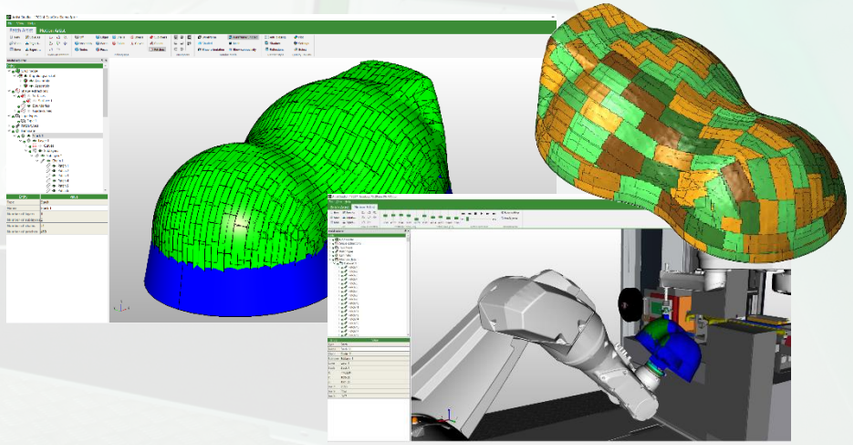
SAMBA *Series*

Flexible lay-up automation platform



ARTIST STUDIO

CAE software for design & production

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AIRBUS
baumann
baumann
http://cevotec.com/en/fpp-technology/

Fiber Patch Placement

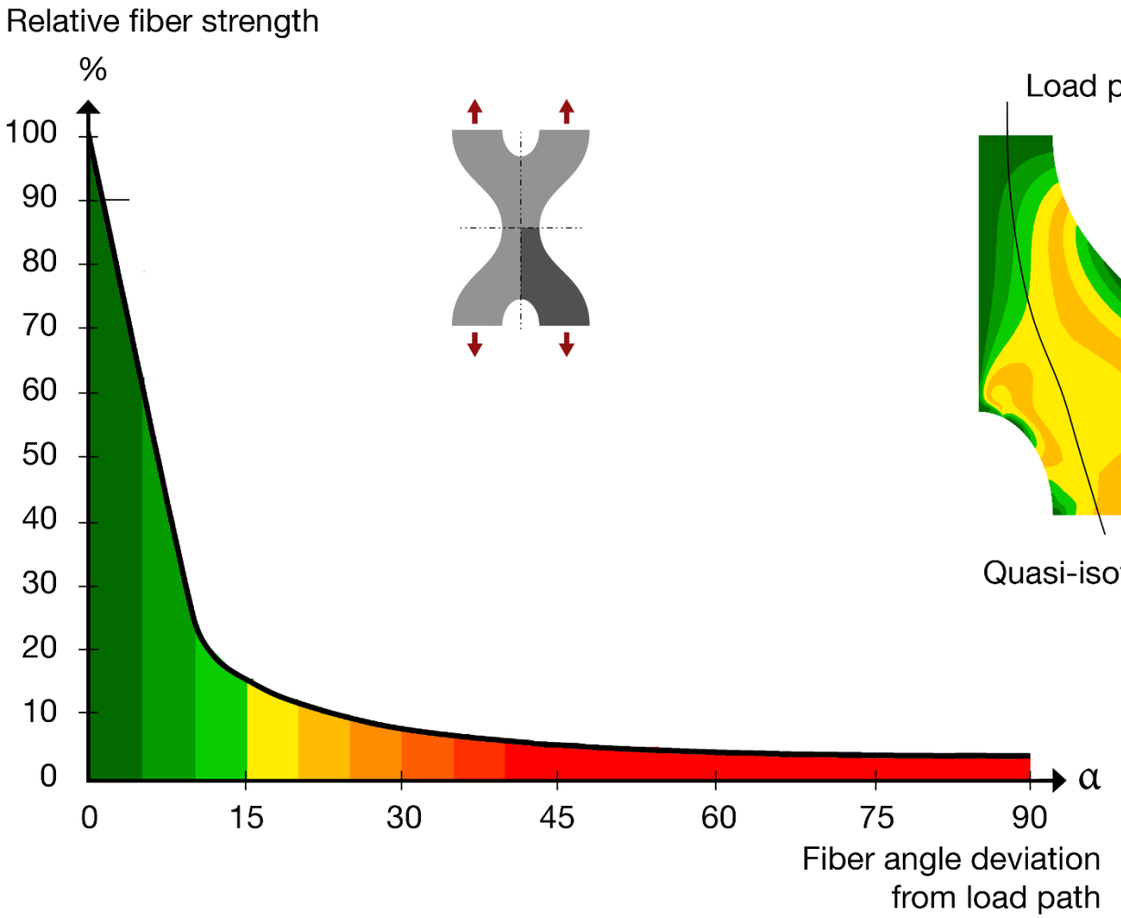
Material utilization

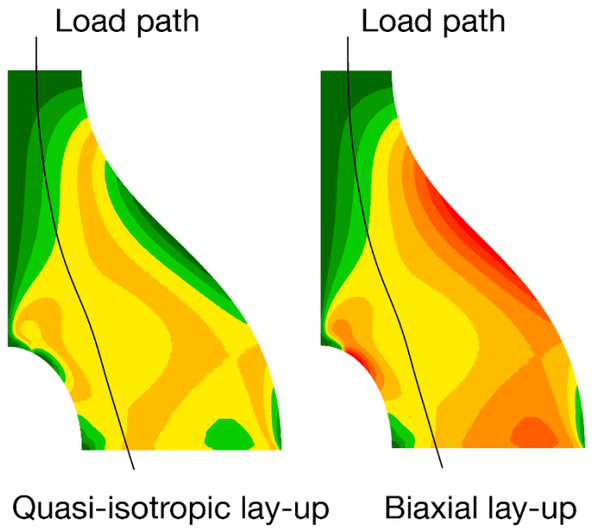
Fact

Using **multiaxial non-crimp fabrics,** especially for complex shapes & curvilinear load paths, cannot exploit the full potential of the material!

Example

Only 15° deviation between the fiber orientation and the load path drops the material utilization more than **80%**.





Fiber Patch Placement

Applications

Focus industries

- Aerospace
- Automotive
- Medical
- Sport

Applications areas

- Multi-material components
- Complex geometries
- Tailored reinforcements

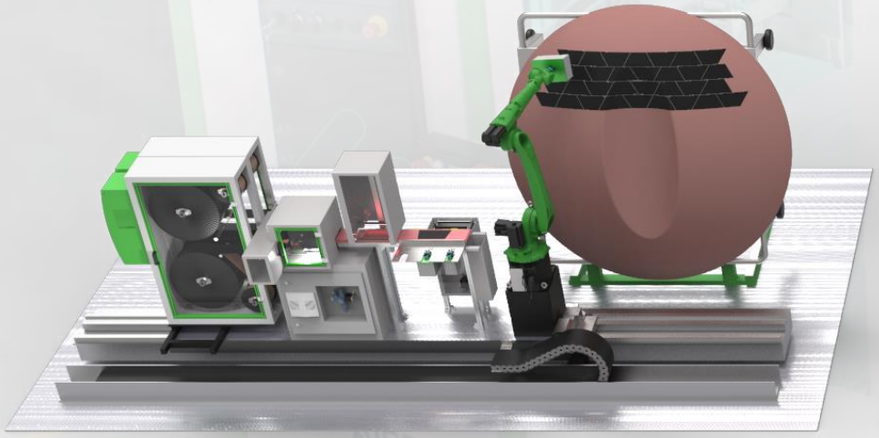
SAMBA *Series*

Additive 3D fiber lay-up systems.

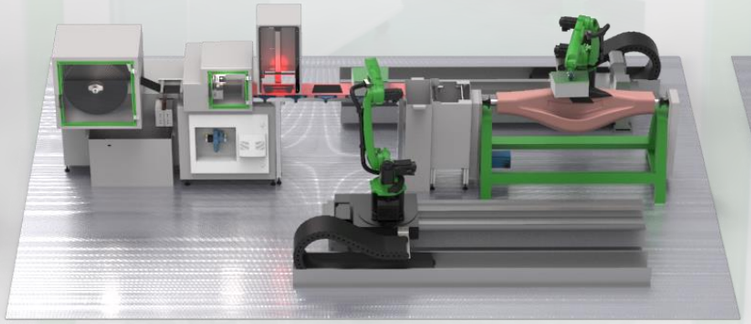
Flexible production platforms – one system, multiple parts.

Modular, scalable systems

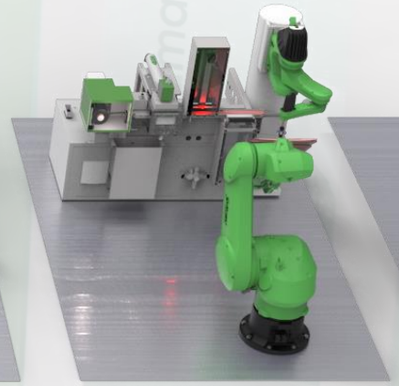
- **Material feeding & cutting** e.g. laser, ultrasonic, mechanical
- **Quality control systems** e.g. cameras, sensors, computer
- **Robot with patch gripper** e.g. 4-axis pick & place, 6-axis robot
- **Tool manipulator** e.g. 6-axis robot, tilting rotator, linear table



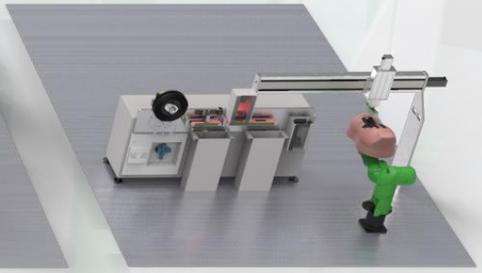
SAMBA *Multi*
carbon, glass and other



SAMBA *Scale*
high-throughput



SAMBA *Pro*
flexible production

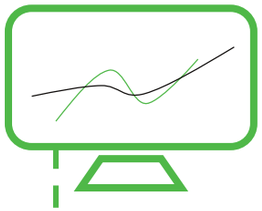


SAMBA *Step*
prototyping / R&D

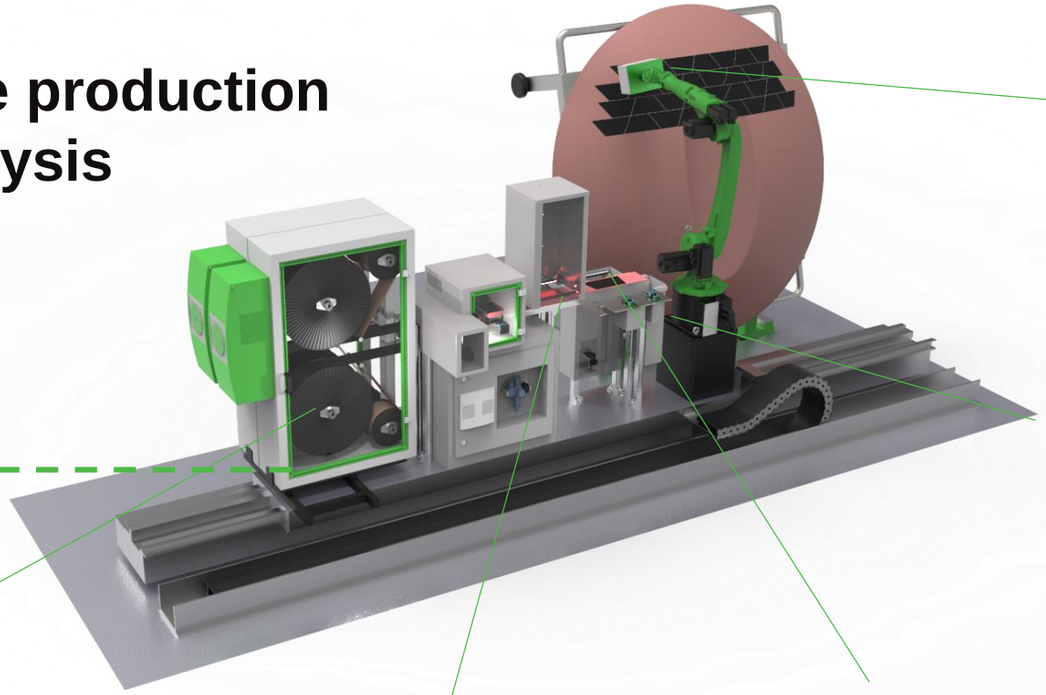
All systems available in dry fiber and thermoset-prepreg configurations

Industry 4.0 automation with Fiber Patch Placement

Continuous process & quality control for key process parameters



Real-time production data analysis



Controlled deposition process

Interfaces

Station for in-process gripper exchange

Controlled tape feeding

Vision control patch

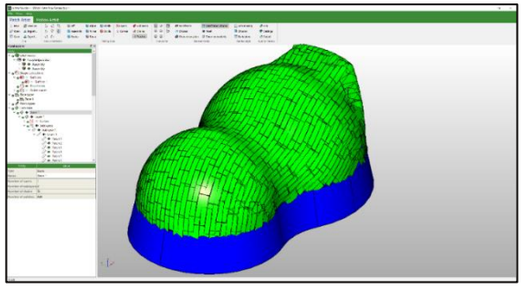
Vision control patch position

+ Global parameters

Objective: Replace individual unit tests by continuous process monitoring

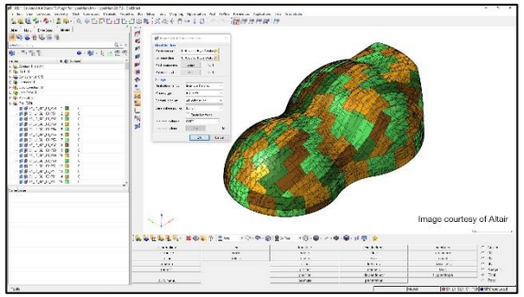
Comprehensive CAE process for Fiber Patch Placement

Enabling a continuous virtual process chain for patch technology



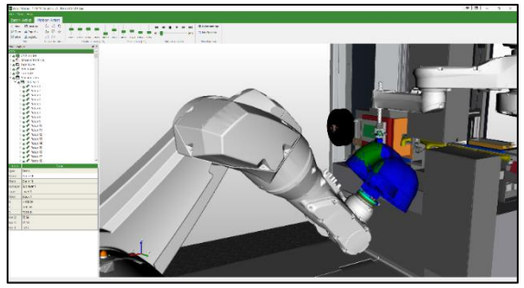
ARTIST STUDIO - PATCH ARTIST

Modeling of optimized patch-based laminates



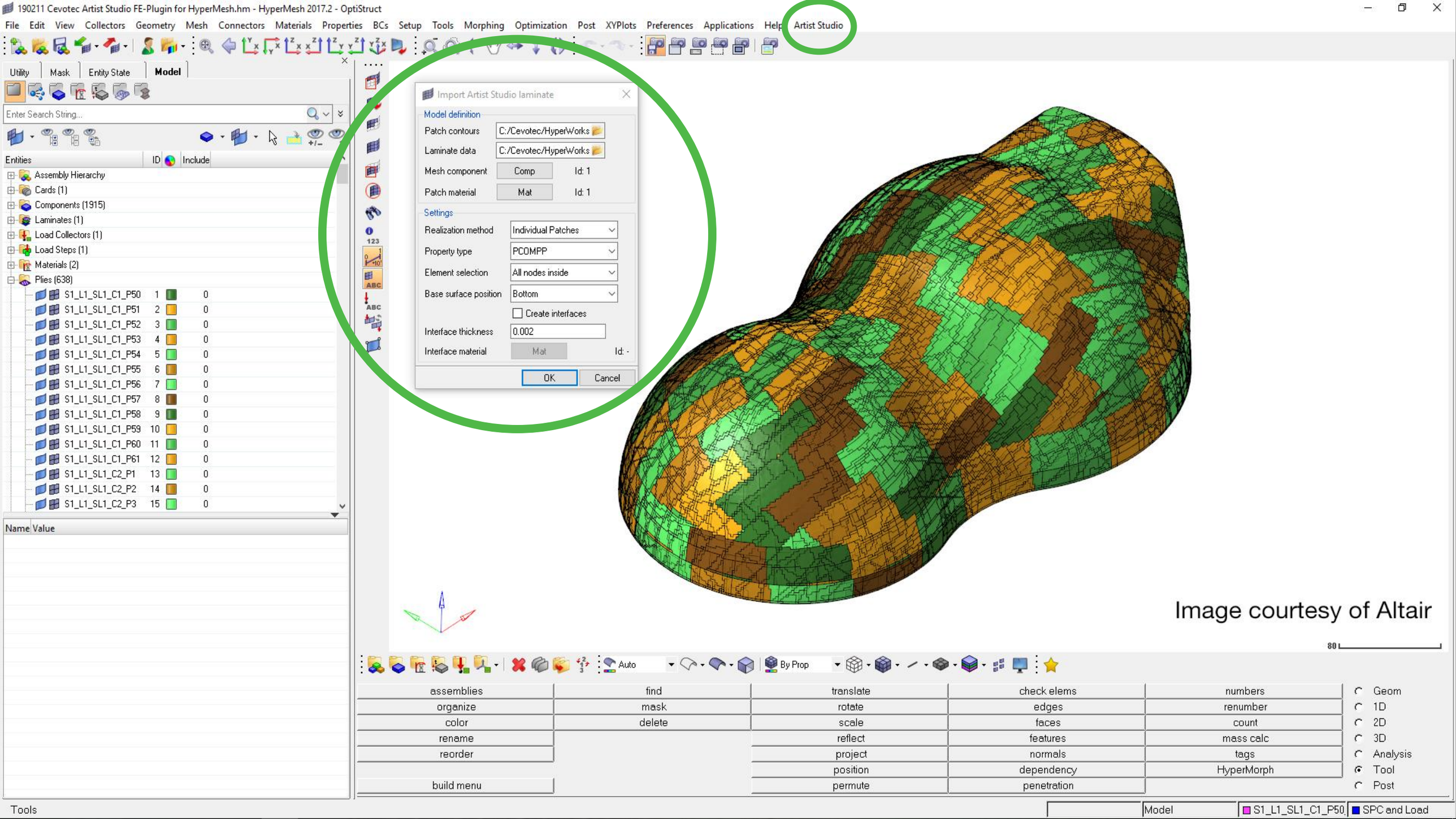
ARTIST STUDIO Plug-in for HyperMesh

Automated modeling of patch-based laminates



ARTIST STUDIO – MOTION ARTIST

Offline robot programing and robot movement simulation

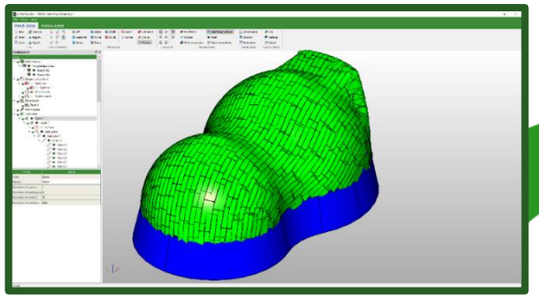

190211 Cevotec Artist Studio FE-Plugin for HyperMesh.hm - HyperMesh 2017.2 - OptiStruct
File Edit View Collectors Geometry Mesh Connectors Materials Properties BCs Setup Tools Morphing Optimization Post XYPlots Preferences Applications Help Artist Studio
Utility Mask Entity State Model
Enter Search String...
Entities ID Include
Assembly Hierarchy
Cards (1)
Components (1915)
Laminates (1)
Load Collectors (1)
Load Steps (1)
Materials (2)
Plies (638)
S1_L1_SL1_C1_P50 1 0
S1_L1_SL1_C1_P51 2 0
S1_L1_SL1_C1_P52 3 0
S1_L1_SL1_C1_P53 4 0
S1_L1_SL1_C1_P54 5 0
S1_L1_SL1_C1_P55 6 0
S1_L1_SL1_C1_P56 7 0
S1_L1_SL1_C1_P57 8 0
S1_L1_SL1_C1_P58 9 0
S1_L1_SL1_C1_P59 10 0
S1_L1_SL1_C1_P60 11 0
S1_L1_SL1_C1_P61 12 0
S1_L1_SL1_C2_P1 13 0
S1_L1_SL1_C2_P2 14 0
S1_L1_SL1_C2_P3 15 0
Name Value
Import Artist Studio laminate
Model definition
Patch contours C:/Cevotec/HyperWorks
Laminate data C:/Cevotec/HyperWorks
Mesh component Comp Id: 1
Patch material Mat Id: 1
Settings
Realization method Individual Patches
Property type PCOMPP
Element selection All nodes inside
Base surface position Bottom
Create interfaces
Interface thickness 0.002
Interface material Mat Id: -
OK Cancel
Image courtesy of Altair
Auto
By Prop
assemblies find translate check elems numbers
organize mask rotate edges renumber
color delete scale faces count
rename reflect features mass calc
reorder project normals tags
position dependency HyperMorph
build menu permute penetration
Geom 1D 2D 3D Analysis Tool Post
Tools
Model
S1_L1_SL1_C1_P50
SPC and Load

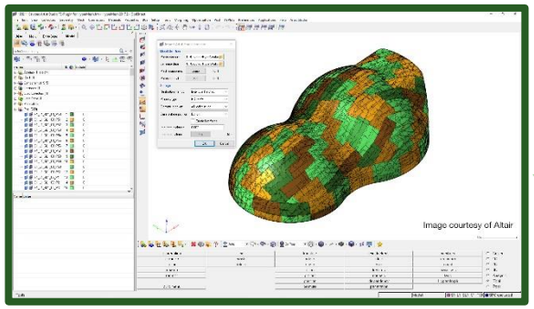
ARTIST STUDIO Plug-in for HyperMesh

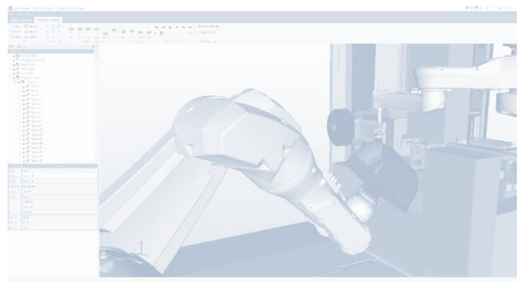
CAD

FEM

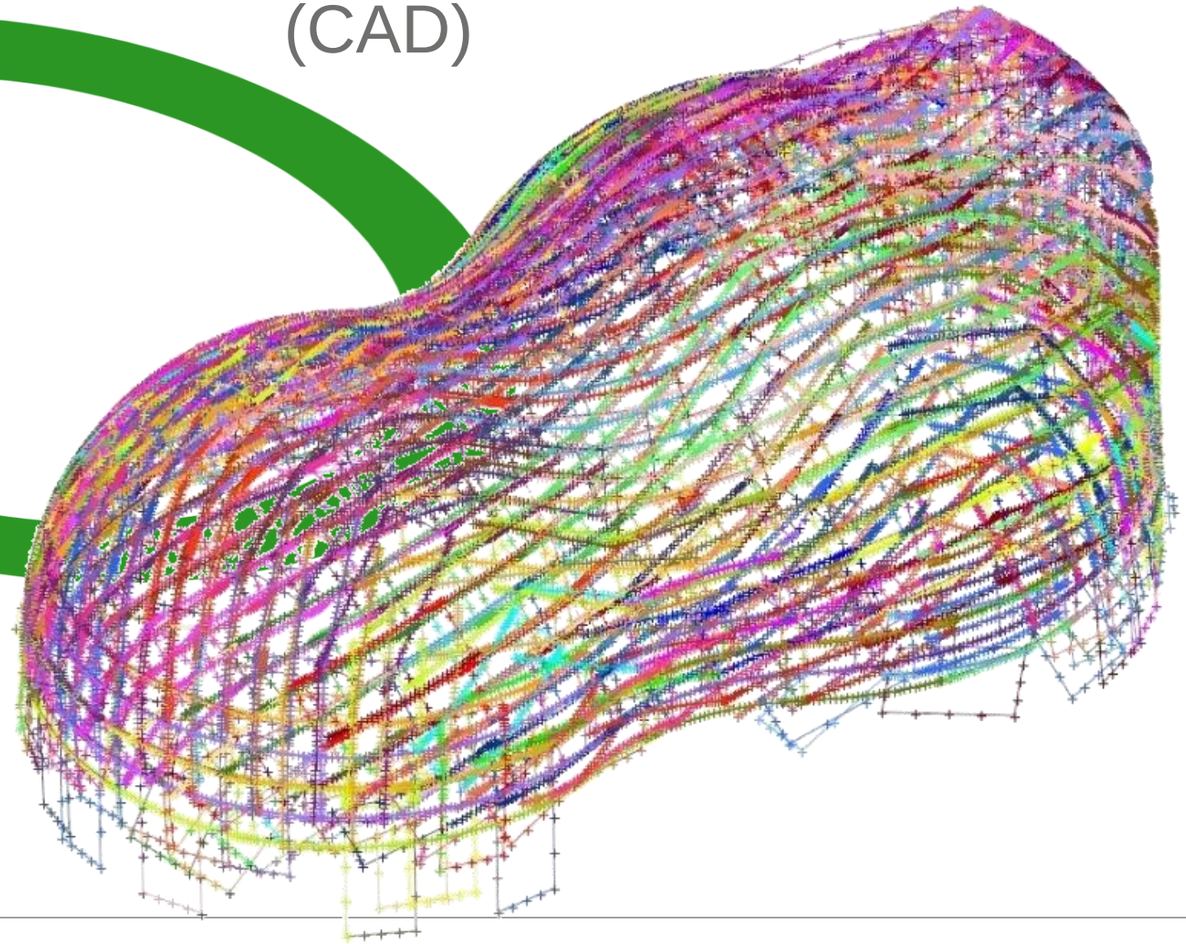
CAM







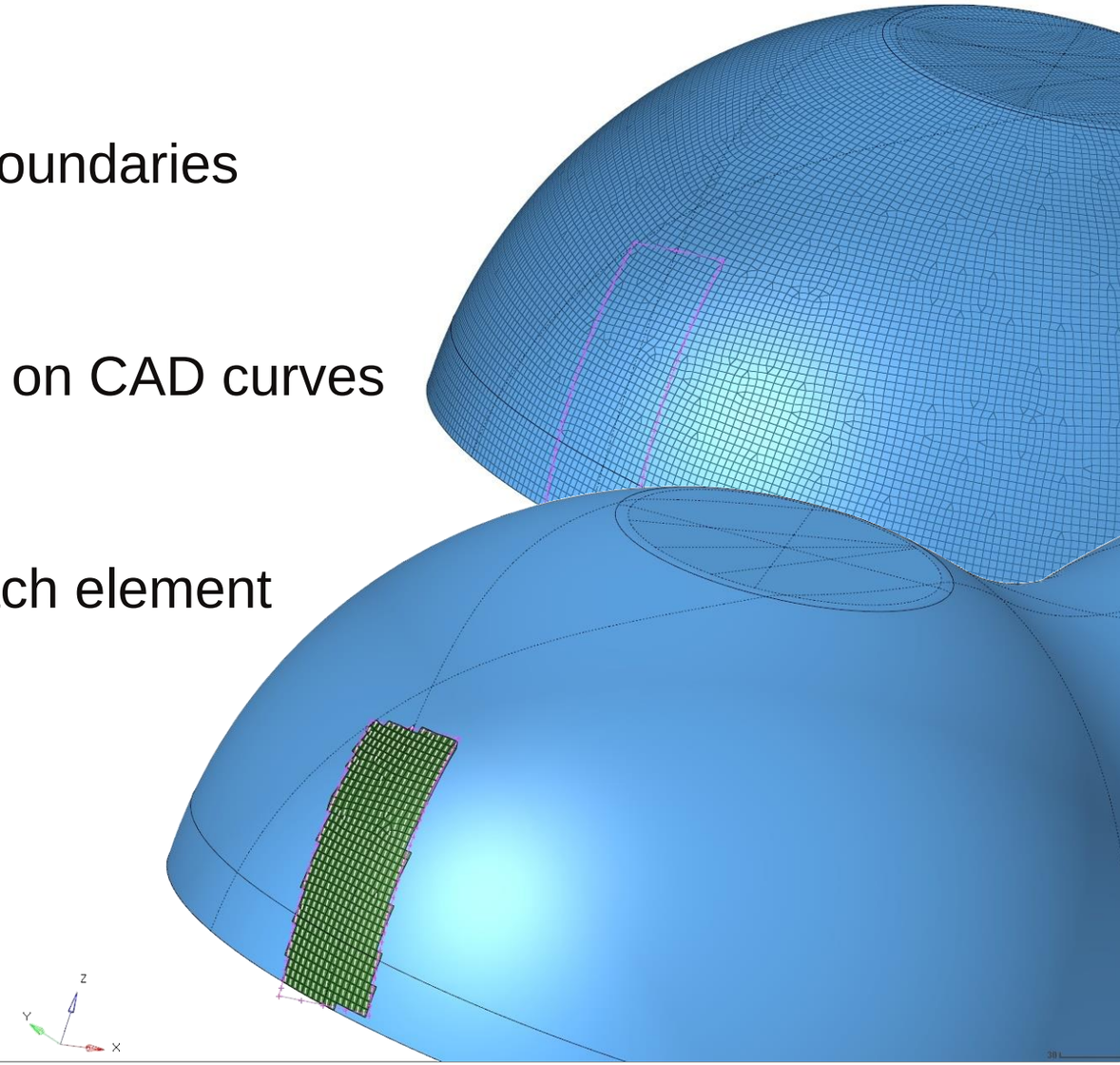
Patch boundaries (CAD)



ARTIST STUDIO Plug-in for HyperMesh

Key functionalities of HyperMesh

- Automated search for elements within patch boundaries
- Definition of curvilinear fiber orientation based on CAD curves
- Assignment of different fiber orientations to each element



ARTIST STUDIO Plug-in for HyperMesh

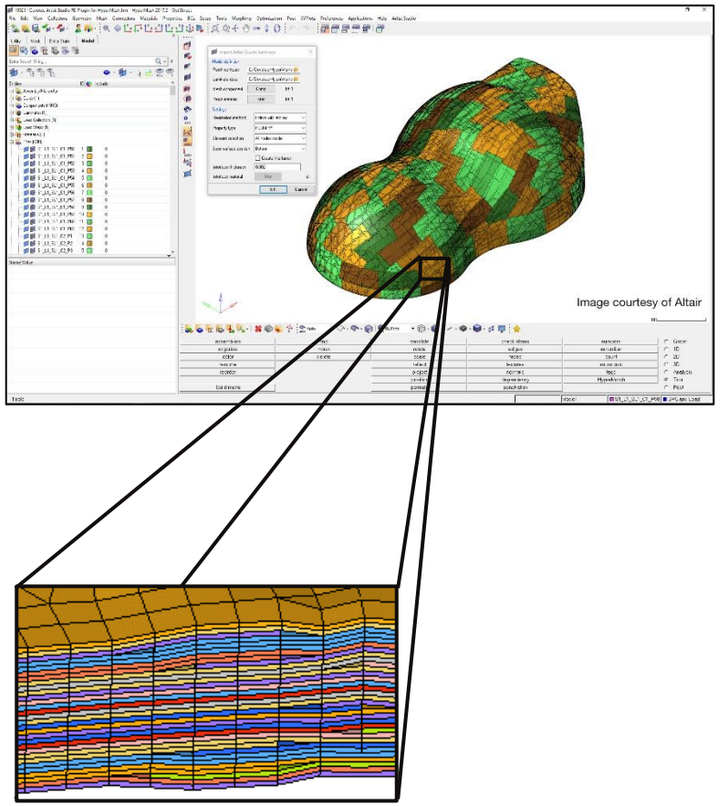
Modeling types

Basic patch lay-up

- Shell-based approach
- Single mesh for lay-up
- Gaps considered with material knock-down factors

Advanced patch lay-up

- Solid-based approach based on shell-to-solid conversion
- Cohesive-zone modeling for delamination
- Gaps directly modeled



Result accuracy & Computation time

Case Study

Re-purposing AFP tapes with Premium Aerotec

Goal: Automated layup of operating box cover

Material: Hexcel M21E pregtow (1/2” width)

Virgin residuals from M-Torres AFP machine

Results: **Weight -70%**

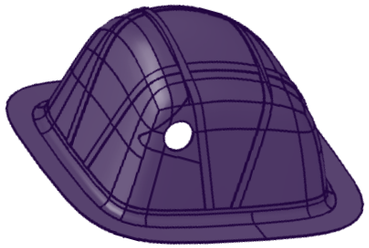
Cost -75%

(to actual version of the part)

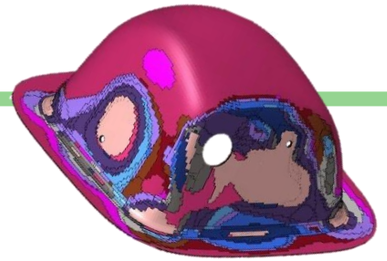
Designing for efficiency with ARTIST STUDIO & HyperWorks™

State-of-the-art virtual product development of the operating box cover

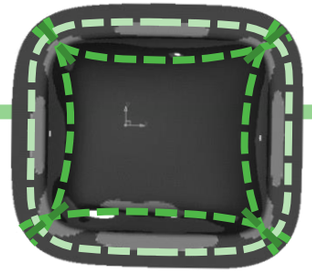
Customer CAD



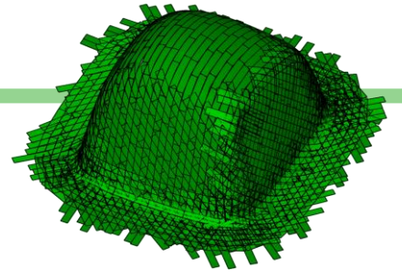
Optimization
HyperWorks



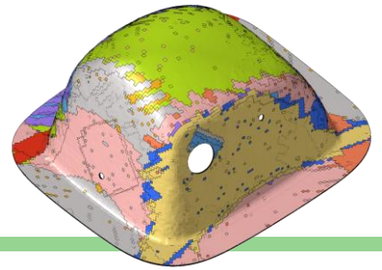
Loadpath definition

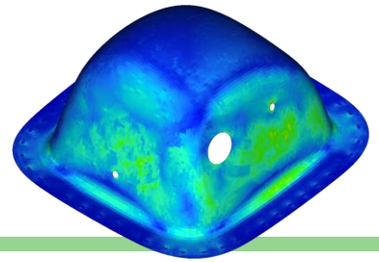


Laminate creation
PATCH ARTIST

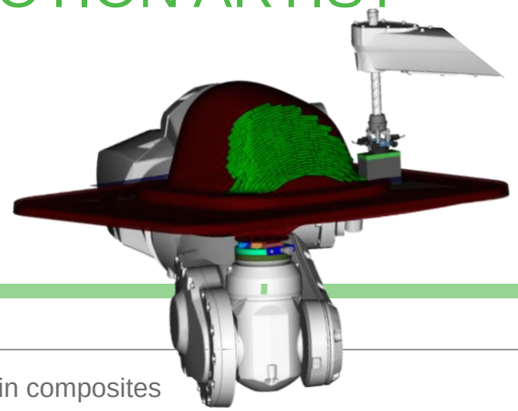


Laminate verification
ARTIST STUDIO Plug-in for HyperMesh

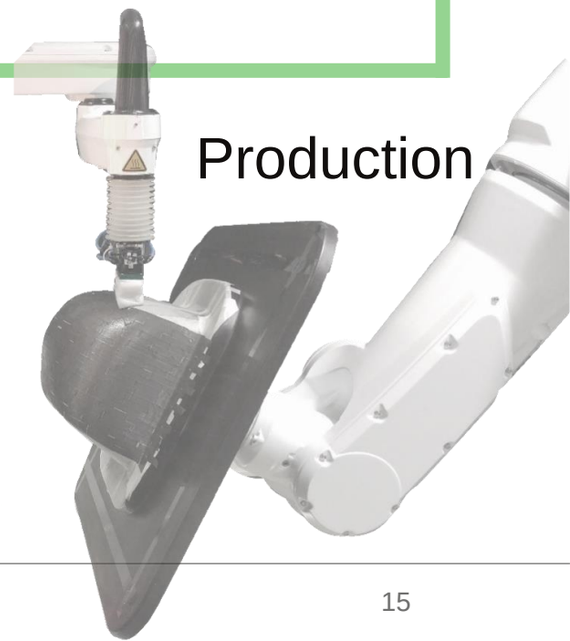




Manufacturing Simulation
MOTION ARTIST



Production



Acknowledgement

Altair

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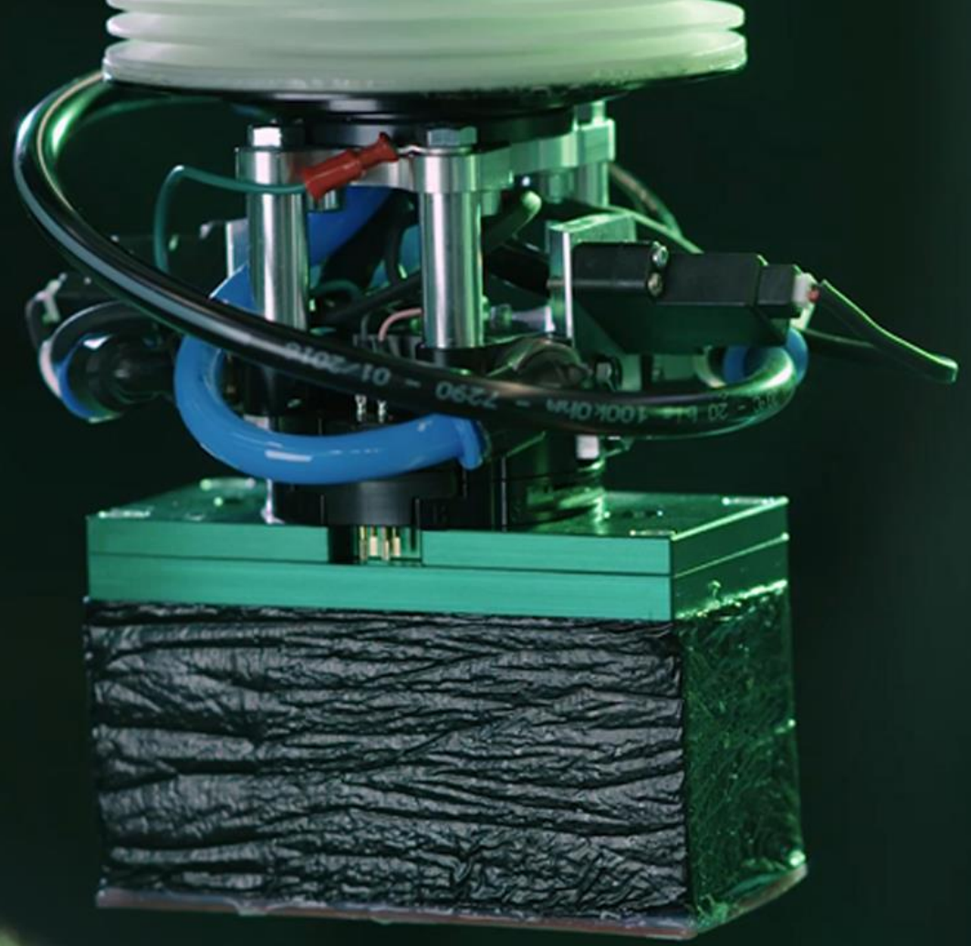

Summary

- Smart automation for high performance production with Fiber Patch Placement
- CAE process for FPP
  - ARTIST STUDIO (CAD-CAM)
  - ARTIST STUDIO Plug-in for HyperMesh (FEM)

Outlook

- Increase of Composites 4.0 and CAE capabilities

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We enable manufacturers to produce complex composites in high volume and superior quality. For a lighter, more sustainable future.