



*Smart production technology
for complex fiber composites*

Lightweight Production 4.0 for Urban Air Mobility

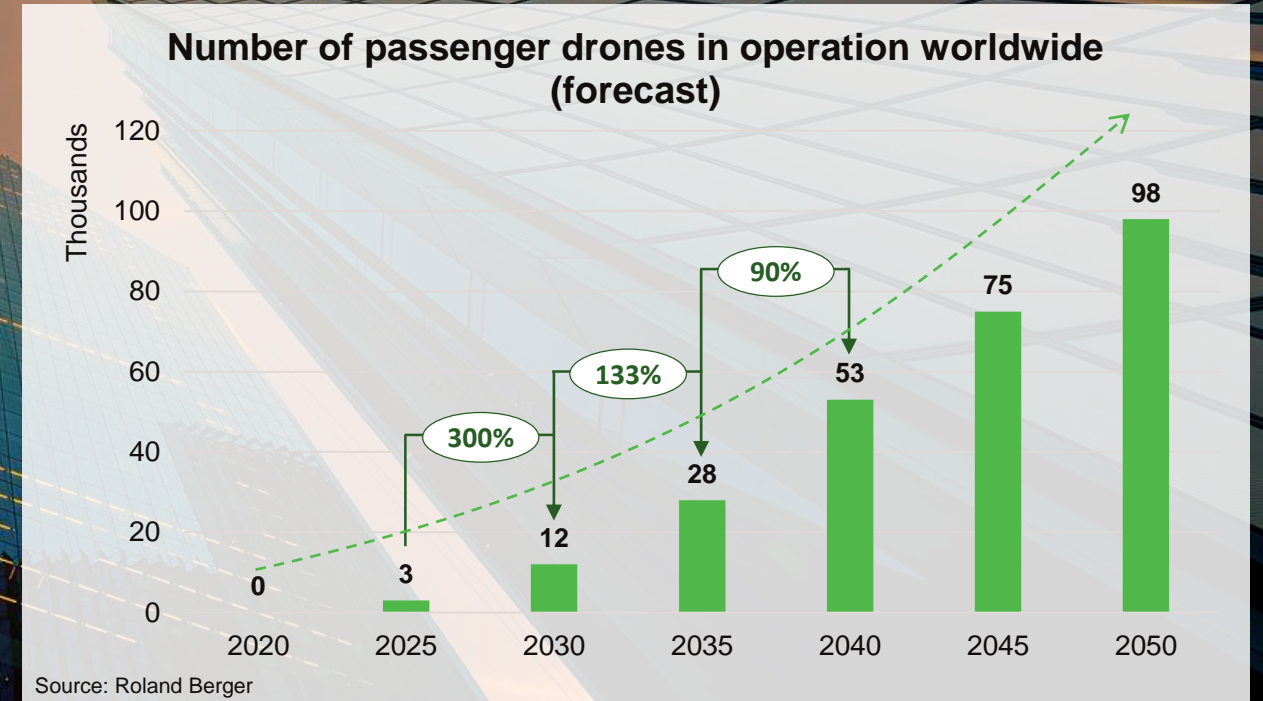
Design for fast & efficient production ramp-up

Thorsten Groene, CEO & Co-Founder
September 4, 2019

cevotec
milestones in composites

A new horizon for lightweighting

A composites point of view on urban air mobility



Designed with scalability in mind?

Urban air is different

Unparalleled lightweight requirements of manufacturers



Maximize mission range

Enable low-cost operations

Minimize environmental footprint

Lightweight requirements

>> commercial aerospace

Volumes

>> commercial aerospace

Design

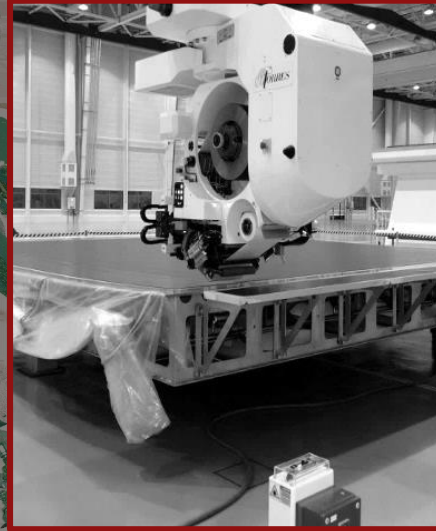
= windows & frames

Today's available composite tools...

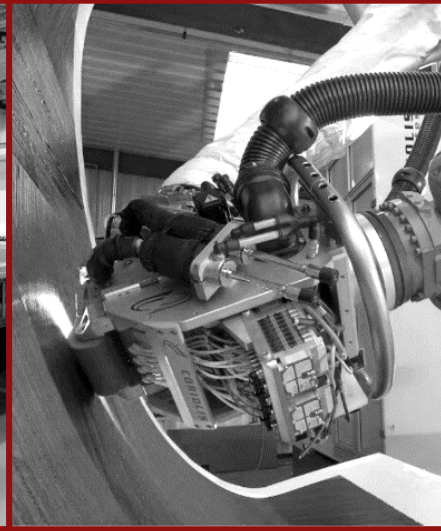
... are not prepared to meet the challenges of UAM



Hand lay-up



ATL



AFP



Press forming / molding

Equipment

little flexibility for changes

Economics

not for low volumes

Materials

scrap, cost, supply issues

Challenges of scaling up composites production

Design &
prototyping

Testing &
qualification

Production
(manual)

Capacity
limit

Component
redesign

Testing &
re-qualification

Production
ramp-up

Switch to automation

Scaling manual processes requires significant time, effort and resources

Composites automation for urban air mobility

... needs to provides flexibility, efficiency & scalability

Extreme lightweight
design opportunities

Cost-efficiency
also at low volumes

10x scalability
from 100s to 1000s

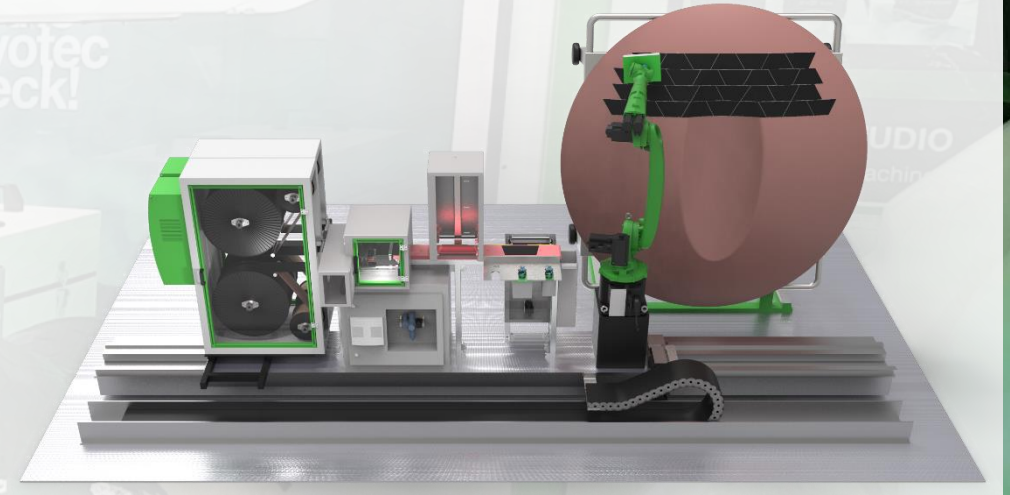


Fiber Patch Placement





Flexible 3D fiber lay-up platform for complex composites

SAMBA Series

Flexible lay-up automation platform

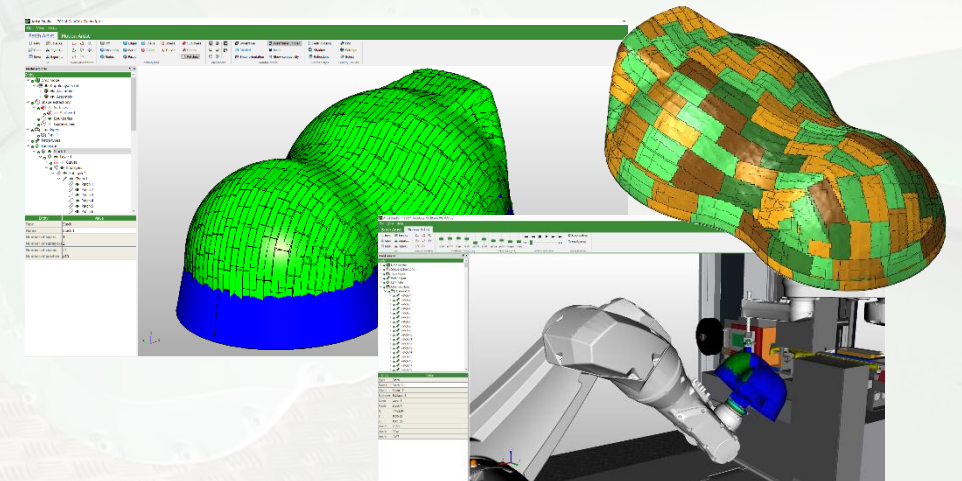


Benefits

-  Flexibility by fast & easy tool change
-  Low cost, also at low volumes
-  Multi-material for extreme lightweight
-  Multi-sensor in-process quality control

ARTIST STUDIO

CAE software for design & production

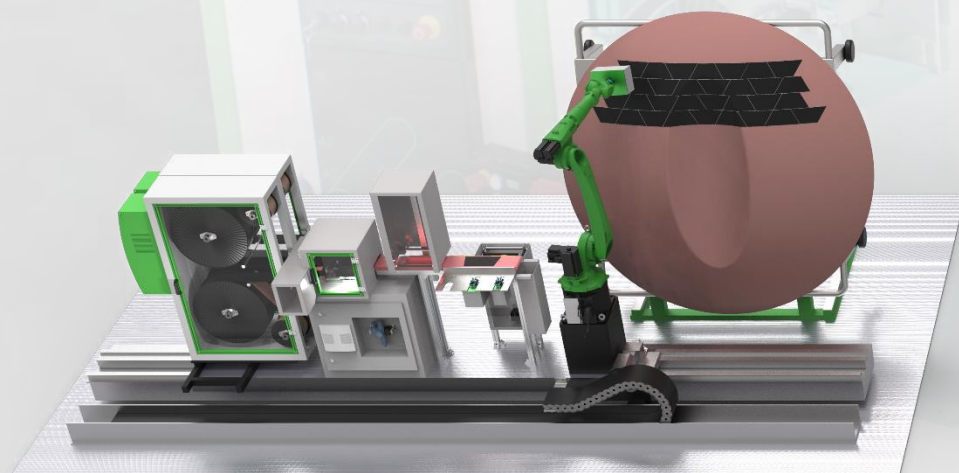


www.cevotec.com/en/fpp-technology/

SAMBA Series

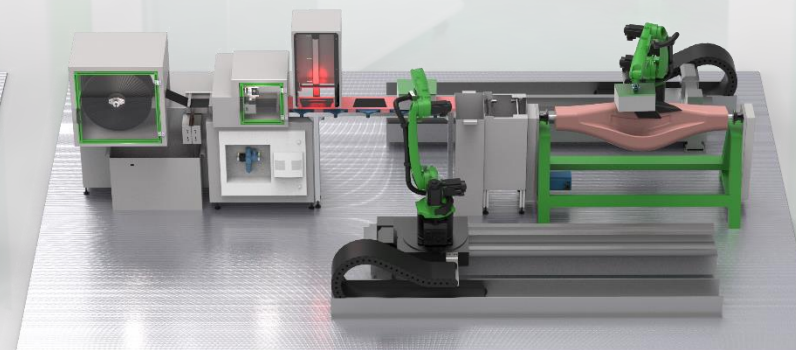
Modular, scalable platforms for multiple part flexibility

Configuration examples



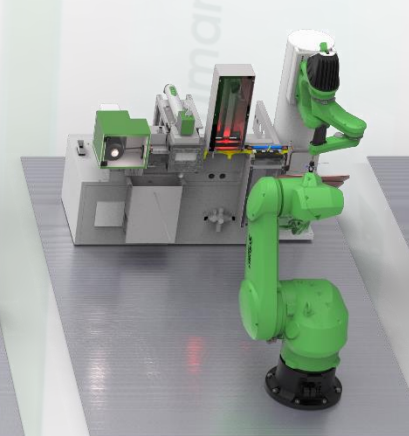
SAMBA *Multi*

carbon, glass and other fibers



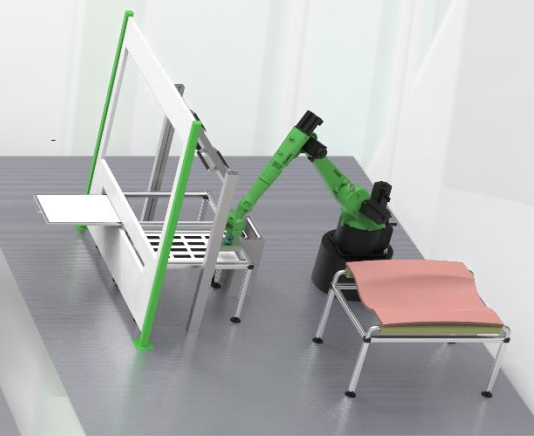
SAMBA *Scale*

high-throughput production



SAMBA *Pro*

flexible production



SAMBA *Step*

prototyping / R&D

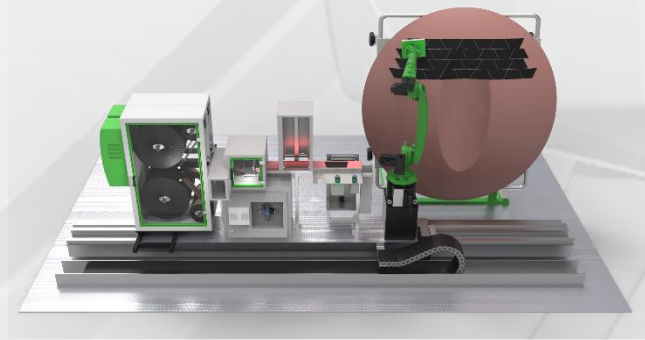
Scalability of production systems: no changes in composite laminates, no re-qualifications

The Cevotec portfolio

Your one-stop partner for patch-based production equipment & software

SAMBA Series

Fiber lay-up automation systems

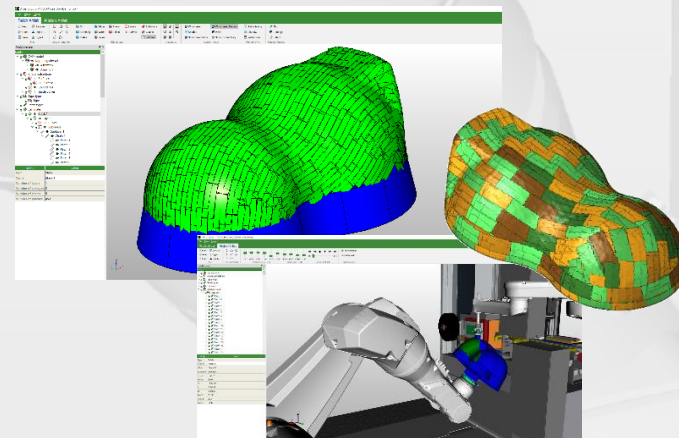


in cooperation with **baumann** AUTOMATION

- Flexible 3D fiber lay-up platforms
- Configurations tailored to applications
- Self-corrective process control

ARTIST STUDIO

CAE software platform



- CAD-CAM for patch technology
- ARTIST STUDIO plug-in for FE software
- Perfectly matches SAMBA systems

cevoLab - customized services

Application development, prototyping, customization



- Product development, prototyping & low-volume production
- CAE analysis & FEM-based optimization
- Customized fiber spread tow and patch grippers

Automation solutions for complex, multi-material fiber lay-up

Recommendations to urban air manufacturers for achieving efficiency & scalability with composites

cevotec
milestone in composites

- 1) Exploit all lightweight opportunities
- 2) Design for scalability (avoid re-qualifications!)
- 3) Automate early, but flexibly
- 4) Leverage technology-specific software



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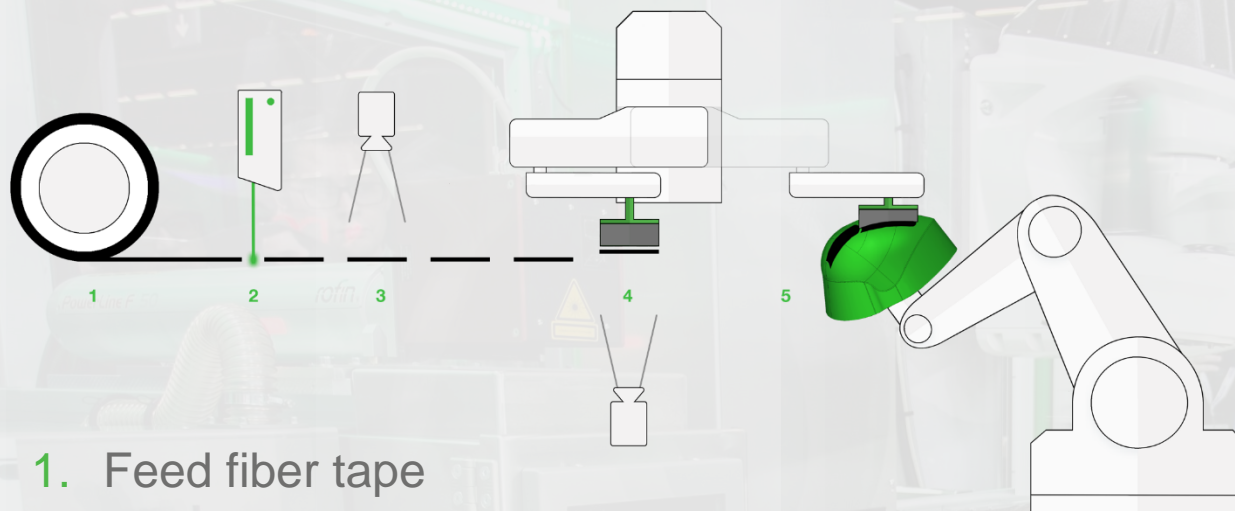
We enable manufacturers to produce complex composites in high volume and superior quality.
For a lighter, more sustainable future.

Appendix

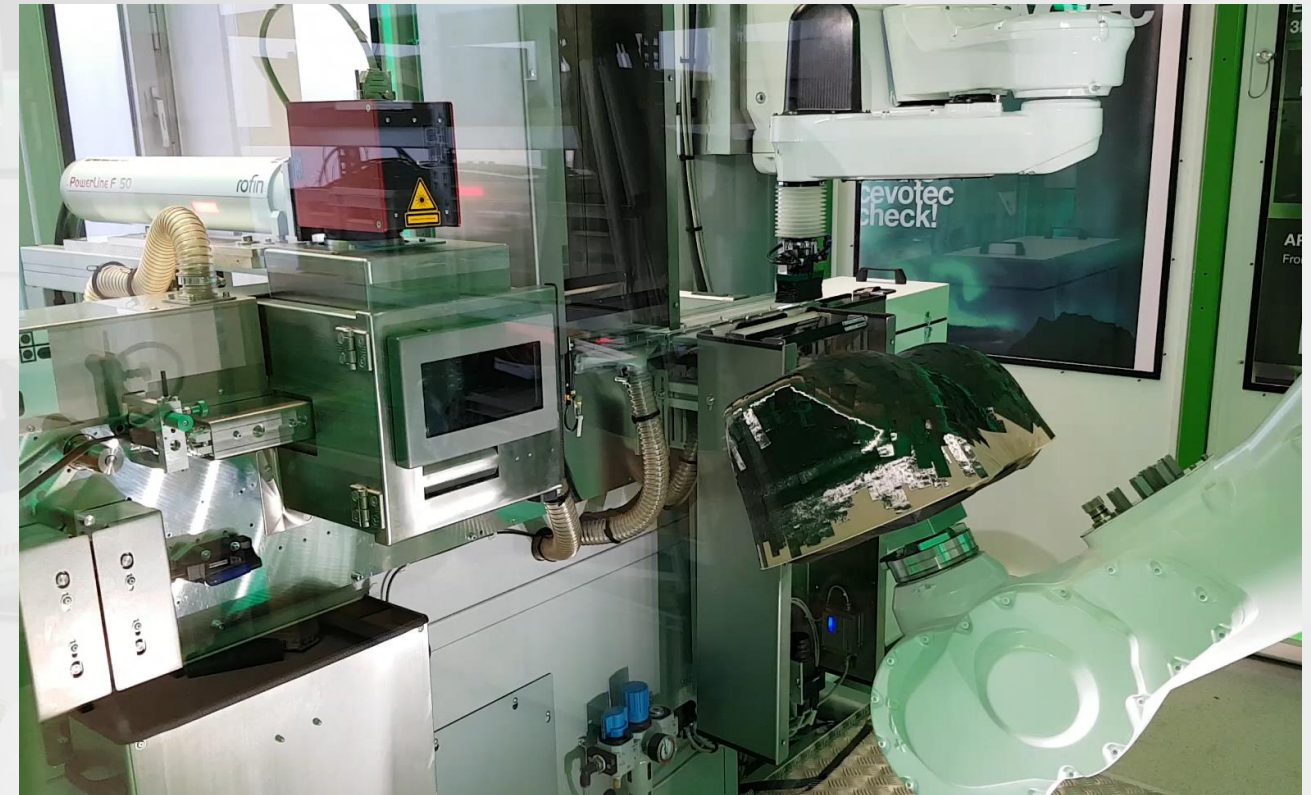
cevotec

The Cevotec process

Fiber Patch Placement (FPP) – flexible additive manufacturing for complex fiber composites



1. Feed fiber tape
2. Cut tape into patches
3. Inspect quality
4. Pick-up, check position
5. Place fiber patch



 <http://cevotec.com/en/fpp-technology/>

Enabling a fully automated, quality-controlled 3D layup for complex composites

Focus industries and applications

Focus industries



Aerospace



Automotive



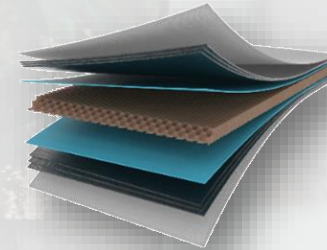
Medical



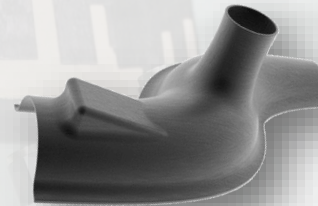
Sports, other

Primary applications

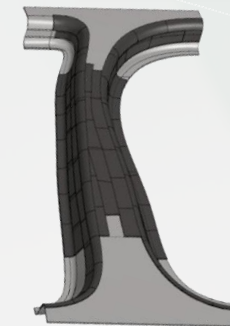
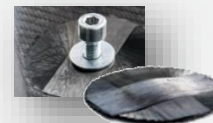
Multi-material
components



Complex
geometries



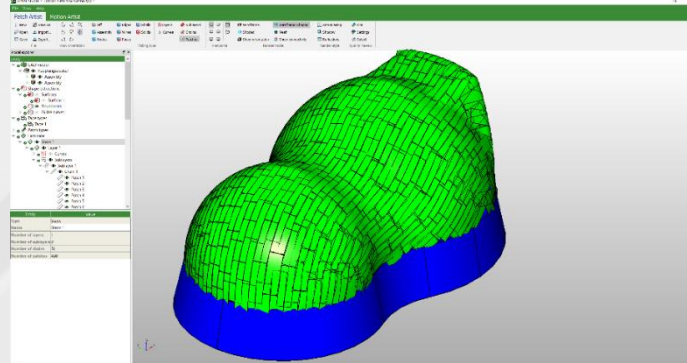
Tailored
reinforcements



Comprehensive CAE software platform for Fiber Patch Placement

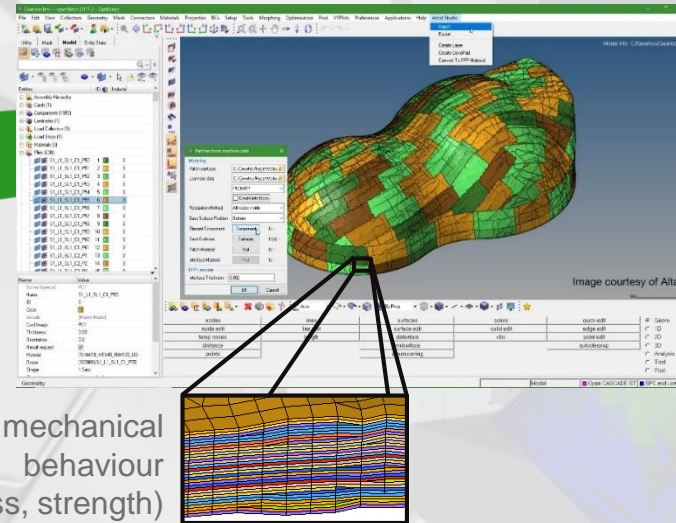
Enabling a continuous virtual process chain for patch technology

CAD – PATCH ARTIST



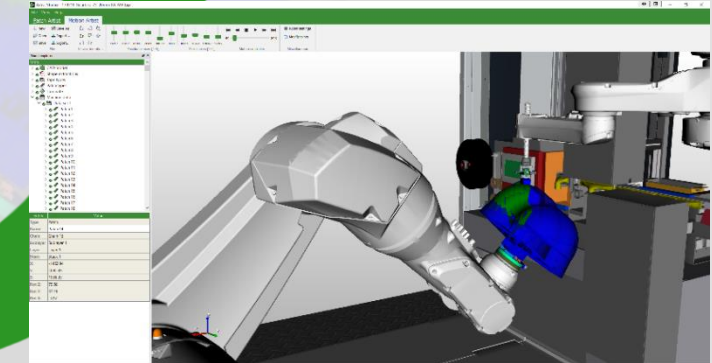
Generate a patch-based laminate with optimized patch overlaps

Simulate mechanical behaviour (stiffness, strength)



ARTIST STUDIO PLUG-IN
for commercial FE software

CAM – MOTION ARTIST



Generate machine data through offline robot programming

Digital development suite cuts design-to-prototype time from days to hours

Massive drop in strength of classical laminates

Average fiber-to-load deviation is significantly reduced with Fiber Patch Placement

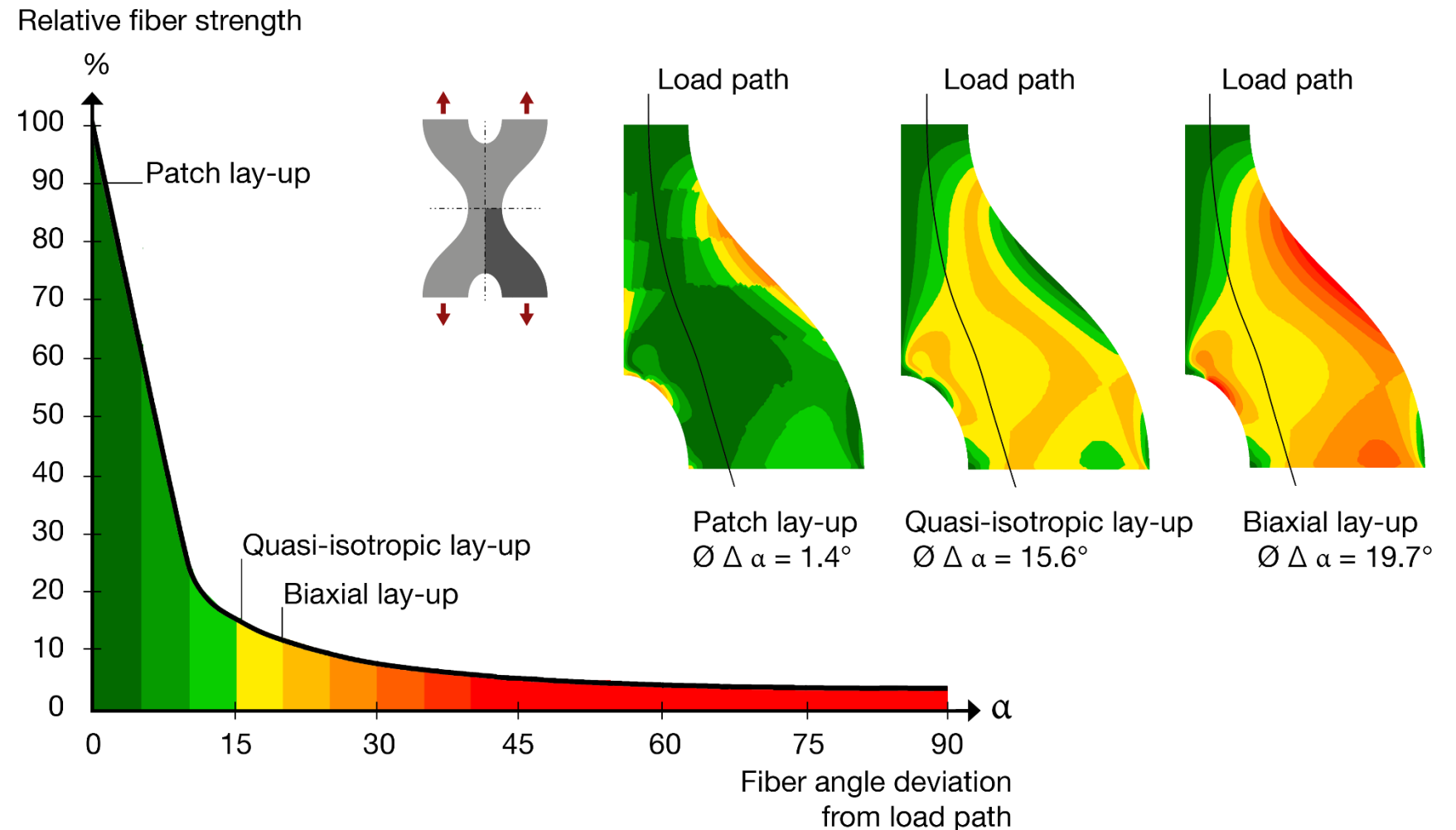
Fact

Multiaxial non-crimp fabrics such as quasi-isotropic lay-ups cannot exploit the full potential of the material.

Example

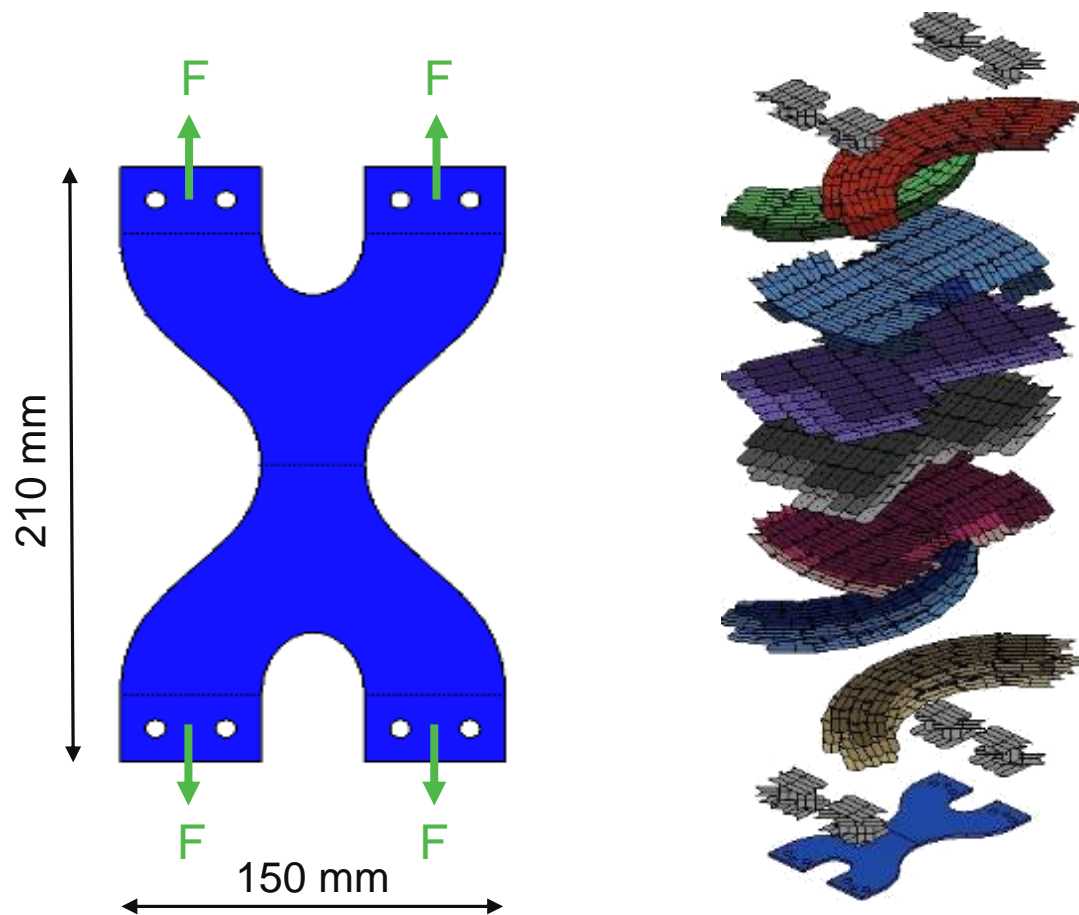
Only 15° deviation to a tension-based load path leads to an extremely reduced strength (>80%)

► Patch layup supports optimal lightweight design

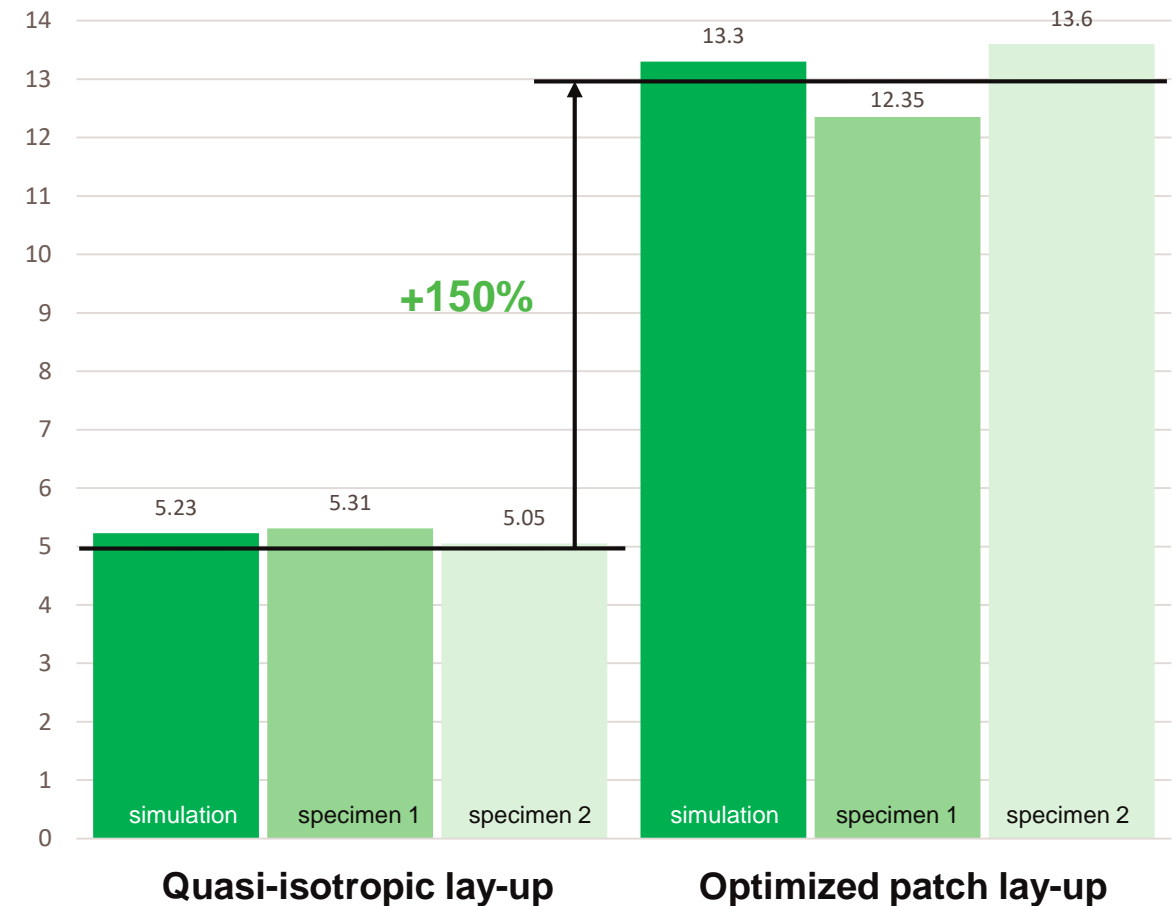


2.5x stiffness increase with load-optimized patch laminate

High performance lightweight design with Fiber Patch Placement



Mass-specific stiffness [kN/(mm·g)]

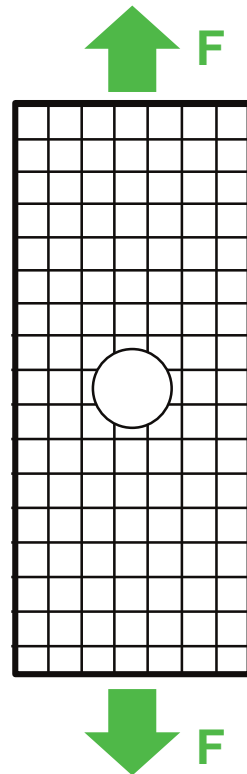


Source: Cevotec and Technische Universität München

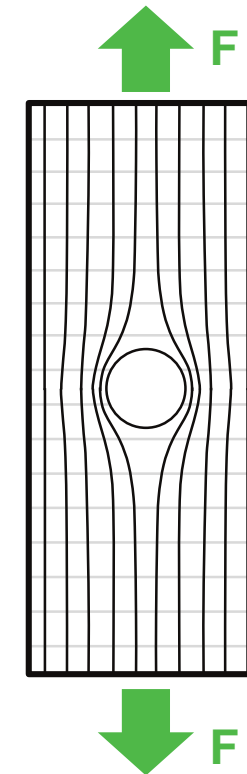
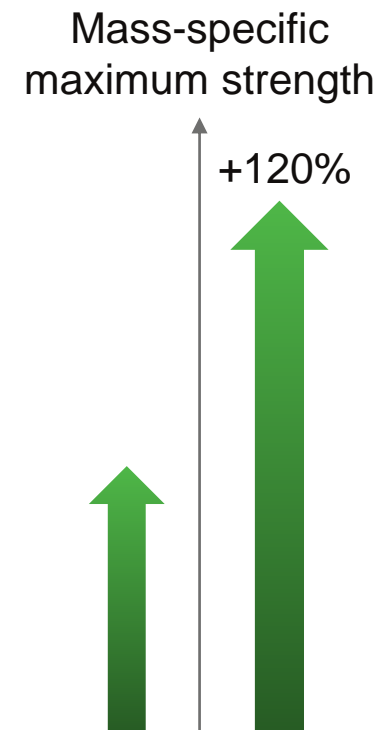
2.2x strength increase through curvilinear fiber orientation

Demonstration at an open hole specimen

Biaxial non-crimp fabrics



Load path oriented fibers (patch basis)

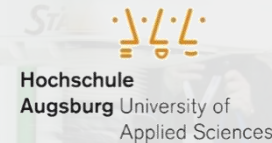


Source: O. Meyer, Short fibre preform technology for load path aligned manufacturing of fibre reinforced plastic components, Doctoral thesis, University of Stuttgart, 2008

References & partners (selection)

References

Premier OEM, manufacturers and institutes develop innovative automation solutions with us. Among them:



Strategic partners

Strong partners share our vision, support us and work jointly with us towards a better future!



Sales partners

Cevotec's exclusive sales representative in North America:

Composite Automation

<http://www.compositeautomation.com>

john@compositeautomation.com



From the press (selection)

Complete press review: <http://cevotec.com/en/from-the-press/>



Trip the light fantastic!

January 17, 2019



Additive Fertigung der nächsten Generation

Fiber Patch Placement mit dem Roboter

May 11, 2018



Mit Fiber Patch Placement zum komplexen 3D-Bauteil

September 06, 2017



Fiber Patch Placement machine, software

April 19, 2017



Durchbruch in der Composite-Produktion

September 23, 2016



Carbon-Patches verstärken die Karosserie

September 17, 2018



Direct 3D-preforming with Fiber Patch Placement

May 10, 2018 (p. 14-15)



Cevotec presenta l'imbuto di finestra al progetto Fiber Patch Placement del Paris Aviation Show

July 05, 2017



Exclusive preview of SAMBA preforming demo

March 6, 2017



Automatisierungsgrad stark erhöht – Fertigungsautomation

December 16, 2016



Fiber Patch Placement soll Automotive-Leichtbau revolutionieren

September 11, 2018



Fiber Patch Placement at scale

February 09, 2018



Cevotec Samba: software en robotcel voor 3D composietdelen

March 13, 2017



Cevotec celebrates successful market launch at JEC World 2017

March 28, 2017



Fiber patch preforms help tailor kiteboard performance

January 28, 2016



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