## About Cevotec

Cevotec is the leading provider of automation equipment based on Fiber Patch Placement (FPP) technology. Cevotec's robotic lay-up systems and dedicated CAD-CAM software enable the efficient, automated production of complex, multi-material composite parts, serving industries such as aerospace and composite tanks. Cevotec's commitment to innovation and sustainability drives its mission to empower manufacturers to build complex composites – in high volume and superior quality, worldwide.


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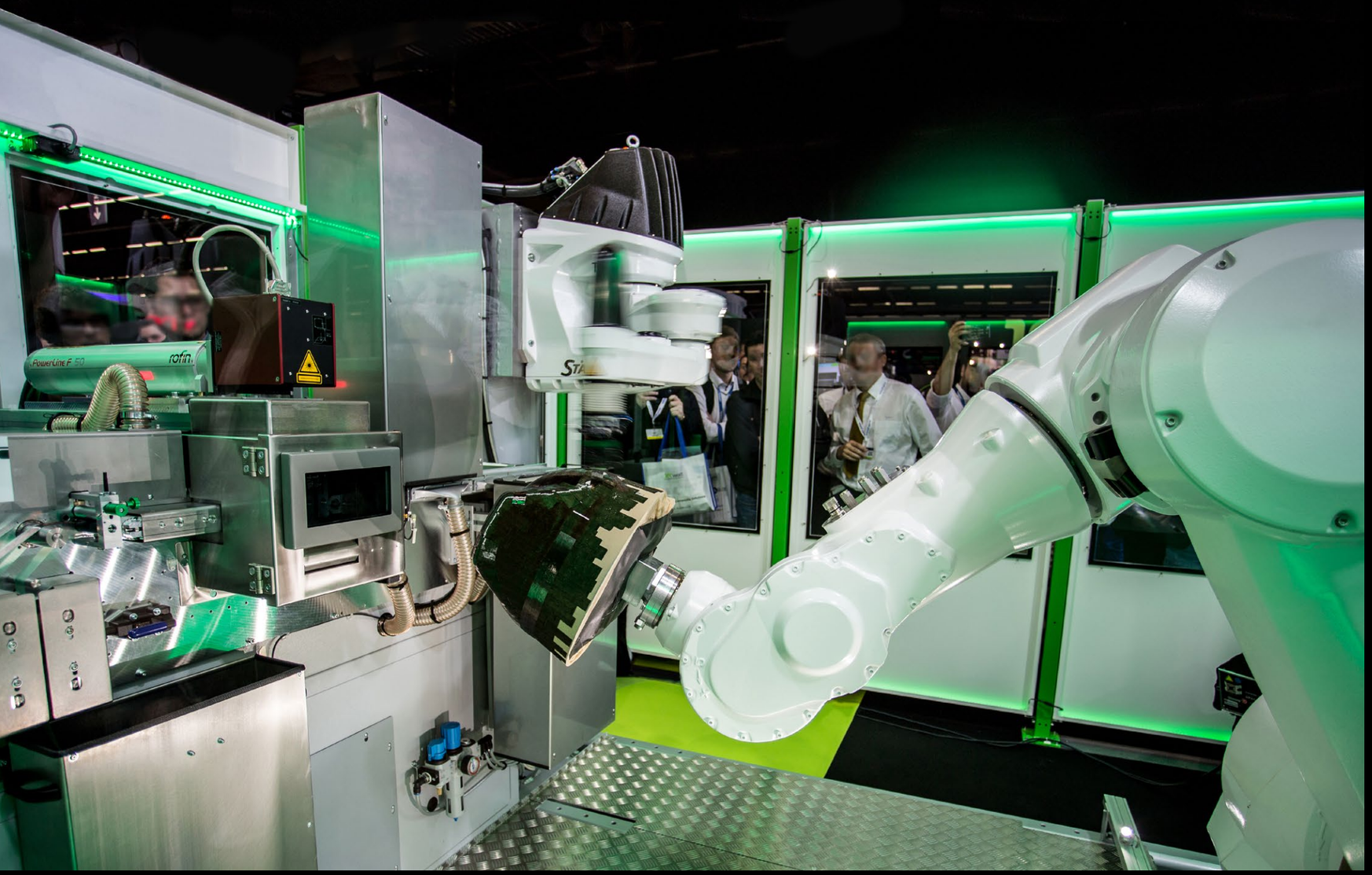
# Fiber Patch Placement



**Fiber Patch Placement is a robot-based, direct-3D placement technology for high-performance composites.**

- Digitized, automated process chain
- 100 % in-process raw material inspection
- Multi-material lay-up capability (carbon, glass, adhesives, etc.)
- 20 % - 60 % cost & time savings

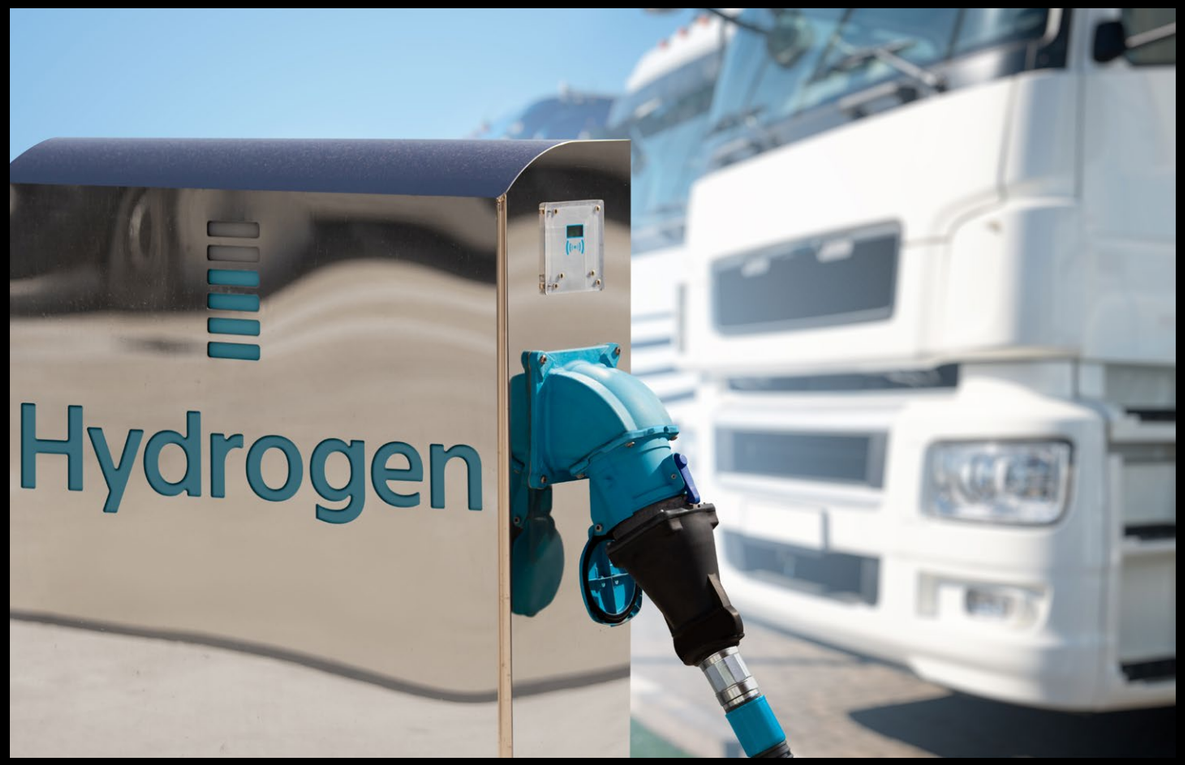
**We enable manufacturers to produce complex composites in high volume and superior quality.**

For a lighter, more sustainable future.

Fiber Patch Placement (FPP) combines productivity, flexibility, and cost-efficiency, even at low volumes, through scalable automation. Using discrete fiber patches, the technology enables automated production of complex 3D shapes, multi-material laminates, and load-adjusted fiber designs, delivering efficient lightweight solutions with a superior buy-to-fly ratio. Its capability to handle a broad variety of materials, including carbon fiber, glass fiber, and adhesives, opens up a new range for automated composite production.

# Store more $H_2$


## Reinforcing the future of $H_2$ storage






# Bridge the_gap

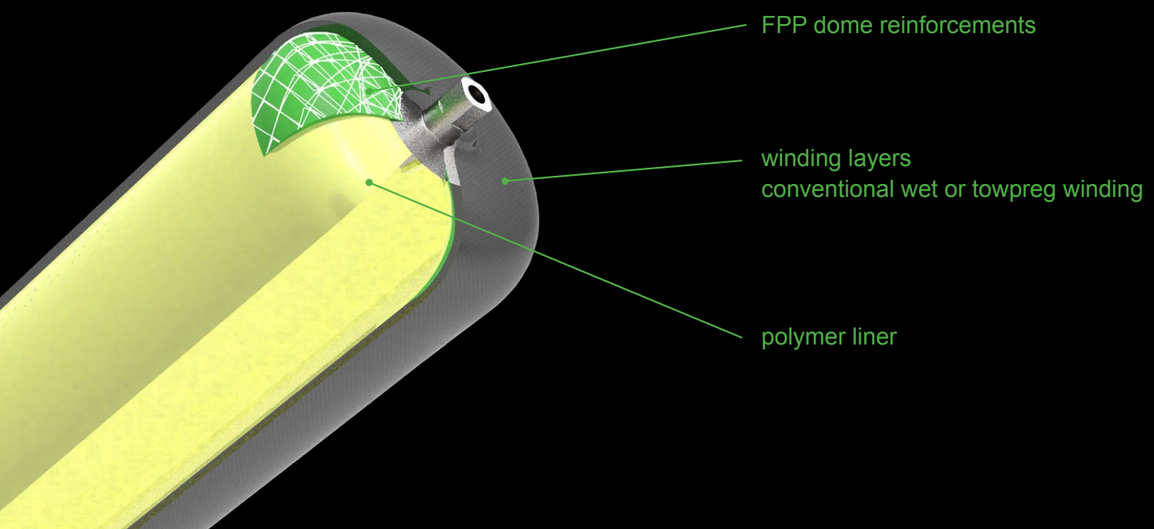
between

AFP & hand lay-up

## High-rate precision lay-up of multi-material aerostructures

# Dome reinforcements: More storage volume at lower cost

Composite tanks enable safe, efficient gas storage, crucial for hydrogen-fueled mobility and the global "net zero" goal. However, the production consumes a lot of fiber material. Reinforcing the tank's domes cuts ~15 % material and cost without compromising mechanical properties, and enables a storage volume increase.



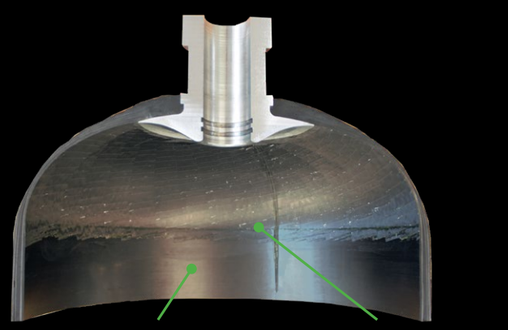

## Full-scale industrial demonstrator

In collaboration with industry partners, we developed and tested an optimized, full-scale reinforced Type 4 tank. The project included laminate design, simulation, optimization, production, and burst testing of 300-bar composite tanks per BS EN 12245 (3.0 x burst safety factor).

**Results:**

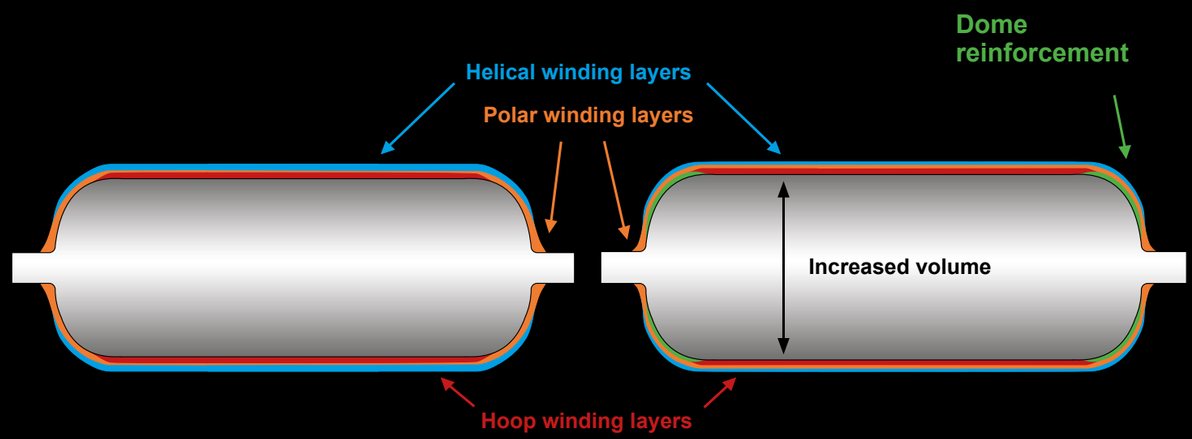
- 108 % of the required pressure with 15 % less material
- Potential for volume increase through thinner cylinder wall
- 17 % improved storage efficiency

Scan for detailed project report

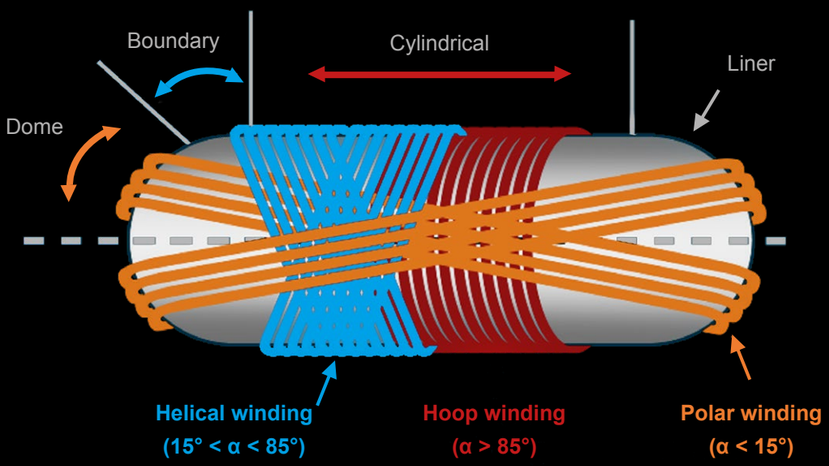



## Dome reinforcements replace certain helical layers in a winding laminate

Certain helical layers are replaced by local dome reinforcements. This reduces the amount of inefficient fibers in the cylindrical section, translating into less material required to achieve equivalent mechanical properties. It also enables an increase of the inner tank diameter as the thickness of the cylindrical area decreases.




## Background: Three typical winding patterns of composite tanks

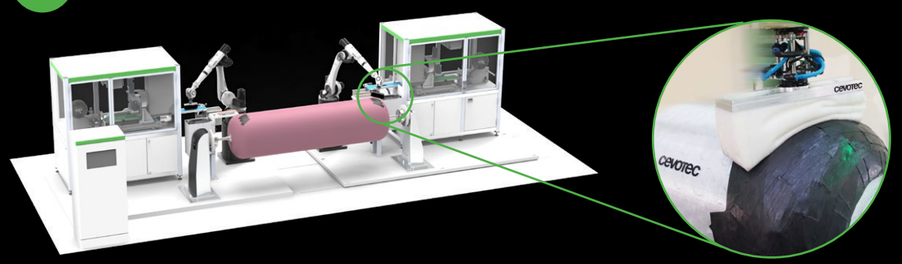



Carbon fiber performance depends on alignment with component stresses. Filament-wound tanks use three patterns: hoop winding (α > 85°), helical winding (15° < α < 85°), and polar winding (α < 15°). Helical layers support stresses in the dome area but underperform in the cylindrical area due to fiber orientation.

# SAMBA Pro PV-2: Integrating dome reinforcements in industrial production

Cevotec's SAMBA Pro PV-2 system is the first industrial equipment able to place dome reinforcements directly onto the liner without additional manual manufacturing steps. This can be combined with established wet or towpreg winding equipment.

1




**Automated dome reinforcement directly on liner**

See the process in action

- Fast cycle time
- Full dome converage
- Flexible fiber designs, incl. non-geodesic

2

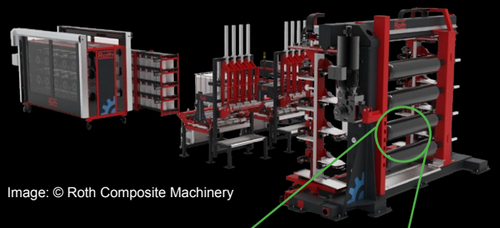
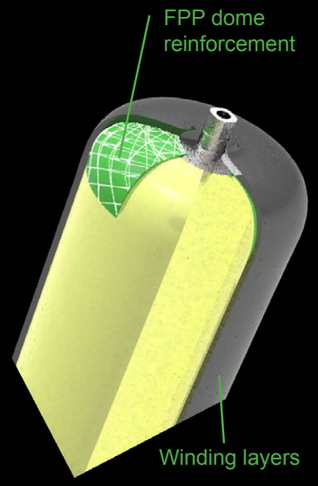


Image: © Roth Composite Machinery

**Filament winding (less material)**

3

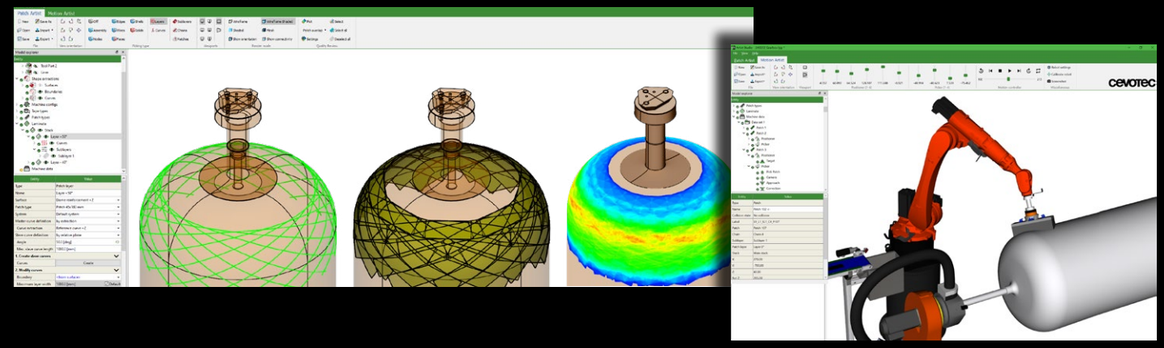



**Lighter composite tank**



**Dedicated features in ARTIST STUDIO**

for generating the design and production program of dome reinforcements

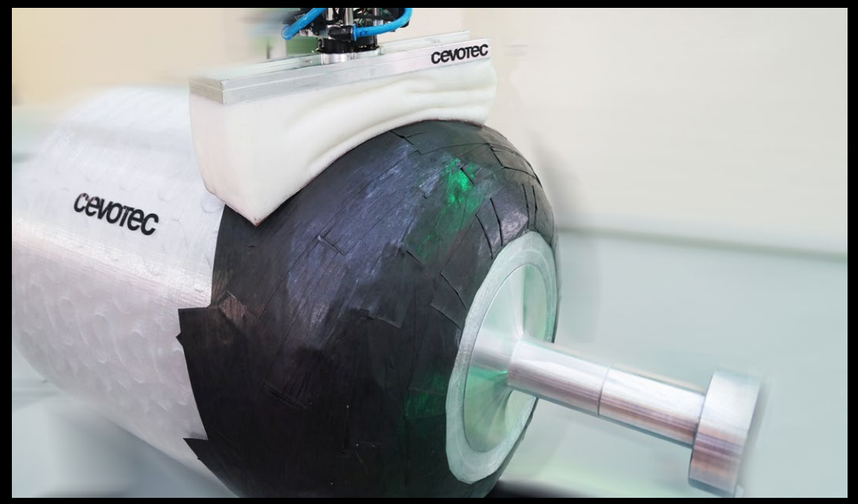



**Your advantages with FPP:**

**More storage volume**
5 % more volume, 20 % better storage efficiency

**Lower cost**
15 % less material for equivalent performance

**Scalable process**
Easy workflow integration, no manual post-processing




Scan for more information

- Economics
- Technology
- Design
- Production integration

# Bridging the gap between AFP and hand lay-up

## Expanding lay-up automation for aerospace composites

**The Problem**
Producing complex, multi-material composite parts, especially in aerospace, involves labor-intensive manual operations, leading to low material lay-up rates, high quality assurance efforts, and elevated component costs. Precise automation is essential for handling complex parts while meeting future quality and productivity standards.

**The Solution**
Fiber Patch Placement (FPP) automates the lay-up of carbon fibers, glass fibers, adhesive films, and other technical fibers on complex 3D geometries.

The form-flexible placement grippers handle a broad variety of materials and perfectly adapt to complex shapes.

By integrating FPP technology, manufacturers can lay-up multiple materials in a fully automated, quality-controlled process, achieving 20 % - 60 % savings in cost and takt time compared to conventional methods.

**Wings**
- Winglets
- Spoilers
- Ailerons
- Flaps
- Slats

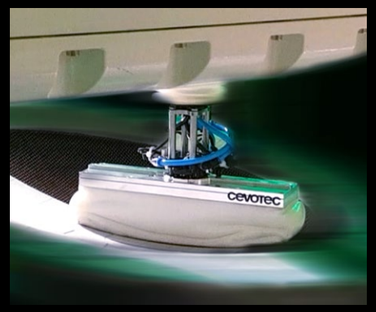
**Empennage**
- Stabilizer
- Rudder
- Elevator
- Dorsal fin
- Aerodynamic fairings

**Fuselage**
- Radome
- Window frames
- Antenna fairings
- Belly fairings
- Landing gear doors
- Cabin liners

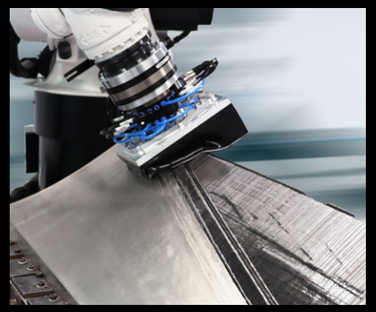
**Engines**
- Nacelles
- Pylon fairings
- Air duct (e. g. engine heat exchangers, HVAC)

Exemplary overview of suitable aerospace applications

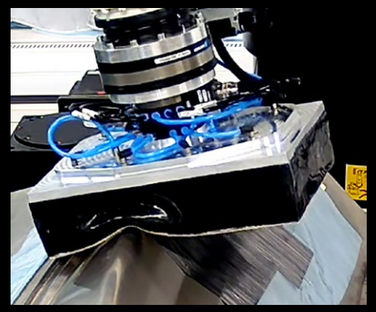
See the process in action




**Form-flexible patch grippers** support the automated and precise fiber lay-up for monolithic and sandwich components.



**Advanced rolling motion placement** features multiple angles of compaction and enables the placement of larger patches on highly curved tools.



**Post-placement push-ins** increase compaction and reduce bridging in areas of high geometric complexity.

**Robotic honeycomb placement** precisely places 3D core material directly on the laminate with a dedicated gripper.

## Your advantages with FPP:

**Automation for multiple materials**
Lay-up capability for many materials. Reduced debulking. Empowers rate increases of legacy parts.

**3D precision lay-up**
Complex 3D lay-up capabilities. 100% in-process inspection. Supports next-generation designs and improves buy-to-fly ratio.

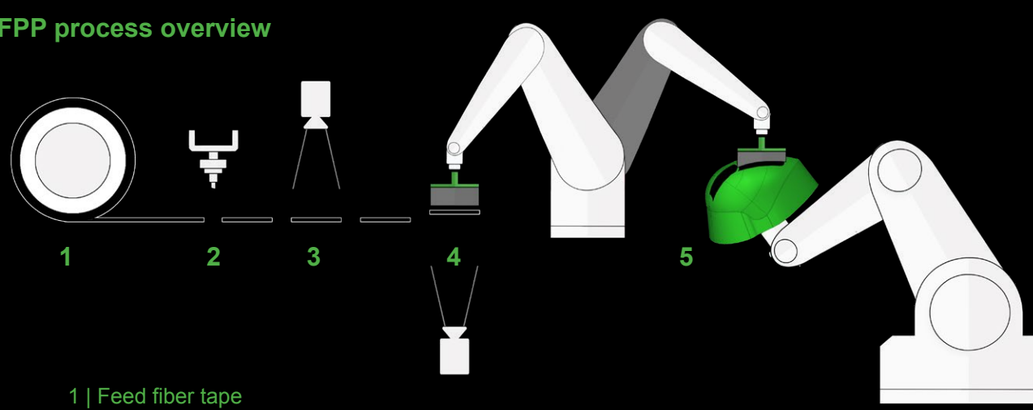
**Efficient design & programming**
Comprehensive software with dedicated FPP design features. Integrates into the existing aerospace design workflows.

**Achieving cost & ESG targets**
20 % - 60 % cost reduction. Improved work conditions. Less scrap. Improves sustainability and enables “net zero” for aerospace.

# How it works: Fiber Patch Placement technology

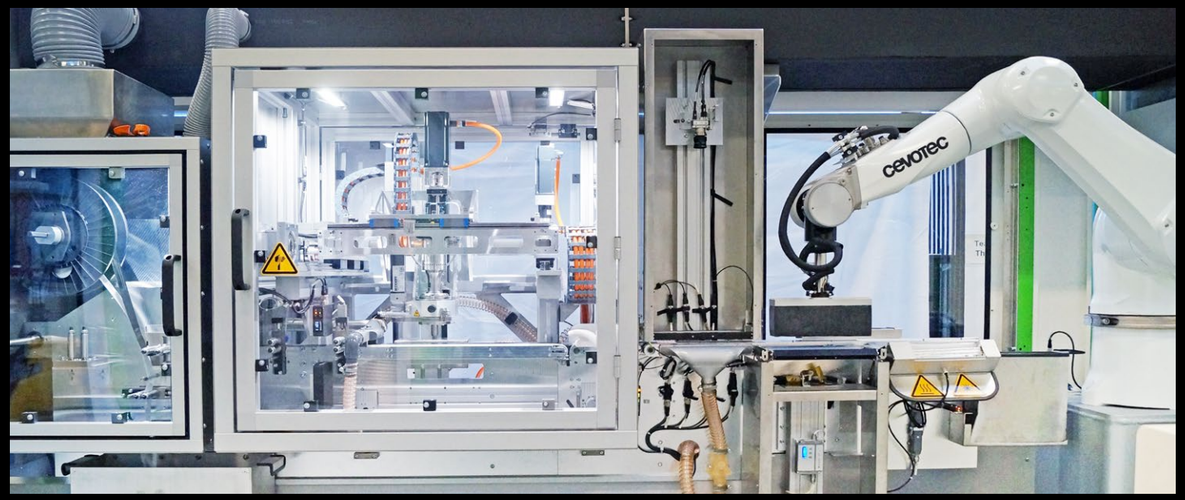
Fiber Patch Placement (FPP) is a robot-based, direct-3D fiber placement technology that pushes the boundaries of automated fiber lay-up. Compatible with a wide range of materials, including carbon fiber, glass fiber, and adhesives, FPP delivers unmatched precision and flexibility. Patches are automatically cut and placed by advanced robotic systems, tailored to your component's size and complexity. Scalable patch sizes up to 300 mm x 200 mm and beyond enable process efficiency also for large components. Inline process monitoring, powered by high-definition cameras and sensors, provide for superior process control throughout the entire laminate lay-up cycle. This empowers manufacturers to produce superior quality in high volumes.

## FPP process overview




1 | Feed fiber tape
2 | Cut fiber tape into patches
3 | Inspect fiber patch quality
4 | Pick up patch, check patch position
5 | Position patch on 3D form tool

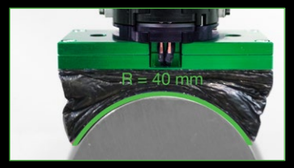
See the process in action

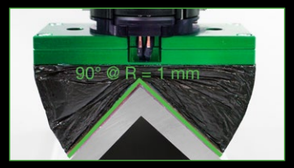



## cevo**Gripper**

The cevoGripper is a form-flexible placement gripper designed for fast, automated lay-up on complex shapes. Available in custom sizes, it adapts to intricate surfaces, placing patches precisely across 90° angles and biaxially curved surfaces without negative draping effects.





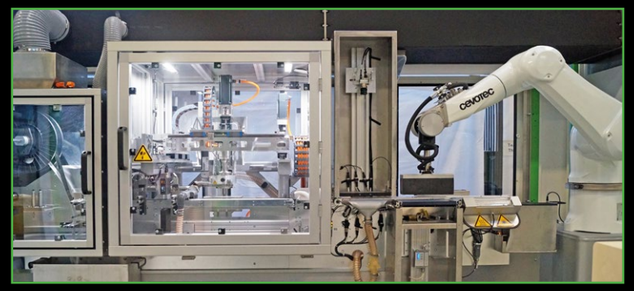




- Sizes from 45 mm x 95 mm up to 240 mm x 360 mm
- Vacuum suction with high mass flow rate
- Integrated patch blow-off functionality
- Customized foam body for specific compaction requirements
- Automated quick-mount for gripper change on-the-fly
- Optional heating for dry fiber tape with binder

The workflow
## 4 simple steps to a complex 3D composite part

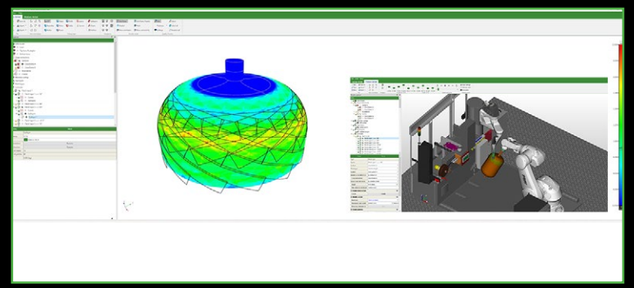
- Design patch laminate in ARTIST STUDIO
- Generate robot program in ARTIST STUDIO
- Set-up SAMBA system, load materials and tool
- Press "Start" on SAMBA system for automated 3D lay-up

# The Cevotec portfolio: Patch-based production technology



## SAMBA Series – automated FPP production systems

· Production platform for automated, complex 3D fiber lay-ups
· Multi-material lay-up capabilities (carbon, glass, adhesives, etc.)
· Customizable robot and machine configurations
· Adjusted to component size and complexity



## ARTIST STUDIO – FPP-specific software platform

· Virtual product development platform for FPP technology
· Efficient laminate design with FPP-specific lay-up features (CAD)
· Automated offline robot programming, process simulation and collision detection (CAM)
· Interface module for commercial FEA software
· Full digital twin of SAMBA system

## cevoLab – the FPP Competence Center

· Individual application development
· Machine customization
· FE-simulation and laminate optimization
· Prototyping and small-scale series production
· Tailored patch grippers

## cevoServices – support, training, maintenance

· Comprehensive development and production support
· Training and consulting for engineering teams
· Regular maintenance of production systems for highest availability
· Fast repair service, also with remote access option
· Patch gripper refurbishment

# SAMBA Series: Modular 3D fiber lay-up systems

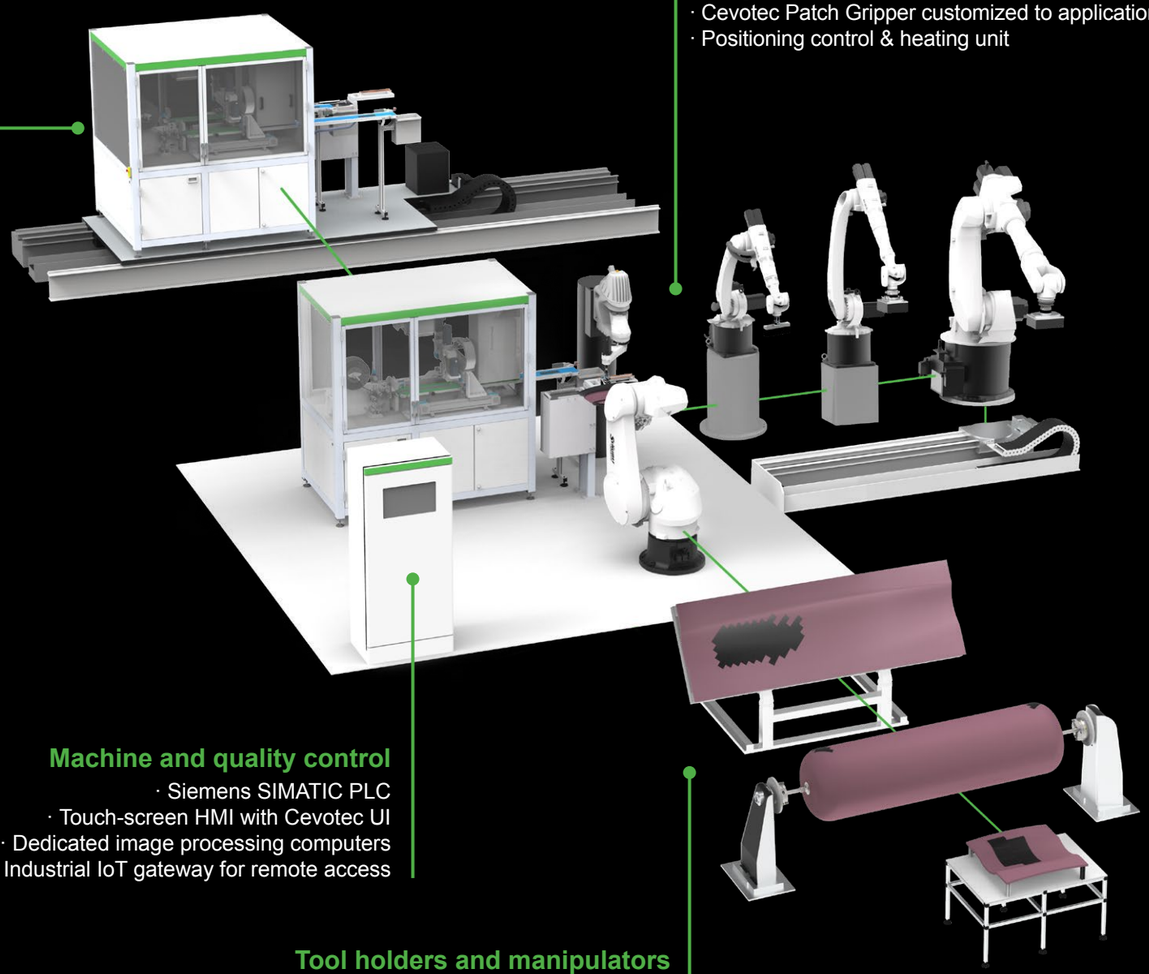
Fiber Patch Placement is a highly scalable and flexible technology. We customize SAMBA systems to your requirements based on four key modules. These modules include solutions for material feeding and cutting, placement, mold manipulation and machine control.

## Feeding & cutting units

· Compatible with wide range of materials
· Multiple, parallel material feeds possible
· Customizable tape widths
· Ultrasonic cutting unit by GFM
· High-precision patch quality control

## Placement units

· Range of placement robots and rails available
· Cevotec Patch Gripper customized to application
· Positioning control & heating unit



## Machine and quality control

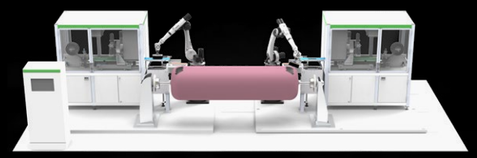
· Siemens SIMATIC PLC
· Touch-screen HMI with Cevotec UI
· Dedicated image processing computers
· Industrial IoT gateway for remote access

## Tool holders and manipulators

· Determined by the application
· Combination of 2 x 6-axis robots possible
· Quick-exchange systems for tools available



## SAMBA Pro PV-2

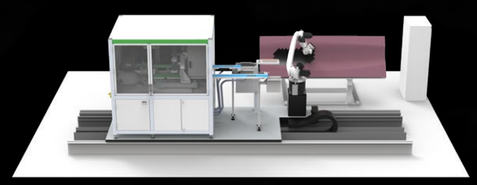


### Optimized for composite tank reinforcements

· Simultaneous patching of both tank domes by 2 placement units
· Linear rail for length variation, adjustable to different tank sizes
· GFM ultrasonic cutting unit; cooled material storage
· In-process quality control and monitoring of process parameters

· Compatible with a variety of carbon fiber and glass fiber materials
· Fully automated robot offline programming in ARTIST STUDIO

## SAMBA Pro Multi

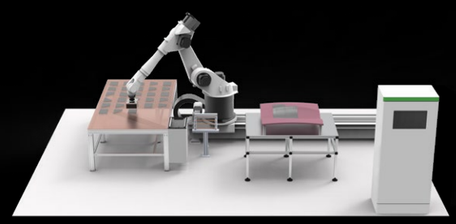


### Optimized for multi-material composite aerostructures

· Large 6-axis placement robot with long reach
· Additional linear rail for extended reach across large tools
· Multi-feeding unit for simultaneous processing of different fiber tapes
· Force-torque sensor for controlled placement e.g. on honeycomb cores
· GFM ultrasonic cutting unit; cooled material storage
· In-process quality control and monitoring of process parameters

· Compatible with a variety of carbon and glass fibers, adhesive prepregs, insulation layers, lightning strike protection materials
· Fully automated robot offline programming in ARTIST STUDIO

## SAMBA Step L



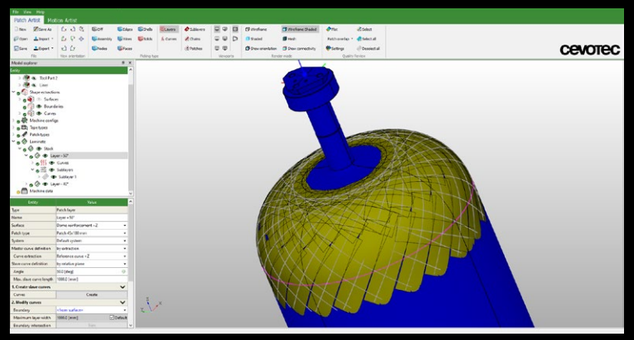
### Optimized for application development, prototyping, R&D

· One 6-axis placement robot (size customizable)
· Additional linear rail for extended reach across large tools
· Maximum material flexibility by feeding pre-cut patches
· In-process quality control and monitoring of process parameters
· Optional advanced sensor package for placement analyses

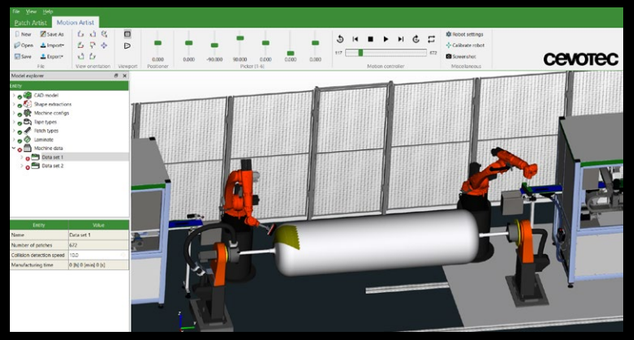
· Fully automated robot offline programming in ARTIST STUDIO
· Lay-up programs can be transferred to SAMBA Pro systems

# ARTIST STUDIO: CAD-CAM software with FE interface

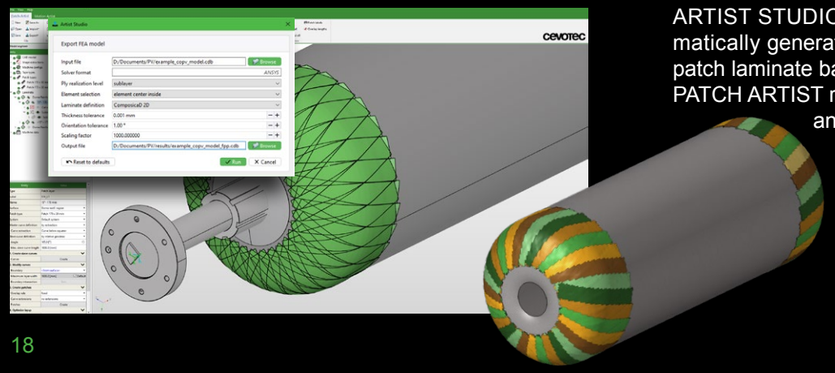
Your engineering team needs efficient tools for faster product development and seamless offline machine programming. ARTIST STUDIO streamlines digital product development and robot programming for Fiber Patch Placement, creating optimized patch laminates and machine programs for SAMBA systems.



PATCH ARTIST is the patch laminate design module. Its user interface is designed to define patch zones easily on imported CAD surfaces, as well as layer orientations, tape thickness, tape width, patch overlaps, patch length and patch cutting angles.



MOTION ARTIST enables you to program SAMBA robots offline in a automated fashion. This module significantly reduces production preparation time while enhancing safety on your shop floor through built-in collision detection and visual process simulation.



ARTIST STUDIO support for FE-modeling automatically generates a detailed FE-model of the patch laminate based on the data defined in PATCH ARTIST regarding geometry, position and orientation of the patches.

## PATCH ARTIST - laminate design (CAD)

| | |
|---|---|
| Interface: | Import of STEP, IGES, STL, CATPart with basic FiberSim support |
| Laminate: | Layer definition with specific material properties and constraints |
| Boundary: | Different lay-up strategies at boundaries (reducing scrap, constant layer thickness) |
| Fiber orientation definition: | Multiple methods to best suit your design specifications (reference curve, plane intersection, reference orientation, geodesic curve) |
| Patch-shape definition: | Rectangular or trapezoid |
| Optimization: | Patch overlap optimization along fiber orientation; local patch length optimization: faster production and improved mechanical performance |
| Accurate placement results: | Patch shape prediction on highly curved surfaces based on a kinematic draping approach; Support for thick laminates using intermediate offset surfaces |
| Visualization: | Mold, laminate, surface normal, fiber orientation deviation<br>Patches and patch normals<br>Individual patch overlap quality and patch length<br>Laminate thickness distribution |
| Manual fine tuning: | Position adjustment for individual patches and geometry |
| Upcoming features: | Patch-overlap measurement and visualization<br>Multi-material production support |

## MOTION ARTIST - robot offline programming (CAM)

| | |
|---|---|
| Robot kinematics: | Digital twin of 4 and 6 axis robots, robot on linear axis<br>Robot-to-robot interaction logic |
| Tool kinematics: | Robot-assisted, linear axis, rotational axis |
| Mold mount point: | Coordinate-based position and orientation |
| Calibration: | Robot to robot positioning, tool positioning |
| Robot movement: | Point-to-Point (PTP), linear |
| Optimization: | Robot movements with consideration of axis limits, robot range, singularities, collision detection, rolling movements for large patches |
| Visualization: | Production cell, robot movements, collisions, laminate |
| Analyses: | Material consumption, production time |
| Interface: | Input: laminate design from PATCH ARTIST<br>Output: machine data program for SAMBA systems |

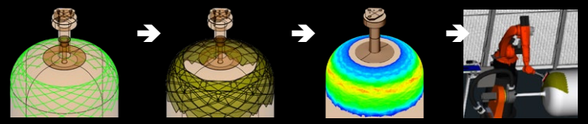
## ARTIST STUDIO support for FE-modeling (FEA)

| | |
|---|---|
| Availability: | FE-modelling support in Artist Studio (currently supported formats: OptiStruct PCOMPP/G, Nastran POMPG and Ansys) |
| Interface: | Expects an existing FEA solver input deck and enhances it with additional FPP laminate properties<br>Requires an existing mesh |
| Properties: | Automated modeling of patches, fiber orientation, thickness, patch overlaps<br>Various element selection methods and multiple patch merging strategies available |

Additional solver support possible upon request.

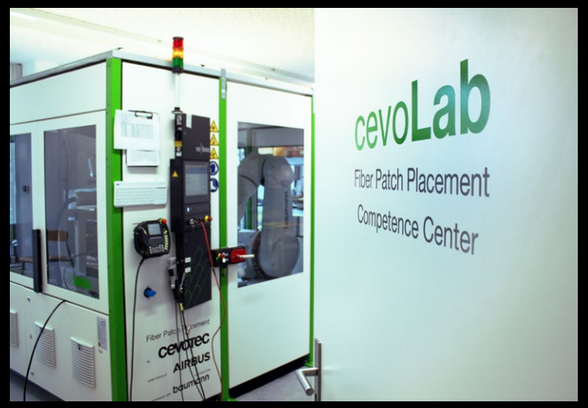
# cevo**Lab: The FPP Competence Center**

## Service offerings



### Application development services

You can develop your application with Fiber Patch Placement together with our technical experts. Test and explore patch technology for your products risk-free. Our comprehensive services range from initial planning to finished prototypes produced in our cevoLab.




### Prototyping & small series production

No matter if you require only a few prototypes for testing in your development process or you are looking to flexibly source small batches of series products – we can produce your laminates for you. Leveraging the latest Fiber Patch Placement equipment in our cevoLab, we offer FPP-as-a-service to support your R&D and production strategy.


### Cevotec lifecycle support

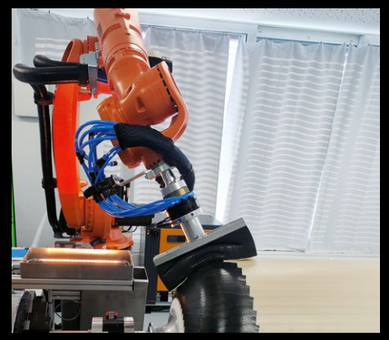
We offer comprehensive support services for development, engineering and production teams, including tailored FPP training and expert consulting. During production deployment, our regular maintenance check-ups and optional remote support ensure an optimized system uptime and fast, effective troubleshooting. We also offer refurbishment services for wear parts like patch grippers and ultrasonic knives.



## SAMBA FPP systems available in the cevoLab

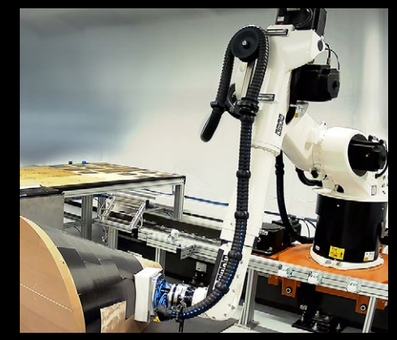
### SAMBA Pro

- Ultra-fast scara placement robot
- Precision laser tape cutting
- Tape width 12.5 – 50 mm;
- patch length 50 – 200 mm
- Build space appox. 1 m x 1 m x 1 m



### SAMBA Pro PV Lab

- For composite tank reinforcements
- Pick & place robot: Kuka KR 22
- Liner size: up to 3500 mm length and 1000 mm diameter



### SAMBA Step L

- Large Kuka KR 60 robot on linear rail
- Flexible feed of pre-cut patches (all materials) up to 300 mm x 200 mm
- Build space approx. 2 m x 3 m x 3 m

# How to get started with FPP

### 1
**ROI & suitability assessment**

Includes manufacturability assessment, unit cost & time analysis, benefits & ROI estimation. This service is complimentary.

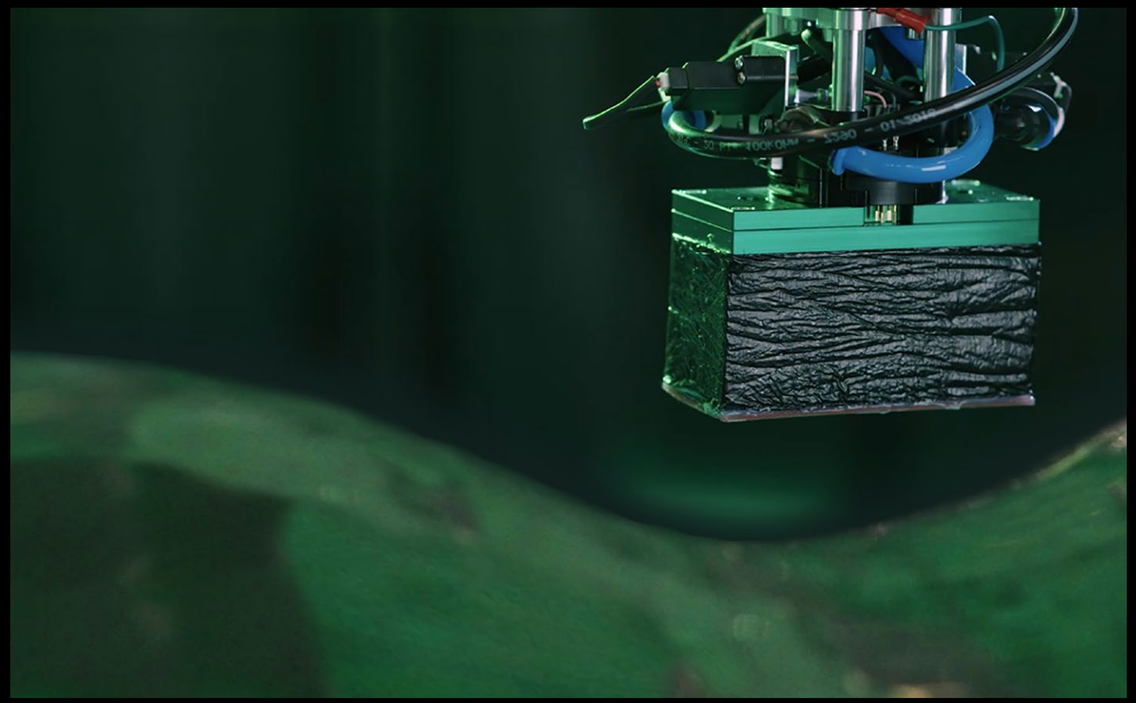
### 2
**Joint application development**

Includes virtual studies, application and demonstrator development, process customization, and more.

### 3
**Customized lay-up equipment**

Includes SAMBA lay-up systems, ARTIST STUDIO software, customized patch grippers, quality control systems, and more.

Fiber Patch Placement enables precise and efficient lay-up automation of difficult-to-handle materials on complex 3D shapes. This allows manufacturers to increase production rates and quality, while simultaneously reducing the cost of production.





## Customer voice

“Cevotec‘s Fiber Patch Placement system expands our existing portfolio of automated production technologies for composite aerospace parts. With the addition of the SAMBA Pro system, we can now automate manufacturing of composite parts that were geometrically too complex for automation while precisely controlling fiber orientations for optimizing part design. It is the perfect enhancement to our robotic production equipment such as AFP and ATL and it allows us to compare technologies and advise our industrial partners on the optimal lay-up strategy. With the addition of SAMBA Pro system, we can automate manufacturing of composite parts at high rates regardless of their complexity. I‘m pleased about the good collaboration with Cevotec: We got a great onboarding after the commissioning in our facilities and receive remote support wherever possible.“

***Dr. Waruna Seneviratne***
*Director, Advanced Technology Lab for Aerospace Systems (ATLAS)*

## Partners & references

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