milestones in composites

The Fiber Patch Placement Specialists

flexible automation platform

multi-material lay-up

self-corrective inline quality control

digital development services

CAD-FEM-CAM software

complex 3D shapes

20% - 60% cost & time savings

The Fiber Patch-Placement Specialists

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Revolutionizing composites with Fiber Patch Placement

Composites Manufacturing
In many applications, fiber composites are irreplaceable for their unique properties, e.g. the high specific strength and stiffness of carbon fiber, the isolation properties of glass fiber, the thermal expansion of composites compared to metals. But labor intensive, manual production processes keep production costs high and limit scalability. Available automation solutions for manufacturers are often very expensive and inflexible when product changes need to be implemented.

Challenges of conventional production methods
- High scrap rates
- Slow lay-up rates
- Inflexible and expensive equipment
- High production cost
- No automated solutions for complex 3D shapes and integrated multi-material lay-up

Fiber Patch Placement
Fiber Patch Placement (FPP) enables a new combination of productivity, flexibility and costs. It offers efficiency even at low volumes through flexible and scalable automation. Adapted to the size and complexity of a component, the technology works additively in “sensible increments”, so called fiber patches. This enables automation for complex 3D shapes, multi-material laminates and locally load-adjusted fiber designs, resulting in efficient lightweight solutions with a remarkably improved buy-to-fly ratio.

Benefits of additive Fiber Patch Placement
- Digitized, automated process chain
- Multi-material lay-up capabilities (carbon, glass, adhesives, etc.)
- Quick and economical product changes
- 100% self-corrective raw material and placement control
- 20% - 60% cost saving compared to manual lay-up
- Full automation for complex 3D shapes
The Cevotec portfolio: Patch-based production technology

**SAMBA Series – automated 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 – CAE software platform**
- Virtual product development platform for patch-based lay-up technologies
- Designed for use with SAMBA systems
- Laminate design and offline robot programming
- Process simulation and crash detection

**cevoLab – the FPP Competence Center**
- Individual application development
- Machine customizations
- 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
- Patch gripper refurbishment

Develop your application exclusively in our cevoLab to explore Fiber Patch Placement and adapt it to your specific requirements.

Cevotec representative in Japan & Thailand: Fujindo Industries
http://www.ficjp.com/en

Cevotec representative in North America: Composite Automation
http://www.compositeautomation.com

**Strategic partners**

AIRBUS
baumann
FPC Fiber Placement Center
PCCL
Fiber Patch Placement is a very scalable and flexible technology. Based on three key modules for feeding and cutting, placement, and mold manipulation, we tailor SAMBA Series systems to your requirements. All modules can be flexibly combined.

**Module 1: Feeding & cutting units**
Modules for tape feeding and cutting differ according to materials processed. Up to four parallel tapes with different materials possible. Ultrasonic or laser cutting. High-precision cameras for raw-material quality control.

**Module 2: Placement units**
Placement modules are individually designed to fit specific applications, along with customized Cevotec patch grippers mounted to the placement robot. Standard robots: Stäubli, Kuka. Additional brands on request. Linear axis for extended reach optional. High-precision cameras for positioning control and instant correction. Heating units for prepreg processing.

**Module 3: Tool holders and manipulators**
Tool holders and manipulators are specific to each application and can be exchanged. Quick-mount tooling systems available for flexible production set-ups.

The SAMBA modules

SAMBA Multi
- Sensor-controlled feeder supplying 4 tapes in parallel
- Tape width and areal weight: to specification

SAMBA Scale
- Sensor-controlled feeder supplying 1 tape
- Adaptable for a variety of different materials
- Tape width 12.5 mm - 50 mm; areal weight < 300 gsm

SAMBA Pro
- Sensor-controlled feeder supplying 1 tape
- Adaptable for a variety of different materials
- Tape width 12.5 mm - 50 mm; areal weight < 300 gsm

SAMBA Step
- Manual feeding of pre-cut patches on trays
- Maximum material flexibility for application development
- Material size and areal weight flexible

Linear axis
- Linear axis for 6-axis robot and feeding unit (optional)
- Size specific to application
- Best choice for large parts with > 2m in width

Scara fast-picker
- Fast-picker for shortest placement cycle time
- For medium to smaller sized parts with high to medium complexity

6-axis robot
- Most flexible robot choice
- Multiple robots possible
- Size adapted to application range

Tool holders
- Sizes and degrees of freedom specific to application
- Options: Individual holders, rotating holders, fixed or linear table
- Robotic-based tool manipulation possible
SAMBA Multi – superior process control with Fiber Patch Placement

Global parameters
- Temperature
- Compaction pressure
- Compaction time
- Contact time from pick-up to placement

Controlled tape feeding
- Temperature for material storage
- Controlled tape pull-off
- Automatic tape positioning to centricity

Real-time production data analysis
and comparison with a database of previously processed patches

Station for in-process gripper exchange
- Automated contamination detection

Vision control patch position
- Position
- Orientation
- Self-correcting process for precise placement

Vision control patch
- Length and width
- Cutting edge
- Waviness
- Self-correcting process for sorting out bad patches

Interfaces
for integration into existing process control landscapes

Request a sample configuration

SAMBA Multi - configuration example

Key features
- Multiple feeding units for processing of up to 4 different tapes
- Cooled material storage for prepreg material and automated change of tapes
- 6-axis robot with long reach on linear rail for large tools
- Direct lay-up of complex 2D and 3D patch laminates
- Scaled patch grippers up to DIN-A4 size
- Automated patch gripper changing in process
- Compaction force sensor for controlled fiber placement
- Automated raw material control
- Self-corrective positioning control
- Comprehensive, seamless monitoring of process parameters

Process specifications
- Tape width: 50 mm – 300 mm
- Min./max. patch length: 100 mm – 300 mm
- Tape weight: 4 x 16 kg
- Fiber throughput: 15 kg/h
- Spool change: < 5 min
- Tape accuracy inspection: < 0.25 mm
- Placement accuracy: < 0.5 mm
- Cutting: Ultrasonic knife
- Patch heating: Infrared heating up to 200°C
- Material storage cooling: Minimum 8°C

Additional options
- Photonic heating: LED light, UV light
- Automated patch gripper exchange: Up to 3 individual gripper sizes
- Laser cutter: 100 W diode laser to replace ultrasonic cutting
- Dust and gas suction: Appropriate filters according to material specification
- Material traceability: Bar code scanner

Cell configuration
- Placement robot: 6-DOF stand-alone robot
- Linear axis: Length to specification
- Additional axis mold manipulator: To specification; 1–3 DOF positioners

Main components
- Robots: Kuka KR60-3
- Controller: Siemens, Beckhoff
- SAMBA cell: Baumann, Cevotec
- Vision control: Cevotec
- Patch gripper: Cevotec

Software support
- Patch and tape laminate design software: PATCH ARTIST & TAPE ARTIST
- Offline programming software: MOTION ARTIST
- FEA simulation software: ARTIST STUDIO Plug-in for HyperMesh™

Materials
- Dry fiber tape: Carbon, glass, aramid, metal, ceramic
- Prepreg tape: Materials on request

Application focus
- Large, complex 2D / 3D component manufacturing
- Combined processing of multiple materials within one part
- Placement of insulation and adhesion layers
- Fiber placement on (honeycomb) sandwich cores

Request a sample configuration
Multi-material components
Exemplary applications
- Aerospace sandwich structures, e.g. fairings, nacelle structures, radomes, control surfaces, UAV structures
- Metal-metal bonding with adhesives

Key features of FPP technology
- Lay-up of different materials with one system
- Adjustable gaps/overlaps of individual patches according to requirements
- Controlled high compaction pressure during lay-up
- Comprehensive quality control protocol with all process parameters

Your advantages with FPP
- Up to 60% time and cost savings compared to manual lay-up
- Automated lay-up of auxiliary materials
- Reduction or elimination of intermediate debulking steps

Complex geometries
Exemplary applications
- Window frames
- Air ducts
- Battery boxes and covers
- Prosthetics and orthotics
- Helmets

Key features of FPP technology
- Patch sizes from small (e.g. 20 mm x 60 mm) to large (200 mm x 300 mm)
- Automated direct 3D lay-up
- Self-corrective, integrated material and positioning control
- Controlled high compaction pressure during lay-up

Your advantages with FPP
- 20% - 60% time and cost savings compared to manual lay-up
- Significant reduction of material scrap
- Product variants easily realizable
- Efficiency at low volume batch production through quick-exchange tool connector

Tailored reinforcements
Exemplary applications
- Pressure tank dome reinforcement
- Panel and board reinforcements
- Reinforcements for holes, joints, etc.

Key features of FPP technology
- Patch sizes from small (e.g. 20 mm x 60 mm) to large (200 mm x 300 mm)
- Robust placement process on many substrate materials
- Self-corrective, integrated quality control
- Controlled high compaction pressure during lay-up

Your advantages with FPP
- Over 20% material savings
- Local tailoring of laminate properties
- Improvement of mechanical properties
- Comprehensive, fully automated production solution

Focus industries
Aerospace | Automotive | Medical | Other

References
Premier OEM, manufacturers and institutes develop innovative composite solutions with us. Among them:
ARTIST STUDIO (CAD-FEM-CAM)

Your engineering team requires digital tools that reduce the time for product development and integrate smoothly with production planning. ARTIST STUDIO is the perfect tool for digital product development and robot offline programming with Fiber Patch Placement. The software creates optimized patch laminates and generates the machine programs for the SAMBA systems.

- Stand-alone CAD-CAM software with plug-in for commercial FEA-software
- Intuitive application and interface logic
- Import of all common CAD file formats

ARTIST STUDIO – laminate design and robot programming software

PATCH ARTIST - laminate design (CAD)

- Interface: Import of STEP, IGES, STL, CATPart
- Laminates: Layer definition with specific material properties and constraints
- Boundary: Different lay-up strategies at boundaries (reducing scrap, constant layer thickness)
- Curve planning: Parallel curves based on user defined master curve
- Optimization: Patch overlap optimization
- Visualization: Mold, laminate, SAMBA system, surface normals
- Curve planning: Curves, curve orientation and curvature (in-plane, out-of-plane)
- Documentation: Browser-based documentation with tutorials

MOTION ARTIST - robot offline programming (CAM)

- Robot kinematics: 4 and 6 axis robots, robot on linear axis
- Tool kinematics: Robot-to-robot interaction logic
- 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 using multicore processing
- Visualization: Robot movements, collisions, laminate
- Analyses: Material consumption, production time
- Interface: Visualization and updates of changes in laminate design
- Documentation: Browser-based software documentation with tutorials

ARTIST STUDIO plug-in for FE-modeling (FEA)

- Availability: FEA preprocessor HyperMesh Release-Version 2017 and up
- Accessibility: Menu-bar with subsequent dialogue-based process
- Interface: Import of laminate from ARTIST STUDIO platform
- Properties: Automated modeling of patches, fiber orientation, thickness, patch overlaps
- Different modeling methods (shell/solid) and strategies for patch laminates
- Documentation: Browser-based software documentation with tutorials

CAD-CAM for AFP

TAPE ARTIST and MOTION ARTIST feature all functions for efficient laminate design also for AFP processes. Laminate planning for AFP can be combined with FPP to create hybrid AFP-FPP laminates.
cevoGripper – the flexible and form-adaptive placement tool

Your key to a fast and automated lay-up process for complex shapes is our form-flexible patch gripper. The gripper is available in tailored sizes to perfectly match your product. The gripper adapts to the most complex surfaces. Even across 90° angles and biaxially curved surfaces, patches are placed precisely and without draping effects.

cevoGripper – adapting to complexity

Configuration
- Available in sizes from 30 mm x 60 mm up to 300 mm x 400 mm
- Automated quick-mount device for fast and easy gripper changing on-the-fly
- Anodized, precisely machined aluminum baseplates
- High mass-flow vacuum stream, powered by pressured air
- Customized body to meet specific compaction requirements
- Optional heating field suitable for heat-activated binder

Scaling up for aerostructures

The R&D system SAMBA Step L can handle a maximum patch size of 200 mm x 300 mm as of today. This serves aerospace’s application and process development requirements. Complex-shaped aerostructures with sizes of up to 2 m x 3 m can be developed with Fiber Patch Placement technology 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 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.

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 and construction to finished prototypes produced in our cevoLab.
Fiber Patch Placement – how it works

Fiber Patch Placement is the additive manufacturing technology for the automated production of geometrically complex fiber composites. It enables a new degree of freedom in automated fiber placement and is compatible with many materials such as different carbon fiber prepreg systems, glass fiber prepregs, adhesive prepregs, and also dry fibers. Defined patches are automatically cut from a tape and precisely placed by two robots and a flexible patch gripper. The size is adjusted to the size and complexity of your component. Because the process is implemented as a series of individually-controlled patch placements, FPP technology enables a superior level of process control for the entire laminate lay-up cycle.

Automation platform for digital manufacturing
Fiber laminates are digitally developed in ARTIST STUDIO software. This includes the offline programming of the production system. Patch laminates can also be imported into FEM software for structural analysis.

Your benefits
- Digitized, automated process chain
- 100% in-process raw material and positioning control
- Multi-material lay-up capability
- 20% - 60% cost and time savings compared to manual lay-up

Efficient and fast processes
Compared to conventional composite processes, Fiber Patch Placement cuts the time from CAD to prototype significantly. Taking nesting, cutting and kitting out of the process, also your recurring production cycle is significantly shortened and simplified. On top of that, production scrap is reduced to less than 10%. That's efficiency that inspires.

5 easy steps to a complex 3D fiber laminate
1. Design laminate in ARTIST STUDIO based on your standard CAD file
2. Create robot production data in ARTIST STUDIO by automated offline programming
3. Load robot data program on SAMBA system and set production parameter
4. Fix tool on robot and load desired fiber material
5. Press “Start” on SAMBA system for fully automated lay-up of your component
Lay-up rates of SAMBA Series

Effective lay-up rates result from process parameters and can be customized to applications. The productivity of all SAMBA machines follows the same simple math for throughput calculation:

\[ m = \frac{\text{patch length} \times \text{patch width} \times \text{areal weight} \times \text{no. robots}}{\text{patch cycle time}} \]

Your complex fiber composites with Fiber Patch Placement

How to get started with FPP

Step 1: ROI and suitability assessment
Includes manufacturability assessment, unit cost and time analysis, benefits and ROI estimation. This service is complimentary for you.

→ How much does your application benefit from FPP?

Step 2: Joint application development
Includes virtual studies, application and demonstrator development, equipment customization, and more.

→ How do you best develop & test your FPP application?

Step 3: Customized lay-up equipment
Includes SAMBA lay-up systems, ARTIST STUDIO software, customized patch grippers, quality control systems, and more.

→ Which system configuration is best for your application?

Cevotec – the experts in Fiber Patch Placement technology

Munich-based automation specialist Cevotec enables manufacturers to build complex composites in high volume and superior quality. With Fiber Patch Placement based SAMBA systems, Cevotec offers customized, fully automated fiber layup systems with integrated process control for manufacturing complex 3D geometries and multi-material laminates. ARTIST STUDIO is the technology-specific CAD-CAM software for generating patch-based fiber laminates and automated robot programming. Benefit from 20% - 60% in cost and time savings when switching from manual layup to Cevotec’s SAMBA systems. From the laminate design to manufacturing, we have expert knowledge and competency in all process steps required to automate the production of complex high-performance laminates. You also benefit from a comprehensive service portfolio, including application-specific customizations and FE-based component development.

The cevoLab – our FPP Competence Center – is available for your application development. You can test and explore the potential of FPP technology for your components. We can then jointly conceptualize your SAMBA Series production system, integrate it into your shop floor and start your series production.

Contact us to get started with Fiber Patch Placement: advantages@cevotec.com.