

EmpowerAX - A collaborative environment for the transfer of fibre-reinforced 3D printing

The Speaker

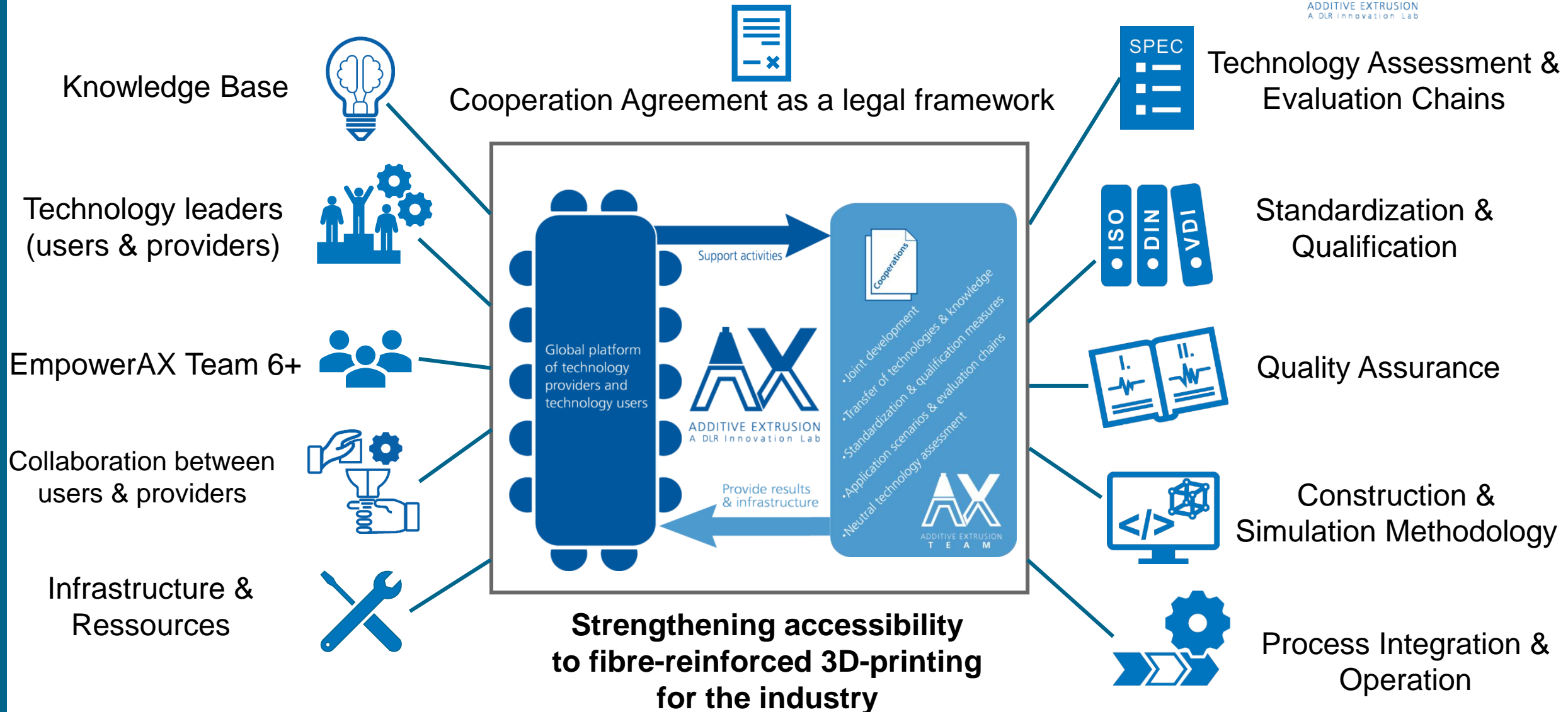


Xenia Stumpf

Lab Managerin
DLR Innovation Lab EmpowerAX

DLR Brunswick, Germany
Institute of Lightweight Systems

DLR Innovation Lab EmpowerAX – An overview



“The real value of Additive Manufacturing is not in replacing all conventional composites manufacturing processes –

The real value of Additive Manufacturing is in developing the right combination of established methods with Additive Functionalisation.”

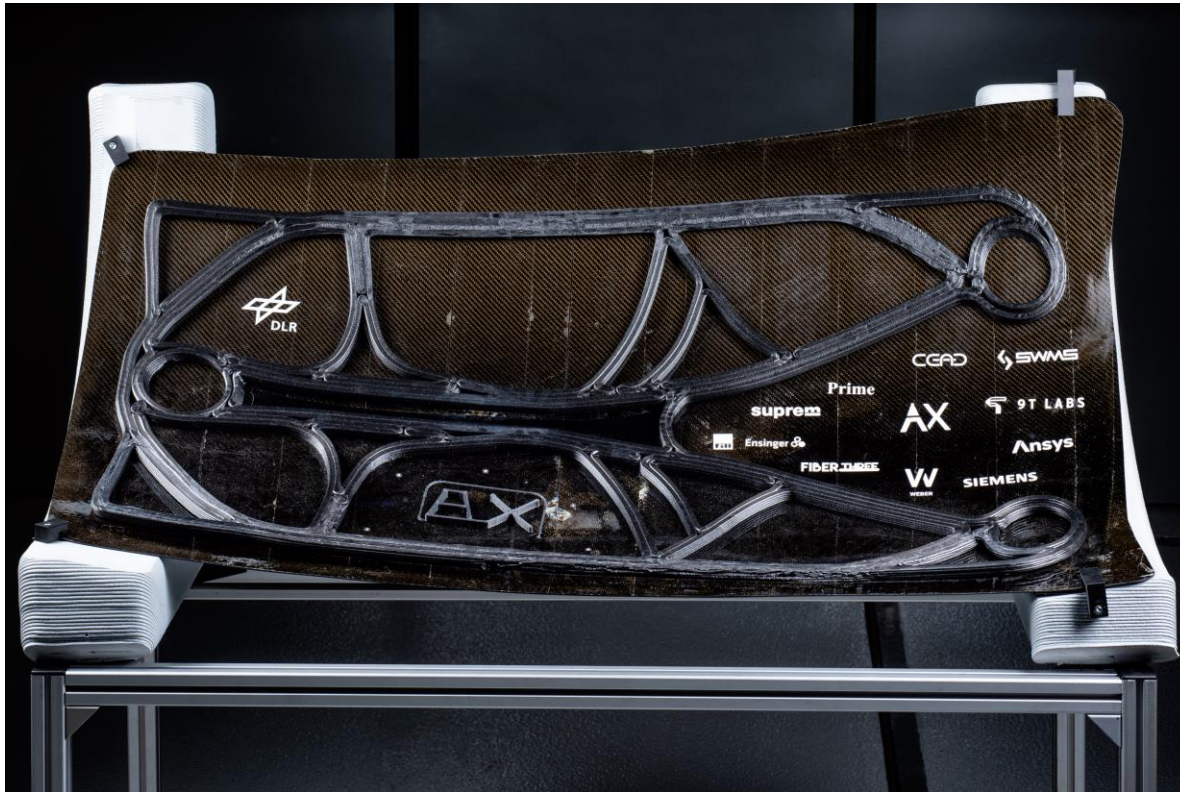




ADDITIVE FUNCTIONALISATION COMBINATION INSTEAD OF SUBSTITUTION

The concept of Additive Functionalisation

Combination instead of substitution

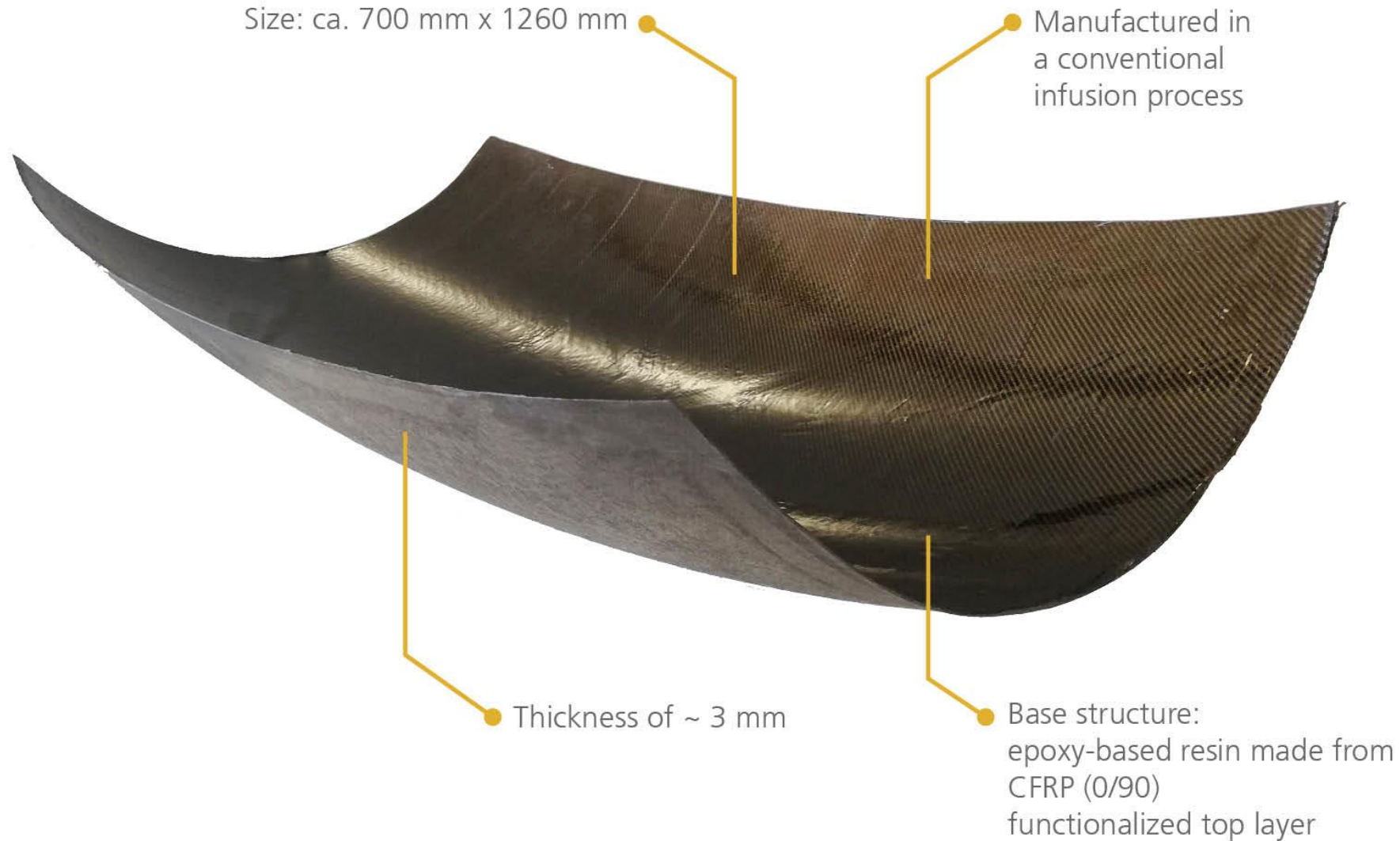


- Combination of conventional & additive manufacturing processes
- Combination of different materials
 - Thermoset + thermoplast
 - Short and continuous fibre-reinforced material (SFRP + CFRP)
- Overprinting of a multi-curved Shell

EmpowerAX Demo Part
„Additive Functionalisation of a multi-curved shell“

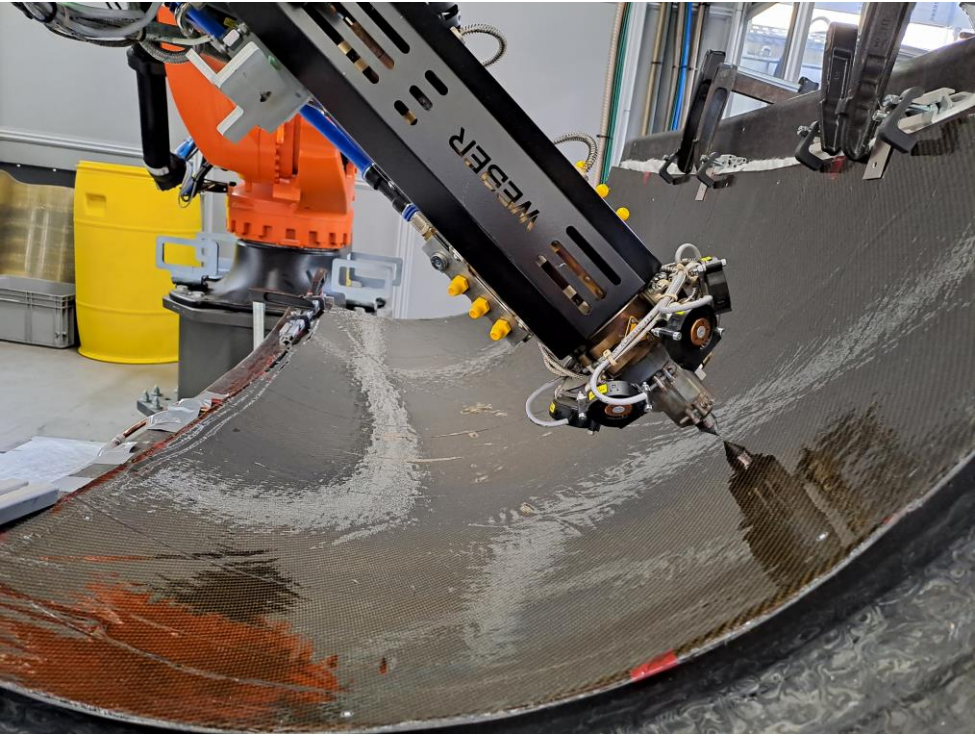
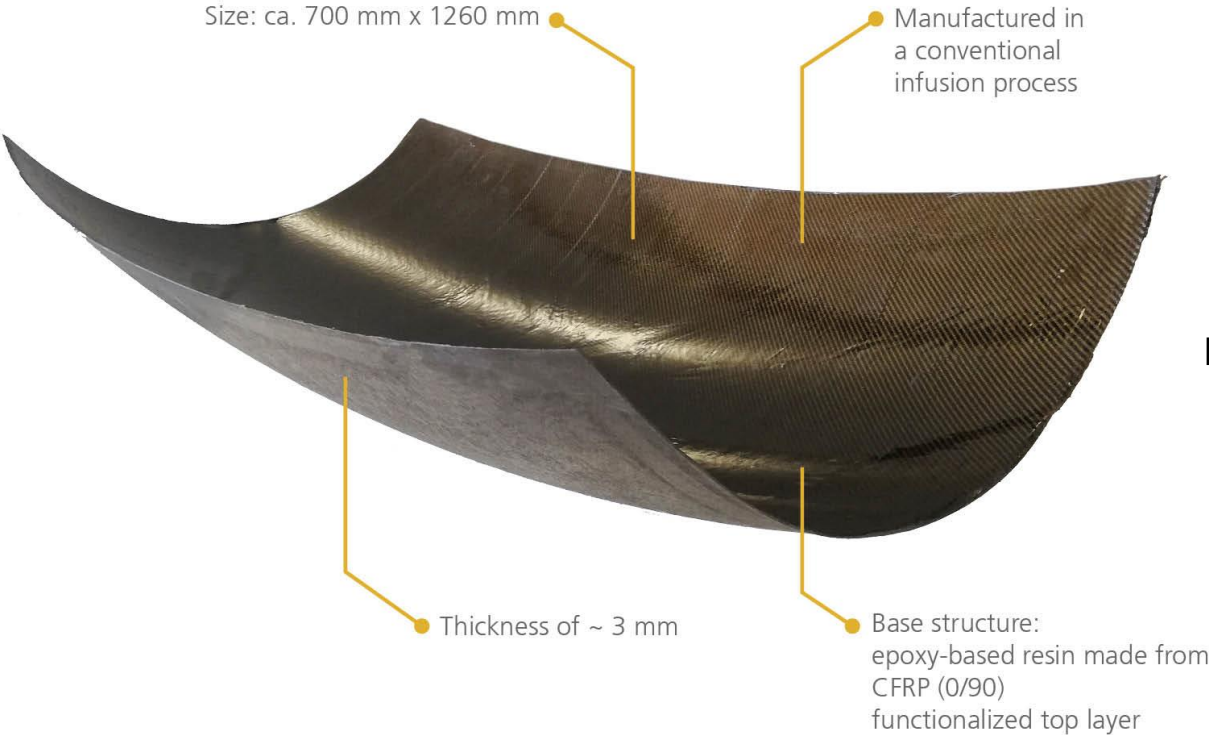
EmpowerAX Demo Part

The Basic Idea



EmpowerAX Demo Part

The Basic Idea



Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

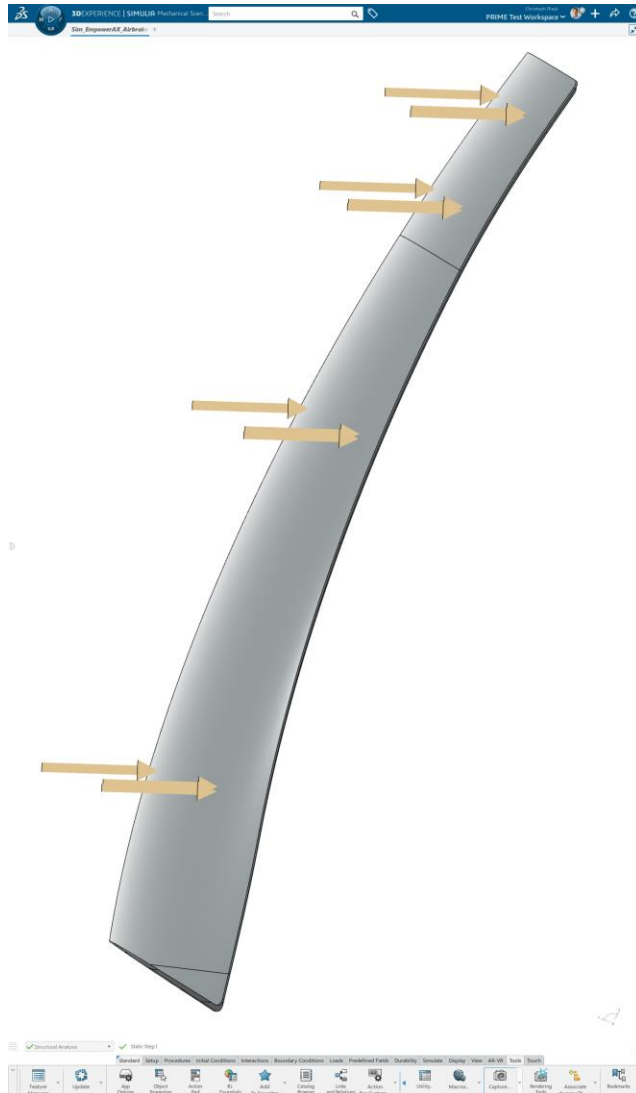
Printing of supports and fixtures by
FIBER THREE MATERIAL

Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS

EmpowerAX Demo Part

Starting point: Topology-optimised Design by PRIME

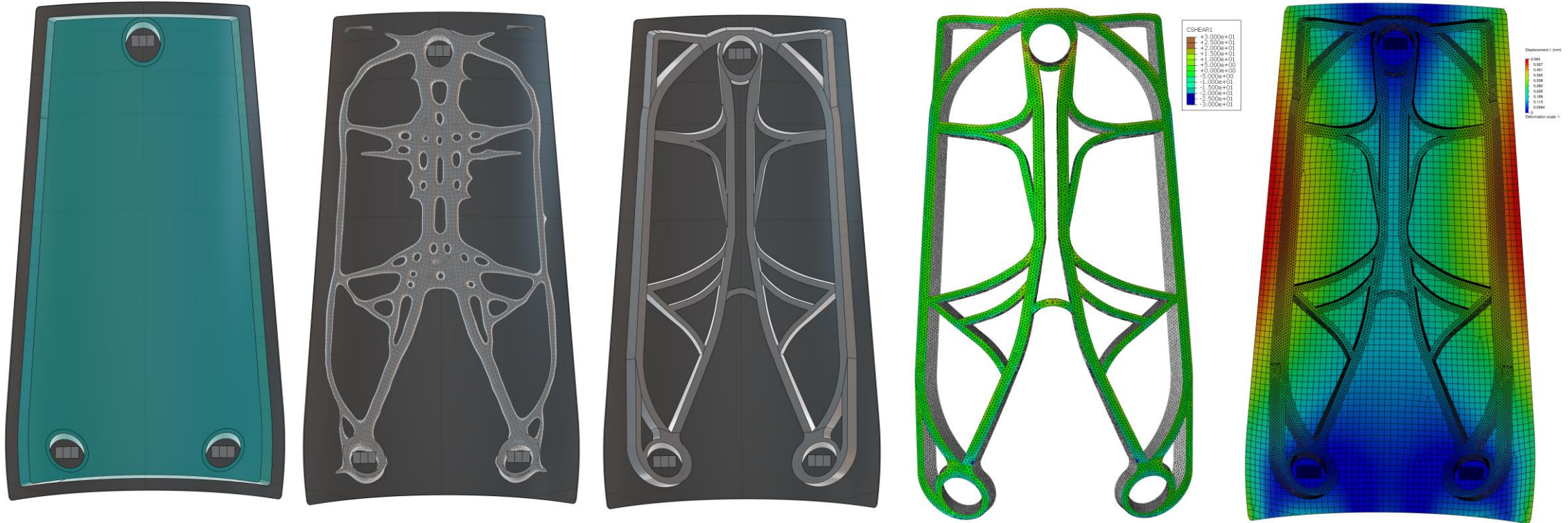


Basic assumptions for loadcase as design requirements:

- Aeronautical application
- During a landing of 360 km/h
- Aerodynamic drag force combined with simultaneous front and side winds

EmpowerAX Demo Part

Starting point: Topology-optimised Design by PRIME



Topology-optimised design to use material only where it is really needed

Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

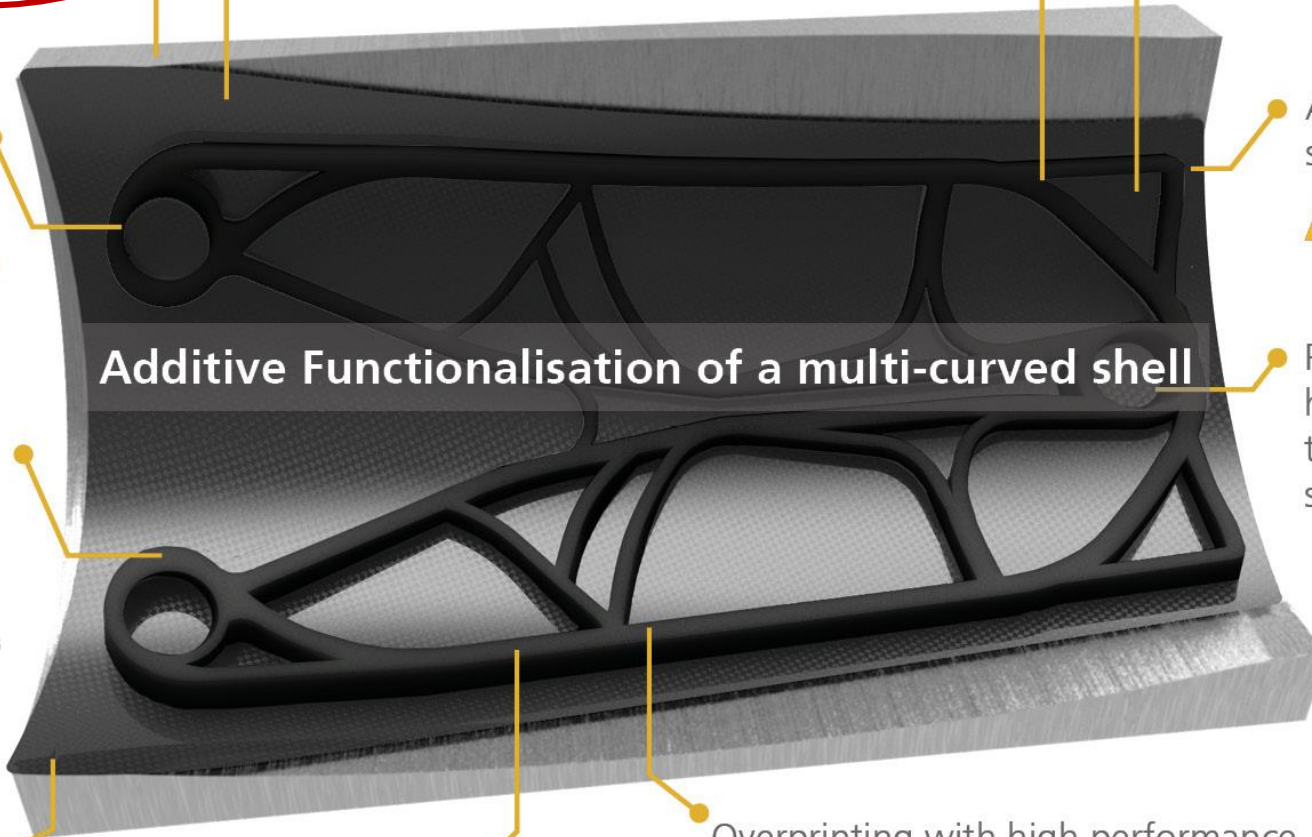
Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

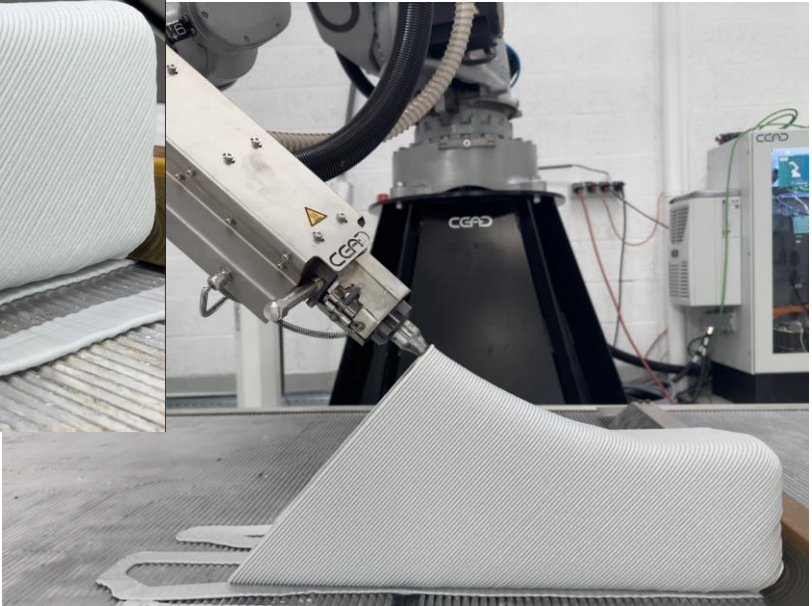
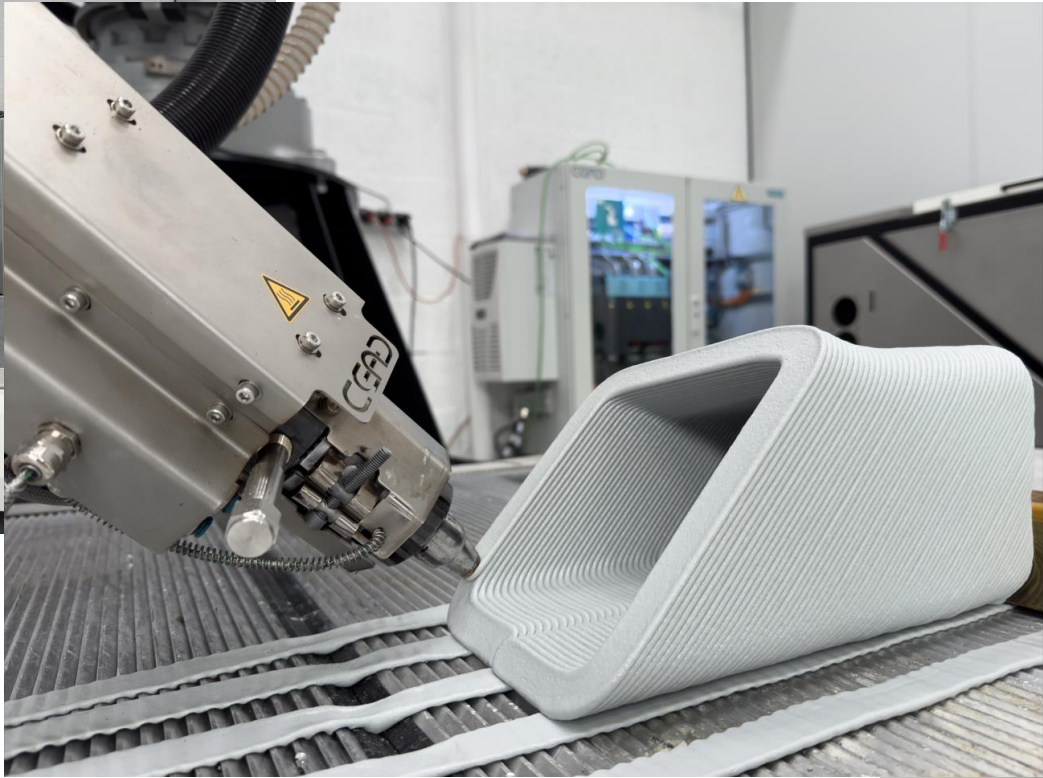
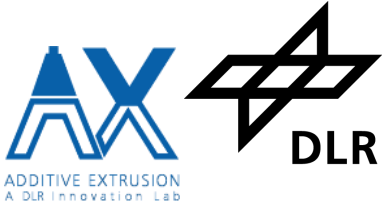
Printing of supports and fixtures by
FIBER THREE MATERIAL

Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS



EmpowerAX Demo Part Printing of the tooling by CEAD



Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

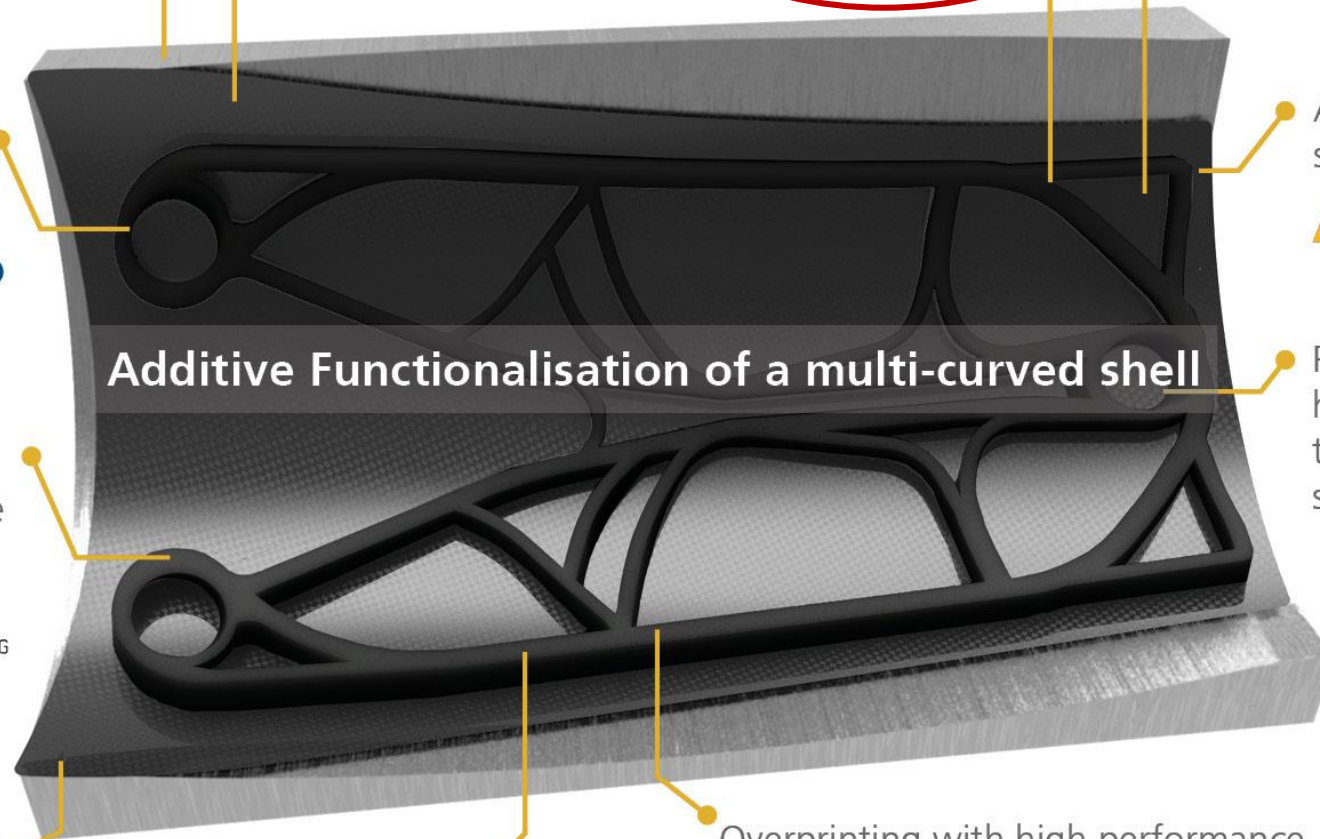
Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

Printing of supports and fixtures by
FIBER THREE MATERIAL

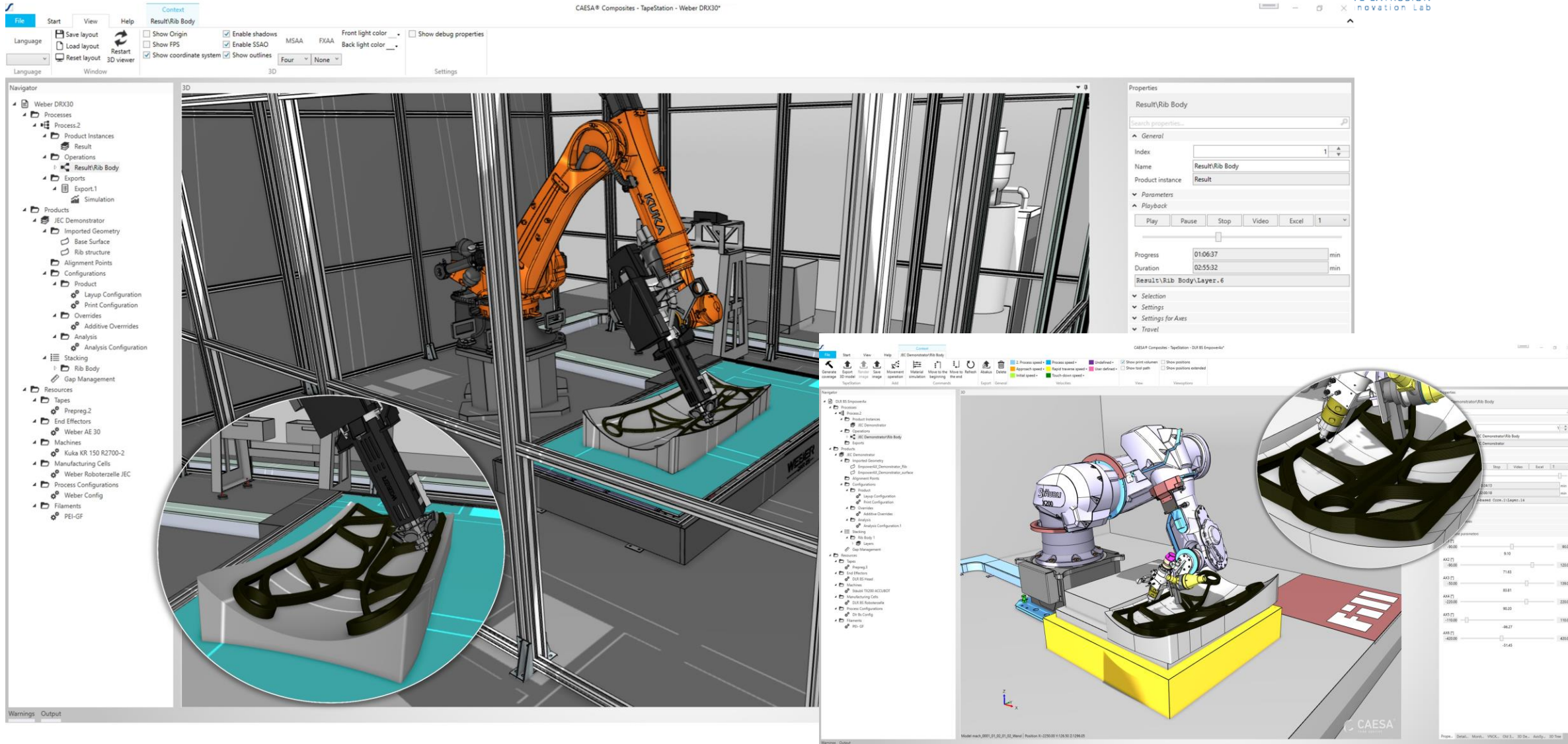
Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS
ADDITIVE EXTRUSION



EmpowerAX Demo Part

Path planning for robotic 3D-Printing by SWMS



The screenshot displays the CAESA software interface for simulating a robotic 3D printing process. The main 3D view shows an orange KUKA robotic arm positioned over a printing bed where a black lattice structure is being printed. A circular inset provides a magnified view of the printing head and the lattice part.

The interface includes several key components:

- Navigator:** A tree view on the left showing the project hierarchy, including 'Weber DRX30', 'Process', 'Product Instances', 'Operations', 'Exports', 'Products', 'JEC Demonstrator', 'Imported Geometry', 'Base Surface', 'Rib structure', 'Alignment Points', 'Configurations', 'Product', 'Layup Configuration', 'Print Configuration', 'Overrides', 'Additive Overrides', 'Analysis', 'Analysis Configuration', 'Stacking', 'Rib Body', 'Gap Management', 'Resources', 'Tapes', 'Prepreg-2', 'End Effectors', 'Weber AE 30', 'Machines', 'Kuka KR 150 R2700-2', 'Manufacturing Cells', 'Weber Robotertelle JEC', 'Process Configurations', 'Weber Config', 'Filaments', and 'PEI-GF'.
- Properties Panel:** Located on the right, it shows settings for the 'Result/Rib Body', including 'Index' (1), 'Name' (Result/Rib Body), 'Product instance' (Result), and playback controls (Play, Pause, Stop, Video, Excel). It also displays 'Progress' (01:06:37 min) and 'Duration' (02:55:32 min).
- 3D View:** The central area shows the simulation environment with a yellow base, a red 'Fail' sign, and various mechanical components.
- Context Menu:** A top toolbar with various icons for simulation control, such as 'Start', 'Stop', 'Reset', 'Material', 'Move to the', 'Align', 'Delete', 'Export', 'Cancel', 'View', and 'Viewports'.

Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

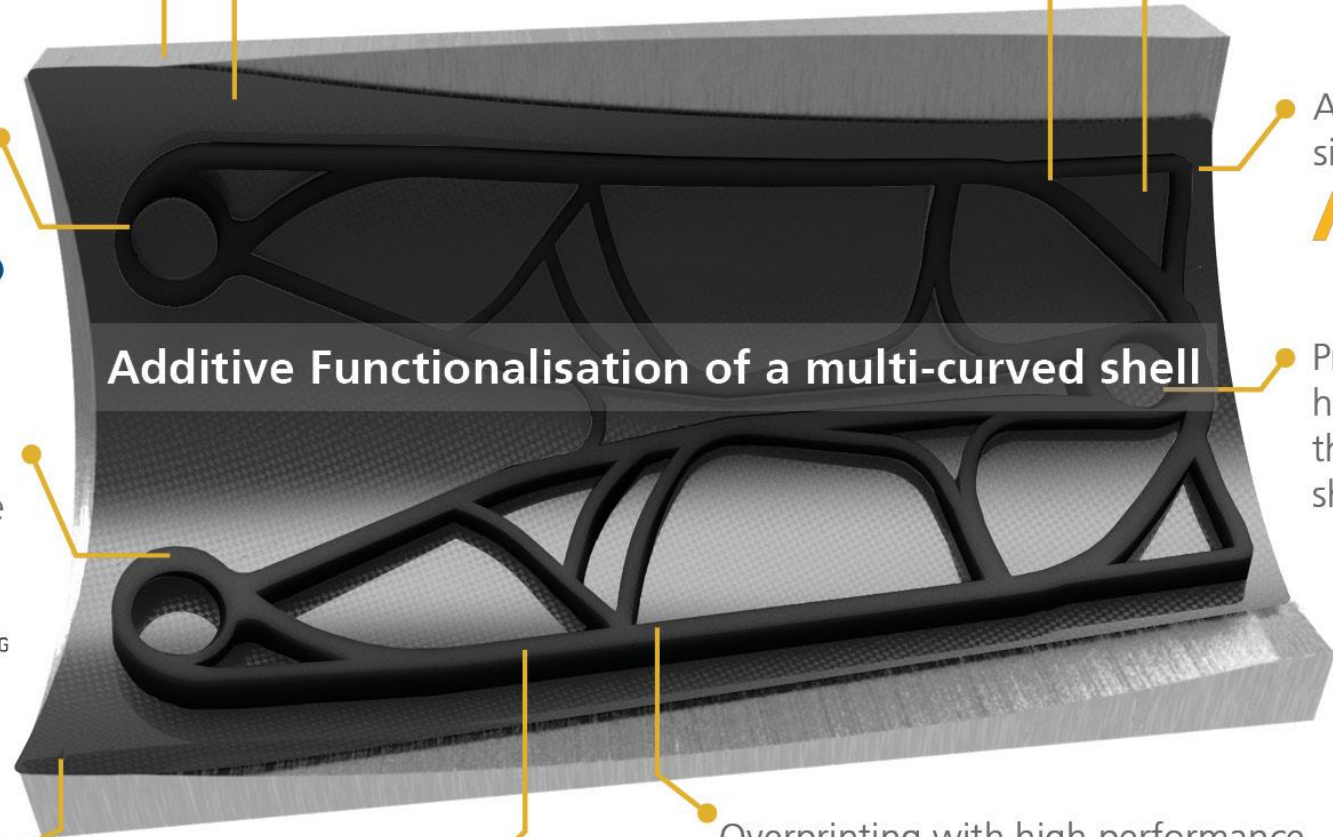
Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

Printing of supports and fixtures by
FIBER THREE MATERIAL

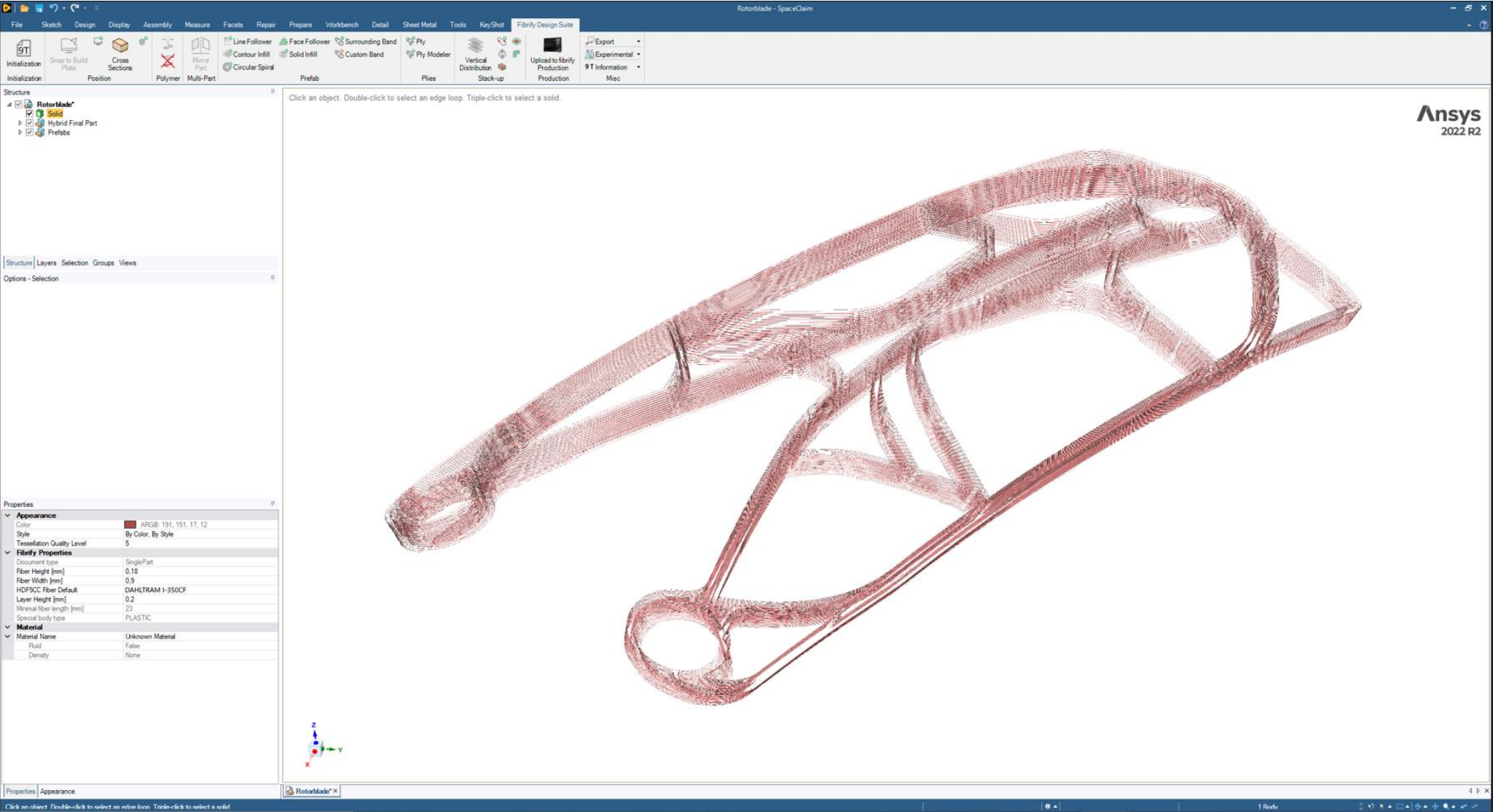
Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS



EmpowerAX Demo Part

Transfer of fibre planning by 9T Labs



Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

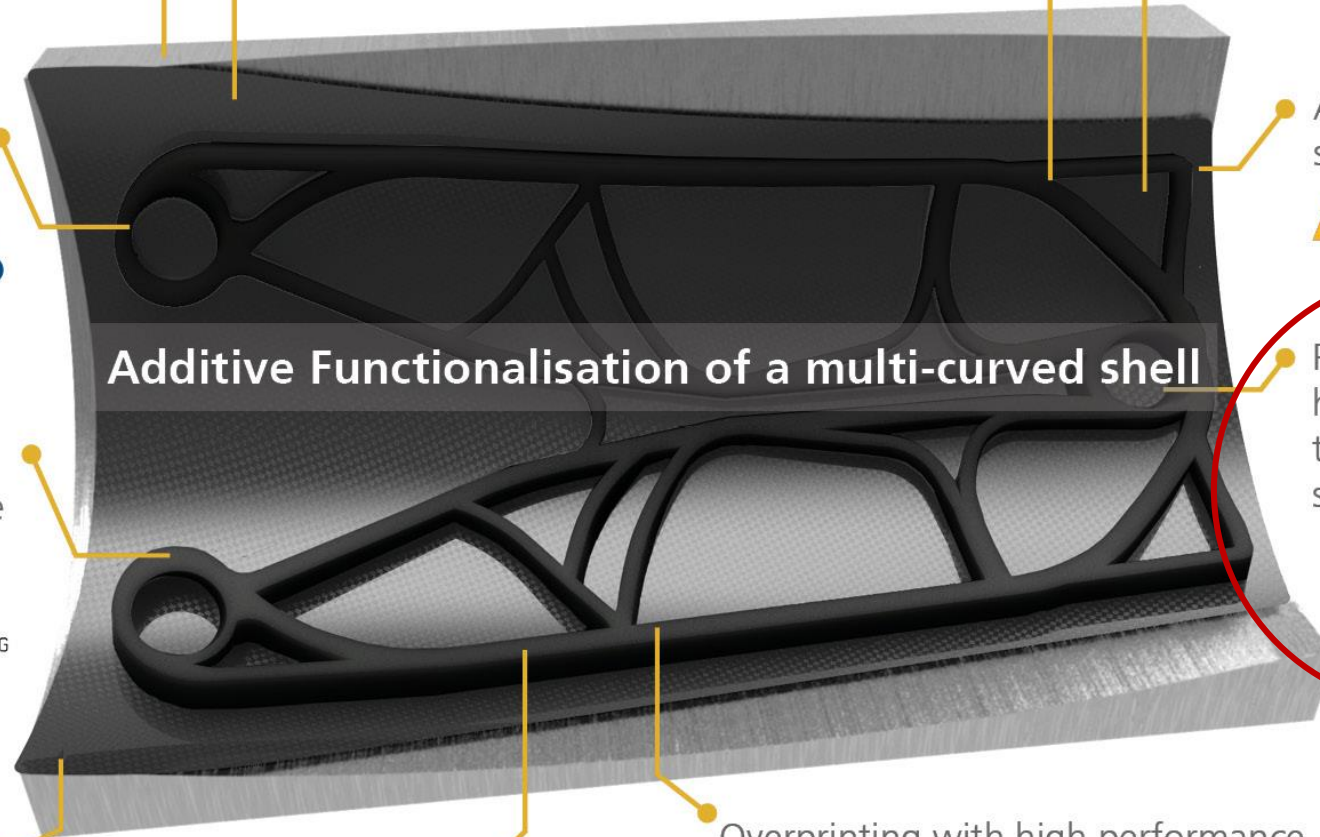
Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

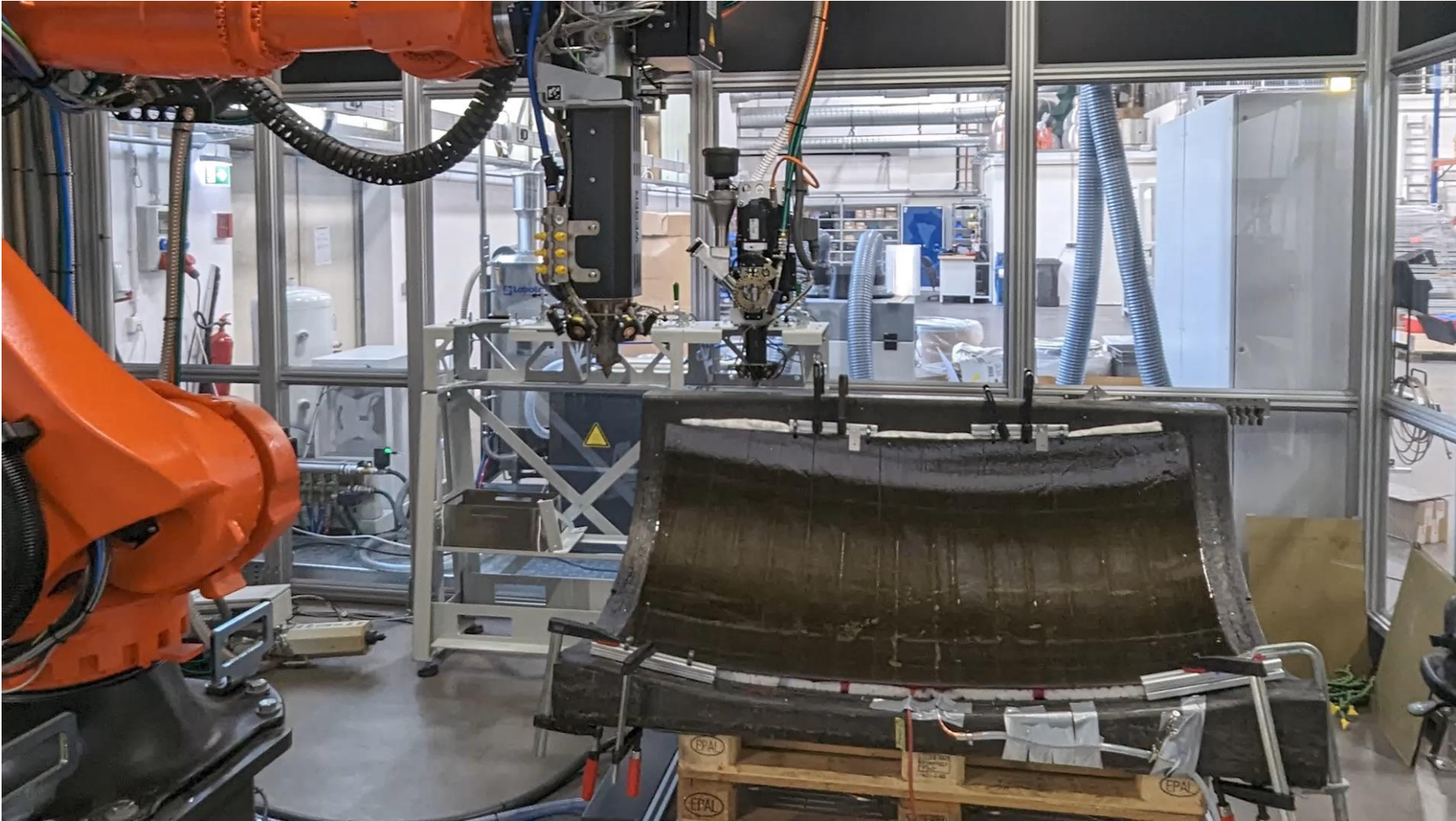
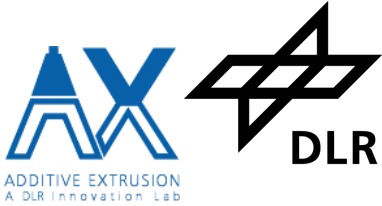
Printing of supports and fixtures by
FIBER THREE MATERIAL

Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS



EmpowerAX Demo Part Printing of the stiffening ribs by WEBER



Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

Additive Functionalisation of a multi-curved shell

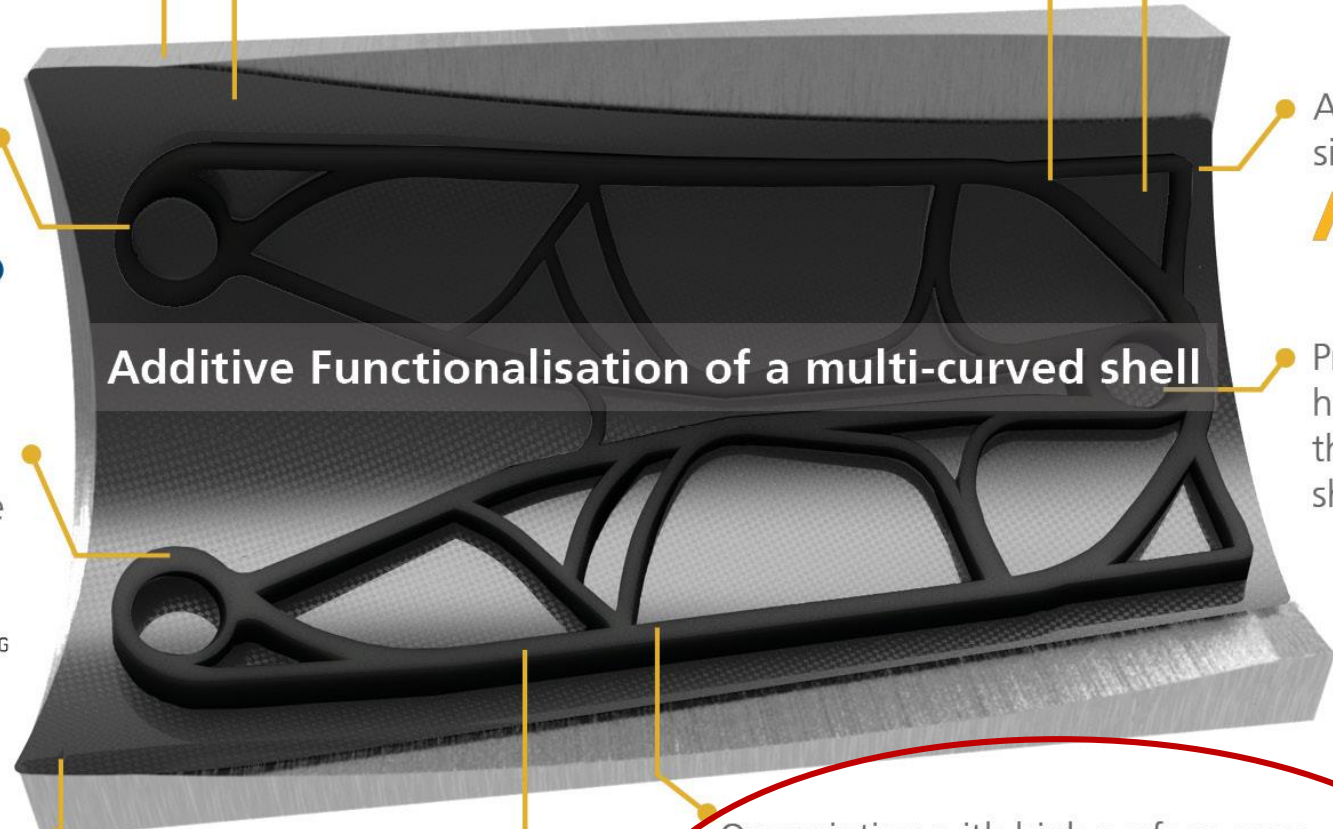
Printing with high performance thermoplastic short FRP by
WEBER additive

Printing of supports and fixtures by
FIBER THREE MATERIAL

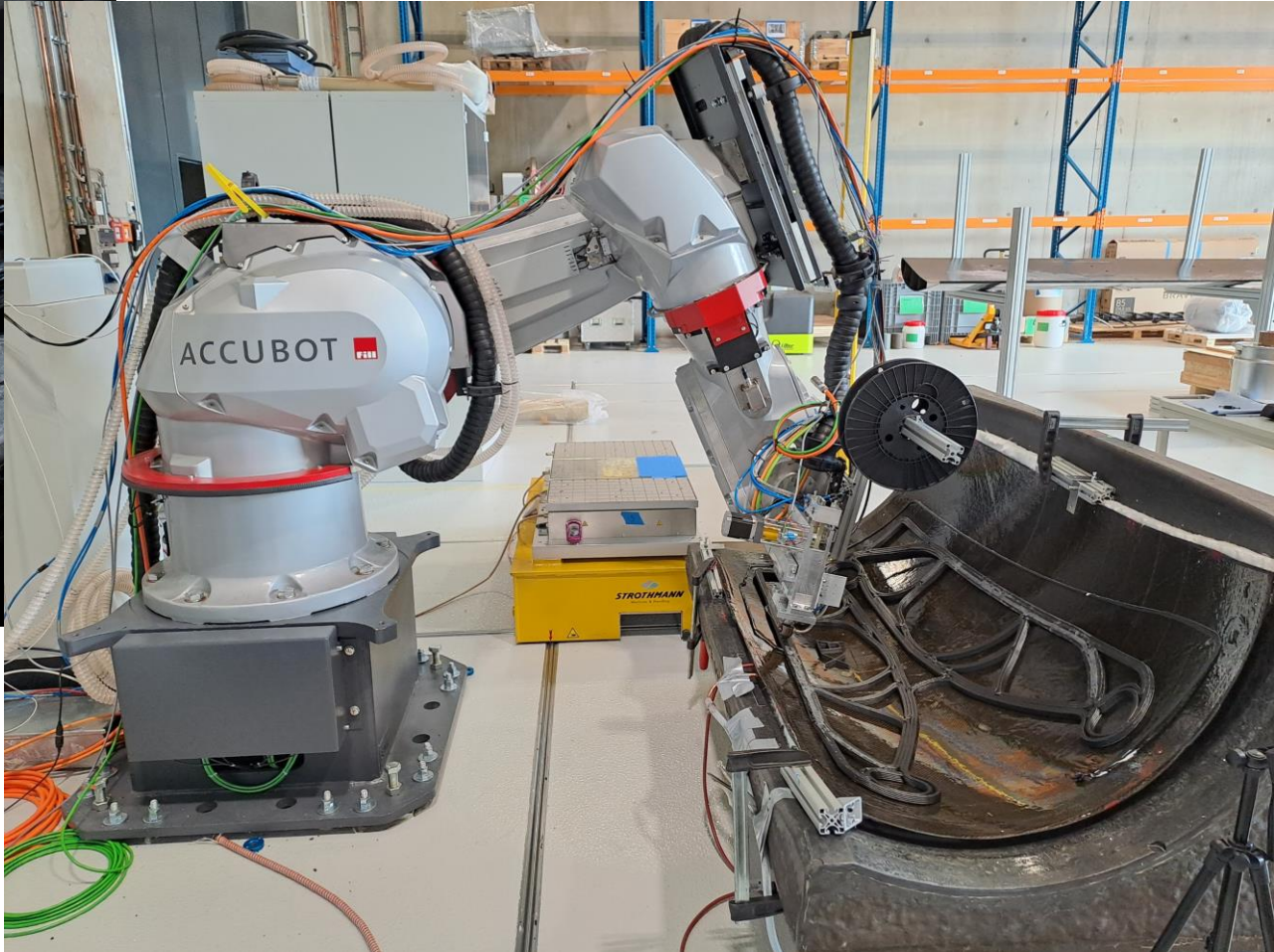
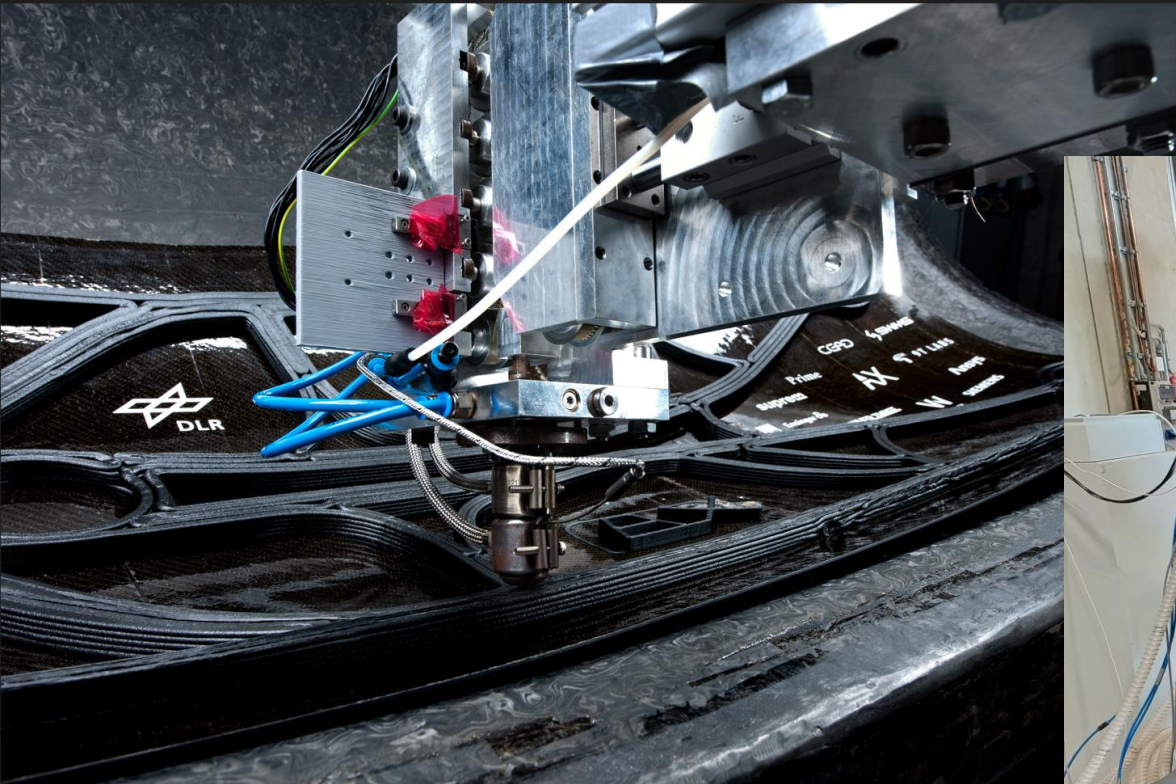
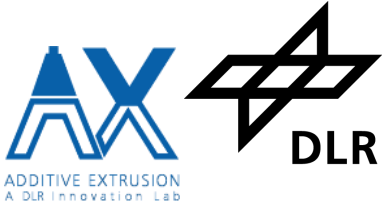
Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by

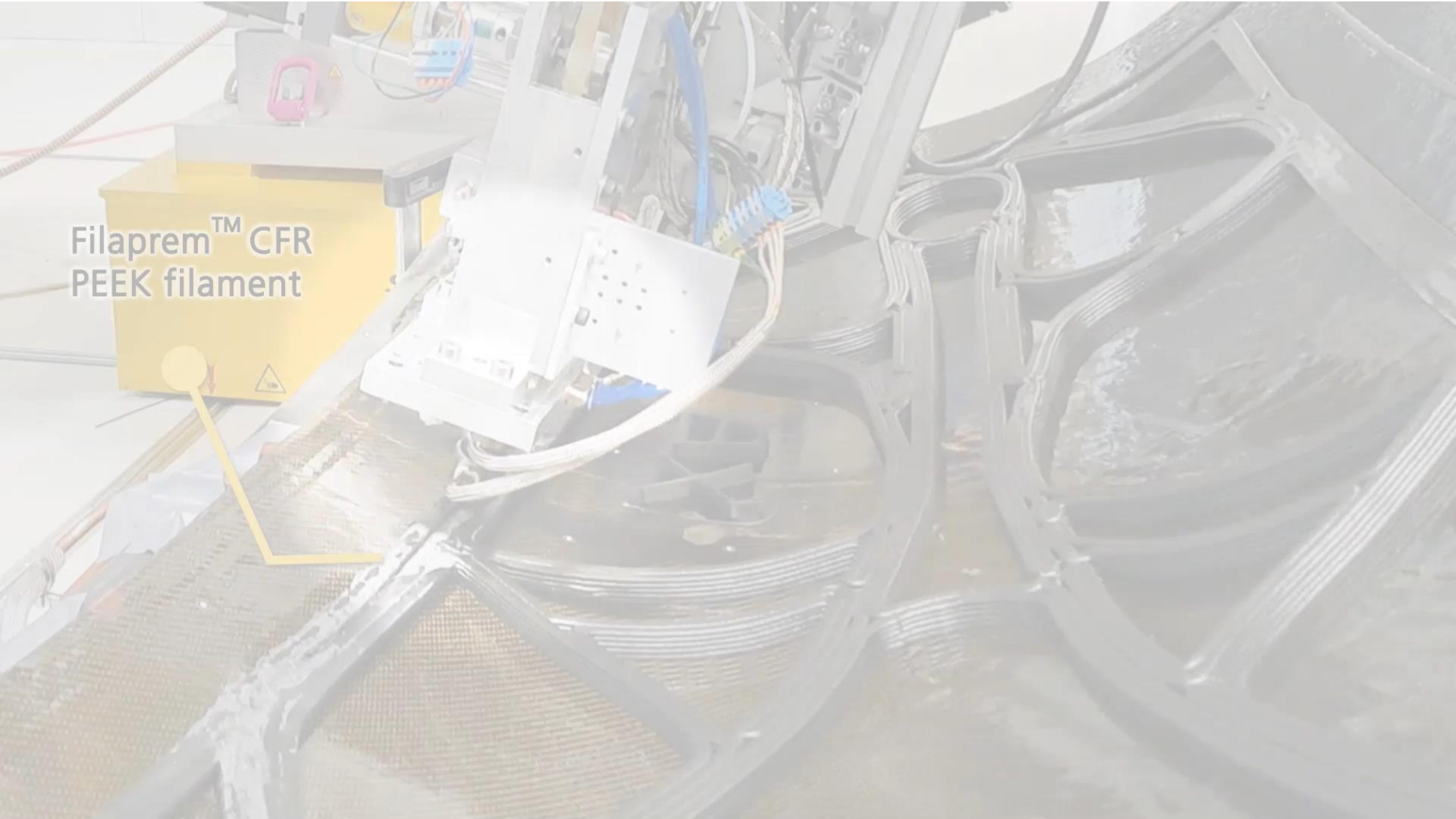
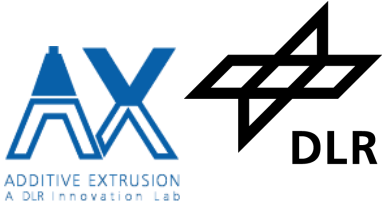
DLR AX SIEMENS
ADDITIVE EXTRUSION



EmpowerAX Demo Part Overprinting by DLR / EmpowerAX



EmpowerAX Demo Part Overprinting by DLR / EmpowerAX



Printing of the tooling by
CCAD
Composite Additive Manufacturing

Manufacturing of the basic shell structure by
DLR

Path planning by
SWMS
DIGITAL INNOVATIONS

Transfer of fibre planning by
9T LABS

High performance thermoplastic short FRP & continuous FRP by
Ensinger suprem

AM process simulation by
Ansys

Design & topology optimisation of the ribs by
PRIME ENGINEERING IDEAS

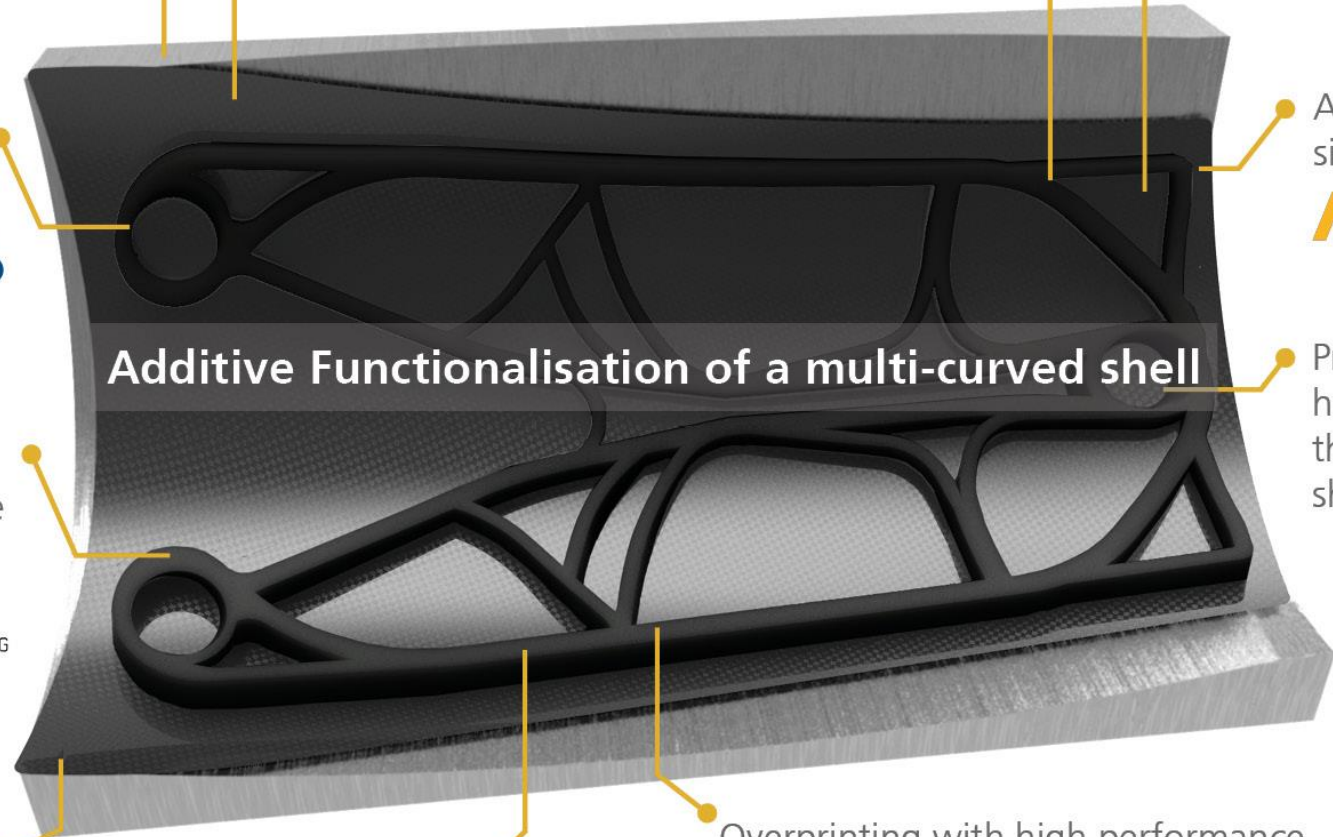
Additive Functionalisation of a multi-curved shell

Printing with high performance thermoplastic short FRP by
WEBER additive

Printing of supports and fixtures by
FIBER THREE MATERIAL

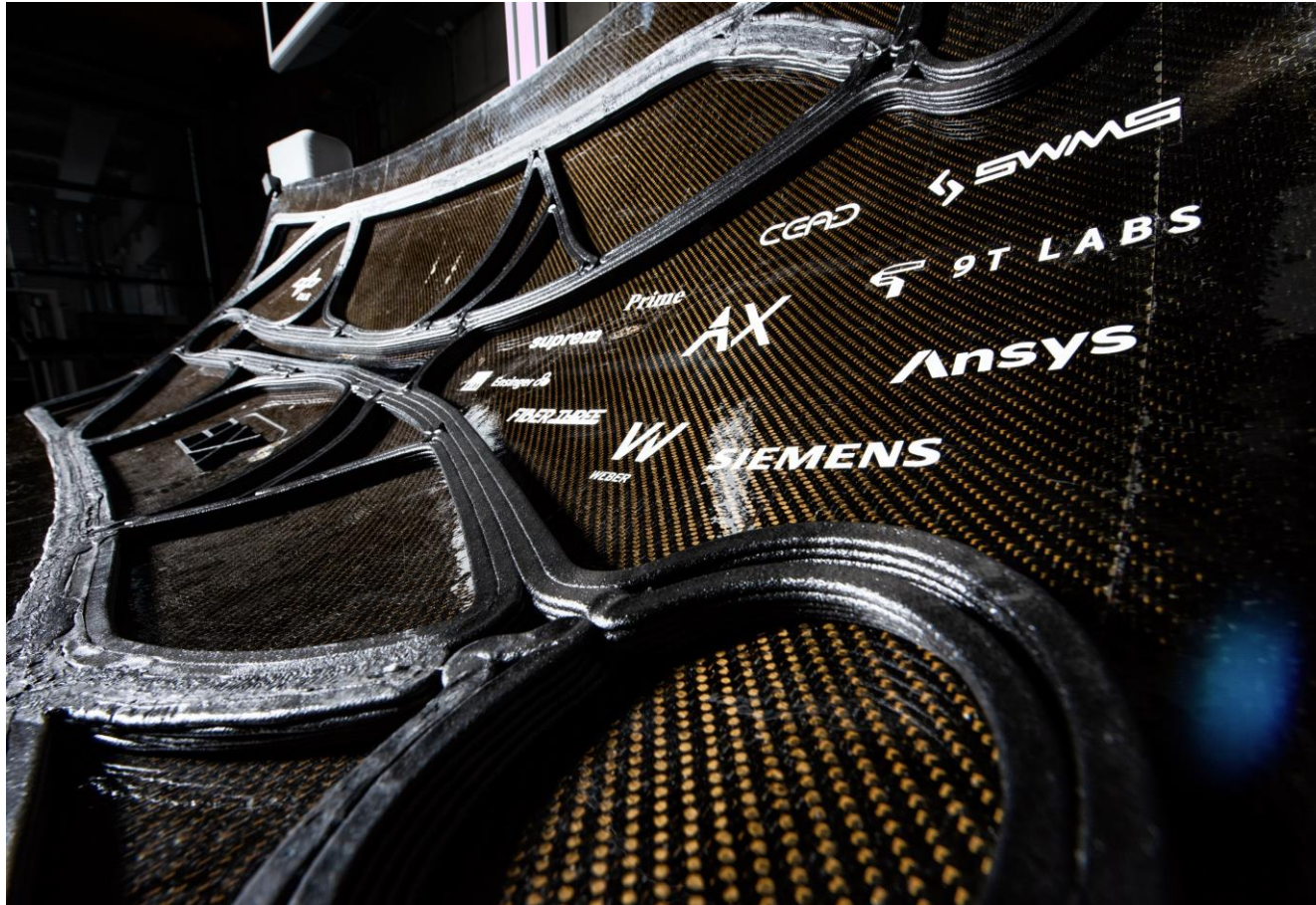
Metrology and NDT by
fill

Overprinting with high performance thermoplastic short FRP + continuous FRP using CNC robotics by
DLR AX SIEMENS



EmpowerAX Demo Part

Additive Functionalisation – Summary



- Additive Functionalisation for cost-efficient manufacturing of composites parts
- Overprinting of a multi-curved shell with short and endless fibre-reinforced materials
- Combination of thermoset and high performance thermoplastic
- Demonstration of an industrially available process chain

INNOVATIONSPREIS
NIEDERSACHSEN
2023

Sieger!
in der Kategorie „Kooperation“



DLR

AX

Prime
suprem

Ensinger

FIBER THREE

CCAD

SWMS

AX

9T LABS

Ansys

WEBER

SIEMENS



MANAGEMENT OF A COLLABORATIVE ENVIRONMENT

Management of a collaborative environment

The working level



Visibility &
regular exchanges



Agility in strategy



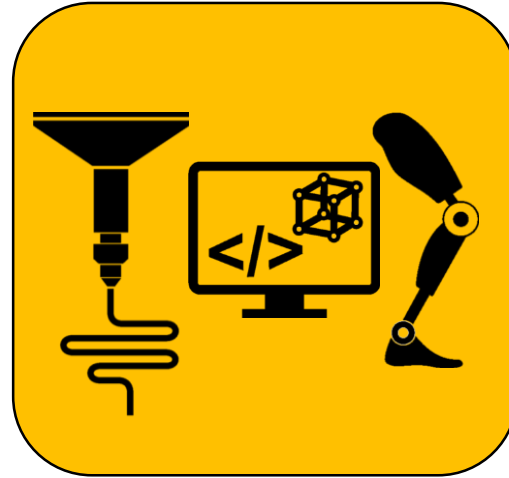
Legal framework

Management of a collaborative environment

The technology level



Interesting Topic &
Technology



Heterogeneous
Partner Structure



Space for
Experimentation

but the most important part of a collaborative environment are...

The most important part of a collaborative environment



People with Passion



EmpowerAX Demo Part on Tour



EmpowerAX Science Day on the topic „fibre-reinforced 3D-printing in application“

EmpowerAX Days
11. Oktober 2023
09:00 – 18:00 Uhr

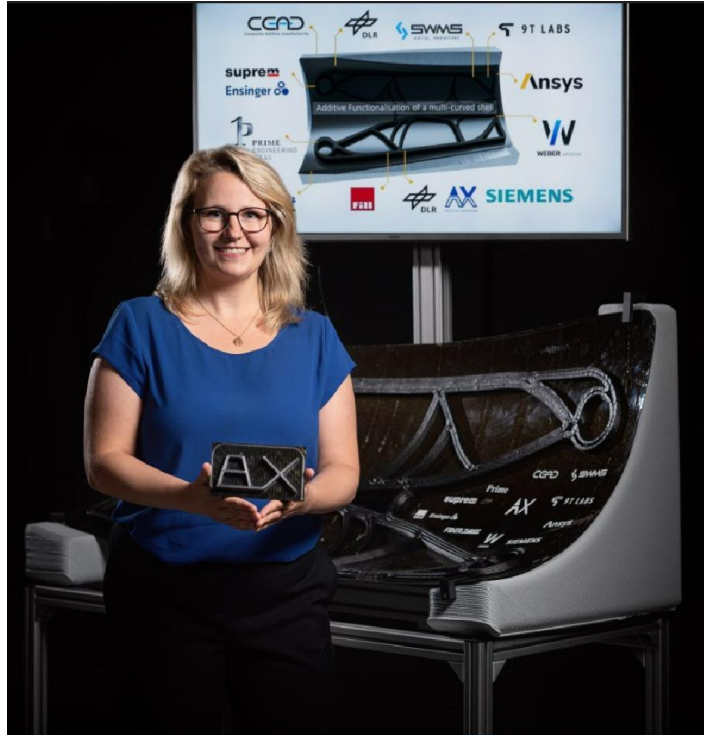
Eine Veranstaltung in Kooperation mit:

COMPOSITES UNITED Niedersachsen ADDITIV

EmpowerAX Science Day on the topic „fibre-reinforced 3D-printing in application“

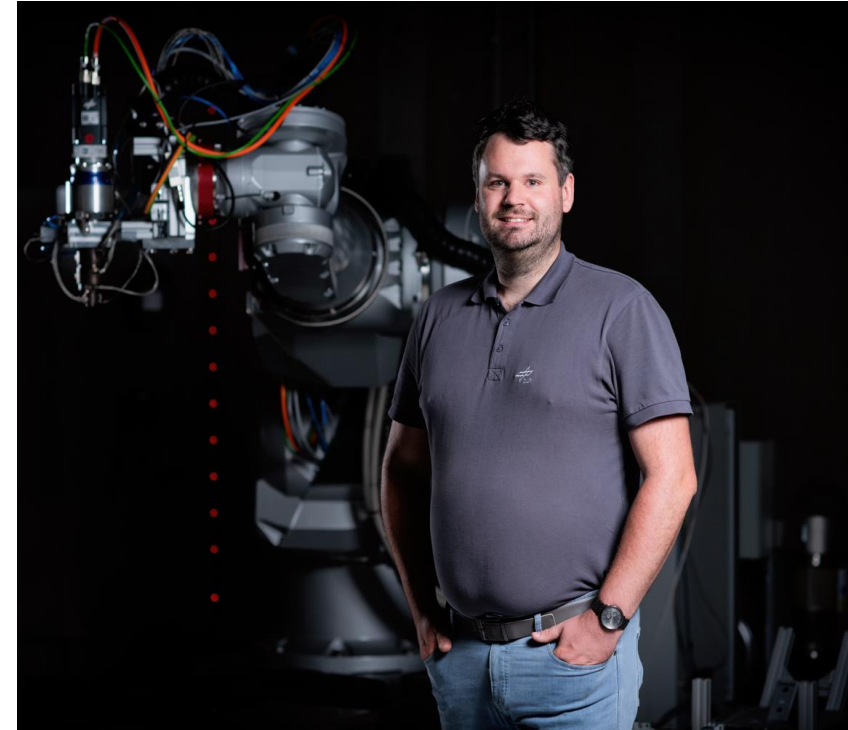


The EmpowerAX team on site



Xenia Stumpf

Deutsches Zentrum für Luft- und Raumfahrt e.V.
Institute of Lightweight Systems | Innovation
Lilienthalplatz 7 | 38108 Braunschweig |
Germany
Telephone +49 531 295-3368
xenia.stumpf@dlr.de



Erik Johannsen

Deutsches Zentrum für Luft- und Raumfahrt e.V.
Institute of Lightweight Systems | Adaptronics
Lilienthalplatz 7 | 38108 Braunschweig |
Germany
Telephone +49 531 295-1369
erik.johannsen@dlr.de

Thank you for your attention!



Questions?