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# RapidRepair: Hightech-Repair of CFRP Components

## Precise – Fast – Certifiable

- 3D detection of multi-curved components
- On-demand generation of individual, complex trajectories for robot guidance
- Integration of all components into an overall system
- Central process control

### The Task

In many areas, there has been a rapid increase in fiber-reinforced plastics (CFRP) in recent years. These are used, for example, in the construction of aircraft (Dreamliner - Boeing or A350 - Airbus), helicopters (Tiger, NH90 - both Airbus Helicopters Deutschland, AHD), automobiles with electric drives (i3, i8 - BMW), wind power stations, rail and commercial vehicles as well as in shipbuilding. What they all have in common is that structural damage occurs during operation, which must be remedied by high-quality repair at the level of a new structure.

A common method of repair is the scarfing of the damaged area and the subsequent gluing of a specially adapted patch. The scarfing must be done with a very low fault tolerance (<0.1 mm), is therefore very time-consuming and is usually carried out manually.

In the field of aviation, the entire process chain for the production of a CFRP component as well as its repair must be certified and completely reproducible. Manual scarfing, however, is highly dependent on the quality and daily level of performance of the workman, thus unsuitable for certification and has to be replaced by reproducible, automated scarfing. The main problem here is that all repairs are different, which means that customized scarfing programs are required for the automation.

### The Approach

To develop a semi-automatic repair system for composite components from aviation, the cooperation project RapidRepair was founded with cooperation partners such as Lufthansa Technik and Airbus. The aim of the project was to develop a certifiable method for the semi-automatic repair (scarfing) of damaged areas on CFRP components with multiple curved surfaces.

The system to be developed had to meet the following requirements:

- The (generally) multi-curved surface of the CFRP component is automatically detected by suitable sensors.
- From the scan data, a surface model of the component is generated.
- The complex trajectories for the scarfing are calculated from the surface model. Here, the previously selected parameters gradient angle and depth of the scarf are taken into account.
- The scarfing is done using a milling tool guided by a robot.
- All calculations as well as the guiding of the robot are carried out via a central process control computer.
- The maximum permissible position tolerance of the scarf must not exceed 1/10 mm in the Z direction and 1 mm in the X/Y direction.
- The automated scarfing process has to be shorter than the manual grinding process.

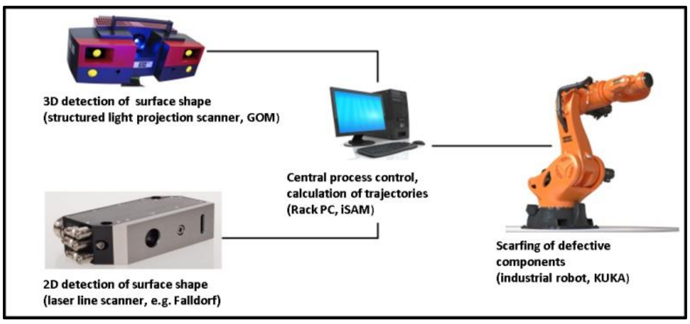


*Figure 1: Central process control – Integration of the system components*

# we deliver solutions ...

### The Solution

In the following, a typical sequence of the automated repair of a CFRP component is described using the example of a helicopter rotor blade.

### 3D Capture of the Surface

Structured light projection – High-precision scanning of the surface

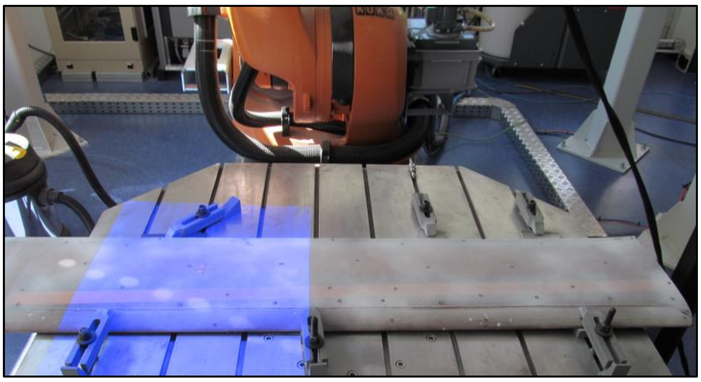

*Figure 2: 3D capture of a CFRP component (rotor blade)*

### User Interface

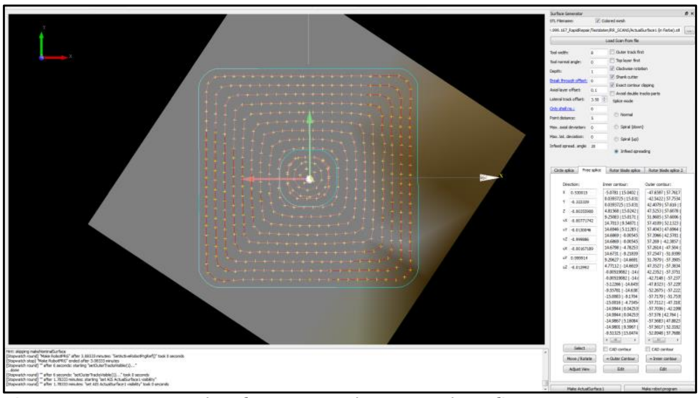

*Figure 3: Reconstructed surface area and generated scarfing program*

### Generation of Trajectories for Scarfing

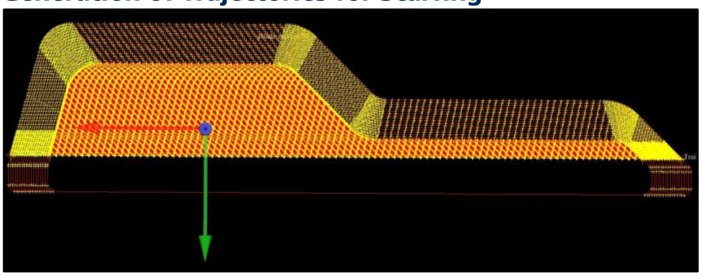

*Figure 4: Calculation of individual, high-precision trajectories*

### Result: Component with Scarfing

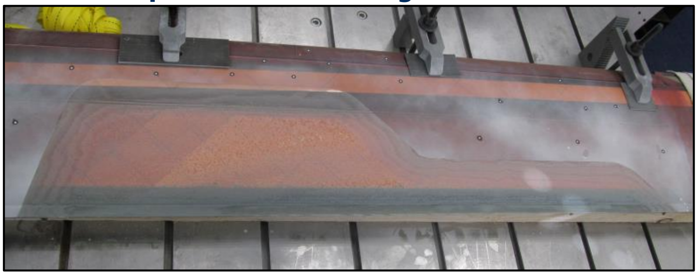

*Figure 5: CFRP structural component (rotor blade)*

### Precise Machining

Verification of the repaired area

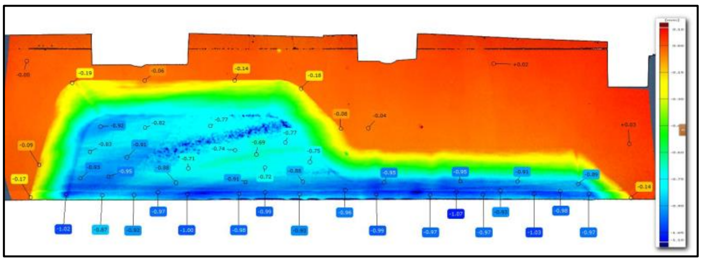

*Figure 6: Verification of the repaired area*

### Fast Execution

- Automated scarfing: 1,5 hours
- Manual scarfing: ca 6 – 10 hours

### Generation of Surface Sections for Scarfing

- Calculation of the cover layers
- Creation of dxf files for the cutter

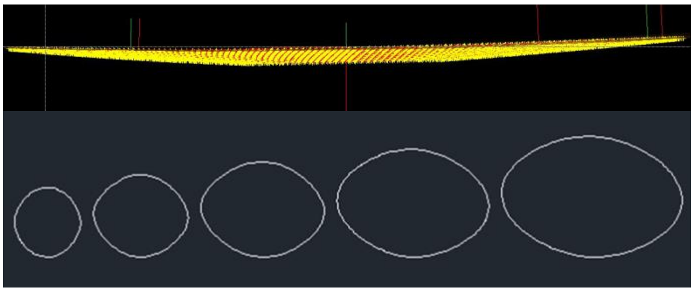

*Figure 7: Cross section through the repaired area and individual layers of the repair patches*

## Facts

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| Industries: | ▪ Aerospace<br>▪ Automotive | Components: | ▪ 3D scanner with structured light projection (GOM)<br>▪ Industrial robot (KUKA)<br>▪ iSAM Rack PC |
| Key functions: | ▪ 3D detection of multi-curved components<br>▪ Online generation of indivual trajectories<br>▪ Central process control<br>▪ Certifiable, high-precision process | Interfaces: | ▪ Ethernet TCP/IP<br>▪ Modbus / Profibus / CAN-Bus ...<br>▪ Digital / Analog |