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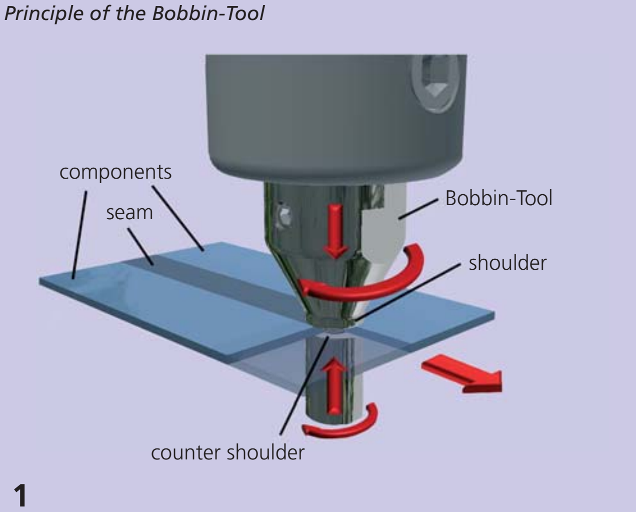
NEW JOINING TECHNOLOGIES FOR FUTURE FUSELAGE METAL STRUCTURES

THE TASK

Since decades multi row riveting has been the established process to assemble fuselage metal structures. Despite the fact that this process is mostly automated, it is still expensive due to long cycle times. An additional problem is that the riveted sections have to overlap, which add unnecessary weight and material costs. This situation implies an enormous cost and weight savings potential. However, this potential can only be exploited through new joining technologies including alternative joining processes, adapted and intelligent systems and clamping fixtures. The large three-dimensional metal sheets of fuselages are floppy. Precisely positioning them for reliable processing poses particular challenges.

Principle of the Bobbin-Tool



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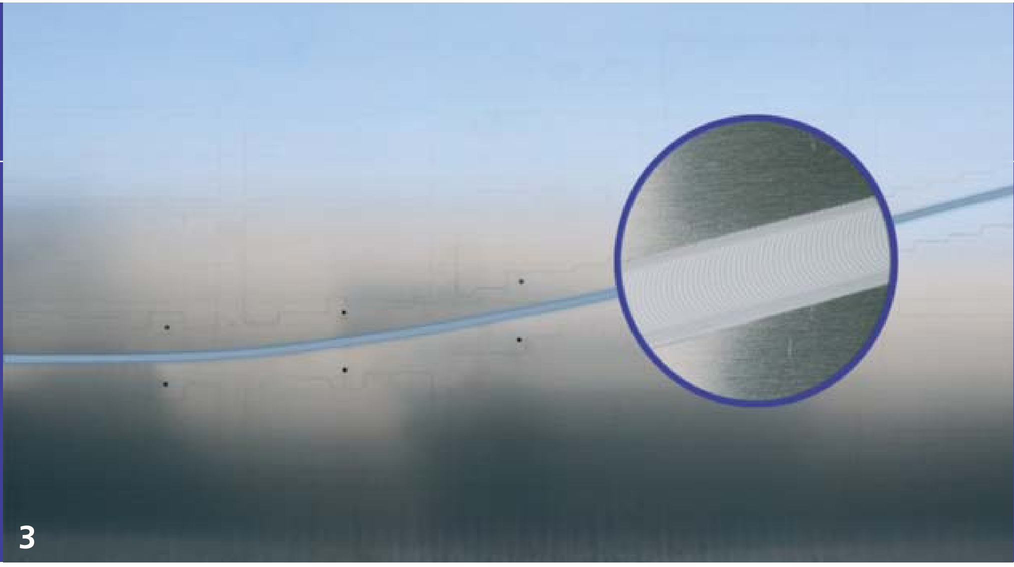
OUR SOLUTION

For many years Fraunhofer IWS engineers have been researching joining technologies for the aerospace industry. Friction stir welding is becoming ever more important in addition to laser beam welding for joining airplane components. As part of the Aerospace Research Program IV effort, IWS engineers have developed intelligent machine concepts to handle large and floppy three-dimensional components and join them via friction stir welding.

Friction stir welding generates enormous forces by default. Typically these forces are balanced with a support structure that is underneath the fixture holding. This approach is too costly for the aerospace industry since here the components are very large and of varying geometries. Thus each part would require its own unique large fixture and support structures. Therefore the team designed a friction stir welding process using flexible fixtures that do not require fixed counter points. The approach makes use of the so-called Bobbin-Tool or DeltaN-Tool. The tool’s double shoulder design does not require additional support structures underneath the joining point (Fig. 1). Overall these tools substantially reduce the forces that have to be handled by the parts as well as the welding system.

This machine concept was first implemented as a pilot system to build demonstration parts up to a size of 2.5 m .



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RESULTS

The aerospace industry uses ever more non-weldable aluminum alloys. Such alloys need to be joined without melting. Friction stir welding joins materials in their solid-state phase and is therefore increasingly employed. The high forces and the solid-state phase processing form a fine-grained and thermo-mechanically reinforced seam structure. The project partners performed extensive testing of the seam quality and confirmed the extraordinary properties of such welds.

Fraunhofer IWS engineers developed a welding robot, which autonomously moves on a three-dimensional rail system using an internal drive. The system also has an intelligent clamping concept. The fixture clamps and aligns the curved parts and positions them for cutting of the joining edges as well as the actual joining processes. The required tolerances are reliably achieved.

First test samples of a fuselage were successfully welded using this new process (Fig. 3). The application of the double shoulder tool and the accompanying technical advantages avoid the need for process control.

These works were performed within the subproject "New joining technologies for future fuselage metal structures" as part of the BMWi effort ECE "Economical metal fuselage generation Best-Eco-Mix".
(project number: 20W111C).

The work will be continued within the Aerospace Research Program V, subproject FUTURE II (project number: 20W1302C). The project will address new developments and optimizations of the machine concept. In particular it is planned to increase the part dimensions to 5.0 m length and to redesign the drive strategy. Achieving these goals will approach realistic airplane dimensions and geometries. Thus the result will be more valuable to judge the feasibility of the technology for future fuselage assembly.

2 Passenger airplane (metal fuselage construction)

3 Friction stir welded test carrier with 3D welds, material: Al 6xxx

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