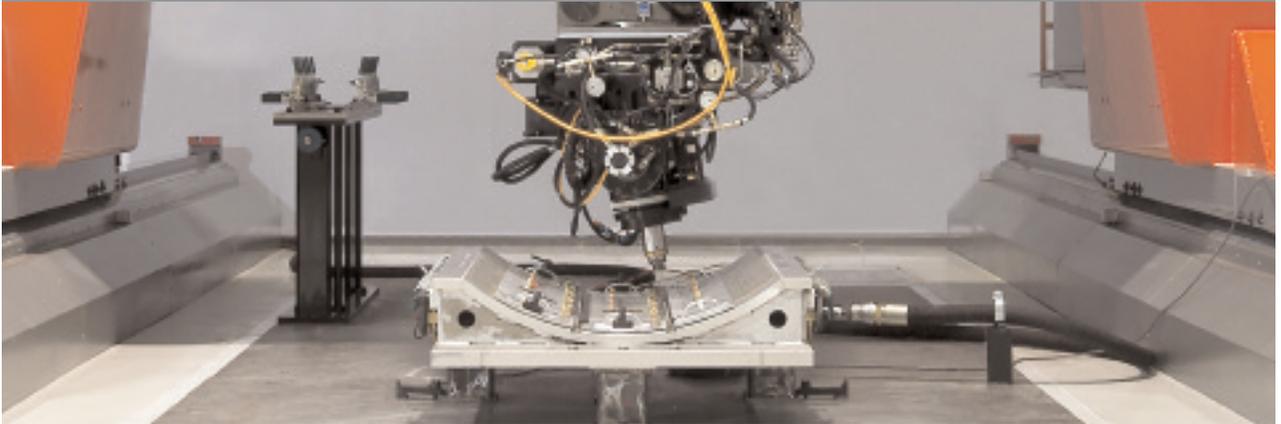




ECLIPSE  
AVIATION

## FRICITION STIR WELDING



### **About Friction Stir Welding**

Invented and patented in 1991 by The Welding Institute (TWI) in England, FSW has already gained acceptance in land and sea transportation systems. Aerospace applications are rapidly expanding as exemplified in the Delta rocket program, military aircraft applications, and, most recently, by the commitment from NASA to incorporate friction stir welding technology into the Space Shuttle's external fuel tank.

### **How Friction Stir Welding Works**

A cylindrical, shouldered tool with a profiled pin is rotated and slowly plunged into the joint line between two pieces of sheet or plate material. Parts must be clamped onto a backing bar to prevent abutting joint faces from being forced apart. Frictional heat is generated between the wear-resistant welding tool and the material of the work pieces.

This heat causes the latter to soften without reaching the melting point. The plasticized material is transferred from the leading edge to the trailing edge of the tool pin as the tool traverses along the joint. The resulting extrusion/forging process leaves a solid phase bond between the two pieces. The process can be regarded as a solid phase keyhole welding technique, since a hole to accommodate the probe is generated and then filled during the welding sequence.

### **The Benefits of Friction Stir Welding:**

- Higher properties and no heat distortion – Because friction stir welding is not a fusion process requiring significant heat input, the properties of the metal in the joined area are higher than those from any other known welding process, and distortion is minimized or eliminated
- Works with multiple aluminum alloys – Friction stir welding can be used to join dissimilar aluminum alloys (wrought or cast products)
- Superior weld quality – Bonding occurs below the melting point of the aircraft material, providing clean and consistent high-strength bonds with minimal distortion. The crushing, stirring, and forging action of the FSW tool produces a joint with a finer microstructure than the parent material and twice the ultimate strength of traditional welded joints



### **Joint Geometries**

The process has been used for the manufacture of butt and lap joints. For each of these joint geometries, specific tool designs are required which are being further developed and optimized.

Longitudinal and circumferential butt joints in Al alloy fuel tanks for space flights have been friction stir welded and successfully tested.

The FSW process can cope with circumferential, annular, non-linear, and three-dimensional welds. Since gravity has no influence on the solid-phase process, it can be used in horizontal, vertical, overhead, and orbital positions.

### **Friction Stir Welding Process Advantages:**

- High joint efficiencies (competitive with riveting and bonding)
- Excellent mechanical properties as demonstrated by fatigue, tensile, and bend tests
- Robust process
- Environmentally friendly
- No fumes
- No porosity
- Energy efficient
- One tool can typically be used for up to 1000m of joint length
- No filler wire
- No gas shielding
- No welder certification required
- No grinding, brushing, or pickling required in mass production