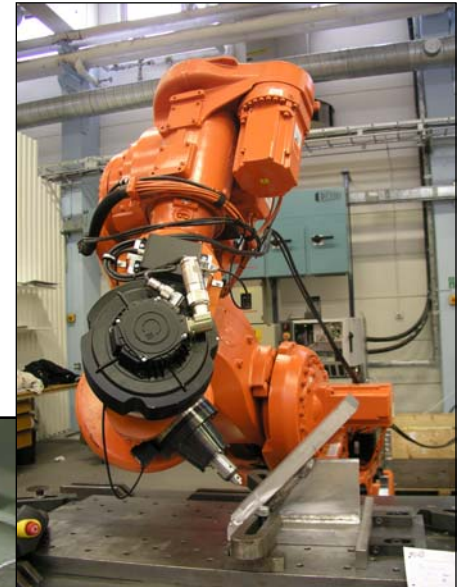
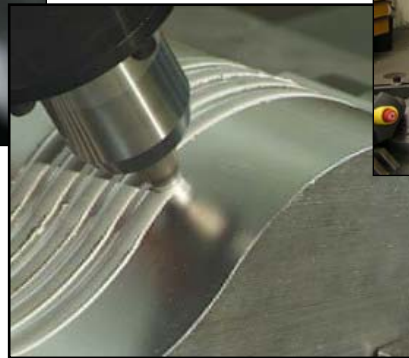
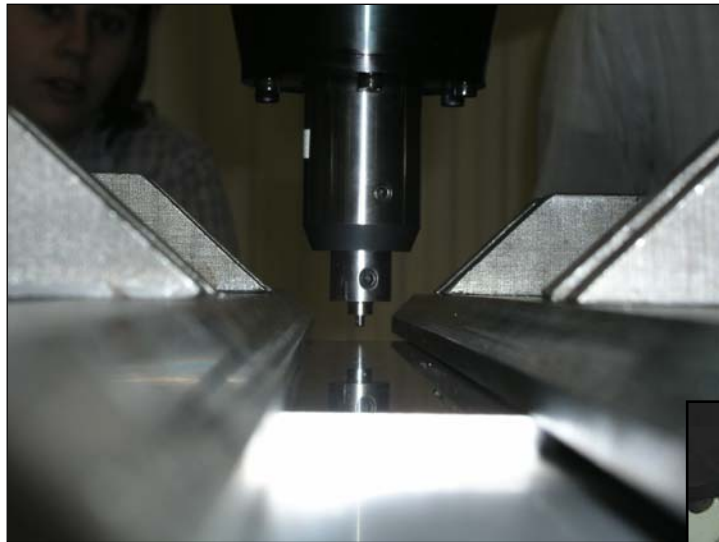


Robotic FSW for Aerospace Applications

AG52 Meeting, Haugesund Norway

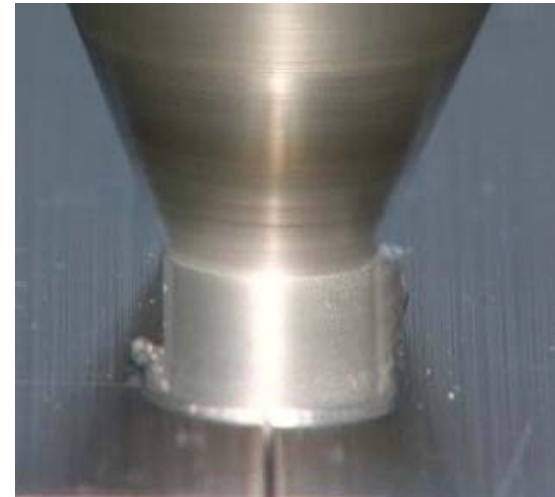
Dr. Mikael Soron, ESAB AB



Robotic FSW for Aerospace Applications

Outline

- Background – the ESAB robot prototype
- Application example
- Experiments – setup, alloys, etc.
- Results – weldability
- Discussion – robot performance
- Concluding remarks



Robotic FSW for Aerospace Applications

Background

- In 2003 ESAB launched “the robot project”.
- Aimed towards flexible 3D joining of (thin) aluminum components for e.g. the automobile industry.
- R&D work finished in 2007 (prototype finished).
- Results showed on great weldability of Al components up to 5 mm in thickness.
- Recently ESAB launched an industrialization project aiming to “finalize” the product by 2009.



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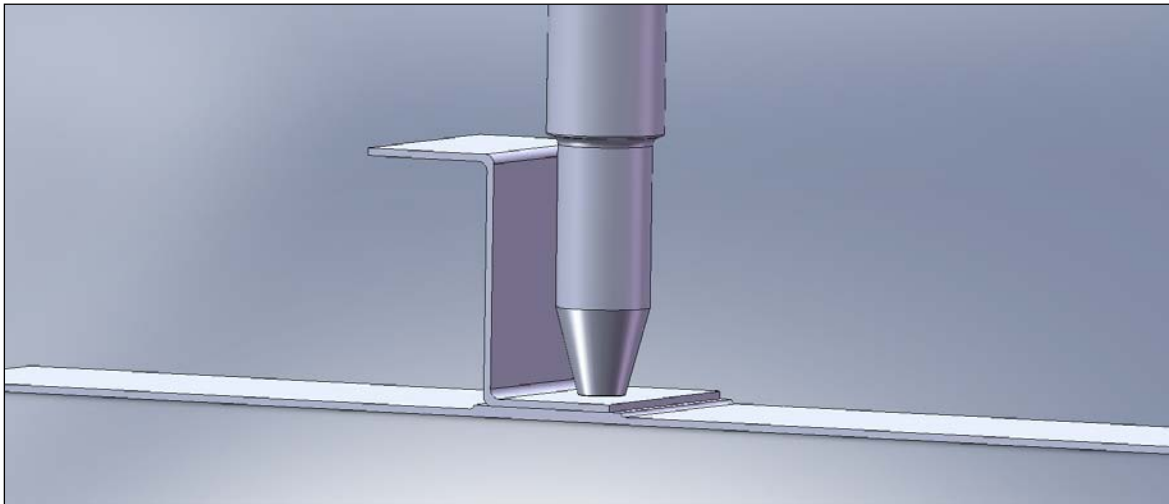
Towards aero application?

- Was not on the original agenda.
- A customer's request...
- The well-known application of stringers on fuselage panels.
- Successful experiments led to new enlarged scope
- To what extends may the robot system apply FSW on:
 - AA 7075, AA7020, AA2050, etc.
 - Regarding thickness, weld speed, geometry, etc.

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A typical “aero application”

- Welding stringers on fuselage panels
- Overlap joint in AA2024-T6 2,5 + 1,6 mm thickness



Robotic FSW for Aerospace Applications

Experiments - Setup

- ESAB FSW Robot System
 - Modified ABB IRB-7600
 - IRC5 Control System (F.C. option)
 - Welding eq. replace 6th axis on robot
 - Customized monitor software
 - ESAB's FSW robot software ext.



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Experiments – Alloys and Tools

<i>Alloys</i>	<i>Thickness</i>	<i>Joint geometry</i>
AA2024-T6	1.6+2.5 mm	Lap joint
AA2050-T3	3 mm	Process test
AA7020-T6	2 / 3 mm	Lap joint, process
AA7075	2 / 3 / 5 mm	Lap, butt, process

<i>Tool</i>	<i>Shoulder</i>	<i>Pin</i>	<i>Remarks</i>
tool_2010	10 mm	2,0 mm	Scrolled shoulder, threaded
tool_2810	10 mm	2,8 mm	Threaded
tool_5010	10 mm	5,0 mm	Threaded

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Results AA2024-T6

- Parameters:
 - Downforce: 5,5 kN
 - Travel speed: 2mm/s (12 cm/min)
 - Spindle: 650 rpm
- Good surface finish



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Results AA2050-T3

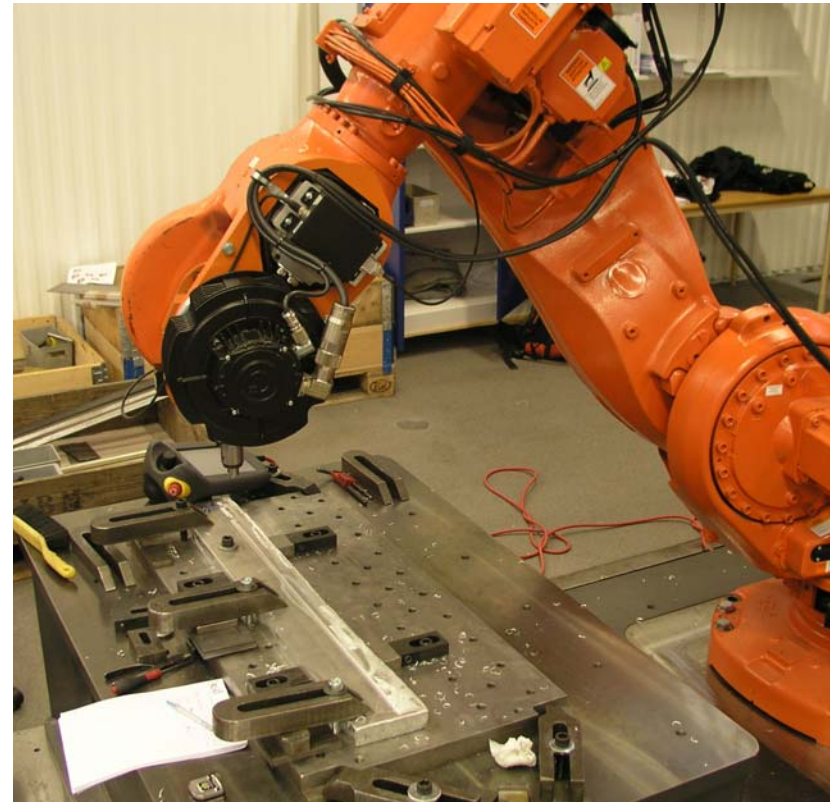
- Parameters:
 - Downforce: 9 kN
 - Travel speed: 10 mm/s (60 cm/min)
 - Spindle: 950 rpm
- Excellent surface finish
- Only process tests performed..



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Results AA7020-T6

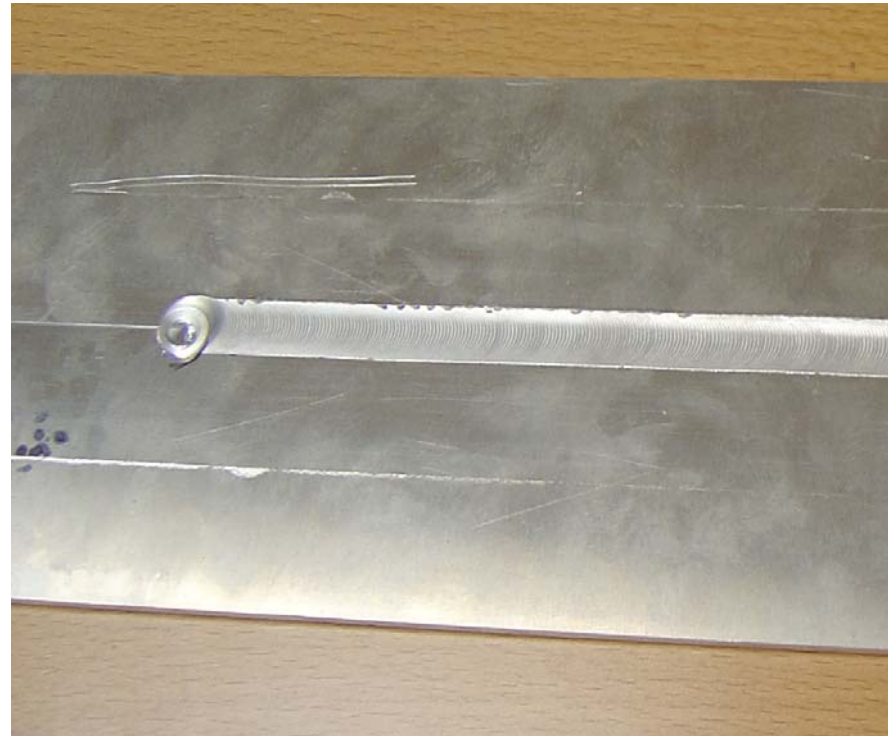
- Parameters:
 - Downforce: 7,5 – 8,2 kN
 - Travel speed: 3 mm/s
 - Spindle: 510 rpm
- Experiment performed as process tests and lap joints
- Longer sample of 800 mm welded with good result



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Results AA7075

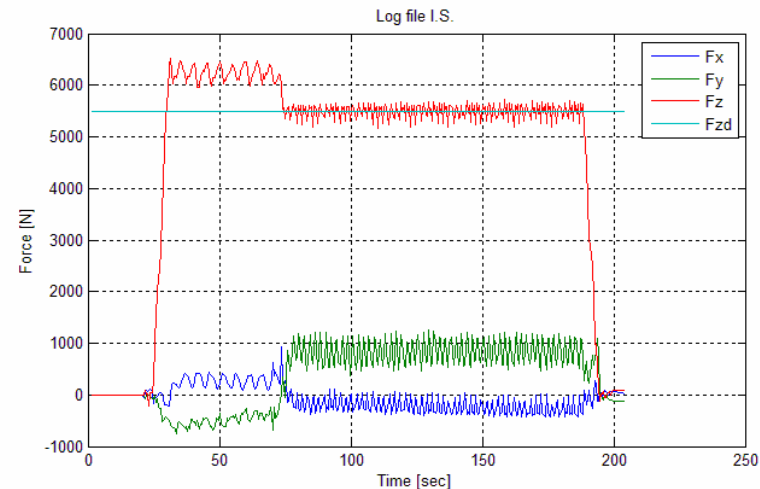
- Parameters:
 - Downforce: 10 kN
 - Travel speed: 3 mm/s
 - Spindle: 510 rpm
- Different setups:
 - lap (3+3 mm),
 - butt (3 mm)
 - and process



Robotic FSW for Aerospace Applications

Discussion

- Test showed on good/excellent weldability on many common aircraft/aerospace alloys
- Different joint geometries evaluated.
- Force capacity ok, although in the upper limit region.



Robotic FSW for Aerospace Applications

Discussion - limitations

- All tests performed on planar objects...
- Unstable results on tilted (45 deg) objects
- Compliant behavior:
 - Unpredictable plunging
 - XY-plane deviation (corrected)
- Thickness limitations:
 - 3 mm butt joint
 - 5 mm lap joint

Robotic FSW for Aerospace Applications

Concluding remarks

- Positive results from tests on common aircraft /aerospace alloys using the ESAB FSW robot system on joints having a thickness of up to 5 mm.
- Limited 3D capacity, which may be eliminated using e.g. positioners and/or optimized fixtures.
- One verified application; stringers on fuselage panels

Acknowledgements

ESAB thanks Institute de Soudure for their technical support and for providing material to this study.