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Report and minutes No 14

from the meeting **9 November 2016** at University West (PTC) Trollhättan, Sweden.

Attendance

Lars Cederqvist, SKB, Sweden (chair)
Mathias Lundin, Swedish Welding Commission, Sweden (secr)
Gunnar Bolmsjö, University West, Sweden
Anna-Karin Christiansson, University West, Sweden
Jeroen deBacker, TWI, UK
Peter Kjällström, Esab, Sweden
Kristofer Larsson, Esab, Sweden
Thomas Murray, Saab Aerostructures, Sweden
Rebecka Nilsson, Esab, Sweden
Jörgen Säll, Esab, Sweden
Ana Silva Magalhães, University West, Sweden
Mikael Soron, AETech AB, Sweden
Pedro Vilaça, Aalto University, Finland
Quinton Weaver, Aalto University, Finland
Anders Westfeldt, Esab, Sweden

Short note on Lic. presentation of Ana Silva Magalhães

The day started with Ana Silva presenting her licentiate thesis on "Thermo-elastic temperature measurements in friction stir welding – Towards feedback control of temperature". After Anas presentation Pedro Vilaça, Aalto University, acting as sensor, gave questions and comments on the presented work. After that extensive interview the audience was invited to ask questions. Ana answered and defended her work in an impressive manner, and was congratulated on a good work so far, since she will continue for a PhD.

Short notes from Technical tour of PTC and demonstration of robotic FSW

Ana and Jeroen demonstrated a 3D FSW application with welding some different runs using the PTC research equipment being an ABB IRB7600 robot 6 axis plus two external axis (handler). Runs with and without force control were demonstrated.

Minutes from the meeting

1. Opening of the meeting

The chair Lars Cederqvist opened the meeting, welcomed everyone and started the meeting. The host Gunnar Bolmsjö also welcomed everyone to University West.

2. Approval of the agenda

The agenda was amended concerning the presentations under item 5, and approved. Timo Salonen, Posiva, unfortunately could not participate and his item was replaced by a presentation from Saab Aero on "Clean Sky 2".

3. Minutes from previous meetings

The minutes from the meeting 27 May 2015 at SKB was approved.

No notes were taken from the meeting 16 May 2016 in conjunction with the TWI Symposium in Cambridge.

4. Short presentation of the organization and activities of new participants

A short round of presentation was conducted. New to the group where:

- Tom Murray, researcher in aeronautical engineering at Saab in Linköping.
- Kristoffer Larsson that replaced Stefan Stoltz at Esab.
- Peter Kjällström, head of product management for submerged arc welding and FSW at Esab.
- Quinton Weaver, masters student at Aalto University, Finland.

The new participants where especially welcomed to the group.

5. Presentations

5.1 Clean Sky 2, Tom Murray, Saab

Tom gave a presentation on Saabs work on cargo doors participating in a large European research project calles Clean Sky 2, CS2 (**Appendix 1**).

Saab is developing different "CS2" cargo door demonstrators for "single aisle aircrafts". Focus is primarily to reduce manufacturing cost, but also reducing the weight and the assembly time.

Also making different demonstrators using e.g. adhesive bonding and machining respectively, to compare. Also making tests with Metal Additive Manufacturing.

There is an opening to apply for funding for projects on FSW and Laser beam welding. However, the call is not out yet, but will start around the new year. Tom will get back with details for Mathias to distribute to the group.

5.2 Invited to present the results of the FlexiFab project, Jeroen de Backer

Flexifab is a large European project that TWI is heavily involved in (**Appendix 2**).

Within the project Jeroen is developing tools with stationary shoulder, with a rotating probe and static shoulder (SSFSW), for robot welding.

The stationary shoulder can be formed to e.g. produce a fillet weld ("corner welding T-joints") or to weld dissimilar thickness joints. The later can save you from using a tilt and get problems with support.

The stationary shoulder can also be equipped with a filler wire.

SSFSW is very beneficial for welding aluminium. Additional to the mentioned there is no "meltdown", reduced vibrations, reduced spindle torque and reduced heat input. Also much beter results on very thin sheets

Jeroen showed examples from welding SSFSW in 0,5 mm AA7xxx and 1 mm in Ti 6-4 respectively. Also showed T-joint of 3 mm AA2024-T3.

Jeroen also showed trials with line scanner seam tracking. Anna-Karin Christiansson mentioned studies in seam tracking done at PTC (**Appendix 3**).

Jeroen also showed, the latest development, a bobbin tool with a stationary shoulder on the top side and a rotating shoulder on the back side.

5.3 Analytical and modelling assessment of the design for the tool probe for 5 cm thick copper, Quinton Weaver and Pedro Vilaca, Aalto University

Quinton gave a presentation on numerical modeling and validation of tools for FSW of copper (**Appendix 4, pending**)

The aim is to look at changing of the geometry around the tip of the probe to optimize the stiring effect.

Quinton showed different changes to the original probe. One of the shapes was chosen for a numerical analysis. Modeling complex geometry using Ansys Fluent. & CFD Post.

Quinton showed the set-up of the trials with respect to functions, programming, boundary conditions etc, and the use of main functions for continuity, momentum and energy.

It takes 2-3 hours computer time per revolution and approx. 6 revolutions are needed for one simulation.

Quinton showed post processed illustrations of flow rate, temperatures, strainrate etc.

The model can also give probe loads, and Quinton showed lower probe load for the simulated changed tool.

The simulated tool gave more mixing at the tip and less X-force.

5.4 New FSW machines for 2016/2017. Anders Westfeldt, Esab

Anders gave a broad presentation on what is going on in the industry involving Esab, as an equipment developer (**Appendix 5**).

Anders presented welding equipment:

- Large equipment with two welding heads to China Rail Car, CRRC, which is the largest supplier of railway vehicles in the world.
- Equipment for rocket launcher for the new Ariane 6, European Space Agency, ESA. For welding fuel tanks for Airbus Safran Launchers.
- Siemens Energy for welding of copper coils for generator wings.

Esab have also developed a new electro mechanical welding head that is more compact and powerful than a hydraulic one. The head itself is producing the z-move.

5.5 Future R&D at University West , Gunnar Bolmsjö

Gunnar gave an update on the activities at PTC (Produktionstekniskt Centrum at University West) concerning robotic FSW (**Appendix 6**).

PTC has funding from the project MAPLAB (Swedish Tillväxtverket). And also have collaboration and partnership with Nordic FSW Center in Oskarshamn. PTC Is also open to collaboration with others.

Gunnar presented upgraded equipment with an added 2-axis positioner, and added support to the positioner to minimize deflection.

Gunnar presented ongoing and planned studies.

Discussed the possibility to form a consortium for future studies.

5.6 Verification of depth controller at SKB, Lars Cederqvist

Lars presented the work at SKB for a depth controller (**Appendix 7**).

Lars will also present this on the upcoming TMS conference (see item 6). He explained that they have different manufacturing technique for the lid and the canister tube, and this cannot be controlled only by force control.

Lars also presented the status of the forming of a Nordic FSW center in Oskarshamn. Main objective to assist industry with implementing the FSW process.

6. Messages and Reports – conferences, articles etc

Upcoming events:

- IIW Commission III intermediate meeting 6-8 February 2017 in Hungary.
- TMS 2017 conference 26 February to 2 March 2017 in San Diego, US.
- IIW Annual Assembly 25-30 June 2017 in Shanghai, China.
- TWI Symposium June 2018 in Quebec, Canada (www.fswsymposium.co.uk).

Participation in IIW activities is open to all Svetskommissionen members. Apply for a user and to the desired working unit respectively at www.iiwelding.org.

7. License and patent issues

Un-featured tools are possible to use without violating the patent since December 2012

Featured tools are possible to use without violating the patent from,
- January 2015 in Europe
- September 2015 in US

Noted that there are a couple of thousand patents within the field, mainly concerning tool configuration, that are hard to navigate through.

TWI has a spread sheet online covering all patents. See www.twi-global.com/EasysiteWeb/getresource.axd?AssetID=195120&type=Full

Patents are no problem for research. However, companies are obligated to review the patents before starting manufacturing.

There seems to be a lot of overlapping patents.

Decided to keep this item on future agendas to check any issues concerning the use of the process.

8. Short report on FSW standardisation activities in IIW

Mathias presented a short status on the ISO standardisation projects that are conducted within IIW (**Appendix 8**).

ISO 25239-1 to -5 Friction stir welding – Aluminium, published in 2011, under revision.

ISO/DIS 18785-1 to -5 Friction stir spot welding – Lap welds in Aluminium, ongoing project..
As a member of Swedish Welding Commission one has access to the documents produced by IIW-C-III, see item 6.

9. Information projects – Inventory

No amendments to the list of info projects from the working group, hence no new appendix.

All members were asked for proposals on information activities, such as popular articles, manuals, guides/guidelines etc, to promote the spread and use of the FSW process in the Nordic countries.

10. Working Program and member issues (prospective participants etc)

No amendments were made to the working program/outline.

Contact at GKN that would be interested in participating was discussed.

11. Arrangement for subsequent meeting(s)

Next meeting was decided for June 2017 (date to be decided) at Esab in Laxå, Sweden. It is an opportunity to see equipment . Esab will return with a suiting date.

12. Closure of the meeting

The chair thanked everyone for their contribution and closed the meeting.

Meeting secretary

Mathias Lundin