RAPOLAC

Rapid Production of Large Aerospace Components

**Funding:** European (6th RTD Framework Programme)

**Duration:** Jan 2007 - Dec 2009

**Status:** Complete with results

**Total project cost:** €2,734,683

**EU contribution:** €2,140,650

**Call for proposal:** FP6-2005-AERO-1

**CORDIS RCN:** 81484

**Background & policy context:**

Shaped metal deposition (SMD) is a prototyping system that allows complex parts to be built directly from a CAD model with minimum finishing. The system builds components layer by layer without the need for tooling. Complex parts can be made with improved material properties and hybrid components can also be created.

The advantage of SMD is that complex parts, or those that need a lot of machining, can be made quickly and cheaply: in some cases lead times have been reduced by 70%. The finished parts can also have improved material qualities, the process has low to zero harmful emissions and it does not require tooling. Uses include rapid prototyping, one-off parts, repair, and complex or hybrid components.

The SMD rig consists of a robot with a TIG welding head and a manipulator, housed inside a sealed chamber with wire fed in from outside. The system welds the wire in an inert argon atmosphere to prevent the substrate, electrode and part reacting with atmospheric gases. Once used, the argon can be safely vented via an extraction system, or re-circulated via a scrubber system. A water-cooled vision system allows the welding arc to be viewed and the size of the bead and weld pool to be monitored in real time. Features can be built in any orientation without the need for support structures.

**Objectives:**

To exploit SMD technology fully within aerospace, it must be demonstrated that it is a valid and cost-effective manufacturing route. RAPOLAC will produce a business case for SMD to ensure the take-up of this technology. Further work will define material properties, achieve certification for the process and widen the range of materials which can be deposited. RAPOLAC will concentrate on aerospace materials such as titanium, steels and nickel-based alloys, which are costly and difficult to machine. This process has attracted interest from several aerospace companies, but take-up is limited because:

- weld parameters vary according to the material, substrate, geometry and size
- the material properties are not well understood, and
- the benefits of SMD over more traditional processes are not clear.

To validate SMD for commercial aerospace use, samples containing difficult-to-manufacture features will be constructed from a variety of materials. Material characterisation will be performed, and the process modelled using FE and mechanical techniques. A cost-benefit analysis will be carried out to compare SMD construction with traditional manufacturing routes, allowing a business case to be put forward to encourage take-up by SMEs. The time and material savings are expected to make SMD an attractive option for the manufacture of large aerospace parts.

**Methodology:**

RAPOLAC's aim is to validate SMD to manufacture aerospace parts in a variety of materials. To do this, the properties produced by different materials, geometries and deposition parameters must be catalogued, heat-treatments and machining strategies developed, and the process modelled and
controlled.

WP1 will build the parts needed for microstructural analysis, fatigue and stress tests and will provide data for modelling. It will also investigate the effects of different weld parameters, materials, substrates, part sizes and geometries, and test the control strategies developed. It will look at post-heat-treatment and machining strategies for the finished parts.

WP2 will look at the properties of the parts produced, and develop a database of material properties, residual stresses and susceptibility to fracture.

WP3 will develop both local models (optimising weld parameters to give the best material properties) and global robotic models of the SMD process.

WP4 will look at all aspects of the SMD process and quantify its benefits, comparing SMD with traditional manufacturing processes. It will highlight the cost and environmental advantages and develop best practice manufacturing methods, which will indicate where SMD should be used entirely, and where hybrid manufacture is more cost-effective. This will lead to the creation of a business plan for SMD and encourage its take-up in industry.

### Parent Programmes:
**FP6-AEROSPACE - Aeronautics and Space - Priority Thematic Area 4 (PTA4)**

**Institute type:** Public institution  
**Institute name:** European Commission  
**Funding type:** Public (EU)

### Lead Organisation:

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| **EU Contribution:** €0 |

### Partner Organisations:

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| Universidad Nacional Del Litoral - Instituto De Desarrollo Tecnológico Para La Industria Química | Pellegrini 2750  
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Argentina | [http://www.unl.edu.ar](http://www.unl.edu.ar) | €0               |
| Footprint Tools Ltd               | Hollis Croft  
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| Diad Srl                          | Strada della Praia,12/c  
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**Key Results:**

The final deliverables for RAPOLAC have been chosen to improve process knowledge and to make SMD
more attractive.

Investigations will produce post-heat-treatment strategies, optimum weld parameters and machining strategies for a variety of aerospace materials. These will be obtained by depositing parts and obtaining micro-structural results, tensile and fatigue test results, and surface analysis results. Mechatronic heat transfer models and residual stress models will be created to help in this process. This information will allow the SMD process to be certified for non-critical aerospace applications for the materials and parameters chosen, and will give companies confidence in the process.

As part of the drive to encourage SMD take-up, cost-benefit reports will be produced for SMD with respect to traditional processes, a business case for SMEs will be developed, and a best practice methodology for hybrid parts will be produced.

A website will be set up for the project, the papers used to publicise it and for workshops. Training modules will be developed for interested companies.

The impact of the above deliverables will be:

- Reduction of 60% in the lead time necessary to produce new parts through the elimination of tooling and the use of SMD parts as manufacturing prototypes.
- Reduction of 40% in the cost of manufacturing products through reducing raw material use, finish machining and tooling.
- Reduction of 90% in the inventory held, since the only stock item is wire.

**Technical Implications**

RAPOLAC consortium members are now seeing keen interest in the SMD technology from industry. They have already produced test parts for six different aerospace companies, and have also been approached by companies from other sectors including medical and motorsports.

Footprint Sheffield, the leading industrial partner in RAPOLAC, aims to adopt the technology in its own factory to help the company expand its markets and offer higher-value services.

Richard Jewitt, director of Footprint Sheffield, says: "Footprint's involvement in the RAPOLAC project has been an essential part of developing our future strategy. To survive and prosper we must move up the technology ladder in what we manufacture and enhance the skills level of our staff. Being part of the Rapolac project has enabled us to assess a new manufacturing method, while our staff have been working closely with experienced and highly capable partners."

Documents:
- Final Publishable Summary (Other project deliverable)

**STRIA Roadmaps:** Vehicle design and manufacturing
**Transport mode:** Air transport
**Transport sectors:** Passenger transport, Freight transport
**Transport policies:** Societal/Economic issues
**Geo-spatial type:** Network corridors