Joining Sub-Platform

to Manufuture

Joining – A Core Element to Innovative and Sustainable Manufacturing



Join us at: www.joining-platform.com

Top Level Objectives

Support the European 2020 Strategy in addressing the grand challenges in the areas of:

- Employment
- R&D
- Climate change/energy sustainability
- Education
- Fighting Poverty/social exclusion

Join us at: www.joining-platform.com

‘Fit’ with Europe



JOINING

Joining Sub-Platform Philosophy

Joining, including traditional welding methods, is a core element to innovative and sustainable manufacturing

"The value added by Joining technology in Europe amounted to around EUR 65 billion in 2010.

Over 1.25 million employees were connected with this added value within Europe in 2010"

Join us at: www.joining-platform.com

Joining Platform Mission

To develop a competitive, innovative and sustainable Joining competence that utilises advanced techniques and products, to add value to manufacturing, generating economic growth and skilled jobs for the benefit of EU stakeholders

Join us at: www.joining-platform.com

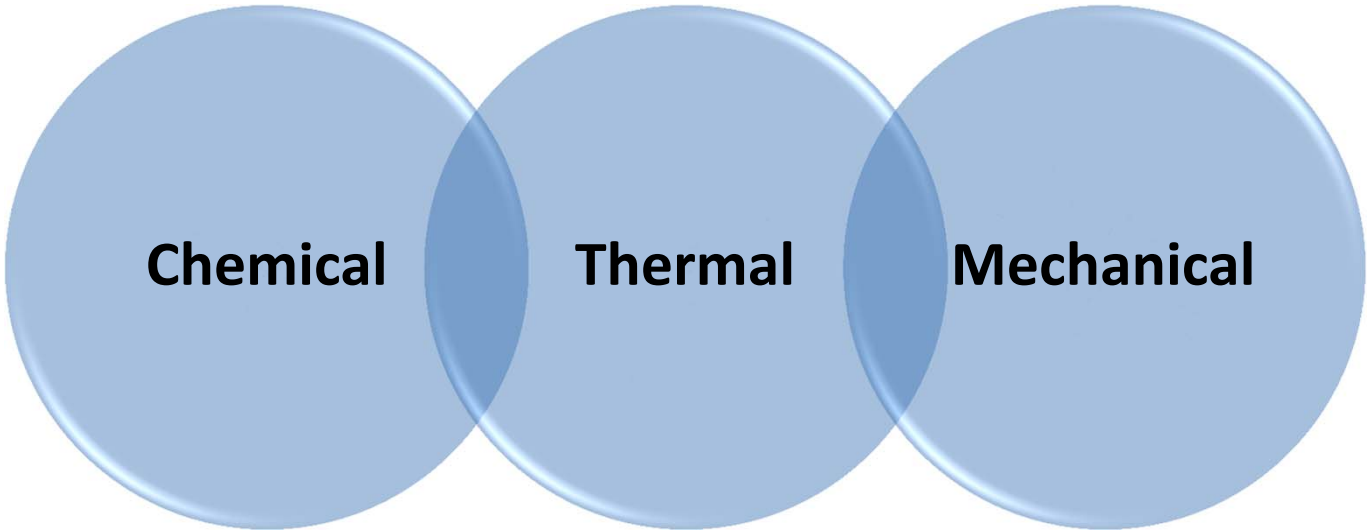
Vision

- **The support of manufacturing through competitive and sustainable Joining techniques as a core element of modern manufacturing**
- **High value, high productivity and flexible Joining processes that support new and existing business models**
- **Joining processes that are knowledge based through scientific understanding**
- **The development of training**

Join us at: www.joining-platform.com

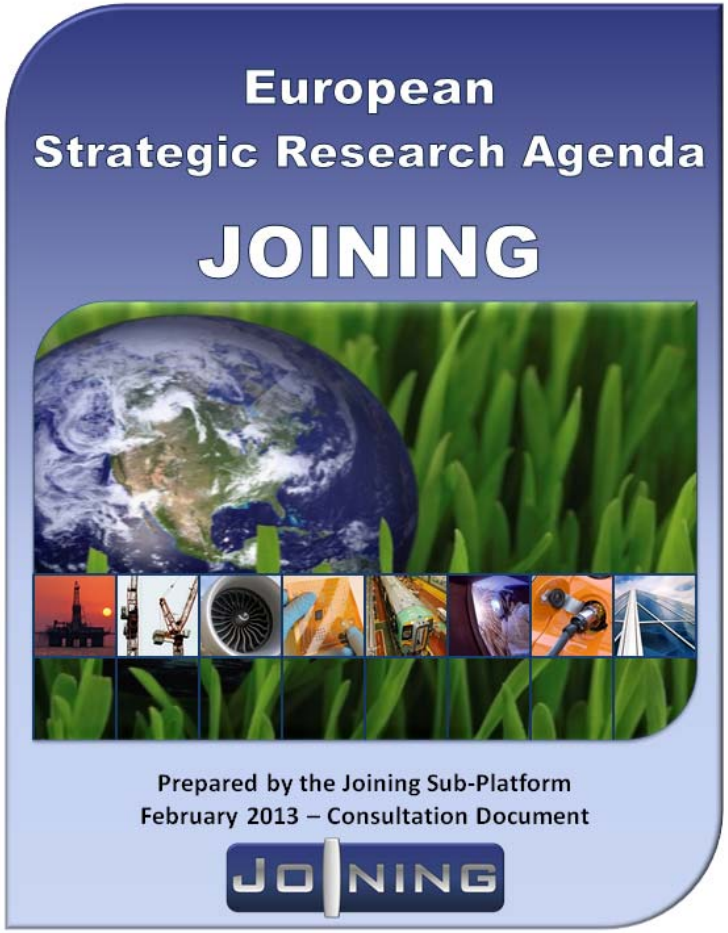
Joining Sub-Platform Definition of Joining

Creating a bond of some description between materials or components to achieve a specific physical performance.



Join us at: www.joining-platform.com

Joining Sub-Platform Strategic Research Agenda





7. Challenges and Opportunities for Joining

In order to ensure the future of Joining within Europe it is vital that the EU is significantly ahead in the development and exploitation of Joining processes. The underpinning knowledge to support this is also of significance and Europe needs to ensure this is secured for generations to come. This in turn will generate opportunities for increased business turnover and the number of jobs not only safeguarded but created.

The importance of the Grand Challenges highlighted by the EU are significant and the uniting of European industry, governments and institutes alike is required in order to bring together an understanding of the key areas of research and to guide the future direction of Joining technology development.

Responsibly driven economic growth is a prerequisite for societal sustainability, addressing the needs of the citizen and the environment and as such is deemed as a key enabler to the success of the EU Grand Societal Challenges (EFFRA, 2012).

Manufacturing needs to incorporate sustainability, from planning and design, to repair and recycling, and the end of a product life cycle. It is these aspects which have a direct influence on Joining technology. Only energy-efficient, environmentally favourable fabrication can create products that are needed by a sustainable EU economy (Middeldorf & Jerzembeck, 2012).

Outlined in the following sections are some of the key PESTLE drivers for individual industry sectors and some of the current industry products, within these drivers, that relate to Joining. Emphasis is then drawn down to technology development areas where Joining plays a critical part of overcoming the technical barriers seen in industry products. This technology development can therefore be used to address the drivers. This is not an exhaustive list of technology areas. Figure 3 provides a schematic of the process methodology used.

Figure 3: Schematic of the process methodology used for mapping the Joining themes.

Join us at: www.joining-platform.com

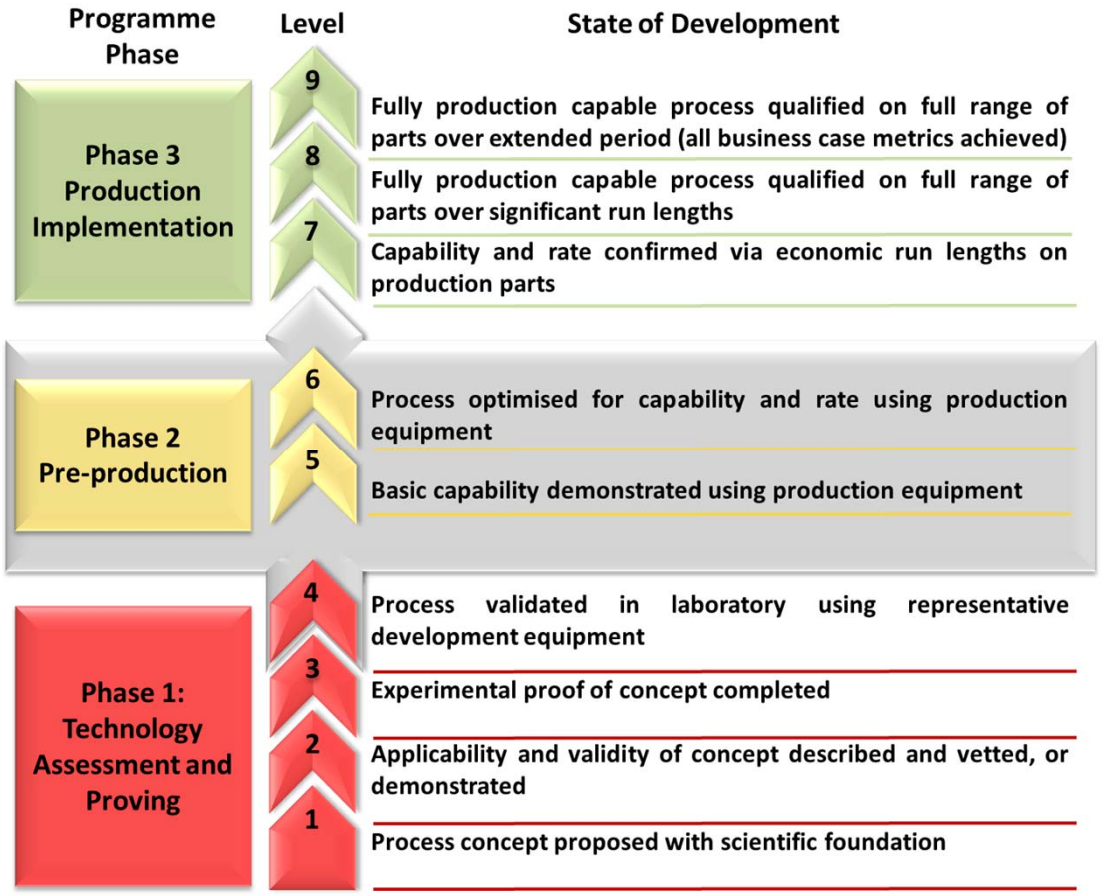
JOINING

Consultation

- DVS, Germany
- EWA, France
- EWF, Portugal
- Industrial Institute of Slovak Republic, Slovakia
- Swerea IVF AB, Sweden
- SINTEF Raufoss Manufacturing AS, Norway
- Tecnalia Corporación Tecnológica, Spain
- TWI Ltd, UK
- Other

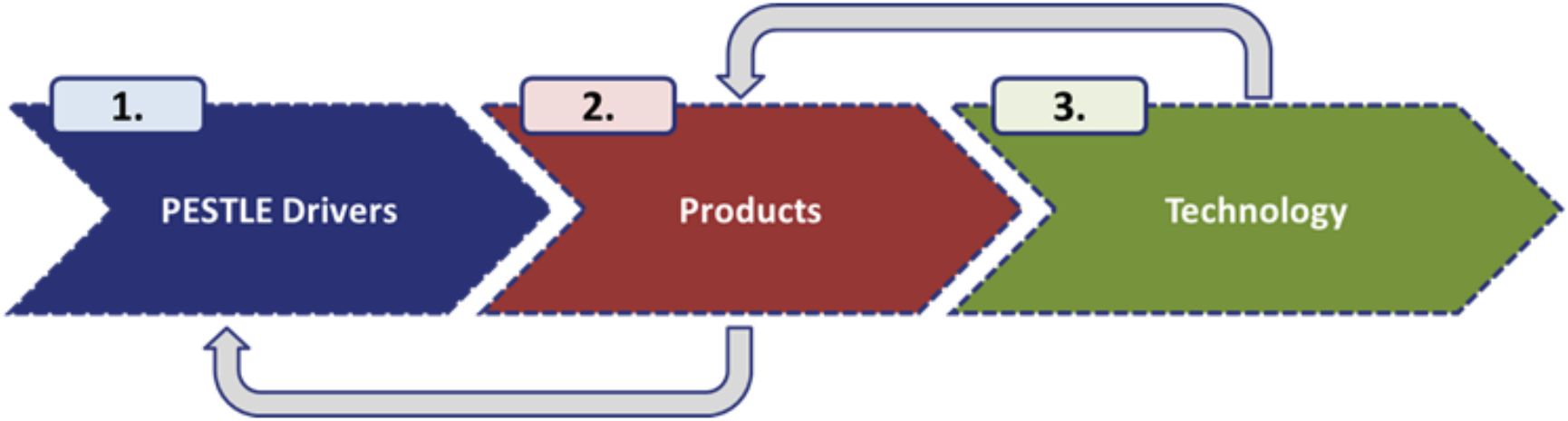
Join us at: www.joining-platform.com

TRL



Join us at: www.joining-platform.com

SRA Approach



Join us at: www.joining-platform.com

Automotive

Automotive and Road Transport

Drivers:

- **Light weighting, prompted by the need for fuel efficiency**
- **Reliability and quality**
- **Low carbon vehicles**
- **Reducing costs**
- **Recyclability and disassembly**
- **Regulatory and legislation requirements**
- **Improved crash performance**
- **Improved driveability (structural stiffness)**
- **Training and skills**



Industry Products Relevant to Joining:

Vehicle bodies

Light weighting is driving the need for optimum designs and this increasingly means using mixed materials within a structure such as vehicle bodies. Also, composites are becoming more desirable over metals due to their **reduced weight**, good corrosion properties, and ease of shaping.

Electric vehicles

The need for **lower cost** and **performance enhancement** is driving the need for improved processes, parts and materials such as battery and fuel cell technology, and the development of **high efficiency** electrical motors. Electric vehicles have different drivetrain constraints compared to traditional vehicles powered by internal combustion engines usually located at the front. This has led to motor and battery positioning requirements in electric vehicles allowing new construction philosophies to be used. Hence, there is now a requirement for a new approach to auto-body construction for electric vehicles.

Main Joining Technology Challenges and Opportunities:

Vehicle bodies:

- Dissimilar/hybrid materials Joining such as aluminium, steel, high strength steel, fibre composites, and plastics
- Joining composites
- Joining of coated high strength materials
- Automated aluminium spot welding
- Joining thin sheets
- Joining multiple sheets
- Joints between tubular structures

Electric vehicles:

- Low electrical resistivity joints
- Low heat input joints to avoid damage
- Joining packs of thin sheets
- Approaches suitable for high volume rapid manufacture
- Performance of joints in HP Hydrogen





Join us at: www.joining-platform.com

Drivers: Automotive

- Light weighting, prompted by the need for fuel efficiency
- Reliability and quality
- Low carbon vehicles
- Reducing costs
- Recyclability and disassembly
- Regulatory and legislation requirements
- Improved crash performance
- Improved driveability (structural stiffness)
- Training and skills

Join us at: www.joining-platform.com

Products: Automotive

Vehicle bodies

Light weighting is driving the need for optimum designs and this increasingly means using mixed materials within a structure such as vehicle bodies. Also, composites are becoming more desirable over metals due to their **reduced weight**, good corrosion properties, and ease of shaping.

Products: Automotive

Electric vehicles

The need for **lower cost** and **performance enhancement** is driving the need for improved processes, parts and materials such as battery and fuel cell technology, and the development of **high efficiency** electrical motors.

Electric vehicles have different drive train constraints compared to traditional vehicles powered by internal combustion engines usually located at the front. This has led to motor and battery positioning requirements in electric vehicles allowing new construction philosophies to be used.

Main Challenges and Opportunities: Auto

Vehicle bodies:

- Dissimilar/hybrid materials Joining such as aluminium, steel, high strength steel, fibre composites, and plastics
- Joining composites
- Joining of coated high strength materials
- Automated aluminium spot welding
- Joining thin sheets
- Joining multiple sheets
- Joints between tubular structures

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Auto

Electric vehicles:

- Low electrical resistivity joints
- Low heat input joints to avoid damage
- Joining packs of thin sheets
- Approaches suitable for high volume rapid manufacture
- Performance of joints in HP Hydrogen

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Power

Offshore Wind Turbines

- Thick section Joining for pylons
- Joining methods for higher volume, thick section
- Joining of composites to metal for turbine blades
- Aluminium coatings for splash zone corrosion protection
- In-situ condition monitoring of joints in wind turbine components (tower, blade, nacelle)

Main Challenges and Opportunities: Power

Wave and Tidal Energy

- Joining of tubular structures
- Joining for higher volume thick section
- Use of composites and Joining of composites to metals for weight reduction
- Corrosion protection coatings

Main Challenges and Opportunities: Power

Solar

- Coatings for PV cells
- Joining of light weight structures
- Composites for light weight structures

Local CHP (**C**ombined **H**eat and **P**ower)

- Joining technologies for mass production
- Joining of fuel cell components
- Ceramic Joining technologies

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Power

Biomass & waste to energy plant

- Sprayed coatings for biomass plant components
- Joining technologies for repair
- Joints between tubular structures
- Joints between dissimilar materials
- Life assessment and extension of Joints

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Power

Fossil fuel power generation plant

- Joining of creep strength enhanced ferritic steels
- Post weld heat treatment
- Joints between dissimilar materials
- Life assessment and extension of Joints
- NDT of Joints in complex pipe work

Main Challenges and Opportunities: Power

Nuclear plant

- Specialist repair
- Specialist NDT of Joints
- Structural integrity & life extension of Joints

Decommissioning and waste disposal

- Joining processes for thick section waste encapsulation containers.

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Aerospace

Airframe

- Cost effective Joining process adoption, for example, solid state and power beam Joining and adhesive bonding.
- Alternative spot Joining techniques
- Cost effective high performance Joining for near net shape manufacture
- High performance curing of composites and further development of out of autoclave composite processing
- Joining composites to metals

Join us at: www.joining-platform.com

Main Challenges and Opportunities: Aerospace

Engines

- Development of affordable environmental, thermal and erosion resistant coatings
- Cost effective additive manufacture for near net shape manufacture (as per airframe above)
- Joining of high temperature materials for aero engines
- Dissimilar materials Joining
- Joining composites to metals

Challenges: Rail, Heavy Duty Vehicles and Ships

- Dissimilar/hybrid materials Joining such as aluminium, steel, high strength steel, fibre composites, plastics
- Joining of composites
- Joining thicker sections, including high strength steel, whilst ensuring good toughness.
- Low distortion Joining techniques to reduce costs, including rework, and improve fuel efficiency. This is particularly important as weight saving is leading to thinner sections, which are more susceptible to distortion.

Challenges: Modern Built Environment

- Dissimilar/hybrid materials Joining such as aluminium, steel, high strength steel, fibre composites, and plastics
- Joining thicker sections, including high strength steel, whilst ensuring good toughness.
- Low distortion Joining techniques to reduce costs and the need for rework.
- Reliable, easy to use repair techniques are required
- Joining of composites.

Join us at: www.joining-platform.com



Nanotechnology Electronics, Photonics, and Sensors

Displays

- Developing low temperature sealing joints to protect displays

- *Circuit boards*

- Joining of the heat track of the circuit board connections on circuit boards.
- Miniaturise soldering and bonding
- Sealing

Join us at: www.joining-platform.com

Challenges: Nanotechnology Electronics, Photonics, and Sensors

Computers and Sensors

- Joining related to replacing toxic components

Electronic systems

- Joining copper to aluminium
- Low resistance joints
- Polymer Joining

Join us at: www.joining-platform.com

Challenges: Medical

Orthopaedics

- **Improved Joints for increased life of orthopaedic implants**
- **Improved implants other than hip joints (i.e. knees, small bone replacements)**
- **Smart implants**
- **New, higher performance materials**

Diagnostics

- **Polymer Joining (especially dissimilar materials)**
- **Adhesives**
- **Lasers**
- **Ultrasonic Joining**

Join us at: www.joining-platform.com

JOINING

Medical

Cardio-vascular

- **Thin section Joining of mixed materials for catheters**
- **Joining of advanced materials such as shape memory and super-elastic metals**

Other Related Joining Technology

- **Joining polymers**
- **Joining of foils to polymer products**
- **Fabrication of electronic packages into implantable metal products (laser Joining, ceramic sealing and prototype design)**
- **Joining of super-elastic alloys to steel**
- **Improved Joining of textiles**
- **Joining of super-elastic alloys to polymer products**
- **Fabrication of sensors into catheter products, i.e. polymer to metal Joining**

Join us at: www.joining-platform.com

JOINING

Oil and Gas: Exploration & Production Facilities

- Joint fatigue improvement in Oil shale extraction due to higher temperatures and corrosion
- Joining where LNG is involved – working with liquid at -164^{o}C
- Joint quality inspection and acceptance criteria
- Joining of steel of different grades and thicknesses
- Coatings for corrosion mitigation

Join us at: www.joining-platform.com

Transmission, Storage & Process

- Joining of steel of different grades and thicknesses
- Development and qualification of weld repair procedures
- Development and qualification of weld inspection procedures
- Inspection & repair of storage tanks
- Coatings for corrosion mitigation
- Pressure equipment directive (PED) for Joining

Join us at: www.joining-platform.com

Pipeline Integrity Management

- Joining of steel of different grades and thicknesses
- Quality inspection for welds
- Complex Joining for high strain areas
- Pipelines during their lifetime will be deformed due to being built on ice i.e. complex Joining for high strain areas
- Joining of pipe flanges
- Joining of composites for pipe metals (liners for metal pipes where the flanges require Joining)
- Joining and performance of Fibre reinforced plastics
- Joining undersea pipelines to avoid failure and very damaging hydrocarbon release

Join us at: www.joining-platform.com

Recommendations

Area 1: General Areas for Development	
High value, cost effective and agile, Joining techniques	Design for Joining and the reduction of Joints
Joining that is optimised for new materials, structures and manufacturing processes	The utilisation of increased ICT in the stability and capability of Joining
Joining technology optimised for product re-use and recycling	Approaches suitable for high volume, high productivity manufacture
New Joining approaches offering cost, quality and/or performance benefits	Improved efficiency and waste reduction in Joining technologies
Identification of alternatives to scarce or harmful substances in joining and coatings	Development of Business models around joining in production (process selection, global market enablers for winning business within Europe)
Preserve know-how and grow intelligence of Joining through creating an increased understanding of the processes and their potential through training and education within industry and academia.	



Recommendations

Area 2: Associated Technologies	
The advanced automation of Joining, from thin to thick section, in the manufacturing chain	Modelling and simulation of Joints, structural integrity evaluation and life extension
Pre and post Joint processes e.g. heat treatment	Inspection methods tailored to Joining applications and in-situ condition monitoring
Joining technologies for repair and re-use	Joining to enhance performance in extreme conditions, including surface engineering
Development of flexible cells for manufacture (process technology, flexible tooling, towards mass customisation)	Quantification of energy usage to enable optimised joining processes

Join us at: www.joining-platform.com

JOINING

Recommendations

Area 3: Specific Joining Requirements	
Dissimilar materials Joining	Development of affordable environmental, thermal and erosion resistant coatings
Joining composites, multi-phase and coated materials	Joining of crack susceptible and highly alloyed materials including for high temperature applications
Joining multiple sheets and complex structures	Development of low temperature sealing joints
Low distortion and low heat input Joining	Miniaturised and thin section Joining, soldering and adhesive bonding
Low electrical resistivity and low thermal conductivity Joints	Joining ultra-high specific strength materials
High productivity, high performance, thick section Joining	Development of hybrid Joining processes
Joining of speciality materials with enhanced properties	High performance joining of non-metallics

Summary

- An SRA consultation document has be drafted
- Available to all JSP Members
- Comments/feedback welcome
- Contribute don’t criticise!
- Timeline to be drafted and circulated
- Fixed in January 2014

Join us at: www.joining-platform.com

Joining Sub-platform Information

Thank You!

Further information available at:

www.joining-platform.com

