‘Joining 4.0: Smart Manufacturing’

Joining Sub Platform – 7th General Assembly

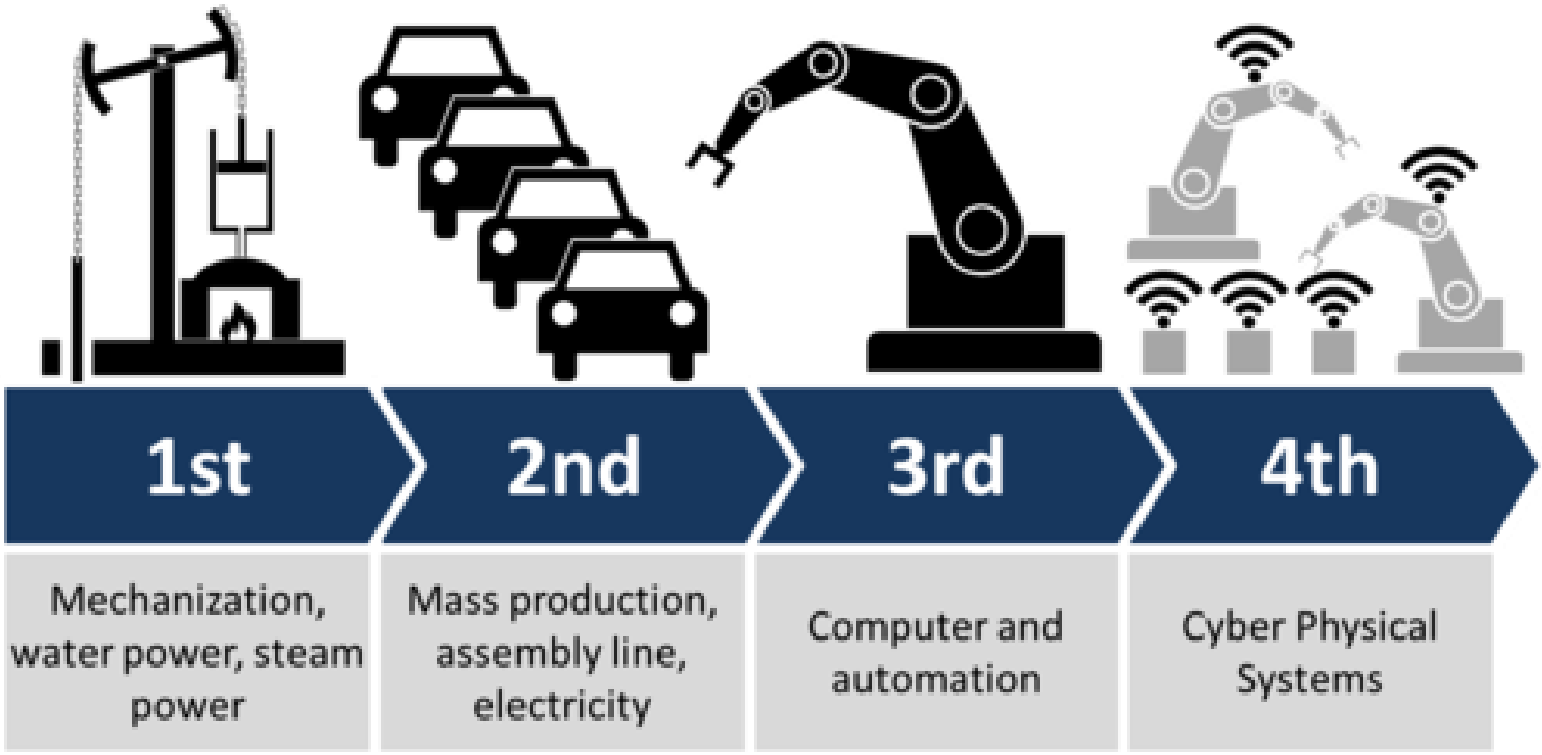
Dr Simon McCaldin

16th Sept 2017

Materials Joining and Engineering Technologies

i4.0: Digital Manufacturing

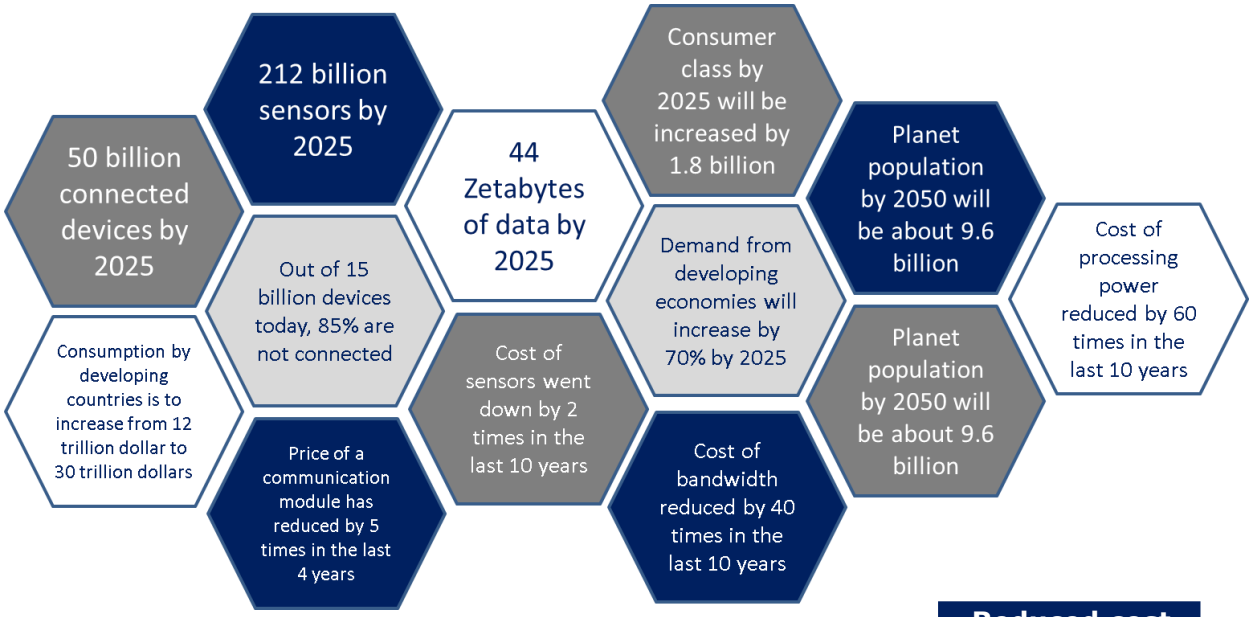
"Put simply Industry 4.0 represents the coming fourth industrial revolution on the way to an Internet of Things, Data and Services…"



Source: https://media.licdn.com/mpr/mpr/p/3/005/097/223/3190c81.jpg

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Drivers for 'Smart Technology' in Manufacturing



Robotics and Smart Technology can bring:

- Greater product quality and levels of consistency
- Greater flexibility
- Wipe out barriers for adoption
- Cost effective compared to skilled operators in long term
- Increased production rate
- Reduced production cycle time
- Reduced wastage and re-work
- Increased resource efficiency
- Shorter innovation cycles
- Connected Supplier and customer

Reduced cost of automation is an advantage now?

World population is increasing rapidly → **Demand is increasing in a similar trend** → **Increase in productivity is a must** → **How to meet this demand?**

Work long hours? or Smart Automation?

Are there enough amount of skilled workers?

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What is Digital Manufacturing?

Its about data connectivity……

Physical networks linked with cyber networks as one system to allow **data driven insights** and action to **create value** across the **entire manufacturing eco-system**.

- 3 areas where digital manufacturing technologies will transform industry:
    - Smarter production
    - Smarter products
    - Smarter supply chains
- Underpinned by 3 core components of this transformation:
    - Industrial Internet of Things (IIoT)
    - Big data
    - Secure and reliable digital infrastructure

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Global supply chain

Manufacturing Execution Systems

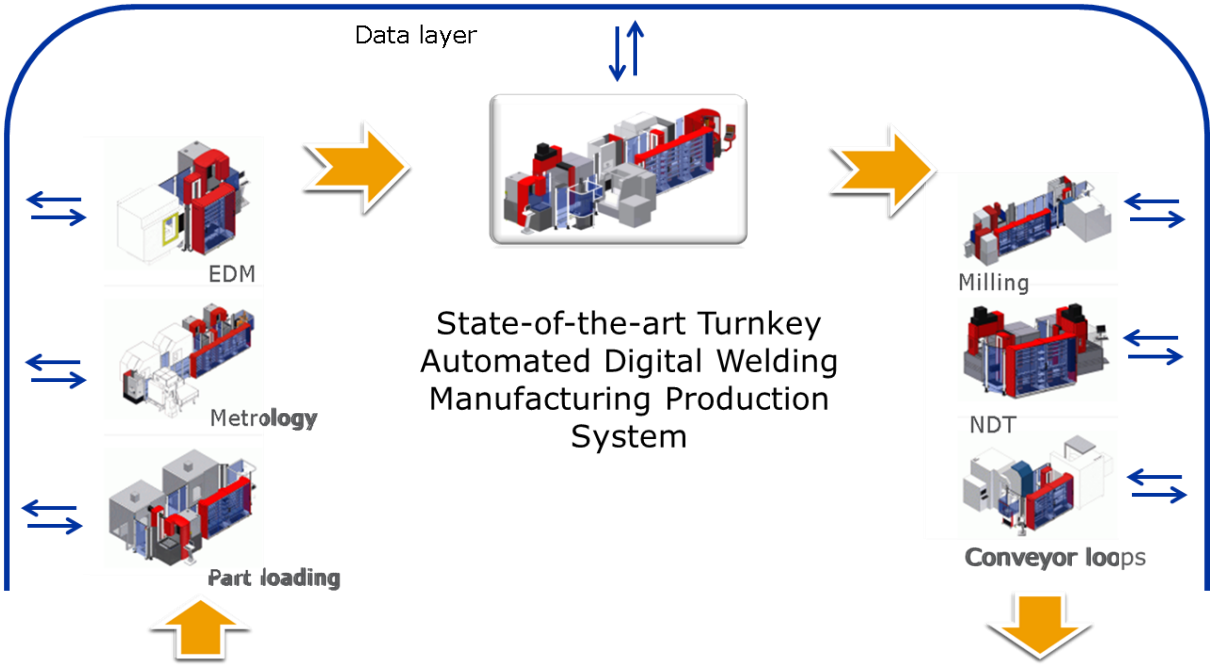
Enterprise Resource Planning

Simulation and Analysis

Local Storage

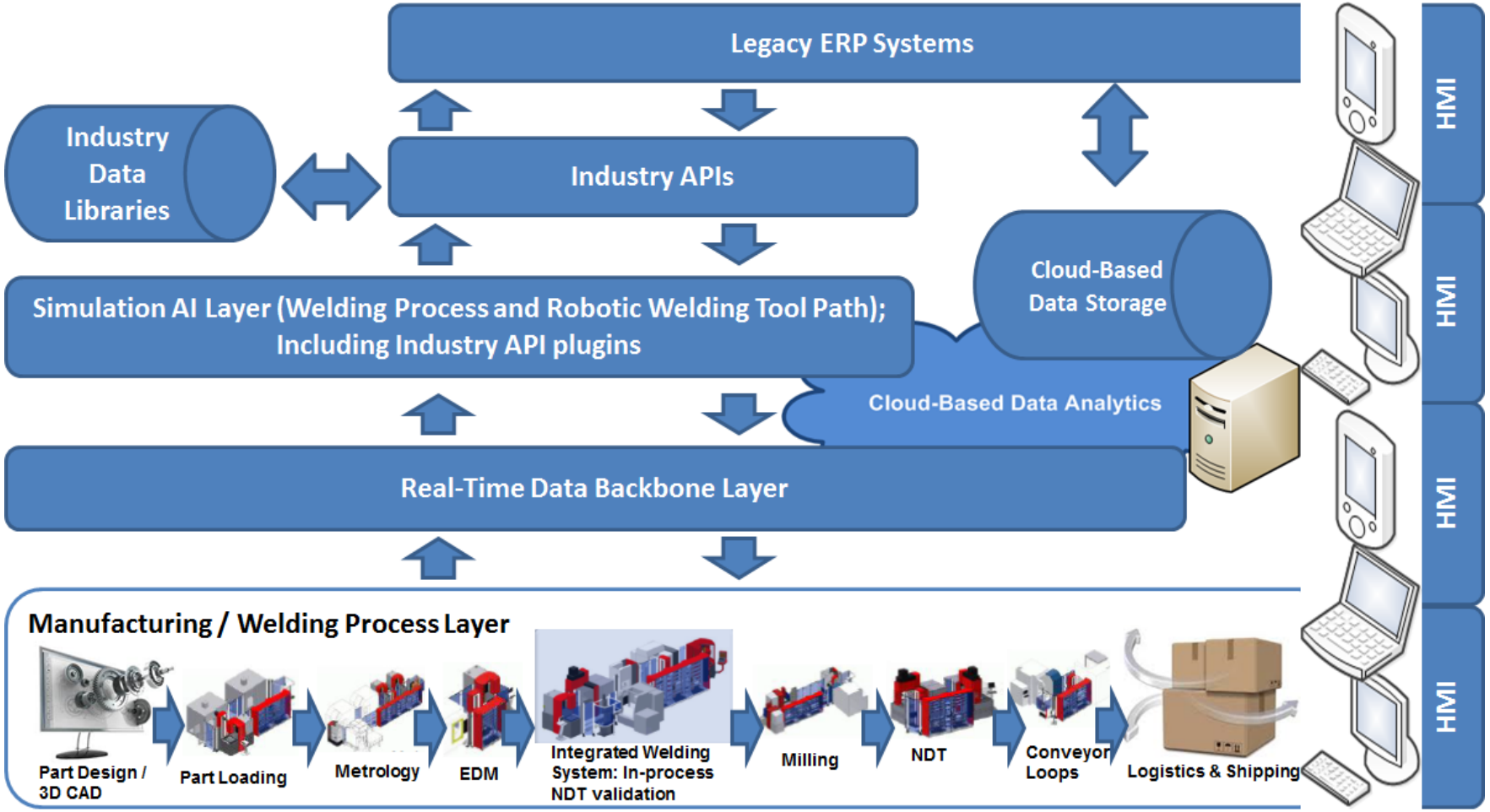
Cloud Storage

Data layer



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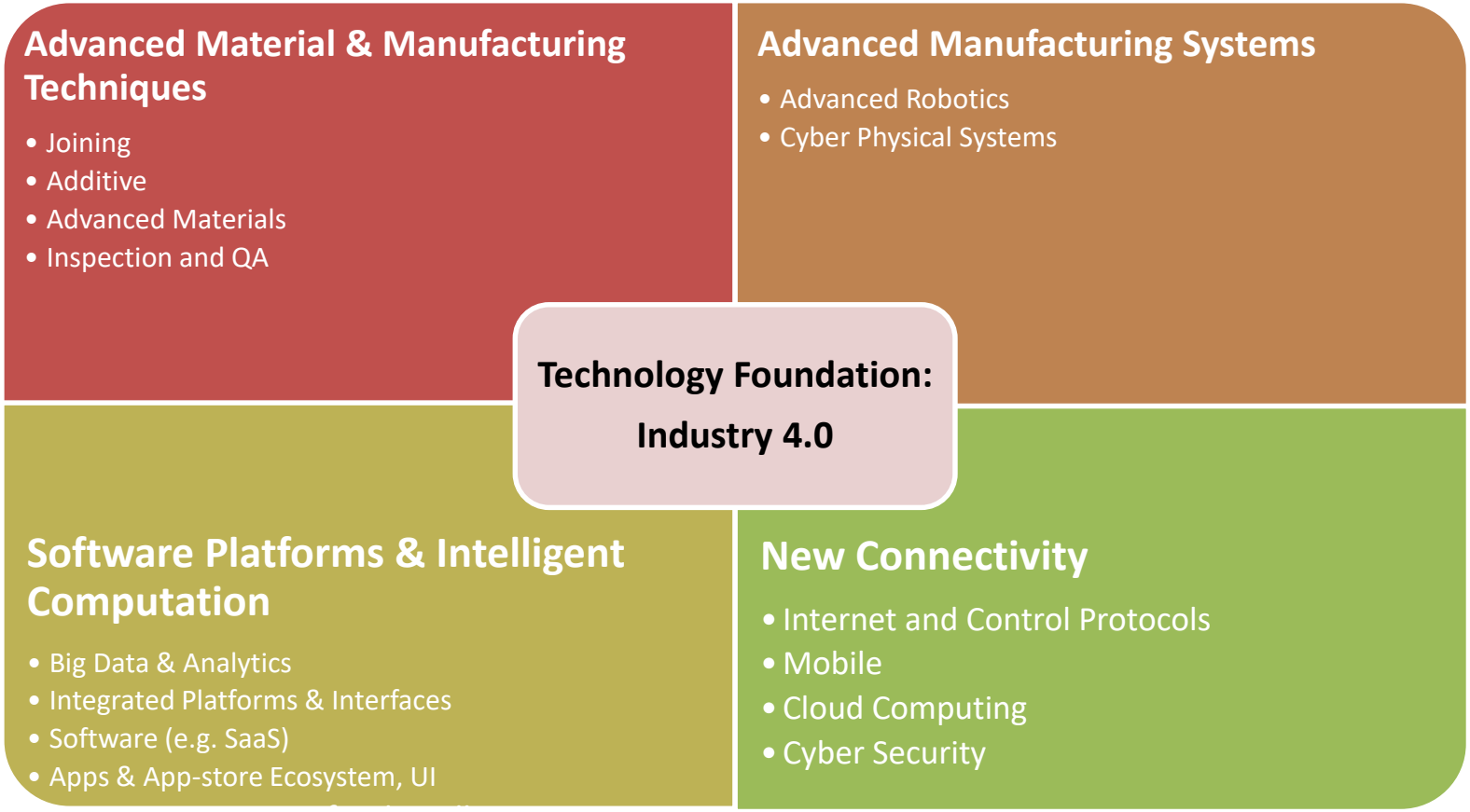
Digital Manufacturing Eco-system: ICT



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Technology Foundations for i4.0

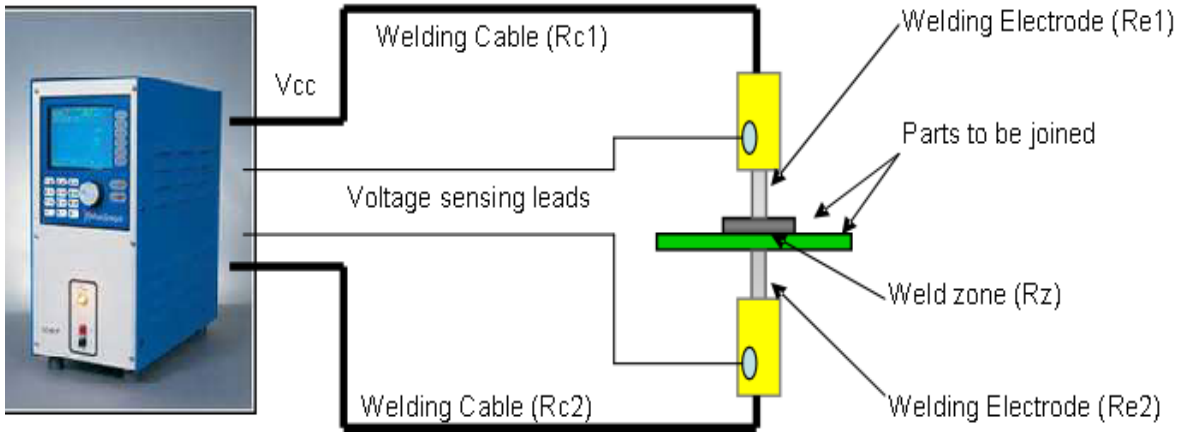
(IfM (2015))

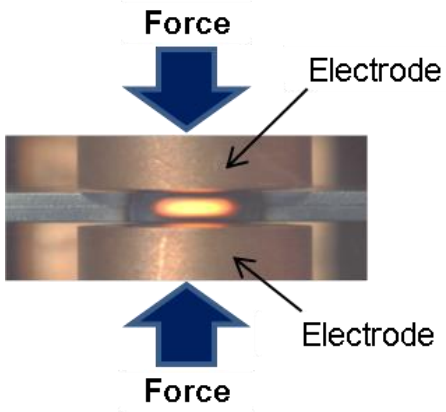


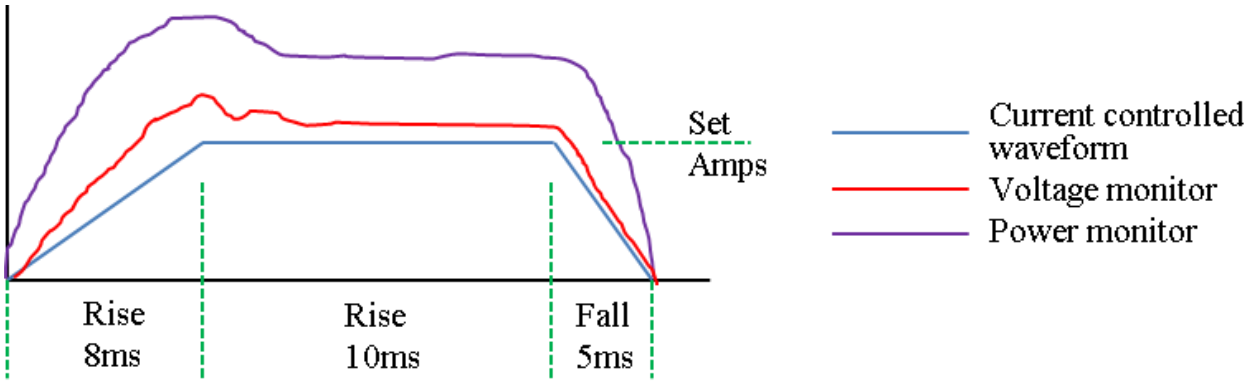
How are Joining technologies and associated manufacturing systems supporting this vision?

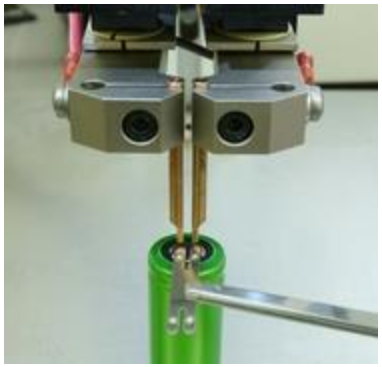
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Simple i4.0: (Micro) Resistance Spot Welding









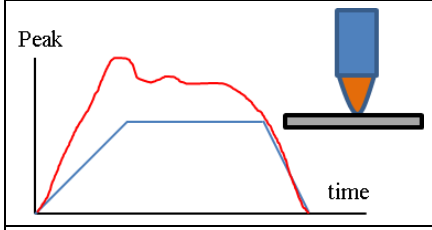
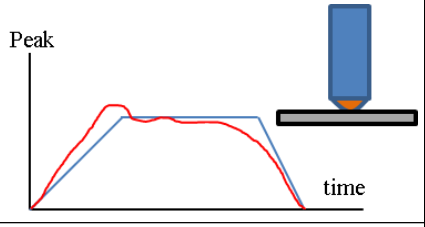
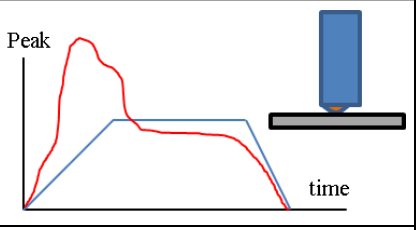
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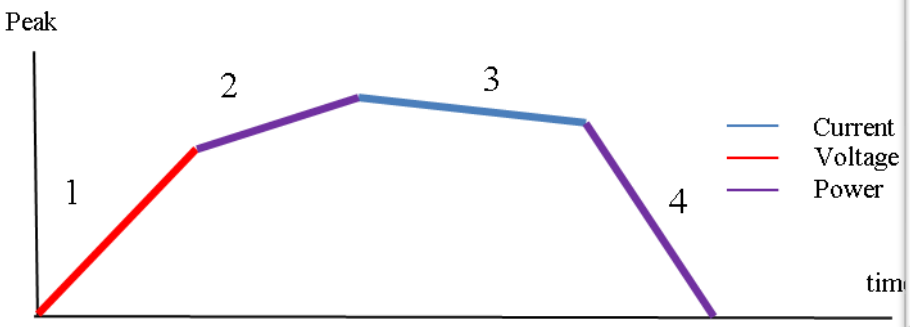
Simple i4.0: Micro Resistance Spot Welding

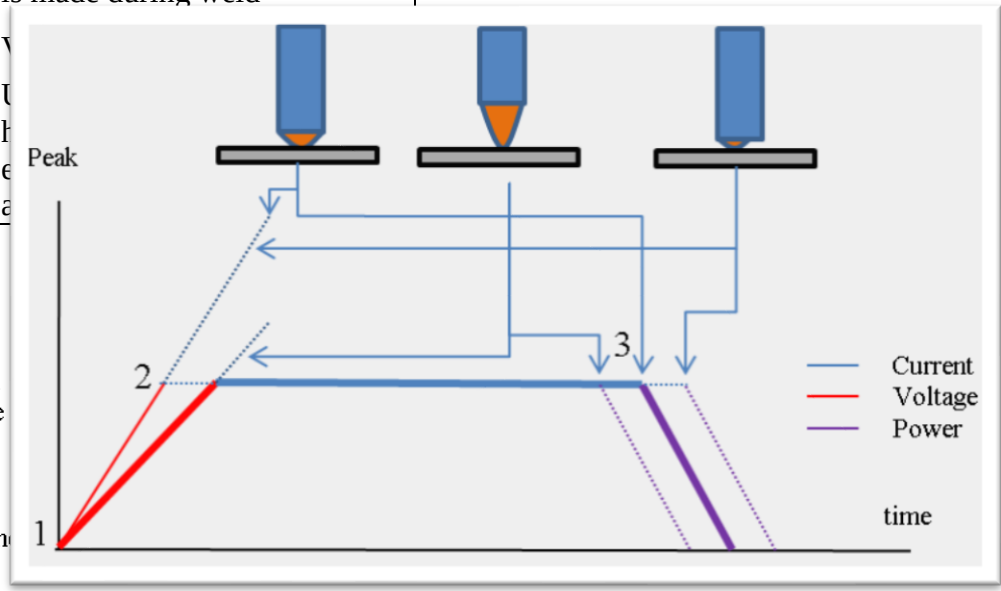
1979-1990	1990-2000	2000-2012	2012-2017
			
Key Feature			
Original closed loop electronic welding	8-bit digital closed loop power supply	16-bit digital closed loop power supply	PC based closed loop power supply (patent GB2506216)
Market Leading Innovation Implemented			
Simple closed loop control	Simple process limits	Window process limits	Built in SPC analysis

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Simple i4.0: Micro Resistance Spot Welding

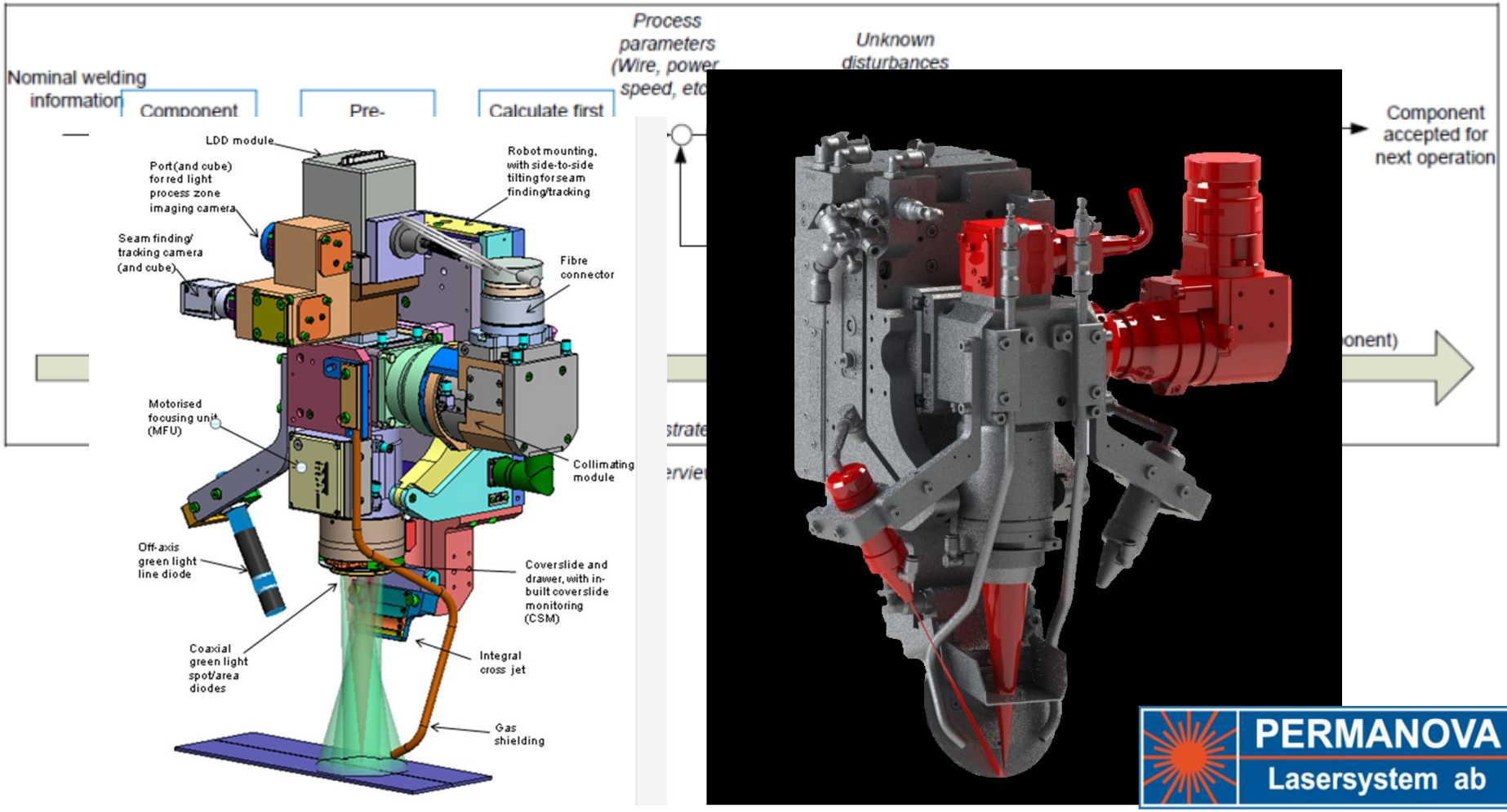
		
New electrode	***Used electrode***	***Damaged/contaminated electrode***
High resistance (small contact area) Voltage x current = Hot joint Potential weld splash at start of weld (High voltage)	Lower resistance (larger contact area) Voltage x current = Cooler joint More stable due to stable voltage	High resistance spot area which reduces once full contact is made during weld





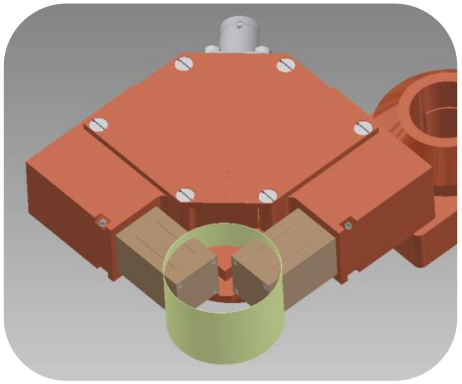
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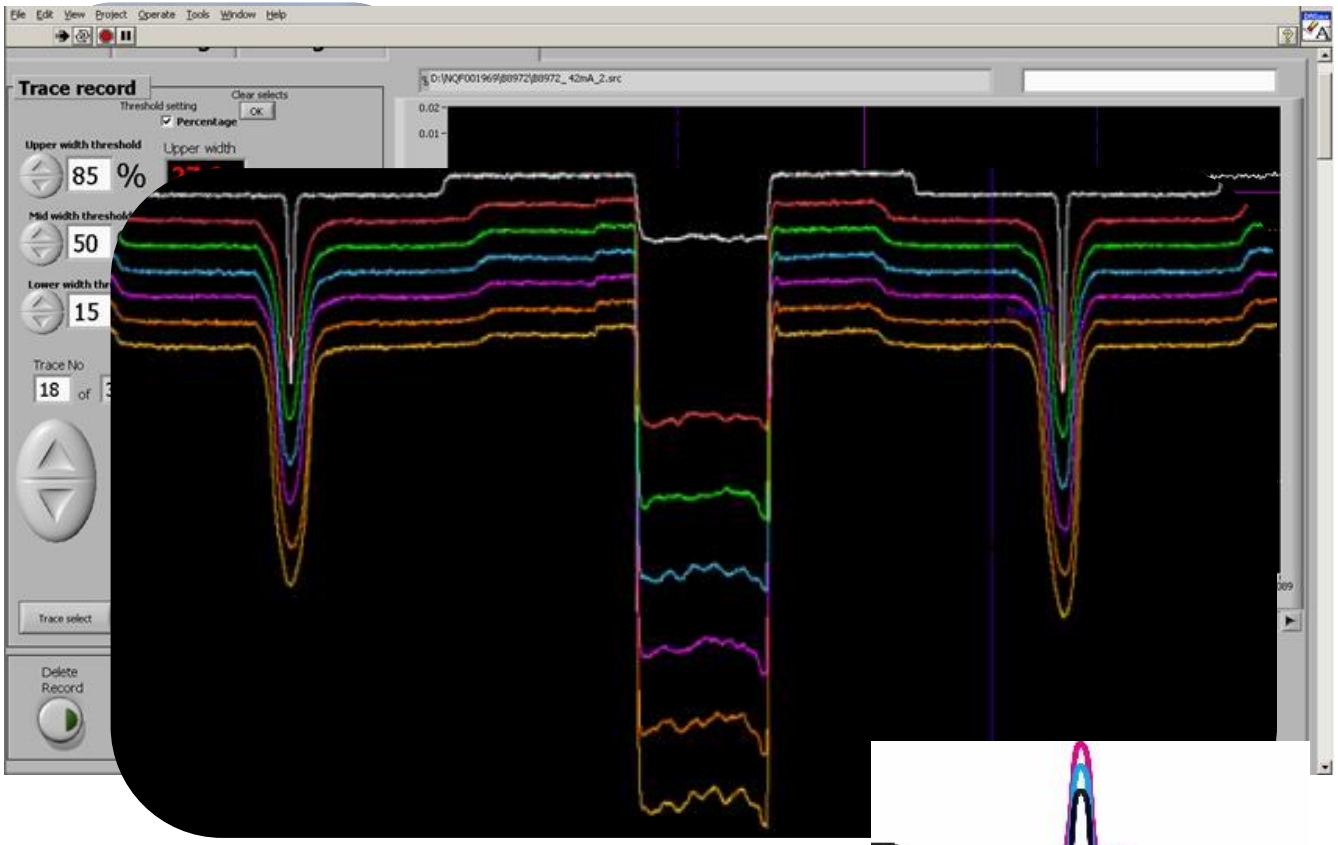
i4.0 Laser Welding: Radicle



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i4.0 Electron Beam: Beam Assure





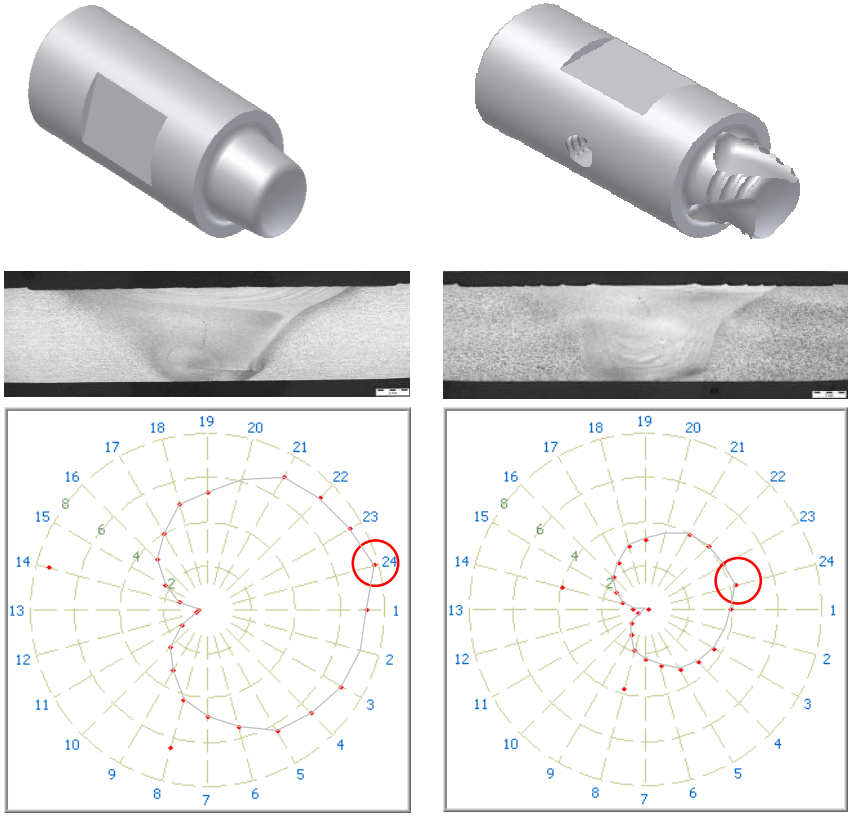
- No two EB machines / gun columns are the same
- Process control to remove or reduce inspection requirements for QA

BeamAssure™
www.twi.co.uk/beamassure

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i4.0: Friction Welding

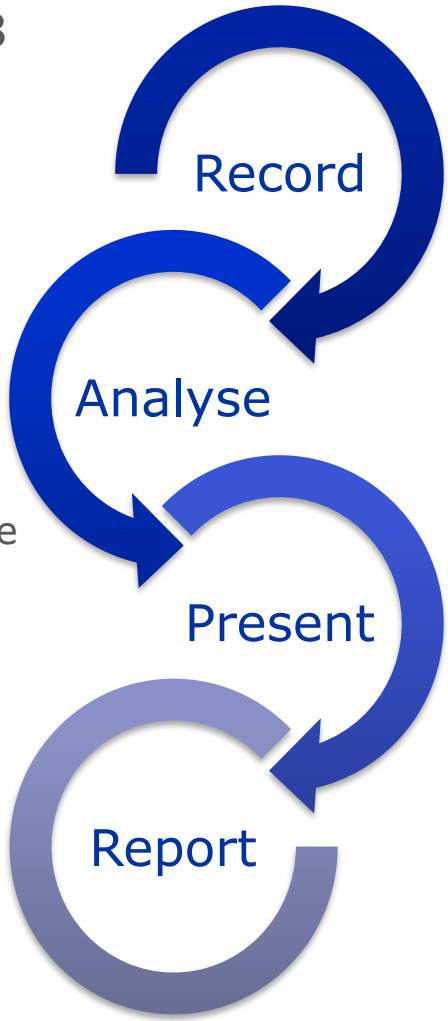




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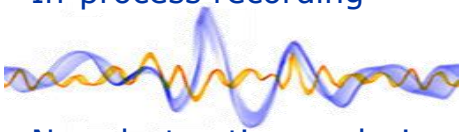
i4.0: Friction Welding

- IPM: TWI core activity since 1978
- Standalone monitoring
  - Independent from machine
  - Recording of raw data
  - Shows what equipment manufacturers hide
- "Weld on any machine"
  - Intrinsic and comparative assessment of weld cycles on several machines placed anywhere
  - Asset risk management / allows machine "brand change"
- Total quality management
  - Traceability, process deviation
  - Statistical Process Control
- Process Engineers' toolbox
  - By process engineers, for process engineers

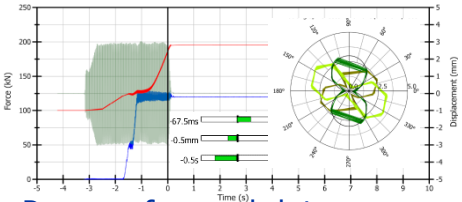




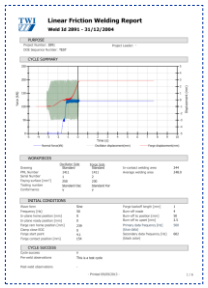
- On-machine sensors
- In-process recording



- Non-destructive analysis
- Tag of parametric events



- Process focused data
- Evaluative visuals



- Product QA
- TQM (digital)
- Industry 4.0

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Global supply chain

Manufacturing Execution Systems

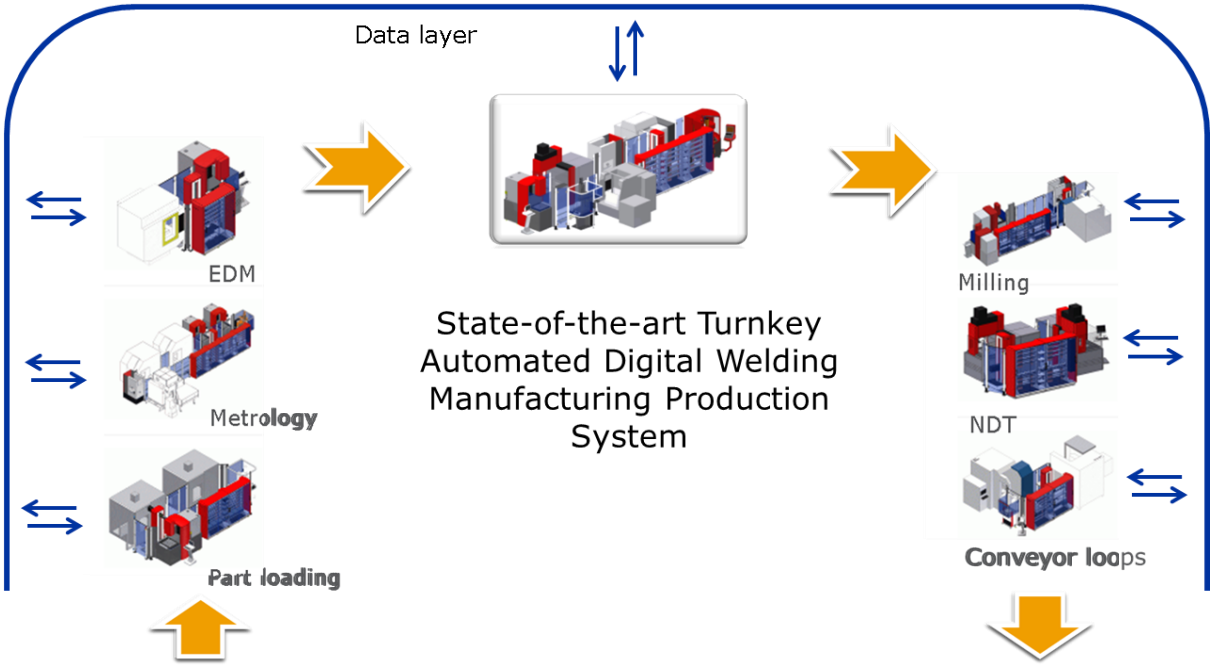
Enterprise Resource Planning

Simulation and Analysis

Local Storage

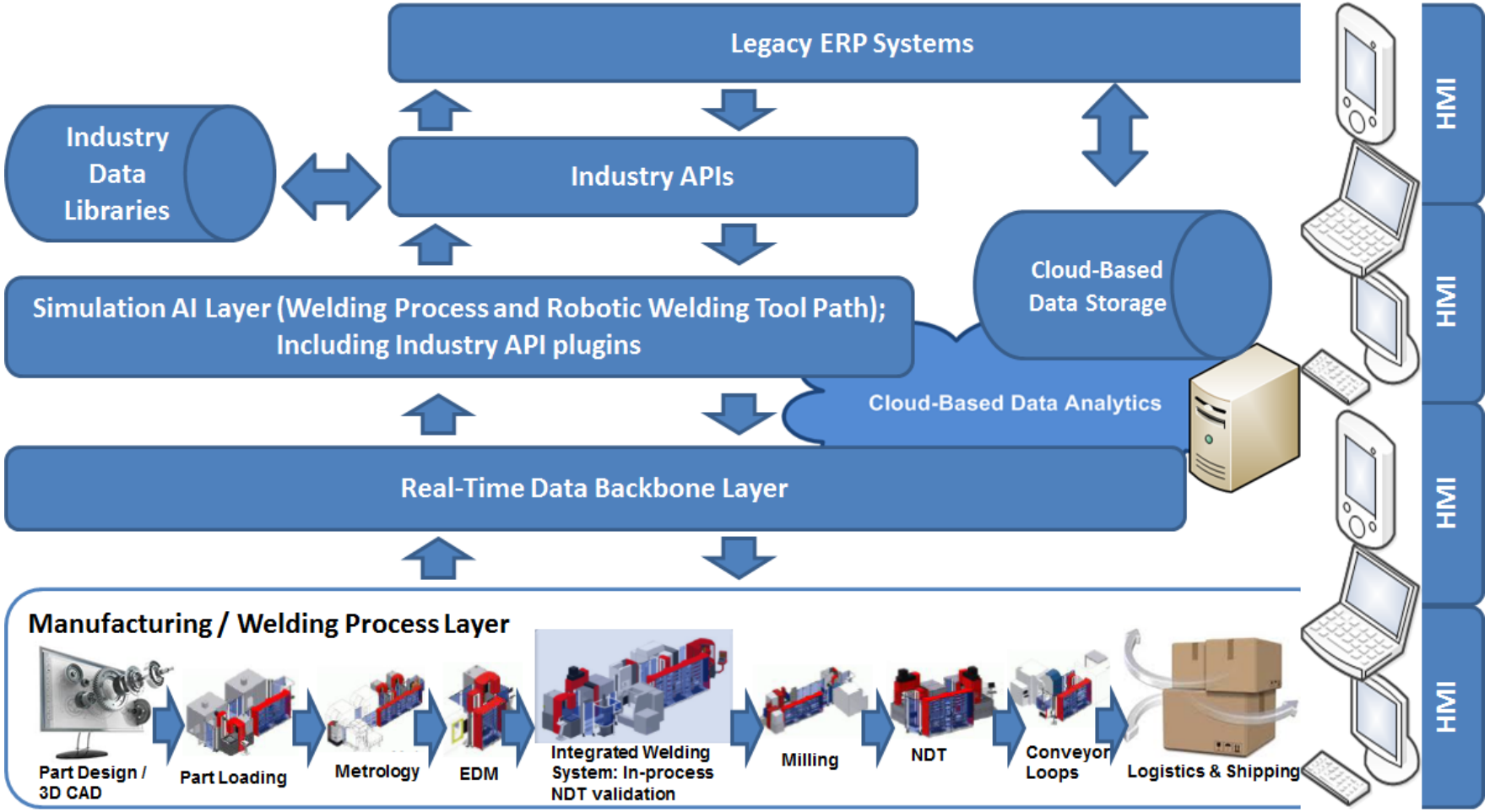
Cloud Storage

Data layer



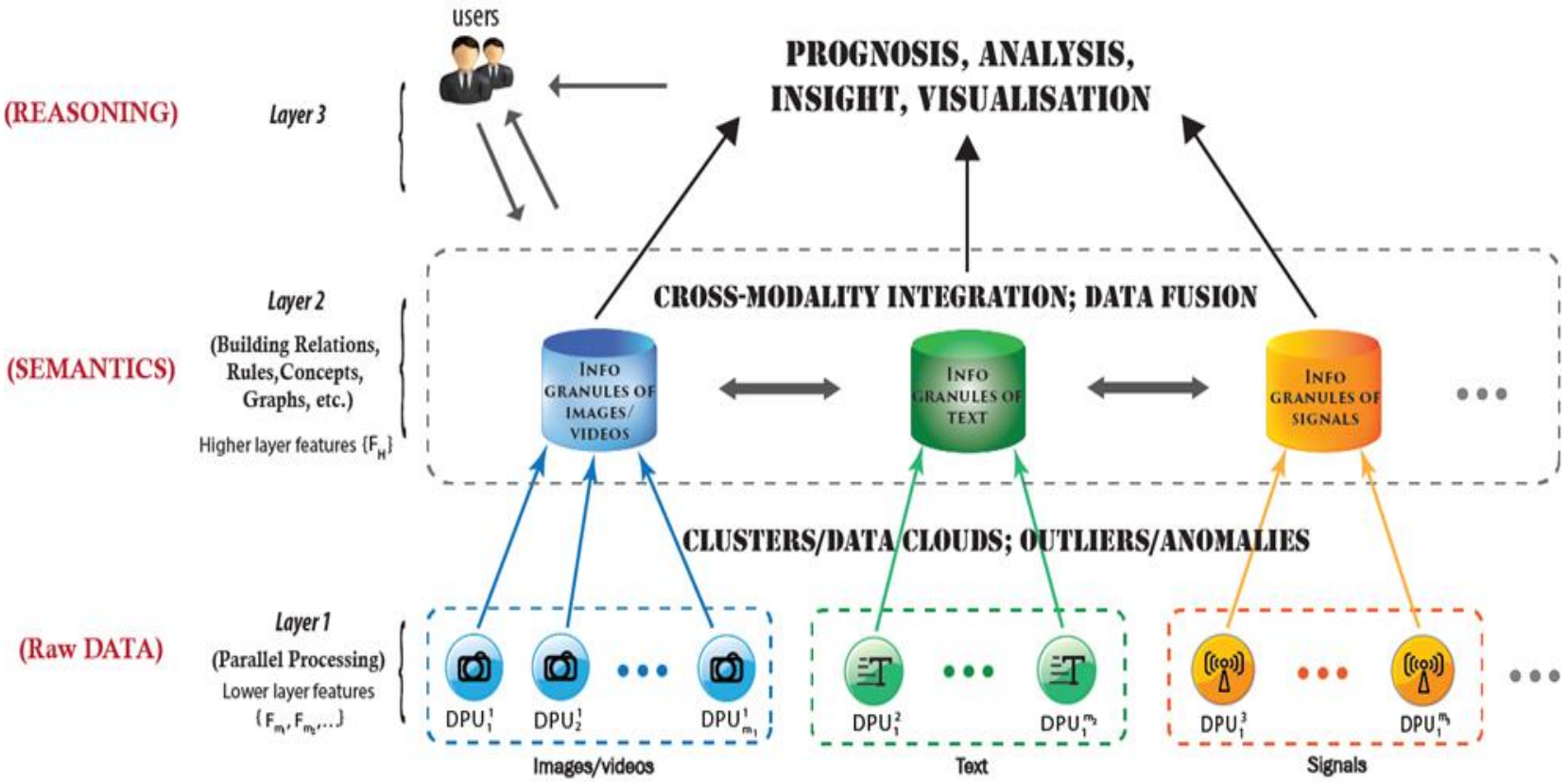
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Digital Manufacturing Eco-system



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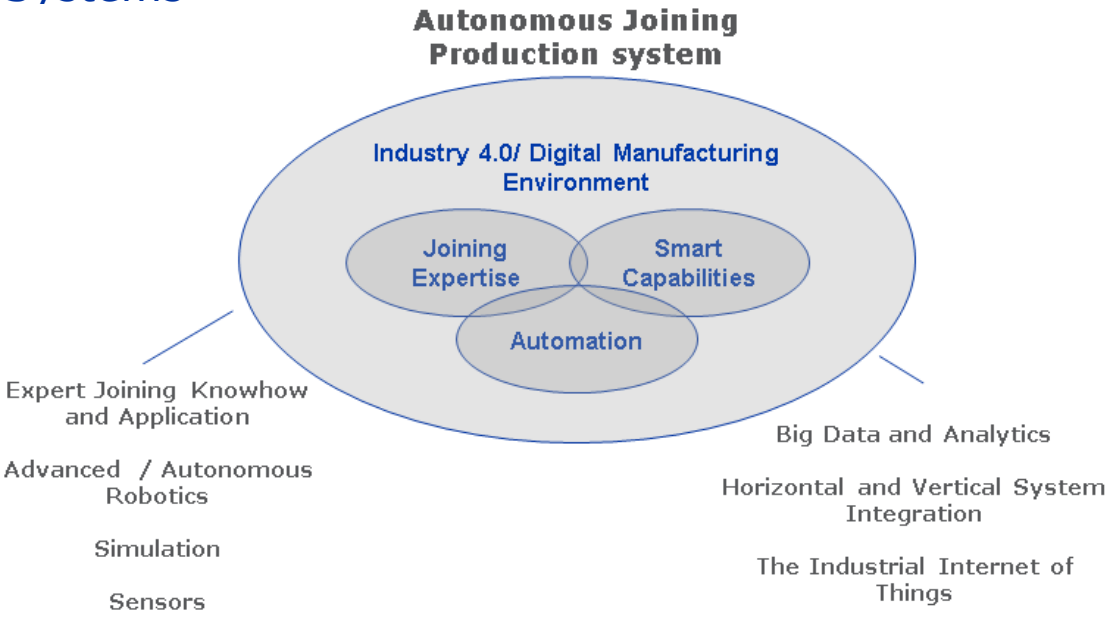
i4.0: The Future?



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Digital Manufacturing for Joining at TWI

Welding Systems Integration Research Extending Processes into Robust Digital Manufacturing Systems



Strategic focus:

- Assisting our members to define their digital manufacturing challenges and lead TWI's response to these opportunities by providing innovative project based solutions.

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Digital Manufacturing Activities at TWI

- **Events & Awards:**
  - TWI Conferences:
    - **Industry 4.0: What it means to TWI and its members**
    - **Digital Manufacturing: Applying the Industry 4.0 Philosophy**
  - External recognition:
    - '**Best New Catalyst**' May 2016: "Smart Industrial Manufacturing: Robots-as-a-Service"
    - '**Outstanding Ecosystem Design Using CurateFx**' May 2017: "Logical Factory: Virtualizing Manufacturing for Agility"

- **Client Projects:**
  1. The specification of a production welding cell
  2. Applying monitoring techniques to facilitate adaptive welding

- **Collaborative Projects:**
  1. ModuLase
  2. AM Motion
  3. LaserSnake++
  4. Grow Industry 4.0
  5. EBwireAM
  6. DREAM
  7. FSWBot

- **CRP**: Digital manufacturing (Joining 4.0)

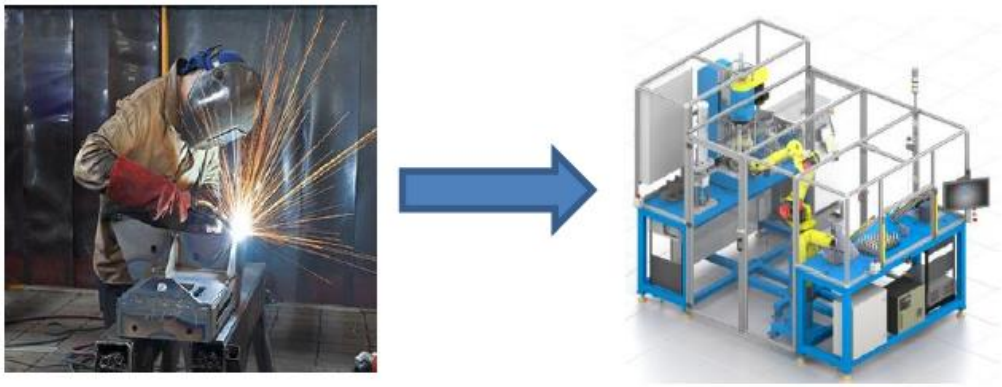
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TWI

J4IC
Joining 4.0 Innovation Centre

Lancaster University

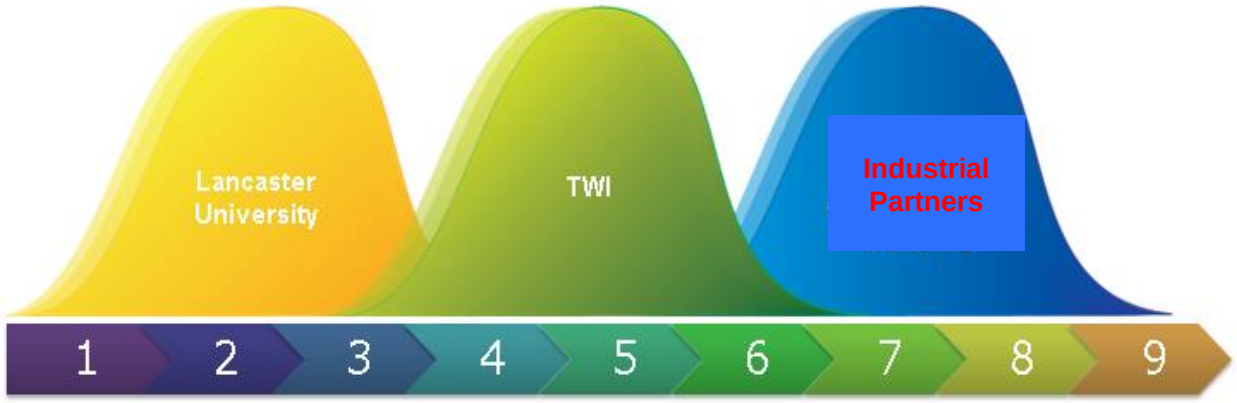
To be world-leading in the research and development of **smart**, **connected** manufacturing systems **based on advanced joining and associated manufacturing technologies**.



Embedding human craft (understanding, knowledge, and experience) **into robotic and autonomous welding systems for digital manufacturing**

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Joining 4.0 Innovation Centre



J4IC HEI-RTO-Industry collaborative model
(full TRL spectrum)

Lancaster Universities I4.0 Competencies:

- Data Science
- High Performance Computing
- Cyber Security
- Engineering

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Joining 4.0 Innovation Centre

DRIVING INNOVATION THROUGH COLLABORATION

JOINING 4.0 INNOVATION CENTRE



The Joining 4.0 Innovation Centre (J4IC) is a strategic partnership between Lancaster University and TWI with the aim of developing a comprehensive research capability focused on the digitalisation of joining and associated manufacturing technologies.

The J4IC will focus on joining technologies in the context of industry 4.0 – a term used to describe the fourth industrial revolution. The Centre will draw on and integrate Lancaster's existing research strengths within engineering, data science and computing, with TWI's world leading knowhow in joining technologies to create, develop and embed transformative manufacturing capabilities for the benefit of industry.

OBJECTIVES

- To be world-leading and industrially relevant in the R&D of digital manufacturing capabilities based on advanced joining and associated technologies
- To create a successful collaborative environment between HEI-RTO-industry with substantial research, technology impact and adoption by industry
- To establish an excellent research environment underpinned by MSc, PhD researchers and academic staff embedded by industry
- Secure a portfolio of research funding from public funding bodies

CORE AREAS

- Digitalised manufacturing capabilities based on advanced joining technologies
- Underpinned with expert joining knowhow, data centric engineering, software platforms, cloud computing, advanced systems connectivity, robotics and communications solutions

J4IC is a long-term strategic partnership between TWI and Lancaster University.

1480.04/17 T +44 (0)1223 899000 E innovationcentres@twi.co.uk W www.twi-global.com

- TWI Innovation Network website

  http://www.twi-innovation-network.com/

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TM Forum / TWI Collaboration

A non-profit global industry association which brings together 90,000+ professional members across **950+ member companies** to collaborate to build highly successful **digital business ecosystems**.
https://www.tmforum.org

Strategic partnership which combines the strengths of TWI & TM Forum to expedite the Digital Manufacturing journey:

- Developing **Industry 4.0 Welding demonstrators** via collaborative projects leading to future business e.g. JIP's, SCP,
- Develop a **technology transfer activity** focussed on identifying our members industrial digital challenges and gaps,
- Deliver in-house and external training focused on Industrial Digital Manufacturing.

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European Strategic Research Agenda for Joining



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.

http://www.joining-platform.com

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Key Innovation Priority Areas for Industry 4.0



- Digitalization of Joining - "Joining 4.0"
- Data management and data collection in Joining Processes and connectivity with in the factory eco-system - "Joining 4.0"
- The utilisation of increased ICT in the stability and capability of Joining - Related to "Joining 4.0"

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Future Collaborative Opportunities

Funding Body	Call	Submission Date
EC	Fast Track to Innovation	21 Feb 2018
EC	**FOF 4 – AM Pilot Lines**	**22 Feb 2018**
EC	FOF 2 – Human-Robot Interactions	22 Feb 2018
EC	FOF 1 – Skills for Manufacturing	22 Feb 2018
EC	ICT-17-2018-19: HPC and Big Data enabled Large-scale Test-beds and Applications	17 Apr 2018
EC	**NMBP-20-2018: Digital Manufacturing Platforms for Connected Smart Factories**	**22 Feb 2018**
EC	ICT-25/27-2018 Robotics PPP	17 Apr 2018

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