Europe's Advanced Manufacturing Partnership

Factories of the Future

Chris Decubber

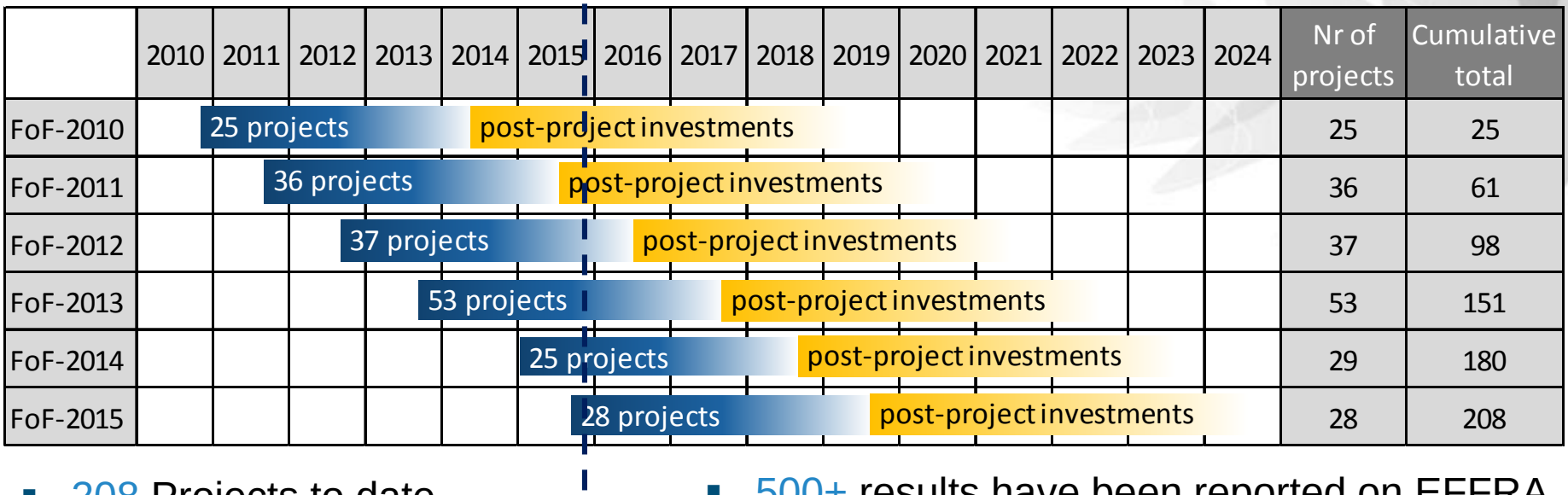
Technical Director

EFFRA

EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION

Factories of the Future

Projects



	Nr of projects	Cumulative total
FoF-2010	25	25
FoF-2011	36	61
FoF-2012	37	98
FoF-2013	53	151
FoF-2014	29	180
FoF-2015	28	208

- 208 Projects to date.
- ~ 1,500 organisations participating
- High involvement of SMEs: 200+
- Majority of projects feature demo activities

- 500+ results have been reported on EFFRA Innovation Portal (www.effra.eu/portal)
- Close to the market exploitation of project results
- Project results enhancing existing products

Factories of the Future 2020

Roadmap

Factories of the Future 2020

Strategic Roadmap

Challenges & Opportunities

- Manufacturing Future Products
- Economic
- Social
- Environmental

Sustainability

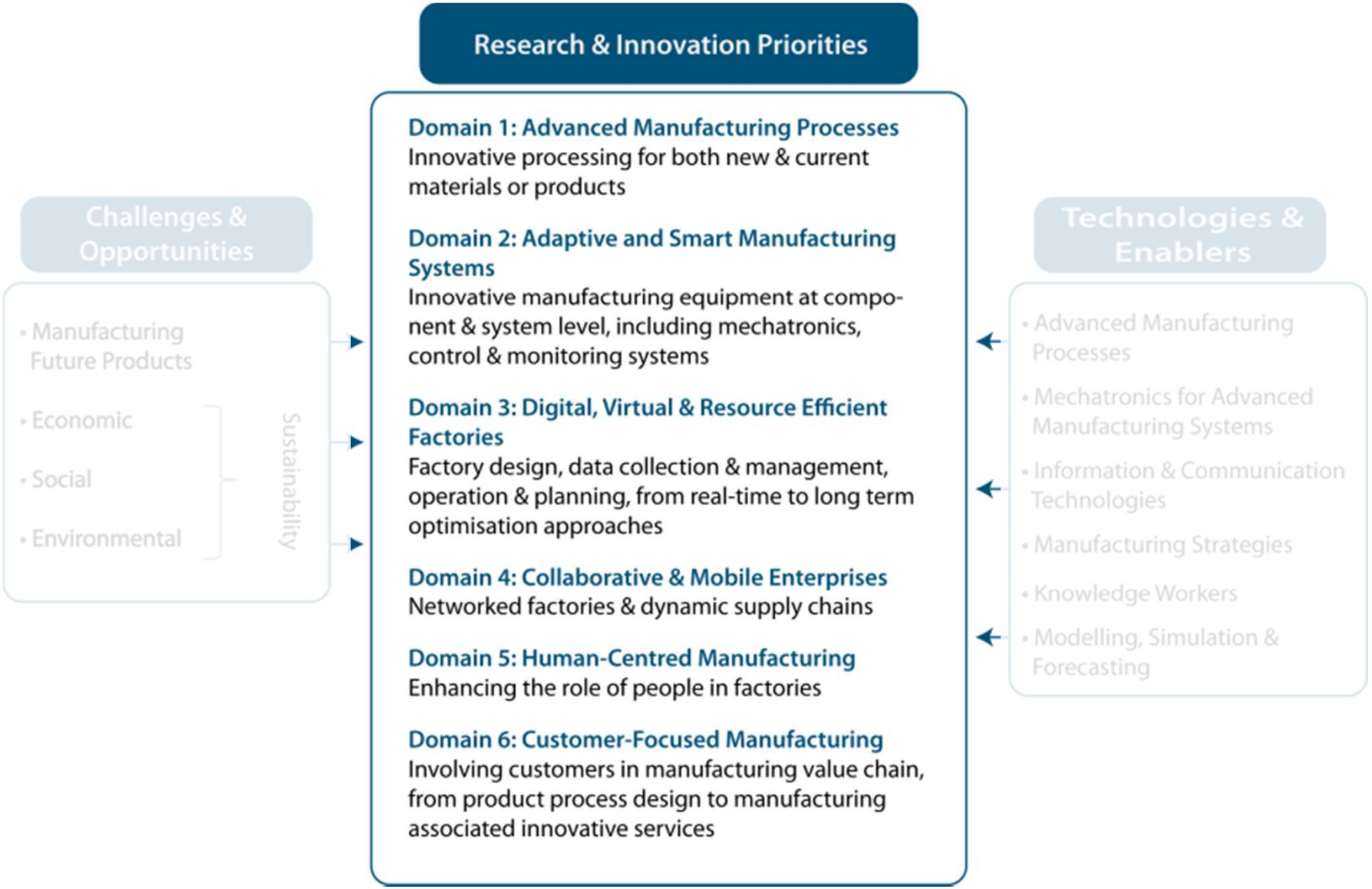
Research & Innovation Priorities

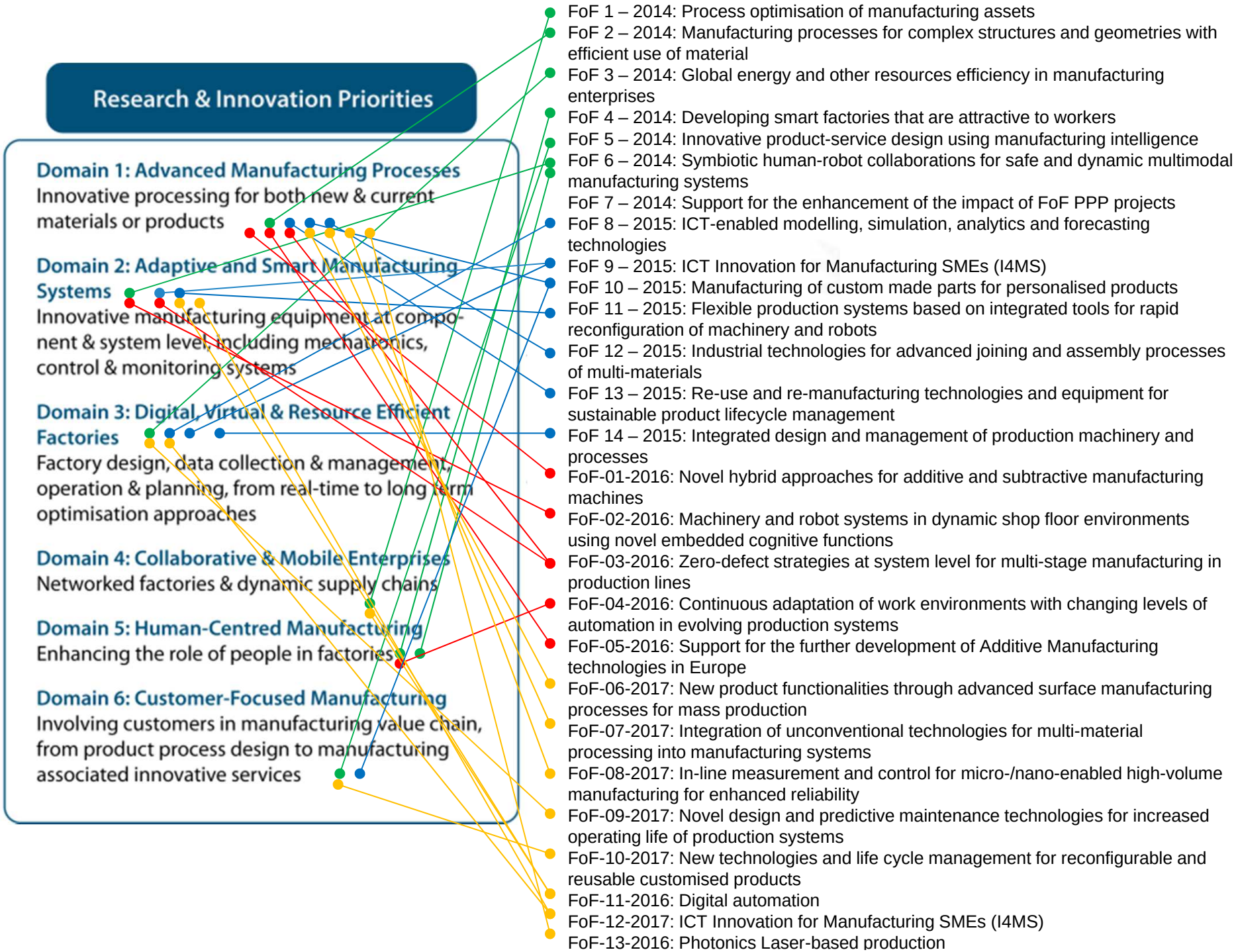
Technologies & Enablers

- Advanced Manufacturing Processes
- Mechatronics for Advanced Manufacturing Systems
- Information & Communication Technologies
- Manufacturing Strategies
- Knowledge Workers
- Modelling, Simulation & Forecasting

Factories of the Future 2020

Strategic Roadmap




Research & Innovation Priorities
Domain 1: Advanced Manufacturing Processes
Innovative processing for both new & current materials or products
Domain 2: Adaptive and Smart Manufacturing Systems
Innovative manufacturing equipment at component & system level, including mechatronics, control & monitoring systems
Domain 3: Digital, Virtual & Resource Efficient Factories
Factory design, data collection & management, operation & planning, from real-time to long term optimisation approaches
Domain 4: Collaborative & Mobile Enterprises
Networked factories & dynamic supply chains
Domain 5: Human-Centred Manufacturing
Enhancing the role of people in factories
Domain 6: Customer-Focused Manufacturing
Involving customers in manufacturing value chain, from product process design to manufacturing associated innovative services
FoF 1 – 2014: Process optimisation of manufacturing assets
FoF 2 – 2014: Manufacturing processes for complex structures and geometries with efficient use of material
FoF 3 – 2014: Global energy and other resources efficiency in manufacturing enterprises
FoF 4 – 2014: Developing smart factories that are attractive to workers
FoF 5 – 2014: Innovative product-service design using manufacturing intelligence
FoF 6 – 2014: Symbiotic human-robot collaborations for safe and dynamic multimodal manufacturing systems
FoF 7 – 2014: Support for the enhancement of the impact of FoF PPP projects
FoF 8 – 2015: ICT-enabled modelling, simulation, analytics and forecasting technologies
FoF 9 – 2015: ICT Innovation for Manufacturing SMEs (I4MS)
FoF 10 – 2015: Manufacturing of custom made parts for personalised products
FoF 11 – 2015: Flexible production systems based on integrated tools for rapid reconfiguration of machinery and robots
FoF 12 – 2015: Industrial technologies for advanced joining and assembly processes of multi-materials
FoF 13 – 2015: Re-use and re-manufacturing technologies and equipment for sustainable product lifecycle management
FoF 14 – 2015: Integrated design and management of production machinery and processes
FoF-01-2016: Novel hybrid approaches for additive and subtractive manufacturing machines
FoF-02-2016: Machinery and robot systems in dynamic shop floor environments using novel embedded cognitive functions
FoF-03-2016: Zero-defect strategies at system level for multi-stage manufacturing in production lines
FoF-04-2016: Continuous adaptation of work environments with changing levels of automation in evolving production systems
FoF-05-2016: Support for the further development of Additive Manufacturing technologies in Europe
FoF-06-2017: New product functionalities through advanced surface manufacturing processes for mass production
FoF-07-2017: Integration of unconventional technologies for multi-material processing into manufacturing systems
FoF-08-2017: In-line measurement and control for micro-/nano-enabled high-volume manufacturing for enhanced reliability
FoF-09-2017: Novel design and predictive maintenance technologies for increased operating life of production systems
FoF-10-2017: New technologies and life cycle management for reconfigurable and reusable customised products
FoF-11-2016: Digital automation
FoF-12-2017: ICT Innovation for Manufacturing SMEs (I4MS)
FoF-13-2016: Photonics Laser-based production

SUPREME

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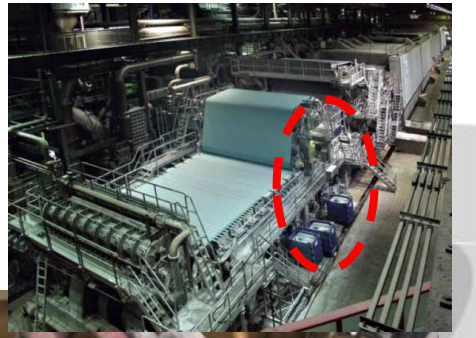
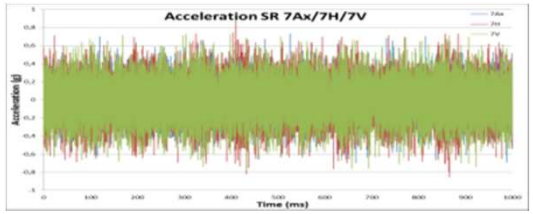
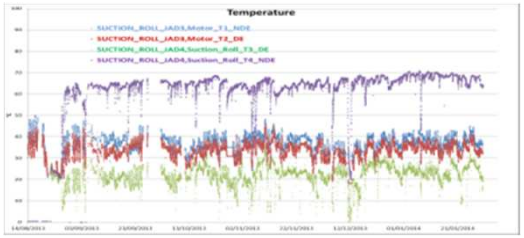
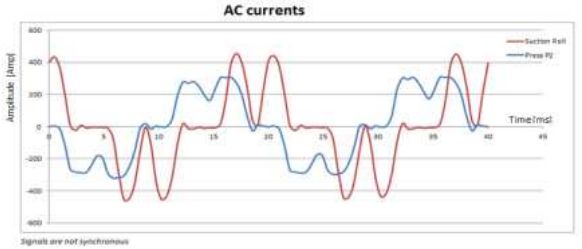
a MANUFUTURE initiative

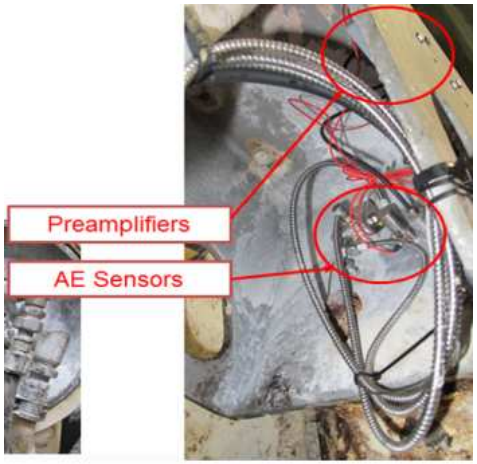
Embedded Condition Monitoring Module

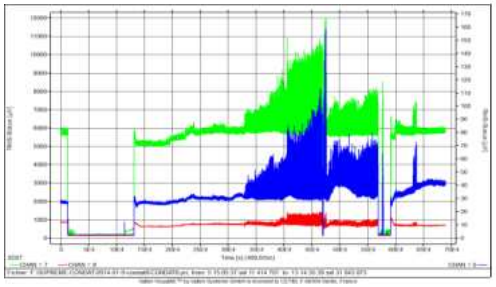


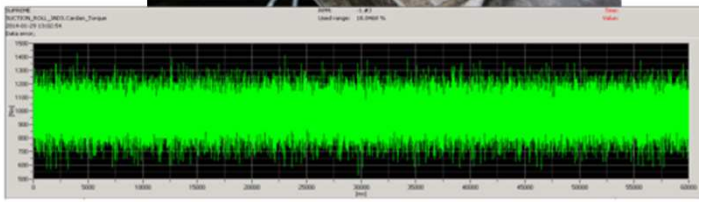








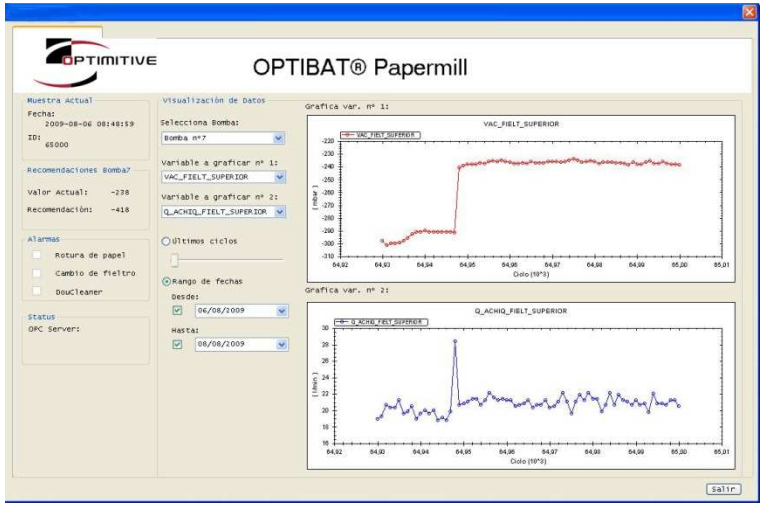




SUstainable **PRE**dictive **M**aintenance for Manufacturing **E**quipment

- Industrial end-user (paper mill) : Condat
- Transfer and Dissemination : Cofely-Endel
- SME's as solution provider :
  - Orloga (Paper engineering)
  - EC_Systems (CMS provider)
  - Optimitive (Process optimization)
  - Loy&Hutz (CMMS)
- R&D partners
  - CETIM
  - FhG-IPA
  - Grenoble-INP
  - CVUT

OPTIMITIVE: how we have changed



OPTIBAT v1.2.8

Before SUPREME

2012

After SUPREME

2015

OPTIBAT v4.10.2

OPTIMITIVE: how we have changed

Before SUPREME

2012

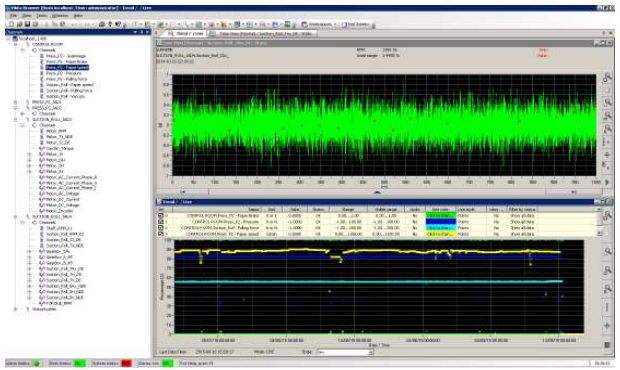
OPTIBAT v1.2.8

After SUPREME

2015

OPTIBAT v4.10.2

ECMS software evolution



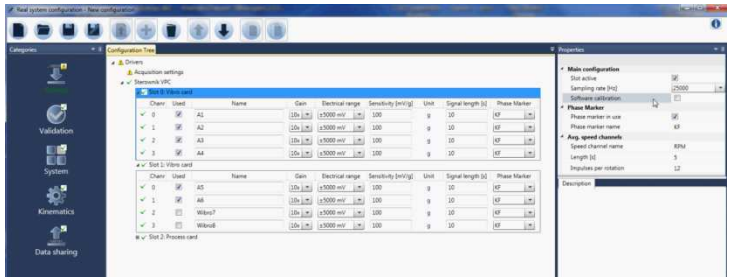
Before SUPREME

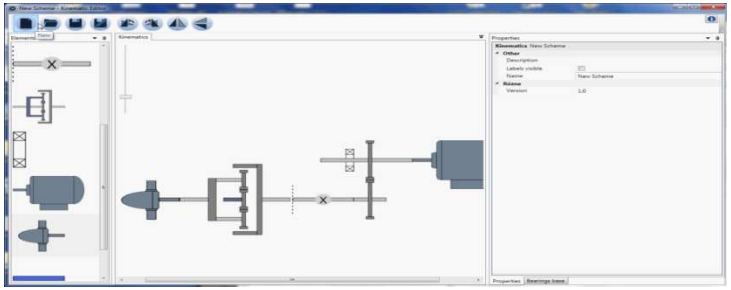
2012

Vibex

After SUPREME

2015



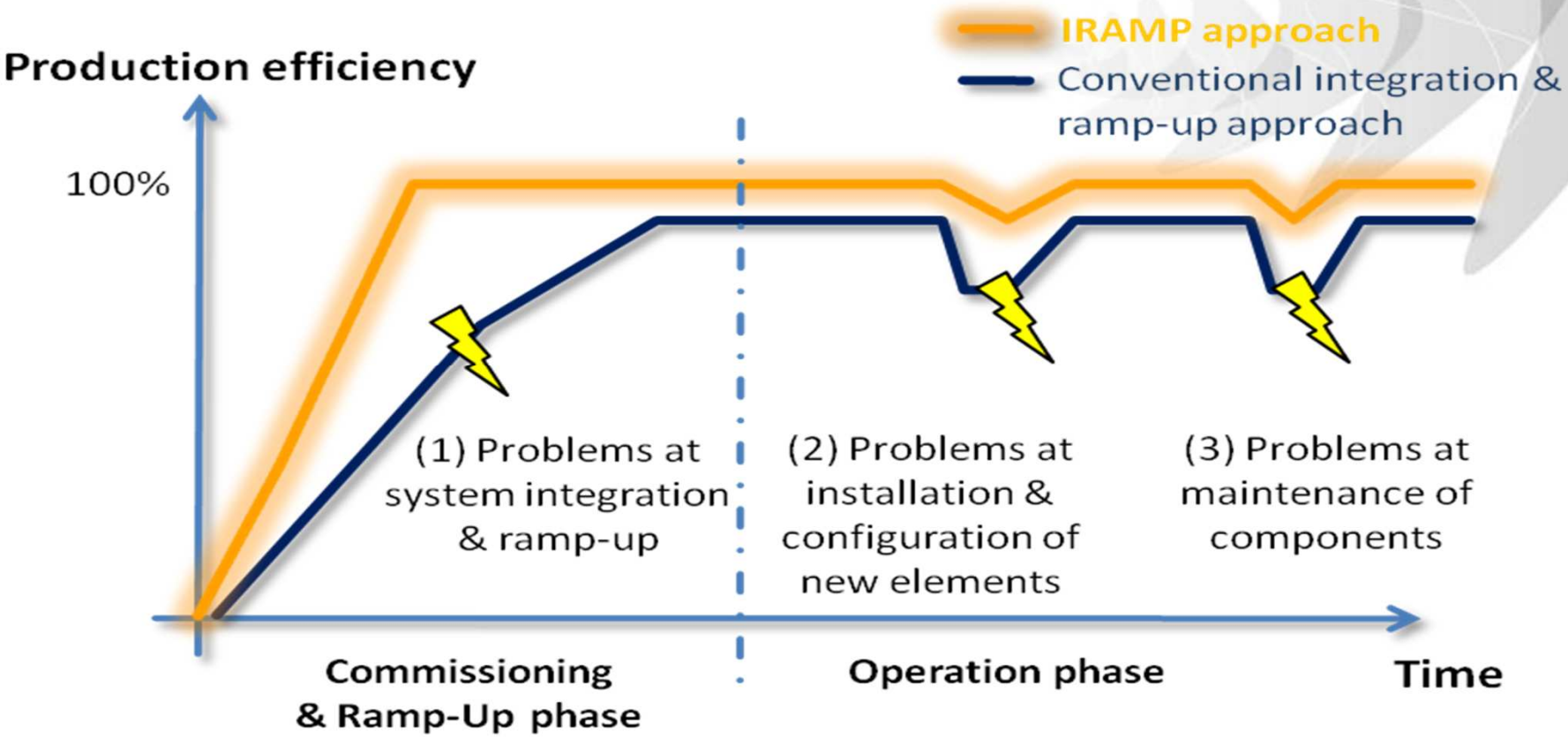


VIBstudio

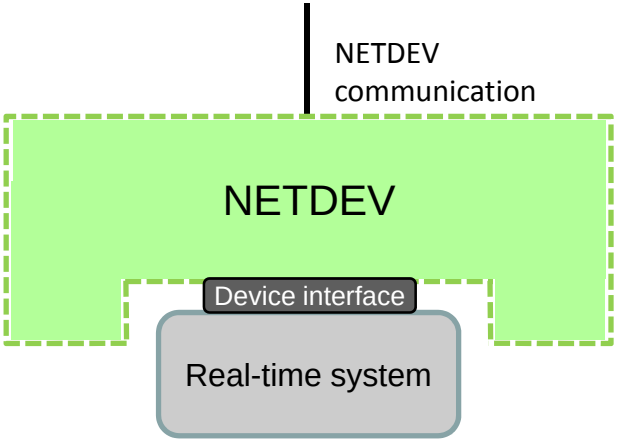
ECS results in trade shows

Factories of the Future: Demonstration

I-RAMP3

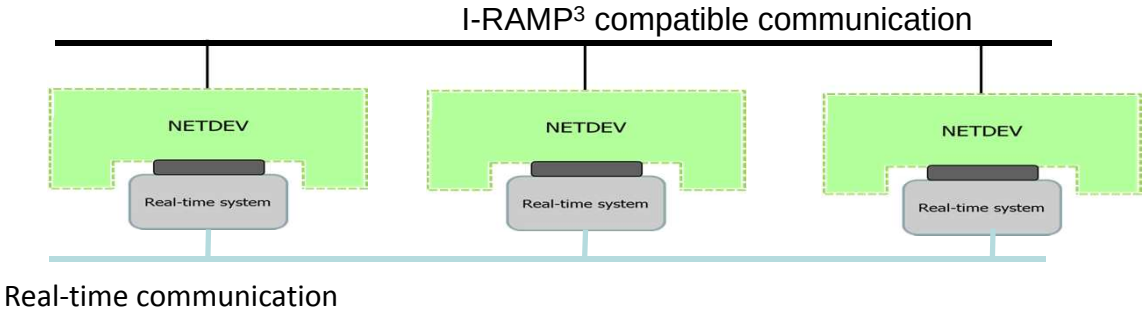


Network-enabled Devices -- NETDEVs



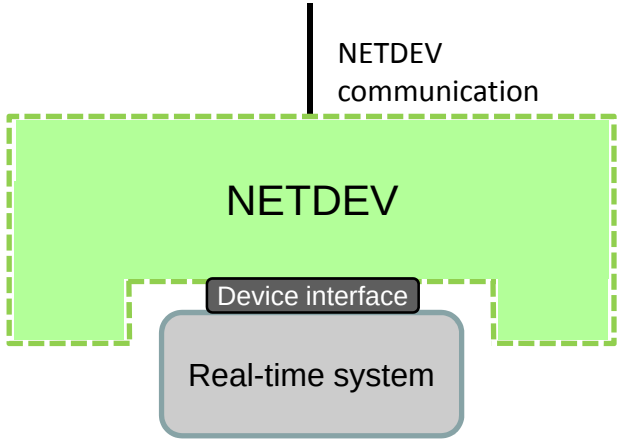
Intelligent extension of traditional devices, featured with

- Self-description
- Self-connecting
- Self-awareness and self-adaptation
- Task driven operation
- High level communication



I-RAMP³ is co-financed by the European Commission DG Research under the 7th Framework Programme

Network-enabled Devices -- NETDEVs

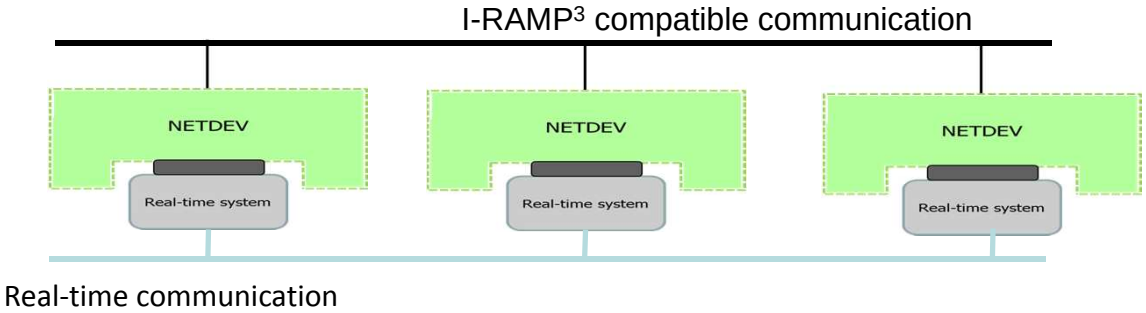


Intelligent extension of traditional devices, featured with

- Self-description
- Self-connecting
- Self-awareness and self-adaptation
- Task driven operation
- High level communication

In the Demonstrators, NETDEVs for

- Servo-presses,
- Welding controls,
- Sensors,
- Cell orchestration,
- Data collection,
- …



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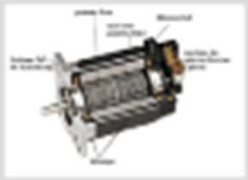
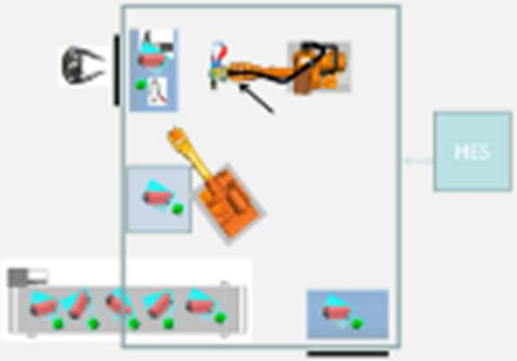
Factories of the Future: Demonstration

I-RAMP3

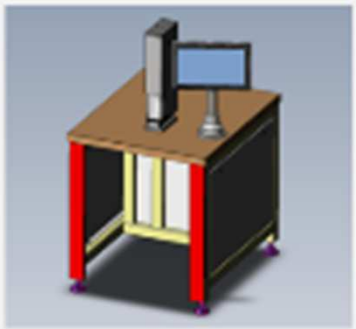
I-RAMP 3
Intelligent Network Devices for fast Ramp-up

Cyber physical solutions exemplified on an e-vehicle assembly line





Set-up and ramp-up of a new E-Vehicle assembly line



Component exchange in E-Vehicle subassembly unit

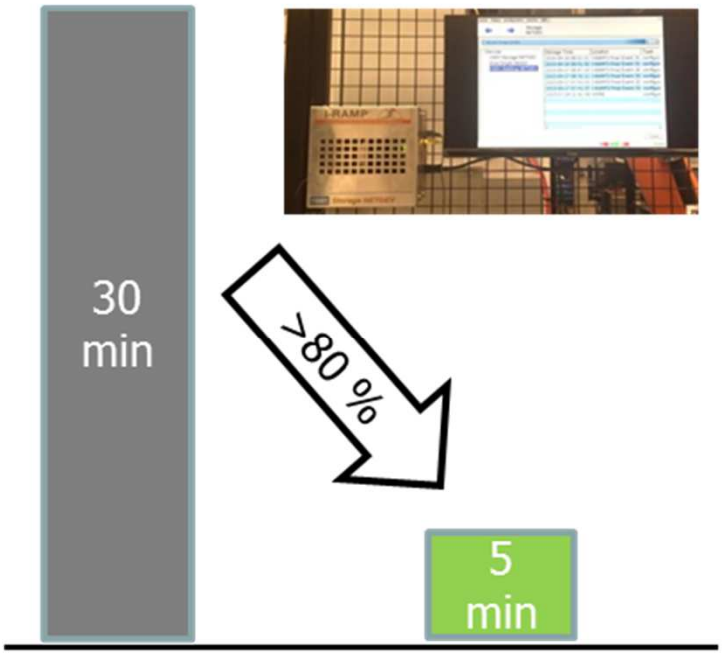
Enhancing devices with re-use and predictive maintenance capabilities

- **50%** Decrease of ramp-up time for joining technologies
- **90%** Decrease of ramp-up time for specialized assembly systems

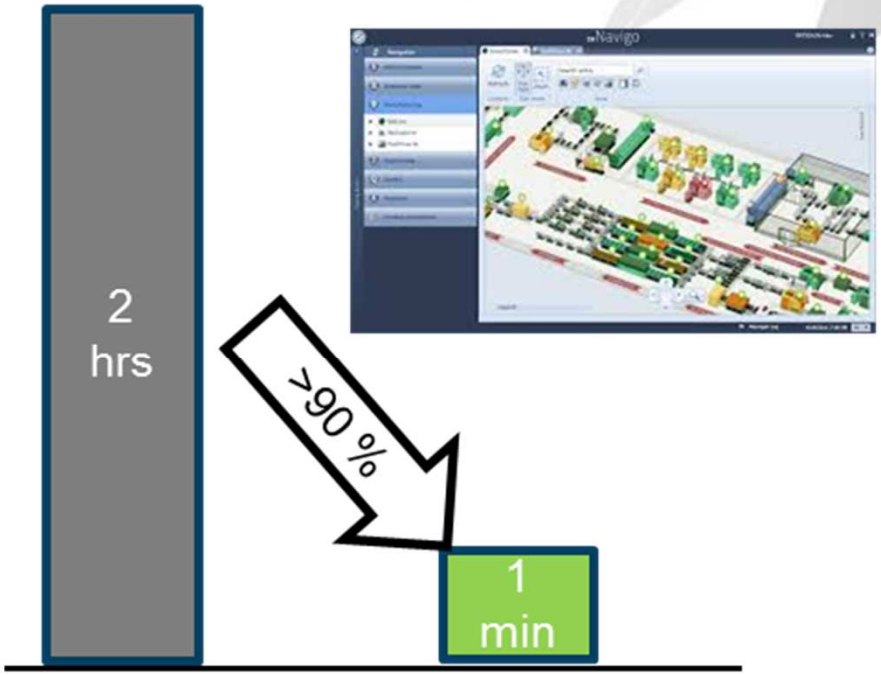
I-RAMP³
Intelligent Network Devices for fast Ramp-up

Impacts -- Examples

Storage NETDEV allows for exchanging a defect welding controller and ramping-up a new one.



Auto-creation and integration of production equipment in MES by equipment self-description and standardized communication



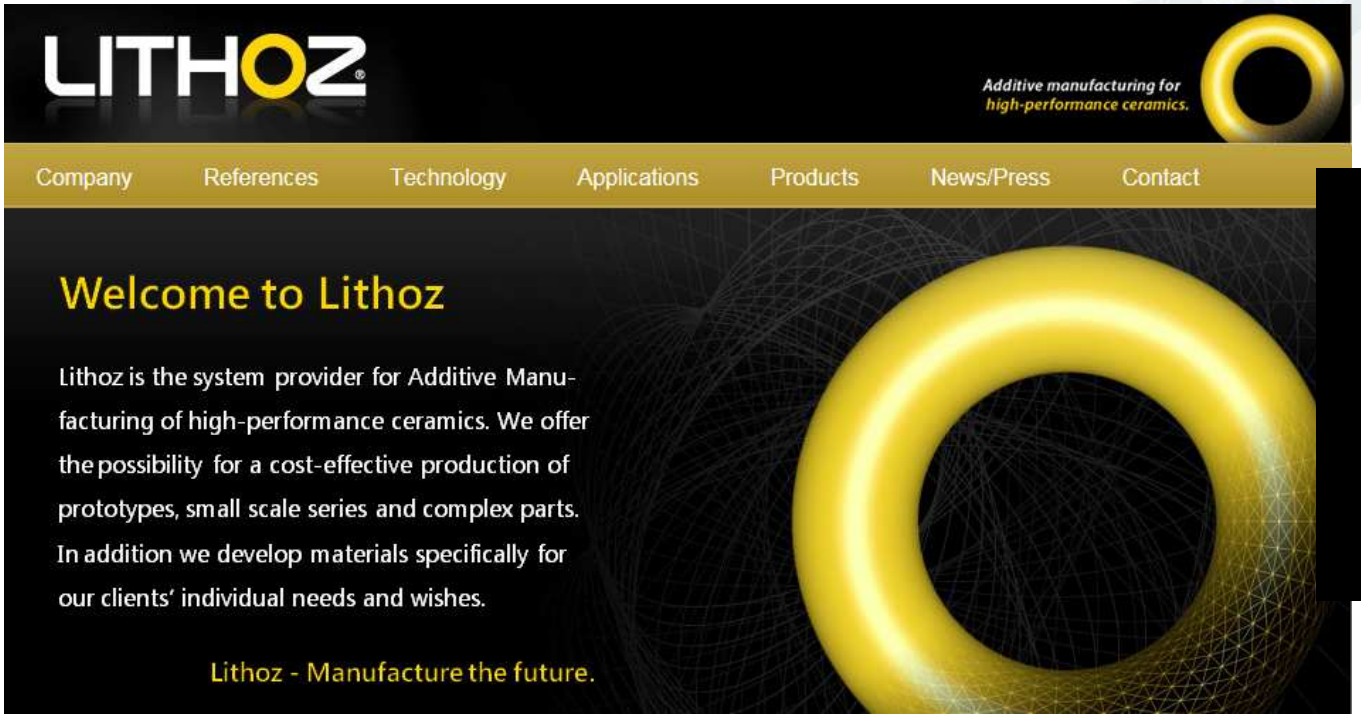
I-RAMP³ is co-financed by the European Commission DG Research under the 7th Framework Programme

Femtosecond Laser Printer for Glass Microsystems with Nanoscale Features

Supported by the European Commission through the Factories of the Future PPP (Grant Agreement Number 637212)

Photopolymer based customized additive manufacturing technologies

PhoCam



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FoF-Impact

Supported by the European Commission through the Factories of the Future PPP (Grant Agreement Number 637212)

NANOMASTER PROJECT OPTIMISES PROCESSES AND UP-SCALING FOR GRAPHENE DELIVERY

NanoMaster Project Optimises Processes and Up-Scaling for Graphene Delivery

As it enters its final phase, the NanoMaster Project is reporting exciting results related to graphene and expanded graphite production and the development of novel nanocomposite intermediates.

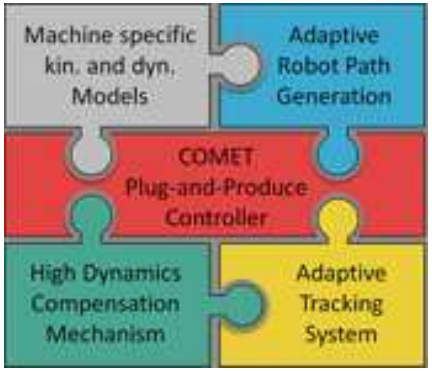
Over the last eighteen months, the project team have focused on optimising and up-scaling the processes for graphene and expanded graphite production and their subsequent compounding with a range of thermoplastics, in order to demonstrate industrial viability and to deliver sufficient quantities of nanocomposite intermediates for use in the final stages of the project.

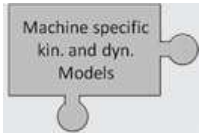
As a result of this work, the project team is pleased to report that production of graphene and few-layer graphene has been scaled from 50g at the end of the first year to 2.5kg currently. Production of expanded graphite and nano-graphite has also been optimise and up-scaled. A densification process was studied to help improve the feeding of these graphite and nano-graphite powders into compounding extruders and to reduce transportation volumes.

Alongside this, optimum lab-scale compounding extrusion parameters have been determined and simulations carried out, subsequently leading to the implementation of pilot-scale production.

A further important activity during stage two was the evaluation of competitor products and comparison with the NanoMaster materials, as Ben Hargreaves, Senior Project

Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future





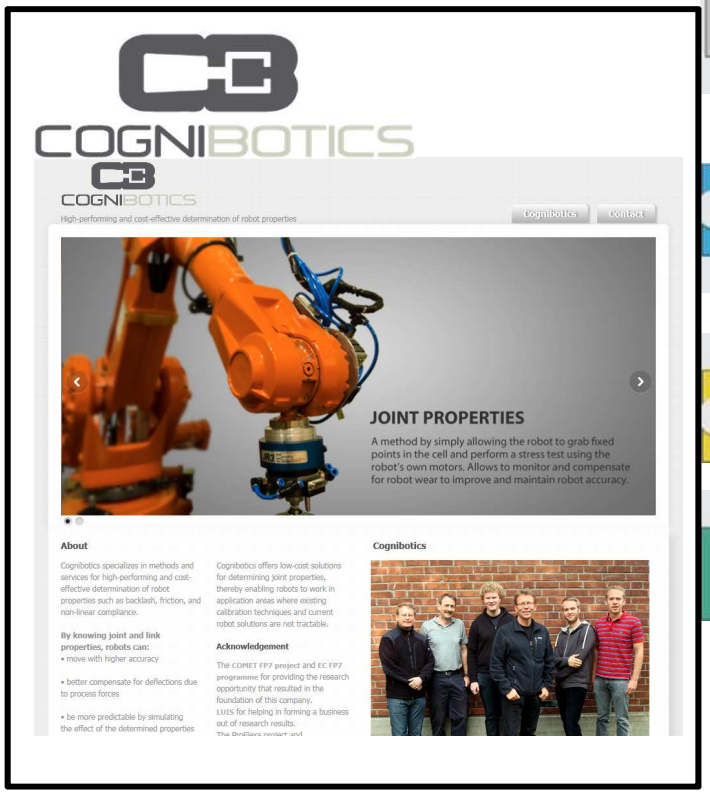
A methodology for describing **Kinematic and Dynamic Models of Industrial Robots (KDMIR)** to define accurately the static and dynamic behaviour of any industrial robot, which is then represented by its unique signature.

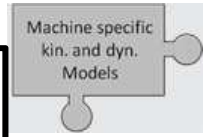
An integrated Programming and Simulation environment for **Adaptive Robot Path Generation** for machining with Industrial Robots (PSIR) based upon the unique signatures.

An **Adaptive Tracking system** for Industrial Robots (ATIR) to detect deviations from the programmed Robot Path to initiate real-time corrections via the robot controller to ensure the necessary machining accuracy.

A **High Dynamics Compensation Mechanism** (HDCM) to accomplish an absolute accuracy of more than 50um; significantly ‘beyond’ the structural capability of the robot system on its own.

Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future





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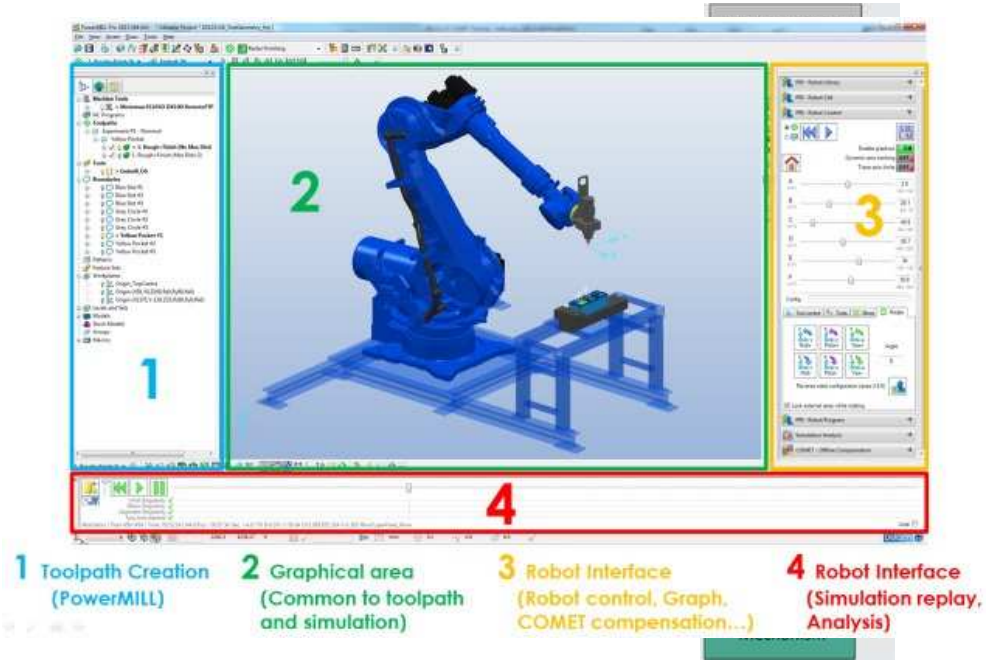
Spin-Off Cognibotics specializes in methods and services for high-performing and cost-effective determination of robot properties such as backlash, friction, and non-linear compliance.

significantly 'beyond' the structural capability of the robot system on its own.

Plug-and-produce COmponents and METhods for adaptive control of industrial robots enabling cost effective, high precision manufacturing in factories of the future



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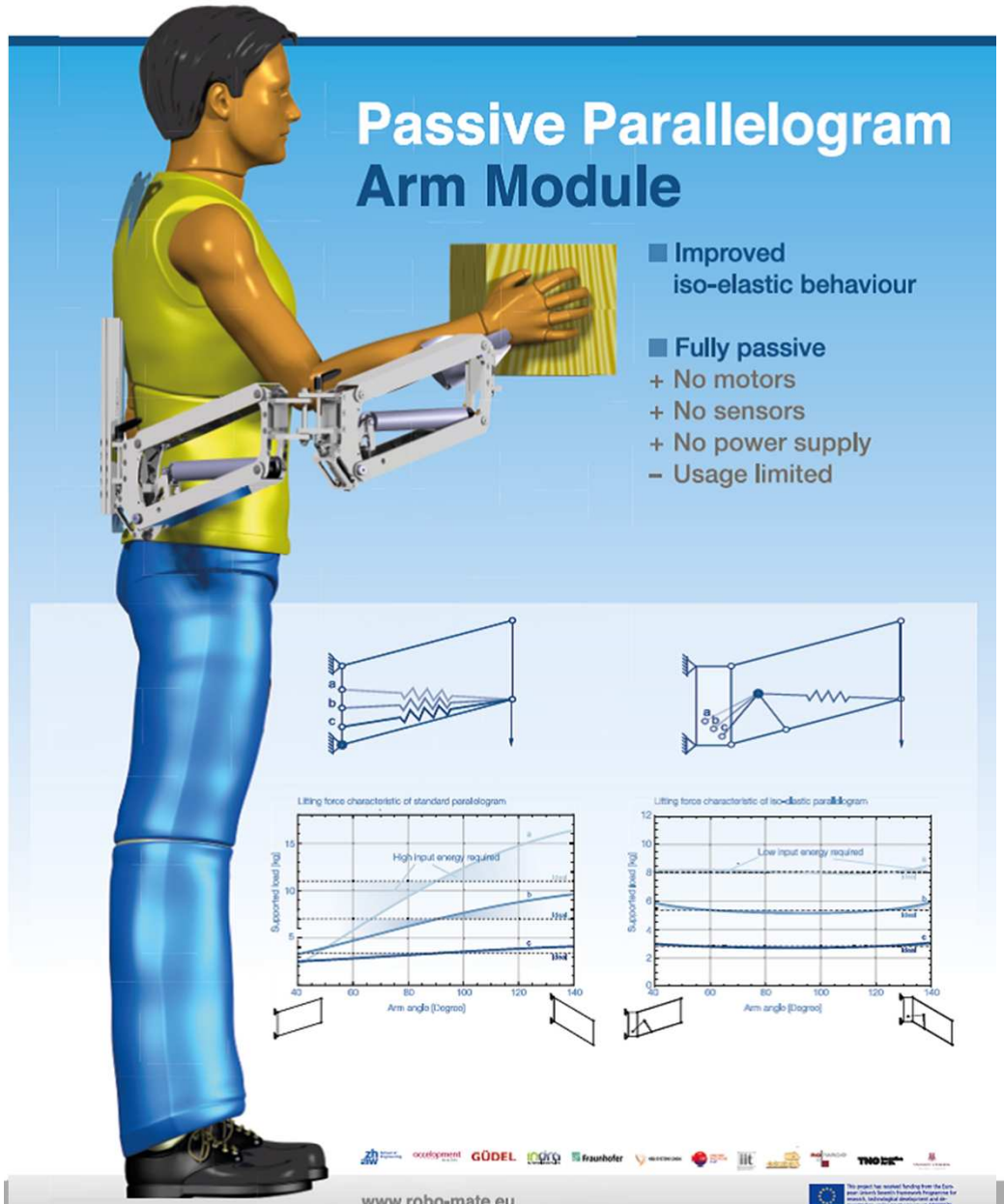
RoboMate



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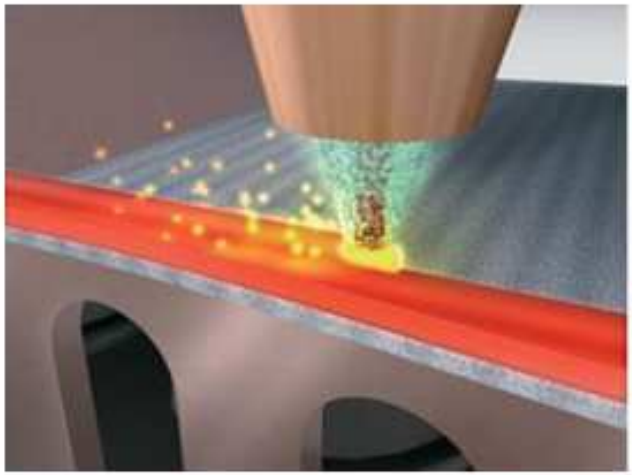
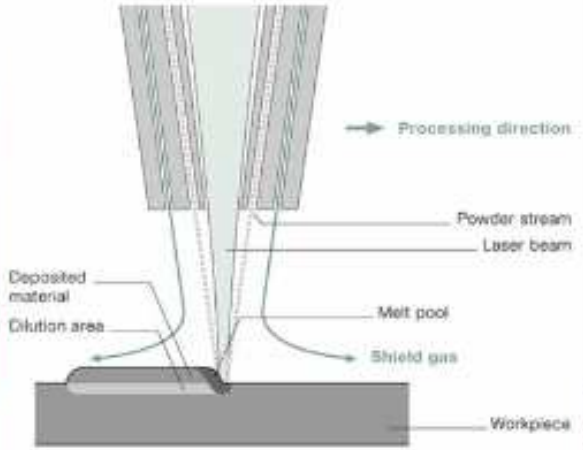
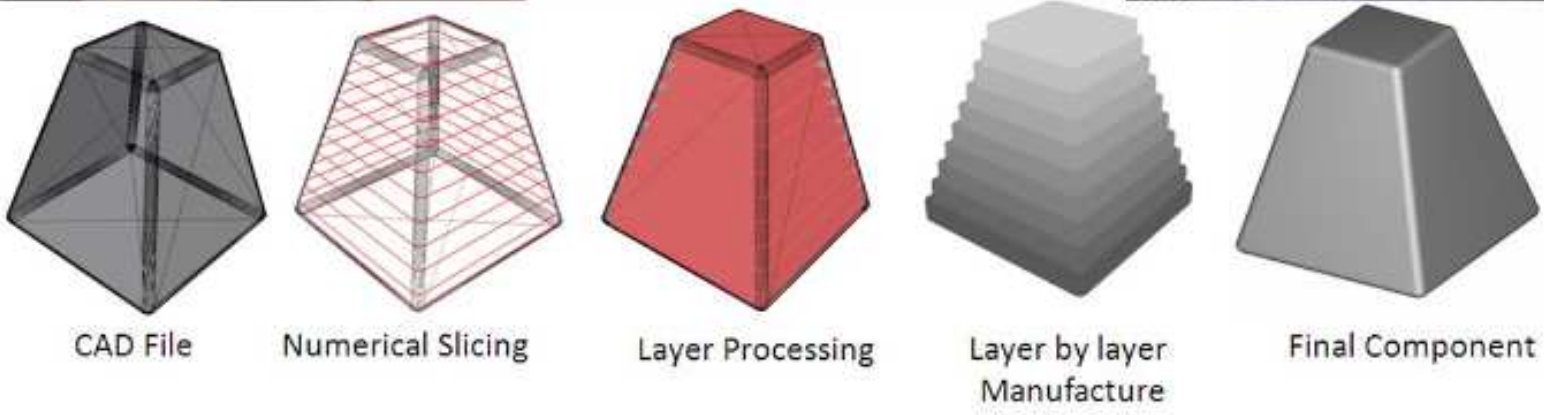
a MANUFUTURE initiative

AMCOR project: develop and demonstrate a flexible and automated manufacturing process for the repair, coating and near net shape production of components composed of functionally graded materials (FGMs).



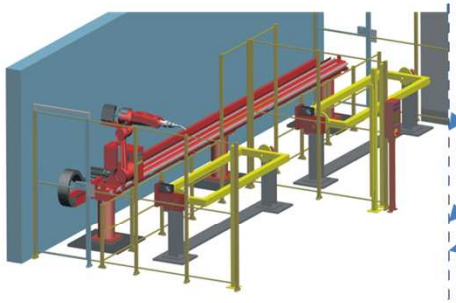




RTO Performers

Supply Chain

Articulated Deposition System (TWI)



- Robot Reach 1.6m
- Work envelope goverend by gantry length (assume 10m)
- Linear Speed 3m/s
- Flexibility measure: 8/10
- Repeatability ±0.1mm
- Accuracy: Variable (Typically 0.5mm – 1mm)
- Cost €110K (for robot only)
- Integration Cost: 40k€

Deposition Process Control (IDEKO)

FGM Design (SIRRIS)

Tomographic Sensors (ETN)

Tool Path Generation and Slicing (SKM)

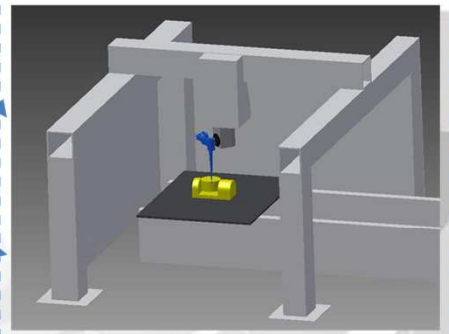
Articulated Robot (OLP)

Gantry Robot (DANOBAT)

Part Scanning / QA (BCT)

Powder Supply (SULZER)

Deposition Process Control (VITO)

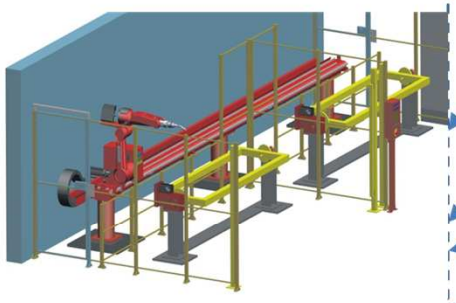


- Reach 0.5m
- Deposition rate 20m/min (linear)
- Flexibility measure: 5/10
- Accuracy: 0.1mm
- Repeatability: ± 0.05mm
- Cost: 200k€ (for Gantry only)
- Integration Cost: 15k€

RTO Performers

Supply Chain

Articulated Deposition System (TWI)



- Robot Reach 1.6m
- Work envelope goverend by gantry length (assume 10m)
- Linear Speed 3m/s
- Flexibility measure: 8/10
- Repeatability ±0.1mm
- Accuracy: Variable (Typically 0.5mm – 1mm)
- Cost €110K (for robot only)
- Integration Cost: 40k€

Deposition Process Control (IDEKO)

FGM Design (SIRRIS)

Tomographic Sensors (ETN)

Tool Path Generation and Slicing (SKM)

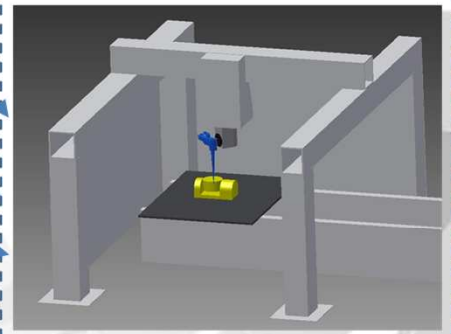
Articulated Robot (OLP)

Gantry Robot (DANOBAT)

Part Scanning / QA (BCT)

Powder Supply (SULZER)

Deposition Process Control (VITO)



- Reach 0.5m
- Deposition rate 20m/min (linear)
- Flexibility measure: 5/10
- Accuracy: 0.1mm
- Repeatability: ± 0.05mm
- Cost: 200k€ (for Gantry only)
- Integration Cost: 15k€

FGM Parts Design, Optimised, Manufactured and Demonstrated

End users

Development of Commercial LMD SYSTEM (SULZER)

Industrial Drive and Control Systems (BOSCH)

Power Generation (SKODA)

Broaches (EKIN)

Gears and Shaft (VCST)

Mining (DENYS)

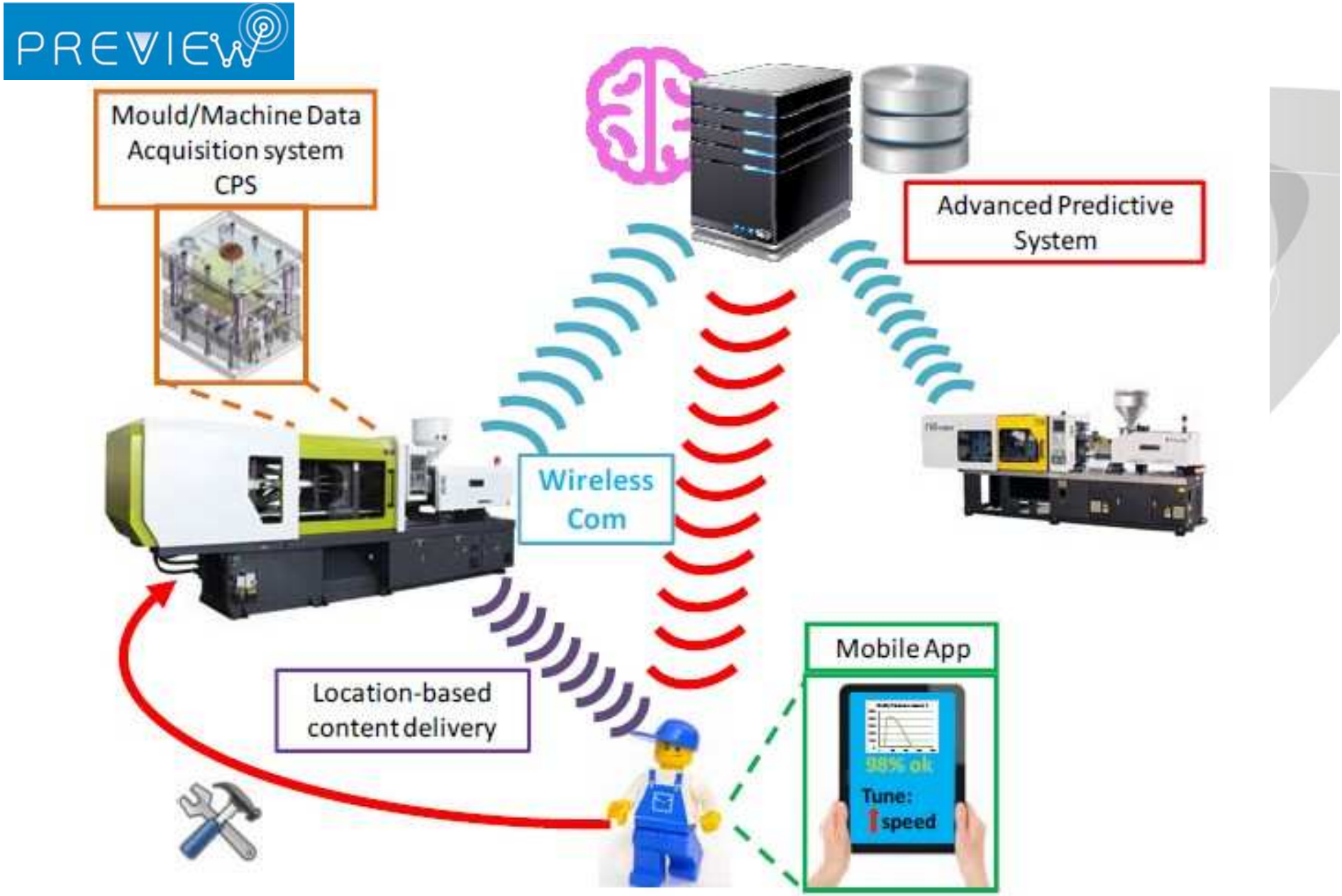
European Industrial Manufacturing Markets

Factories of the Future

PREVIEW

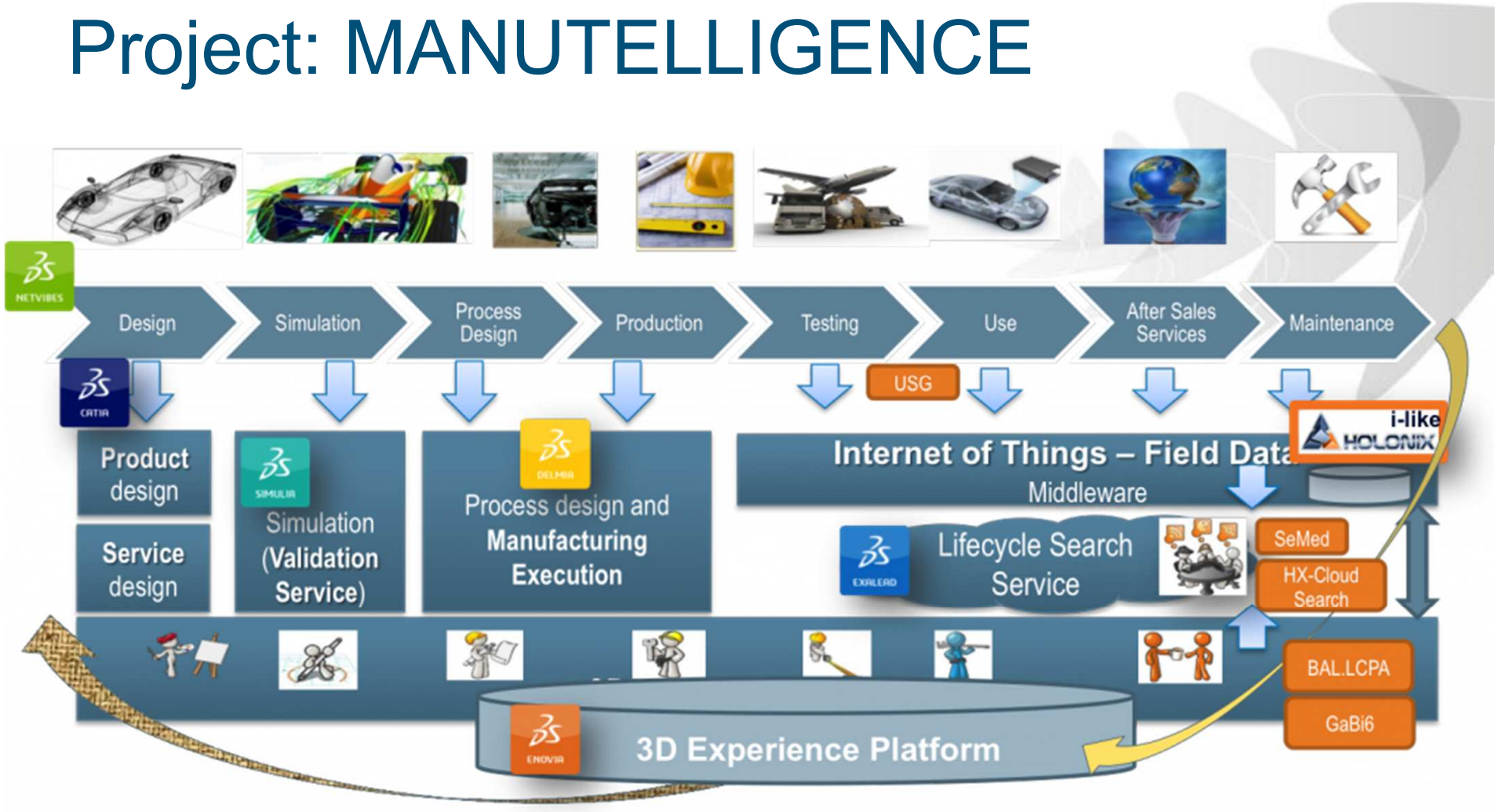
PREDICTIVE SYSTEM TO RECOMMEND INJECTION MOULD SETUP WITH PROCESS OPTIMISATION IN WIRELESS SENSOR NETWORKS

http://www.preview-project.eu/


PREVIEW
Mould/Machine Data Acquisition system CPS
Advanced Predictive System
Wireless Com
Location-based content delivery
Mobile App
98% ok
Tune:
speed

Factories of the Future

Project: MANUTELLIGENCE



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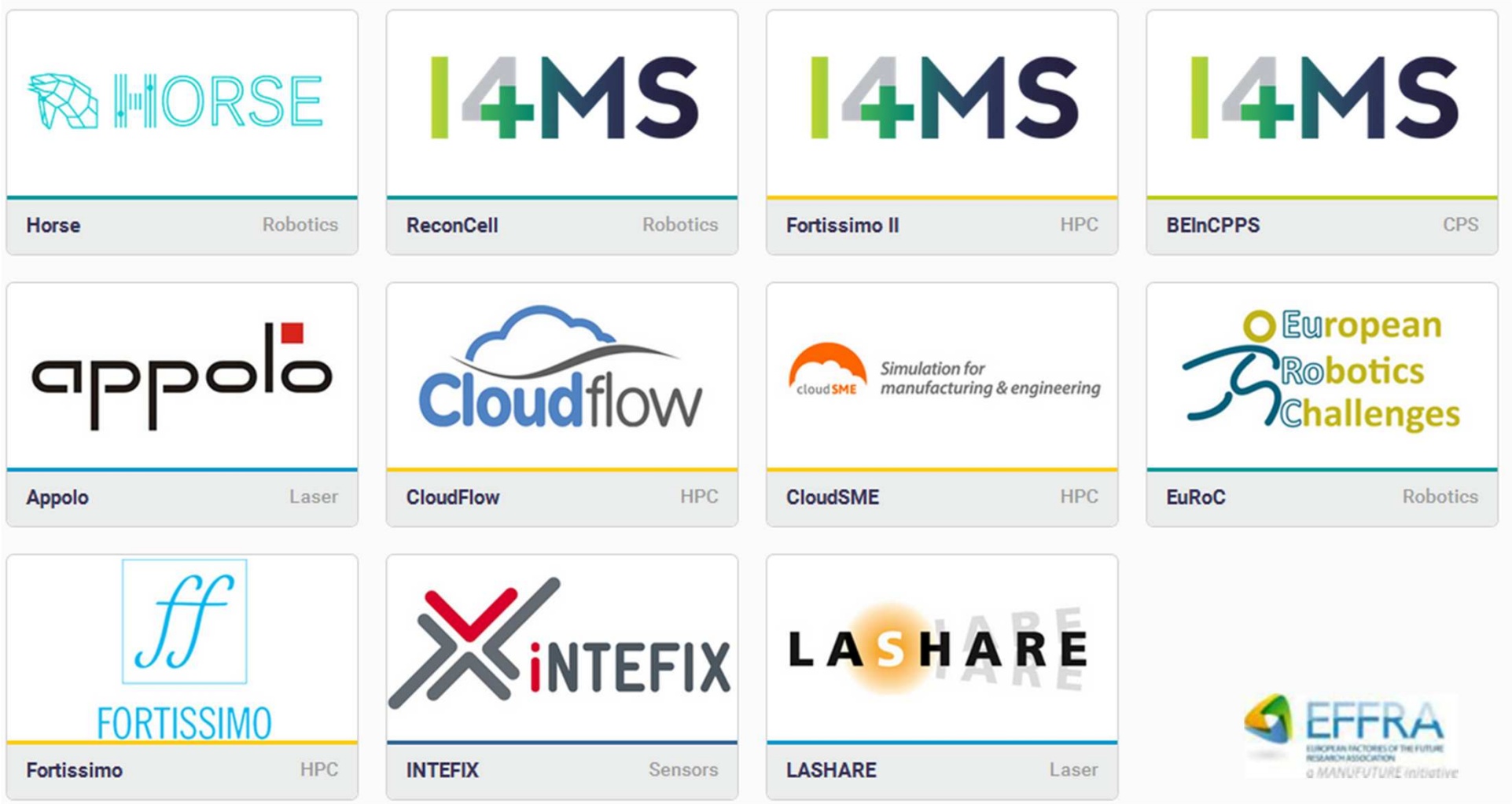
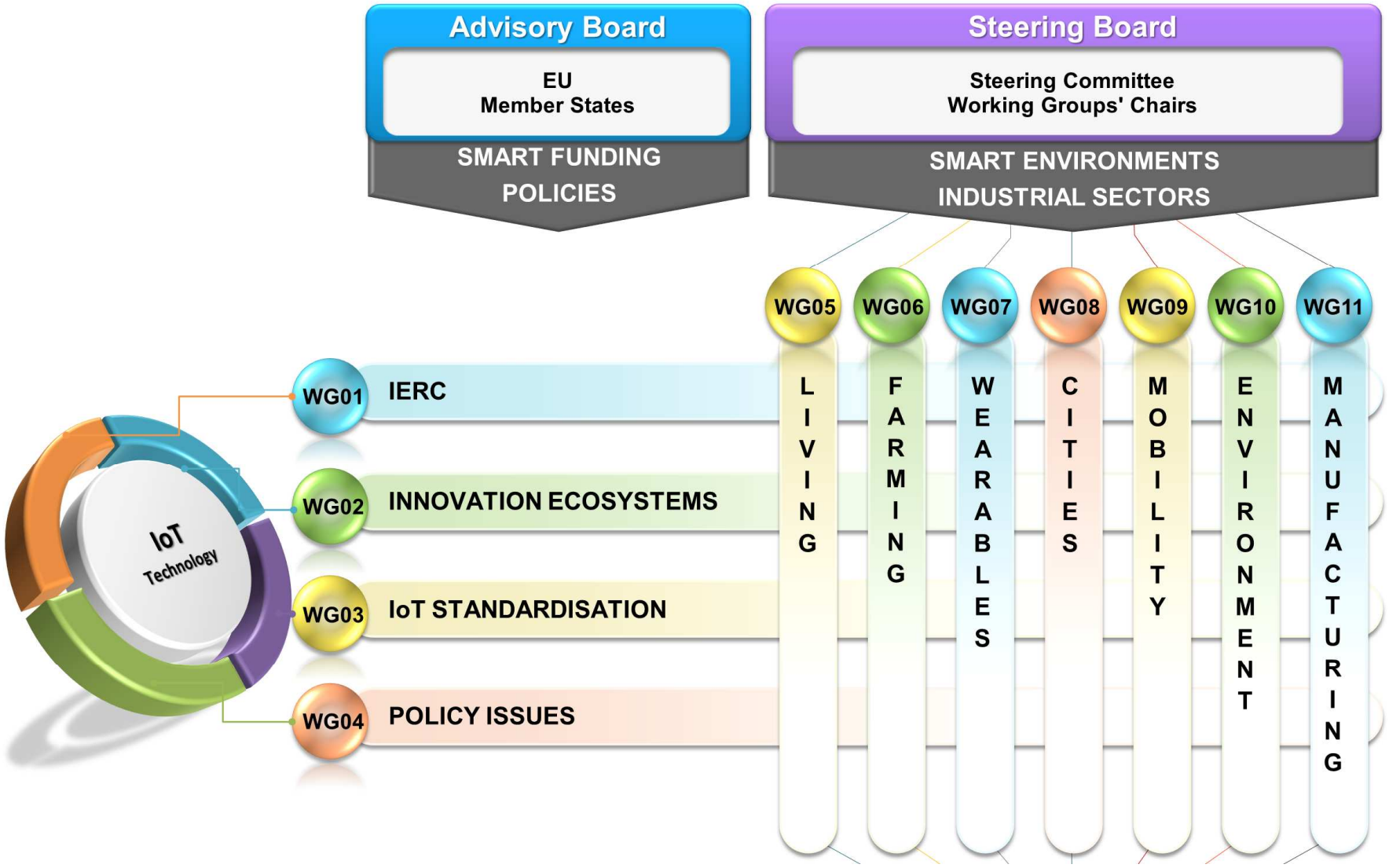
Factories of the Future: Digitisation

ICT Innovation for Manufacturing SMEs

A 'Factories of the Future' Initiative



ALLIANCE FOR INTERNET OF THINGS INNOVATION - AIOTI



5G PPP

The 5G Infrastructure Public Private Partnership, in short 5G PPP, has been initiated by the EU Commission and industry manufacturers, telecommunications operators, service providers, SMEs and researchers.

The 5G PPP will deliver solutions, architectures, technologies and standards for the ubiquitous next generation communication infrastructures of the coming decade.

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BDV BIG DATA VALUE ASSOCIATION

Home | News | Events | Resources | Membership | Task Forces

Big Data Value Association

The Big Data Value Association AISBL is a fully self-financed non–for-profit organisation under Belgian law. Currently there are 24 founding members from large and SME industry and research. The BDVA shall present an industry-led contractual counterpart to the European

About us

BDV BIG DATA VALUE ASSOCIATION
RESEARCH ASSOCIATION
a MANUFUTURE initiative

2016 FoF Call Topics

- Novel hybrid approaches for additive and subtractive manufacturing machines.
- Machinery and robot systems in dynamic shop floor environments using novel embedded cognitive functions.
- Zero-defect strategies at system level for multi-stage manufacturing in production lines.
- Continuous adaptation of work environments with changing levels of automation in evolving production systems.
- Support for the further development of Additive Manufacturing technologies in Europe.
- Digital automation.
- Photonics Laser-based production.

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2017 FoF Call Topics

- Surface manufacturing processes for mass production.
- Integration of unconventional technologies for multi-material processing into manufacturing systems.
- In-line measurement and control for micro-/nano-enabled high-volume manufacturing for enhanced reliability.
- Novel design and predictive maintenance technologies for increased operating life of production systems.
- New technologies and life cycle management for re-configurable and reusable customised products.
- ICT Innovation for Manufacturing SMEs (I4MS).

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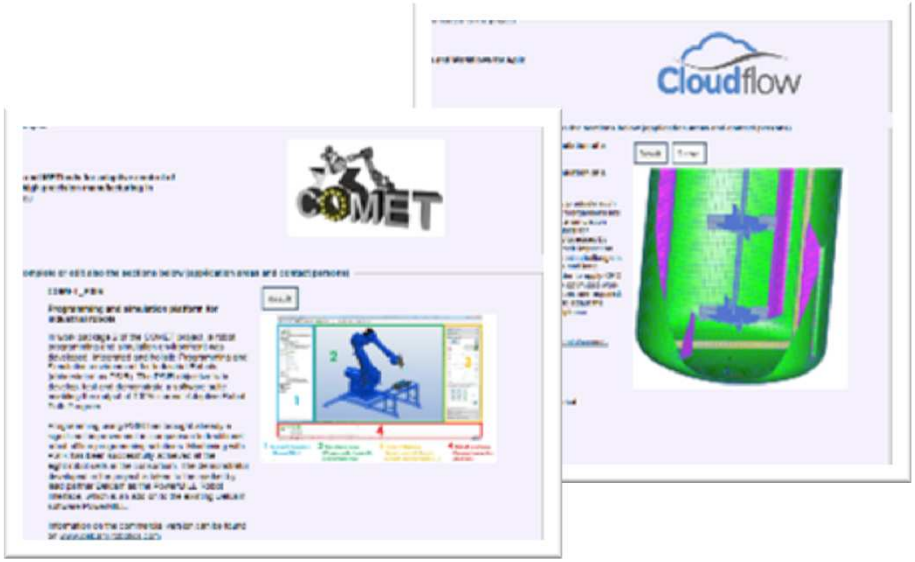
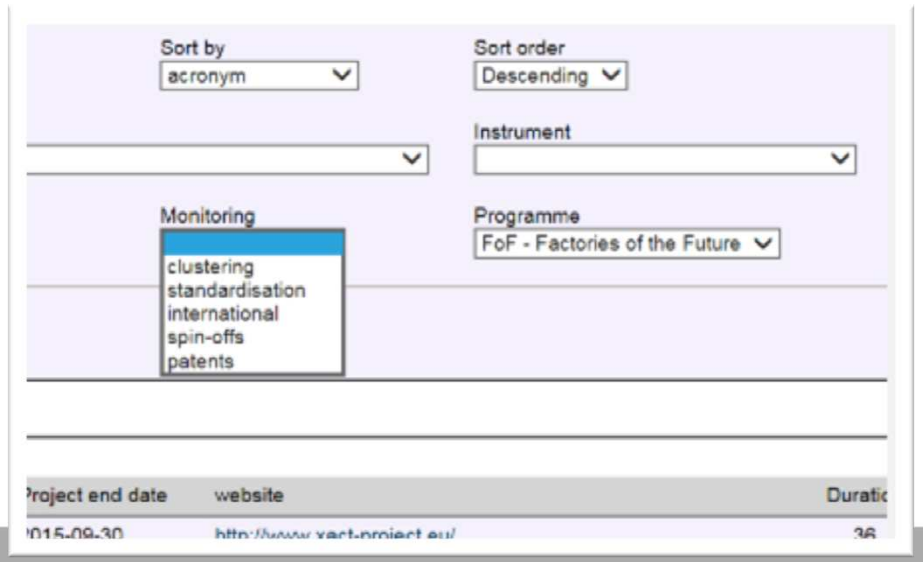
Factories of the Future: Key Tool

EFFRA Innovation Portal





One reference resource…

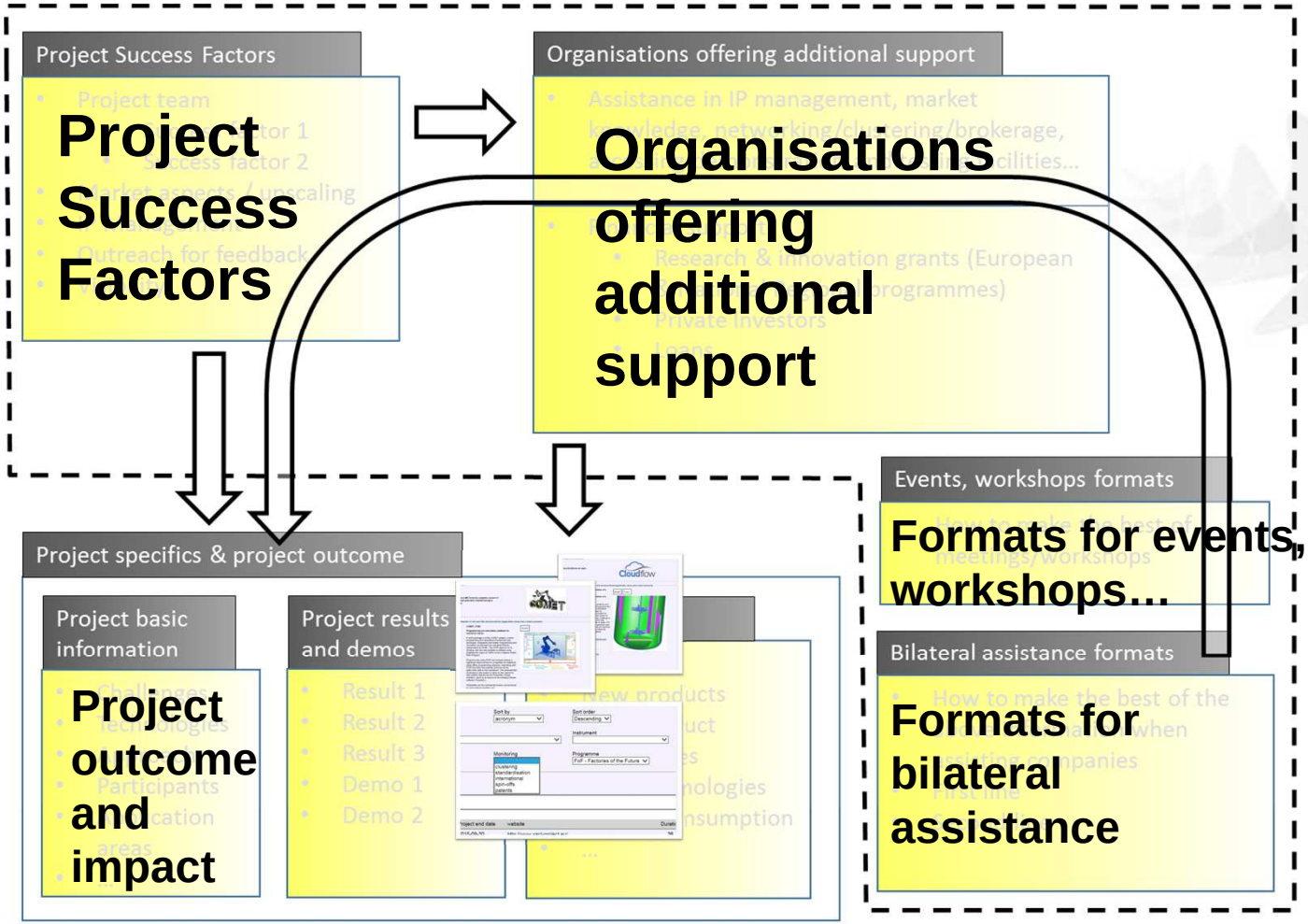
- for **progress monitoring**
- for **sharing information among projects**
- for promoting projects, results and demonstrators to the **wider community**
- for **portfolio management** and analysing coverage of FoF 2020 roadmap
- for **supporting the further roadmapping exercises**
- for **supporting online brokerage**

www.effra.eu/portal

Factories of the Future

Inspiring for and inspired by national and regional programmes

Key activity: stimulating exploitation of project results



Focus of FoF-Impact

Essential Architecture of exploitation toolkit

Address project success factors systematically during whole life-cycle of FoF Projects

Associate supporting organisations to success factors and stimulate support to the projects

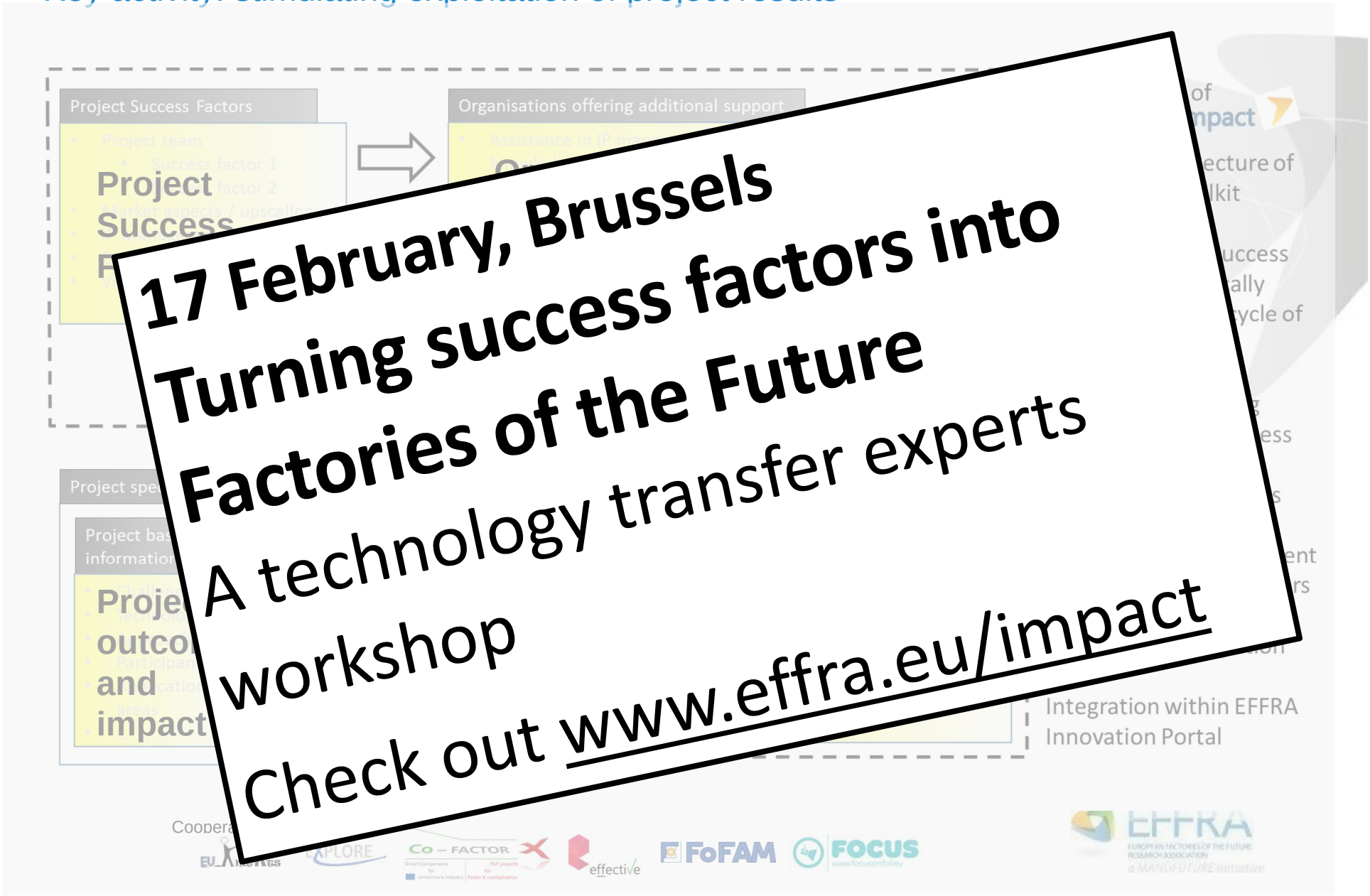
Associate workshop/event formats to success factors and stimulate workshop and event participation

Integration within EFFRA Innovation Portal

Cooperation with other CSAs

EU-Knowledge, EXPLORE, Co-Factor, effective, FoFAM, FOCUS, EFFRA

Key activity: stimulating exploitation of project results



Thank You

chris.decubber@effra.eu

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Factories of the Future
Public Private Partnership