

Europe's Advanced Manufacturing Partnership Factories of the Future



Chris Decubber
Technical Director



Factories of the Future Projects



	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	Nr of projects	Cumulative total	
FoF-2010		25 projects				post-project investments										25	25	
FoF-2011		36 projects					post-project investments										36	61
FoF-2012			37 projects				post-project investments										37	98
FoF-2013				53 projects			post-project investments										53	151
FoF-2014						25 projects		post-project investments									29	180
FoF-2015						28 projects		post-project investments									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 *Multi-annual roadmap for the contractual PPP under Horizon 2020*

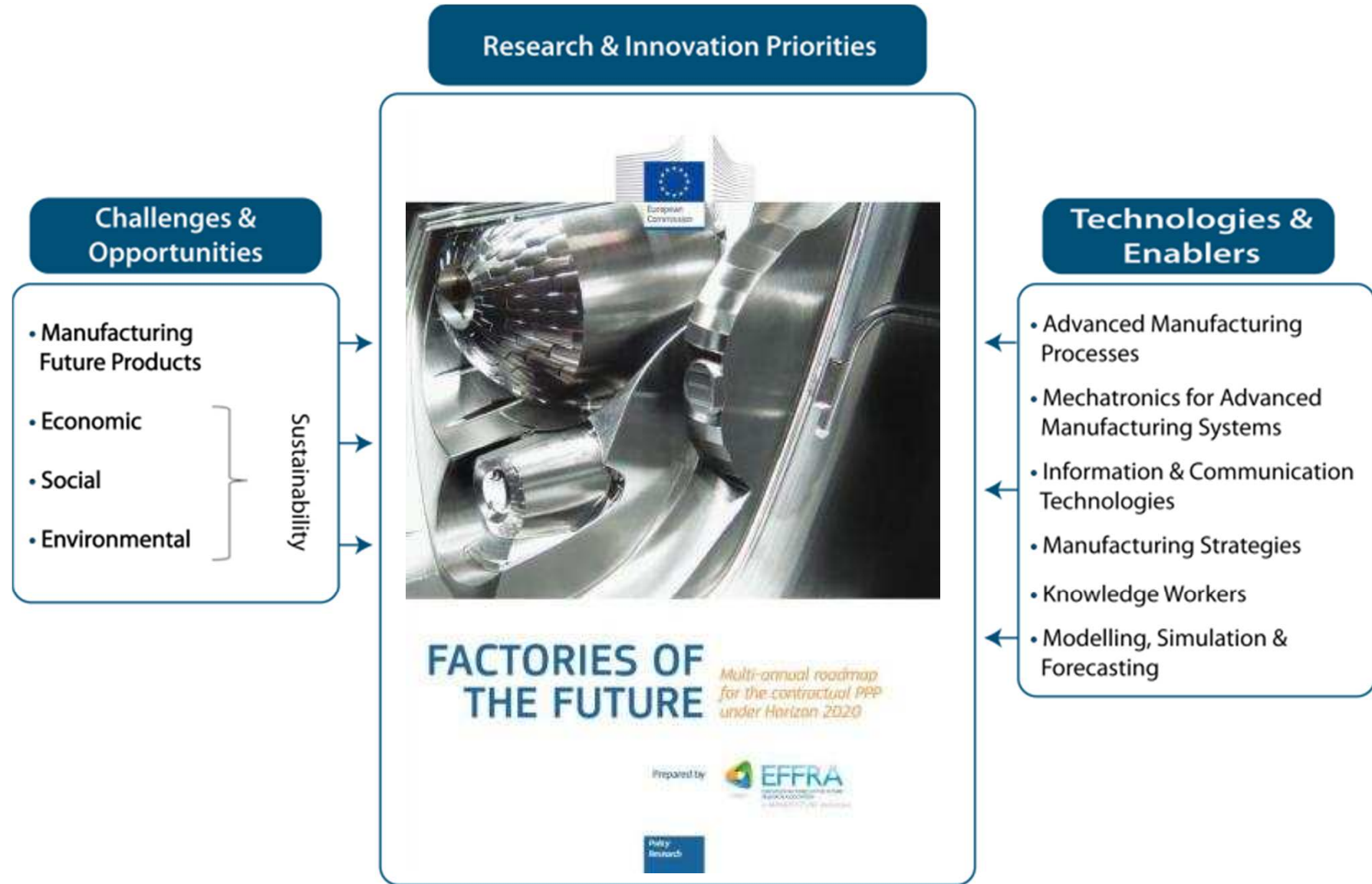
Prepared by



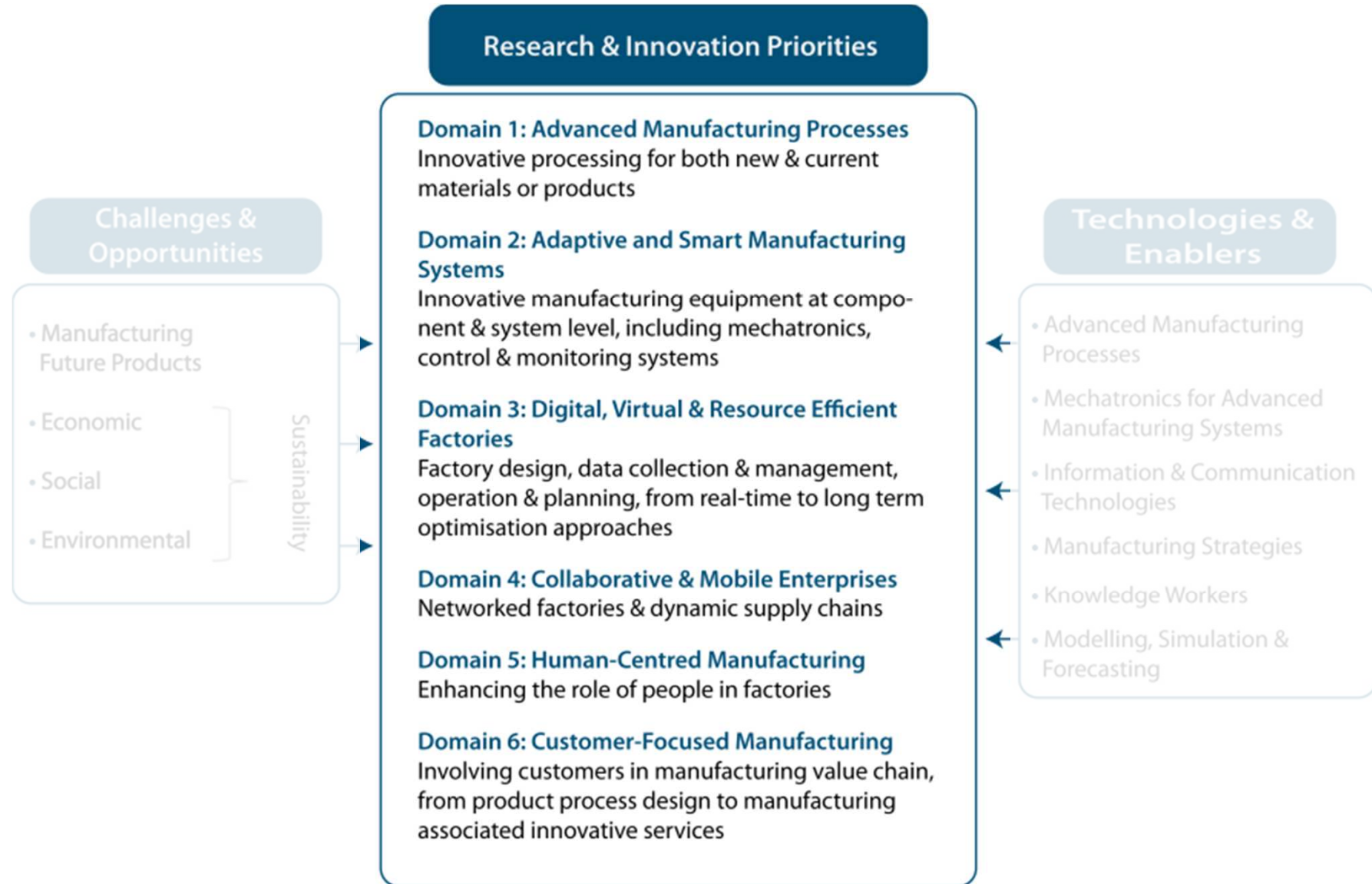
Policy
Research



Factories of the Future 2020 Strategic Roadmap



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

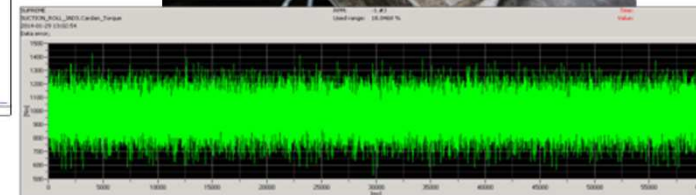
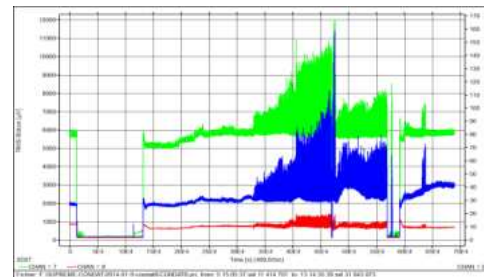
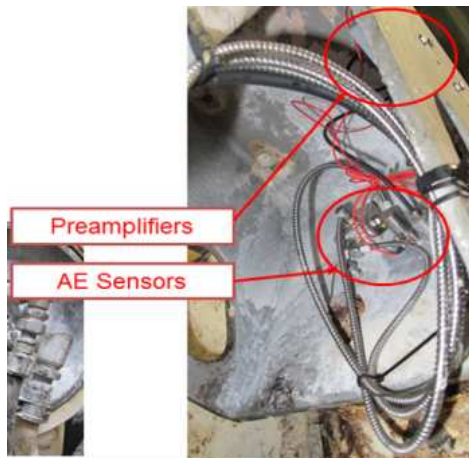
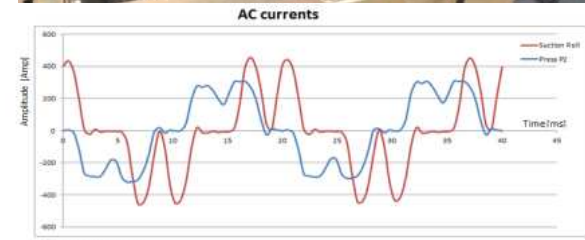
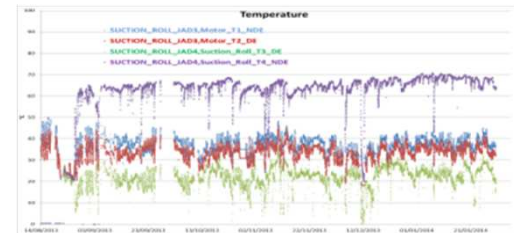
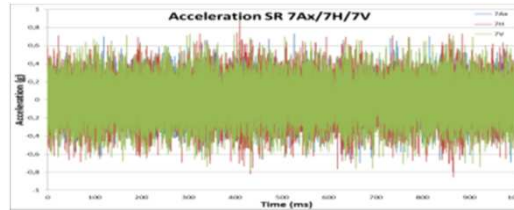
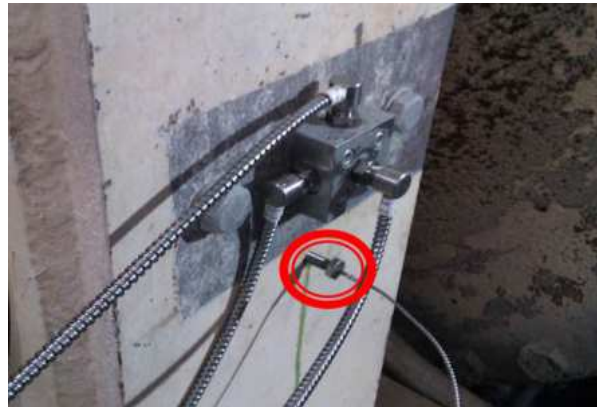
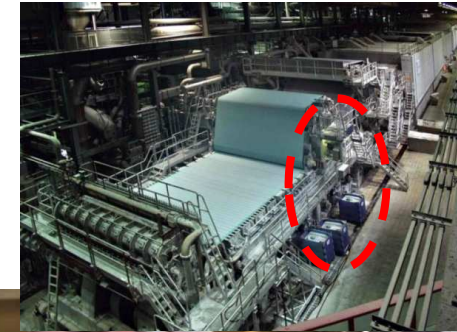
Domain 6: Customer-Focused Manufacturing

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



Embedded Condition Monitoring Module



Sustainable PREDictive Maintenance for Manufacturing Equipment SUPREME

- Industrial end-user (paper mill) : Condat
- Transfer and Dissemination : Cofely-Endel
- SME's as solution provider :

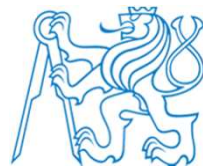


- Orloga (Paper engineering)
- EC_Systems (CMS provider)
- Optimitive (Process optimization)
- Loy&Hutz (CMMS)

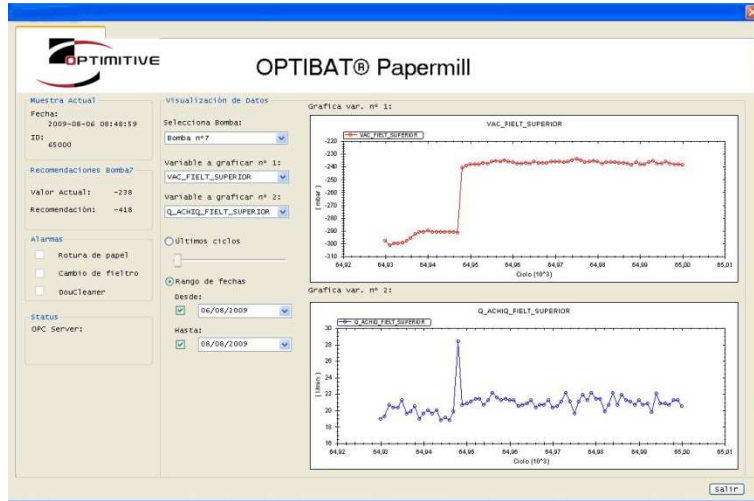


- R&D partners

- CETIM
- FhG-IPA
- Grenoble-INP
- CVUT



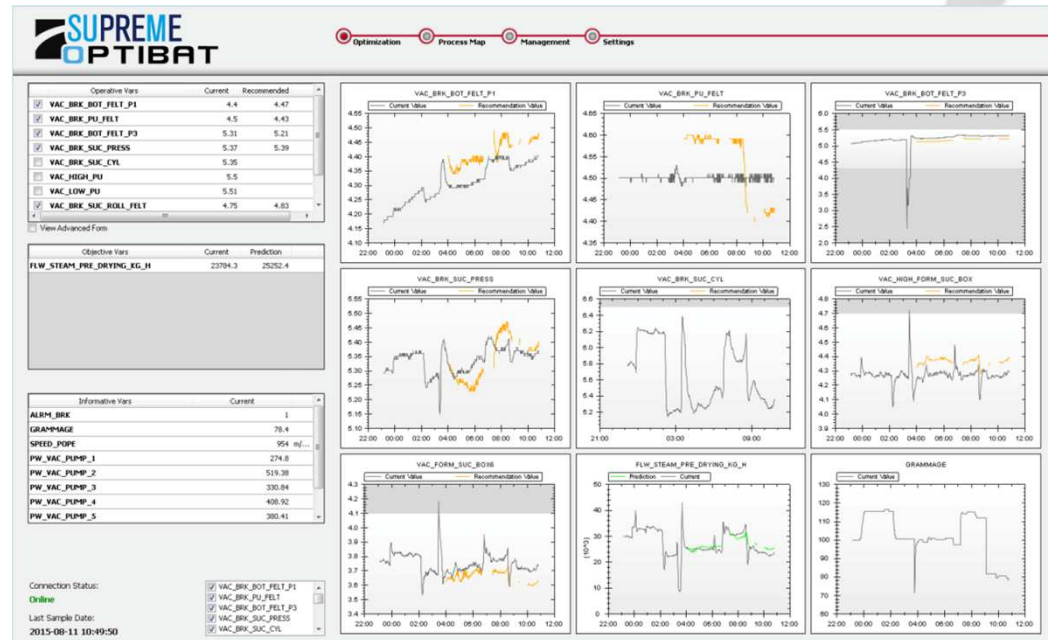
OPTIMITIVE: how we have changed



OPTIBAT v1.2.8

Before SUPREME
2012

After SUPREME
2015



OPTIBAT v4.10.2

OPTIMITIVE: how we have changed



OPTIBAT v1.2.8

Before SUPREME
2012

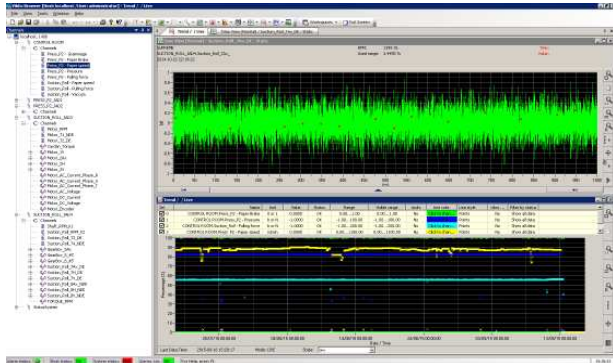
After SUPREME
2015



OPTIBAT v4.10.2

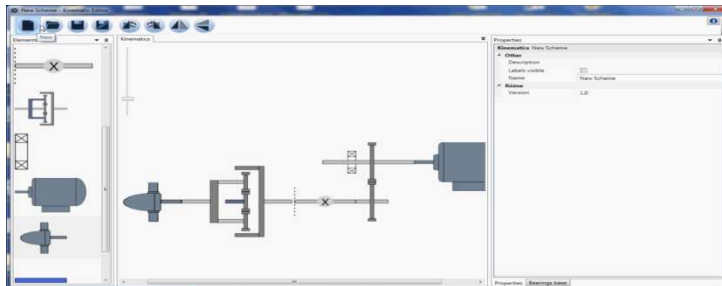
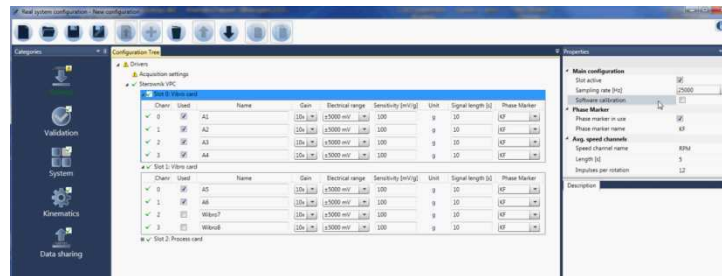
ECMS software evolution

Before SUPREME
2012

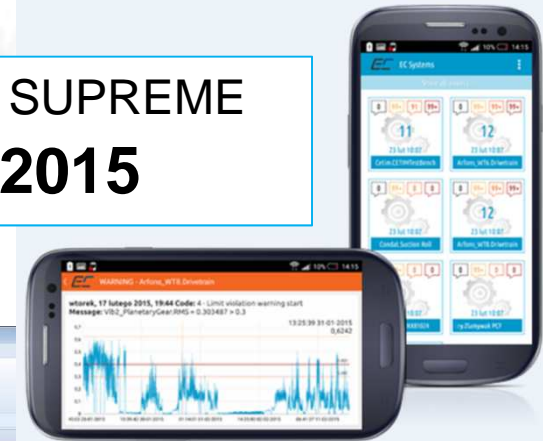
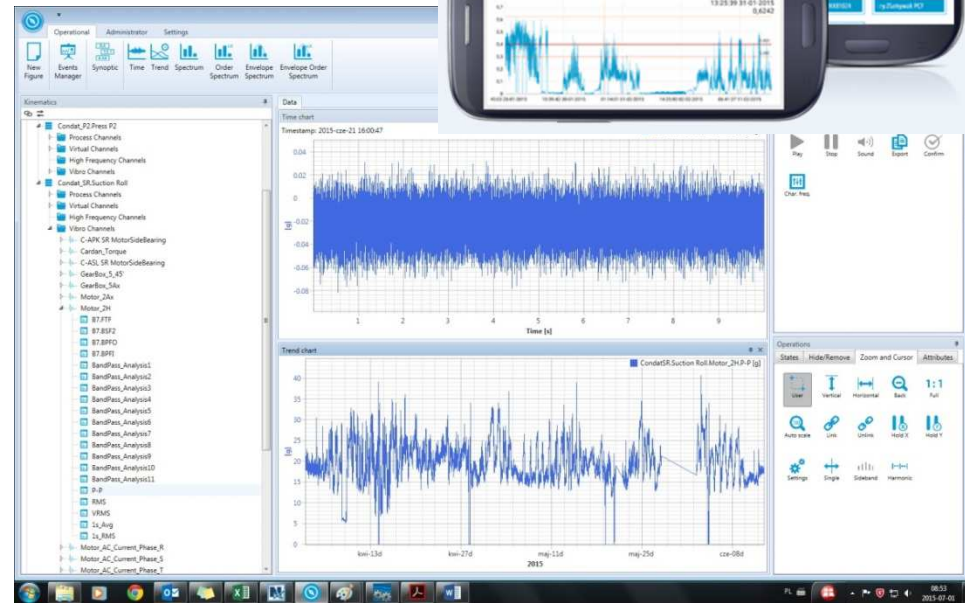


Vibex

After SUPREME
2015

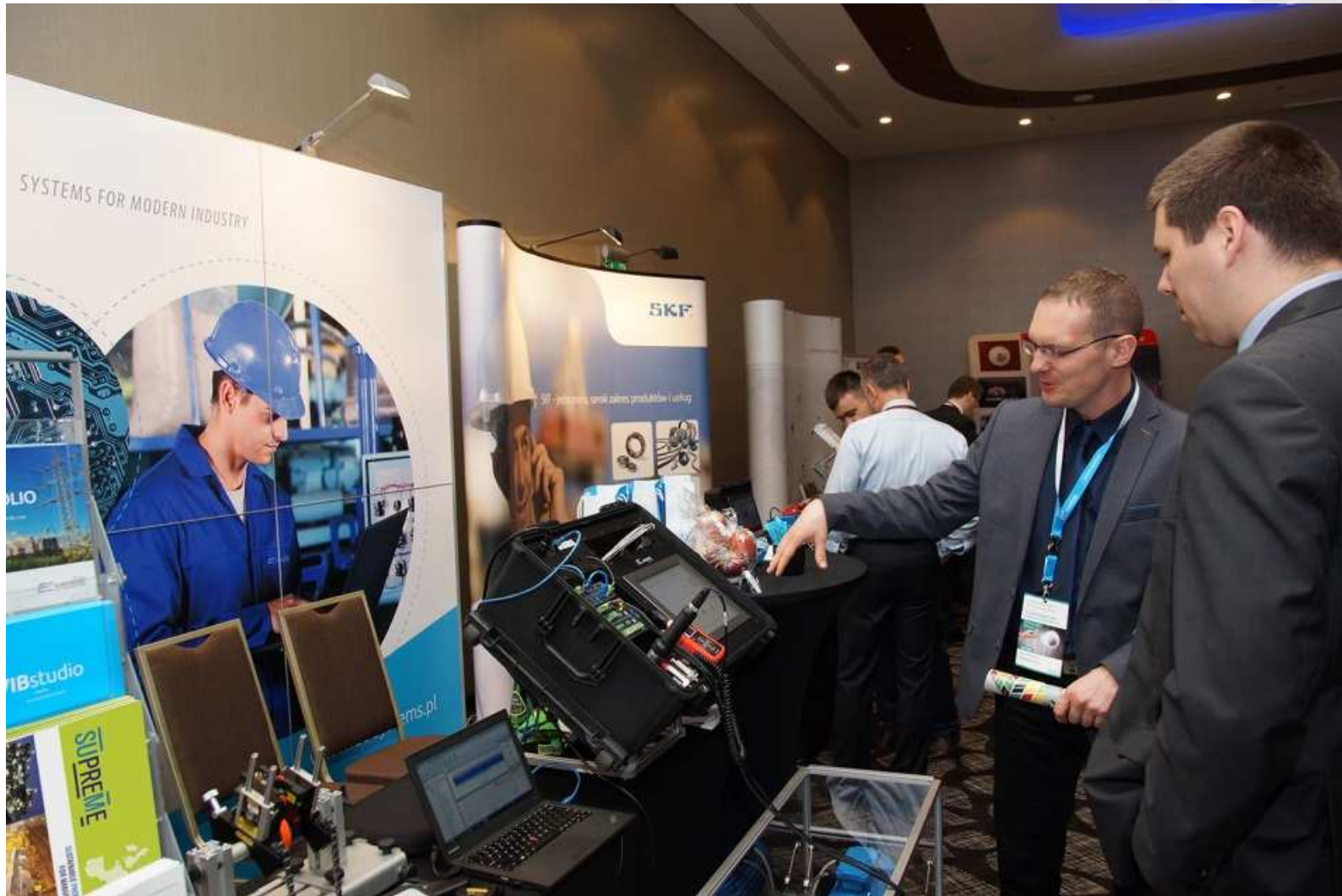


VIBstudio

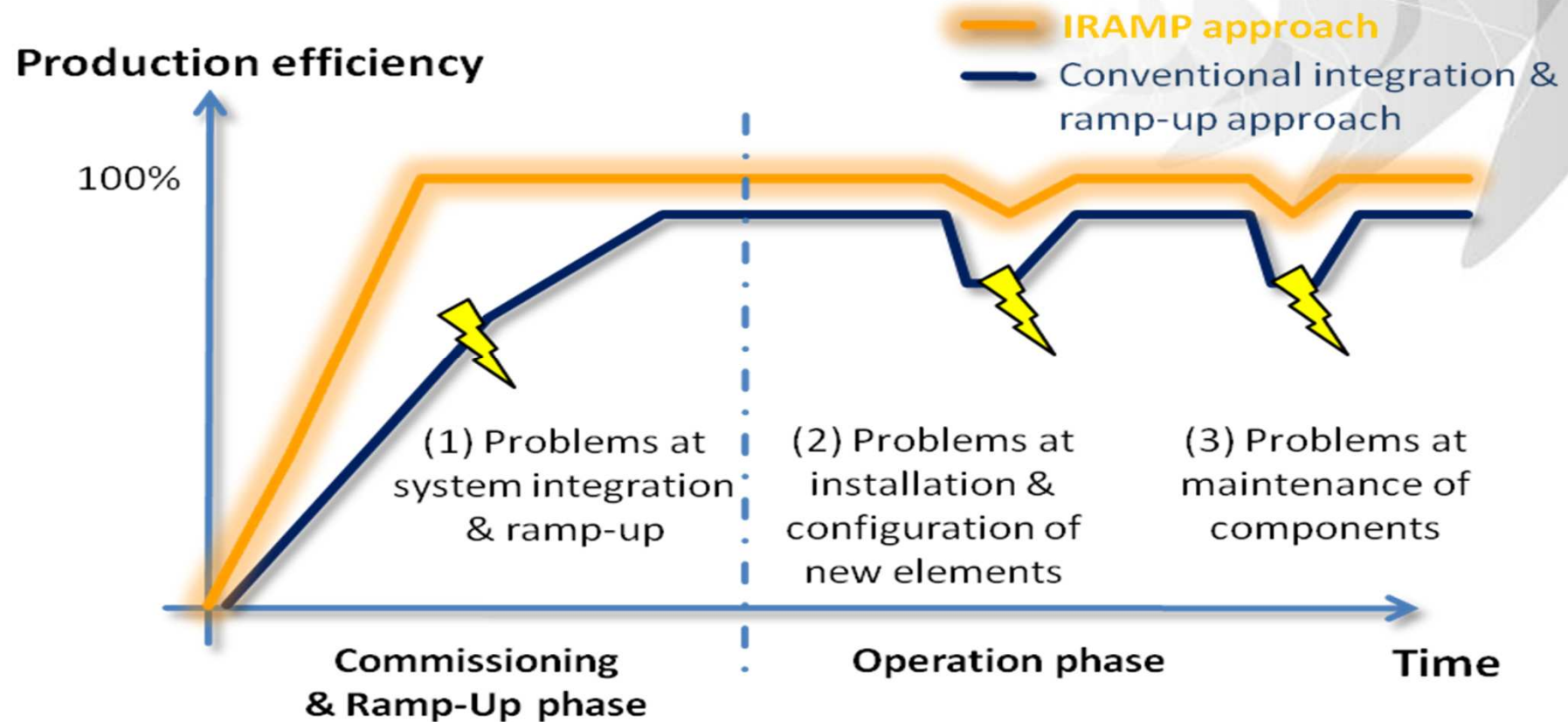


SUPREME

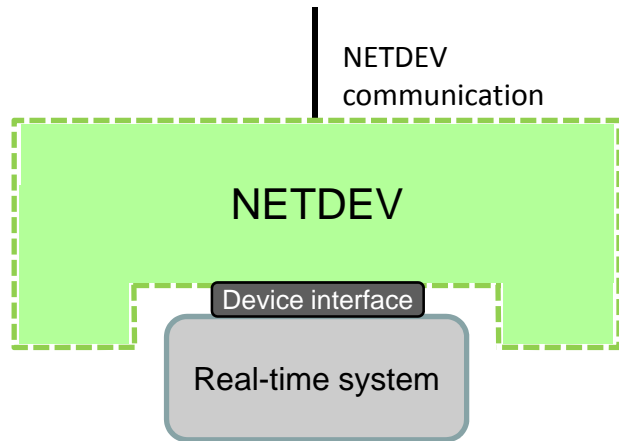
ECS results in trade shows



I-RAMP3

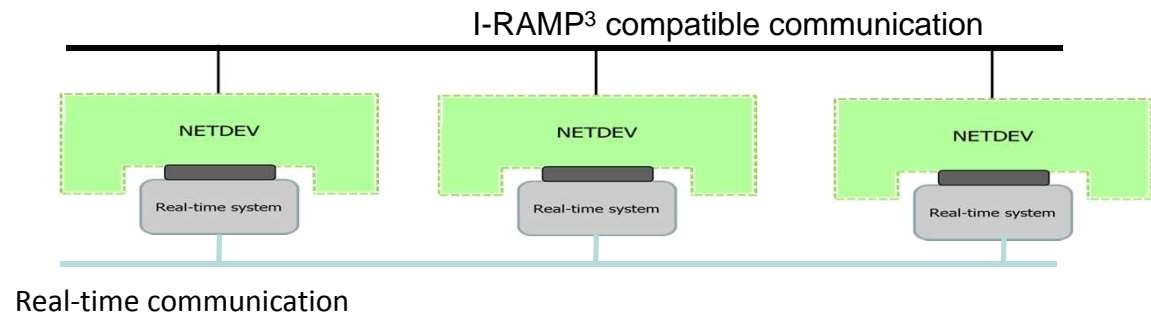


Network-enabled Devices -- NETDEVs

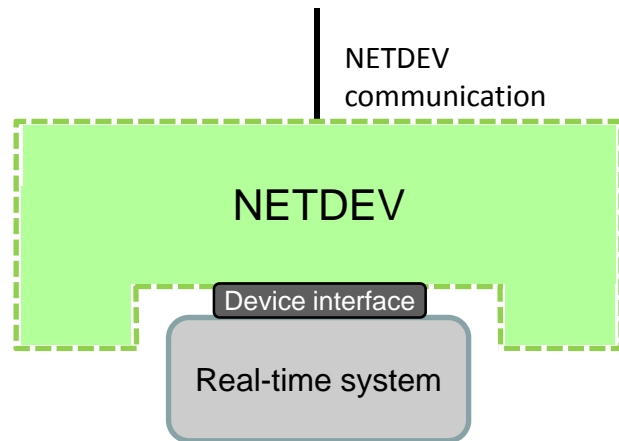


Intelligent extension of traditional devices, featured with

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



Network-enabled Devices -- NETDEVs

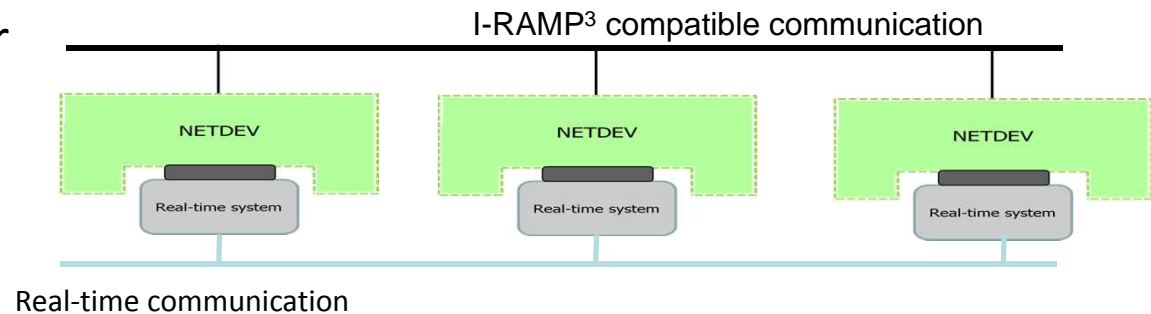


Intelligent extension of traditional devices, featured with

- 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,
- ...

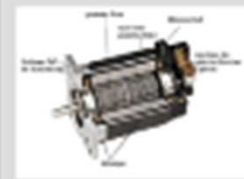
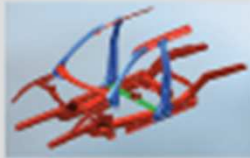


Factories of the Future: Demonstration

I-RAMP3



Cyber physical solutions exemplified on an e-vehicle assembly line



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

The image shows a computer monitor displaying a MES (Manufacturing Execution System) interface. The screen shows a 3D model of an assembly line with various components and tools. A small box labeled "MES" is connected to the main interface.

Component exchange in E-Vehicle subassembly unit

The image shows a workstation with a computer monitor and keyboard on a desk. The desk has red and yellow legs. This represents the interface for component exchange in an e-vehicle subassembly unit.

Enhancing devices with re-use and predictive maintenance capabilities

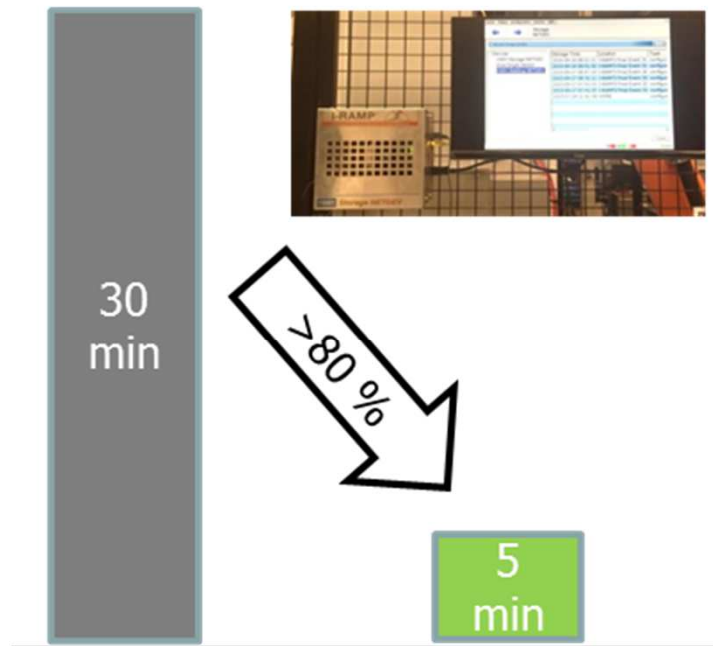
The image shows a complex industrial machine, possibly a robotic assembly station, with various components and a control panel. This represents the enhancement of devices with re-use and predictive maintenance capabilities.

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

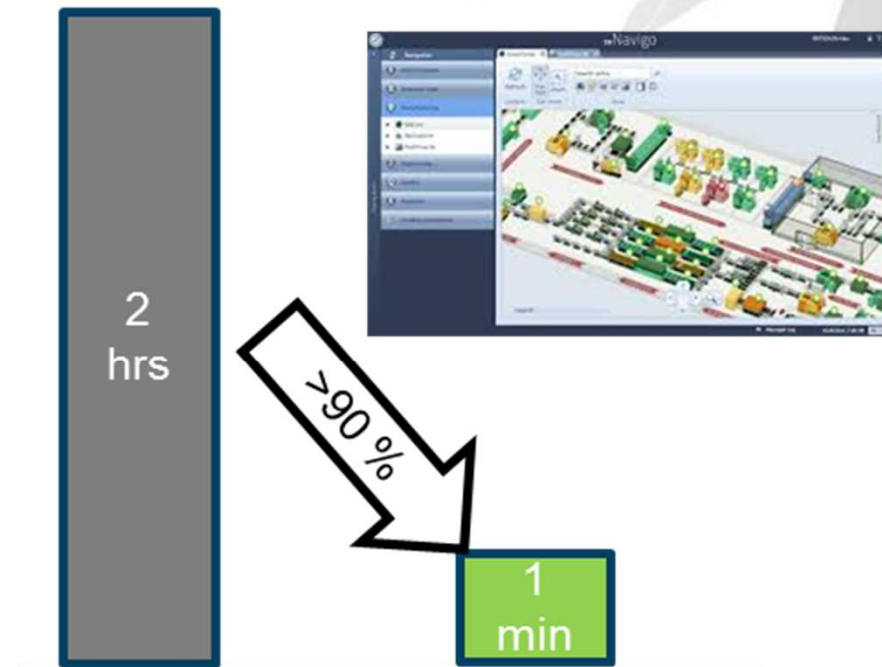


Impacts -- Examples

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



Femtosecond Laser Printer for Glass Microsystems with Nanoscale Features

femtoprint

FEMTOprint

3D printing
for glass microdevices



INTERNATIONAL
YEAR OF LIGHT
2015



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3D glass micro devices.

FEMTOPRINT® is an innovative way of producing your micro devices out of glass or other transparent substrates, integrating optical, fluidic and mechanical features down to the nano-scale in a single substrate.

[READ MORE >](#)



Photopolymer based customized additive manufacturing technologies

PhoCam

LITHOZ
Additive manufacturing for high-performance ceramics.

Company References Technology Applications Products News/Press Contact

Welcome to Lithoz

Lithoz is the system provider for Additive Manufacturing of high-performance ceramics. We offer the possibility for a cost-effective production of prototypes, small scale series and complex parts. In addition we develop materials specifically for our clients' individual needs and wishes.

Lithoz - Manufacture the future.



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.

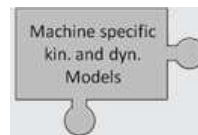
As a result of this work, the project team is pleased to report that production of graphene and few-layer graphene has been scaled from 50g at the end of the first year to 2.5kg currently. Production of expanded graphite and nano-graphite has also been optimised and up-scaled. A densification process 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.



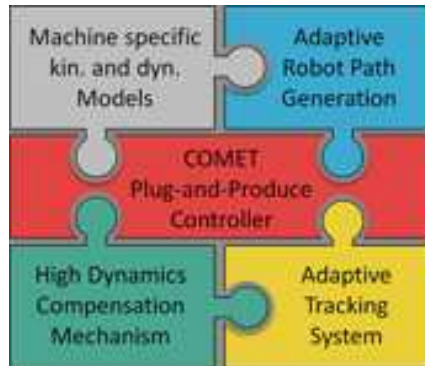
An integrated Programming and Simulation environment for **Adaptive Robot Path Generation** for machining with Industrial Robots (PSIR) based upon the unique signatures.



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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Machine specific kin. and dyn. Models

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.

COGNIBOTICS
High-performing and cost-effective determination of robot properties

JOINT PROPERTIES

A method by simply allowing the robot to grab fixed points in the cell and perform a stress test using the robot's own motors. Allows to monitor and compensate for robot wear to improve and maintain robot accuracy.

About
Cognibotics specializes in methods and services for high-performing and cost-effective determination of robot properties such as backlash, friction, and non-linear compliances.
By knowing joint and link properties, robots can:
• move with higher accuracy
• better compensate for deflections due to process forces
• be more predictable by simulating the effect of the determined properties

Cognibotics
Cognibotics offers low-cost solutions for determining joint properties, thereby enabling robots to work in application areas where existing calibration techniques and current robot solutions are not tractable.
Acknowledgement
The COMET FP7 project and EC FP7 programme for providing the research opportunity that resulted in the foundation of this company, LUIS for helping in forming a business out of research results.
The Drexlerlab members and





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

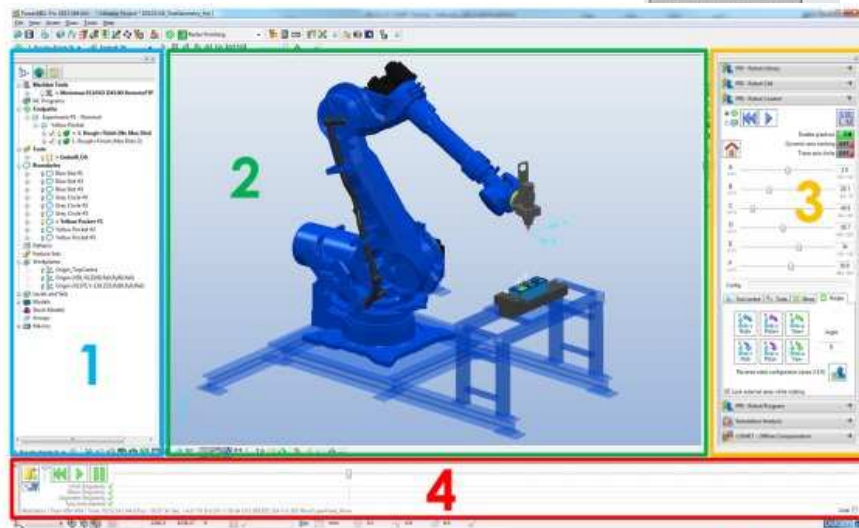


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A High Dynamics Compensation Mechanism (HDCM) to accomplish an absolute accuracy of more than 50um; significantly 'beyond' the structural capability of the robot system on its own.

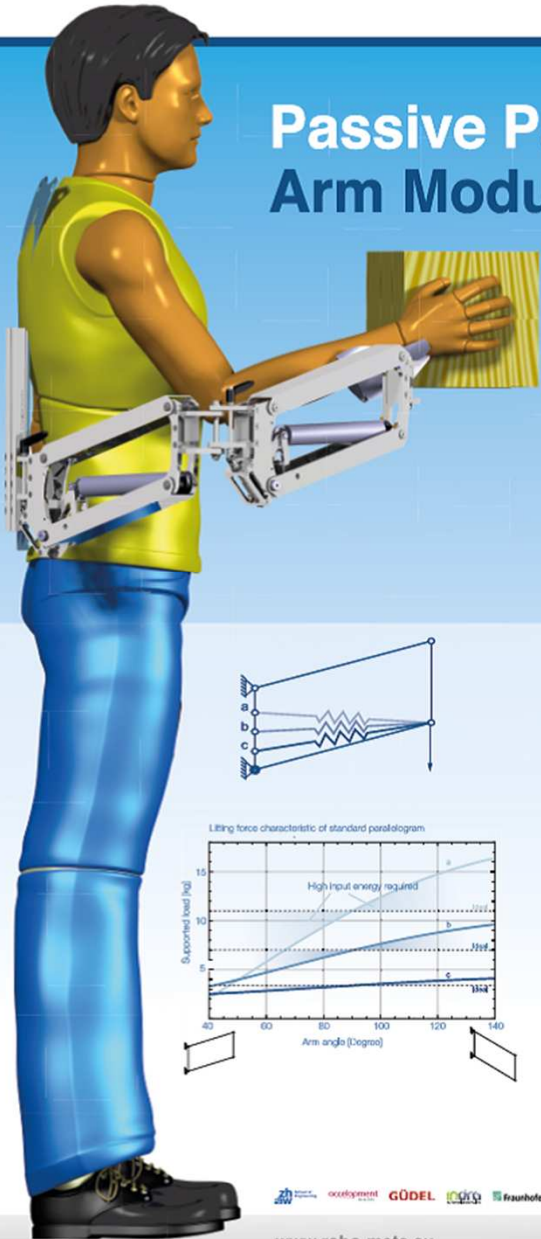


- 1 Toolpath Creation (PowerMILL)
- 2 Graphical area (Common to toolpath and simulation)
- 3 Robot Interface (Robot control, Graph, COMET compensation...)
- 4 Robot Interface (Simulation replay, Analysis)

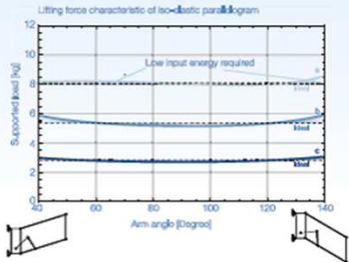
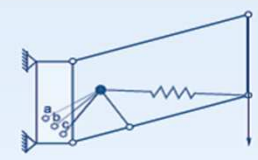
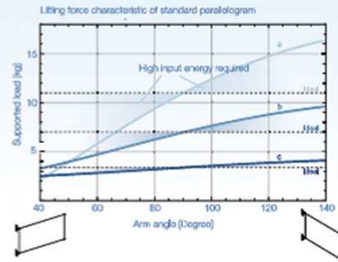
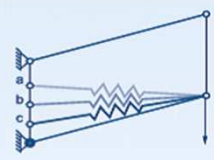


Robo.Mate

Passive Parallelogram Arm Module



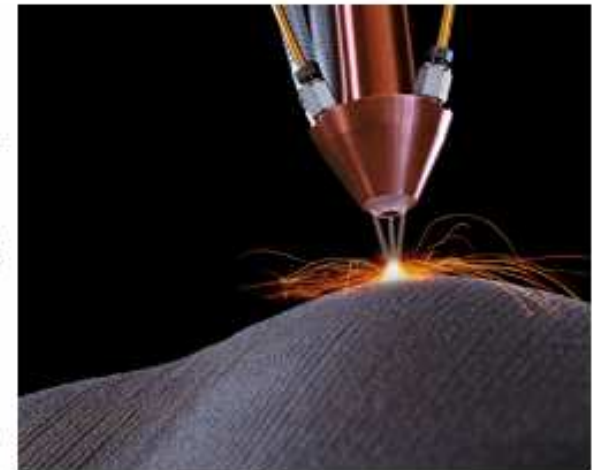
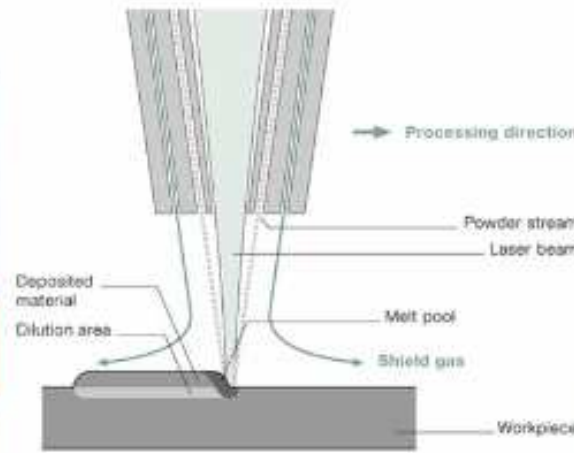
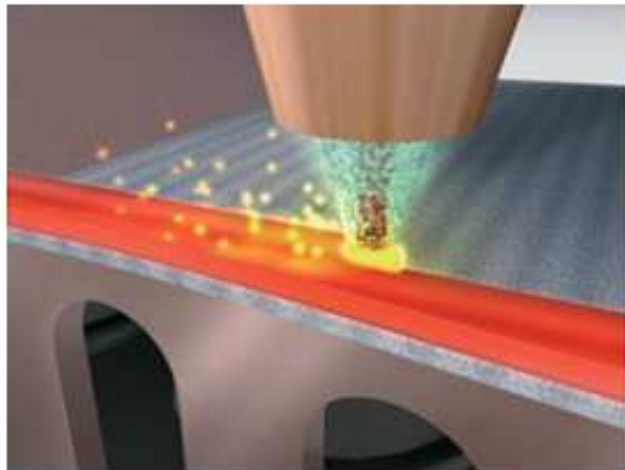
- Improved iso-elastic behaviour
- Fully passive
 - + No motors
 - + No sensors
 - + No power supply
 - Usage limited



www.roboto-mate.eu



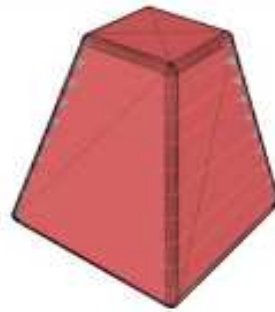
AMCOR project: develop and demonstrate a flexible and automated manufacturing process for the repair, coating and near net shape production of components composed of functionally graded materials (FGMs).



CAD File



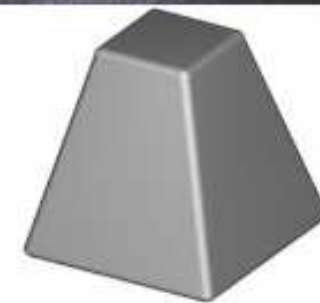
Numerical Slicing



Layer Processing

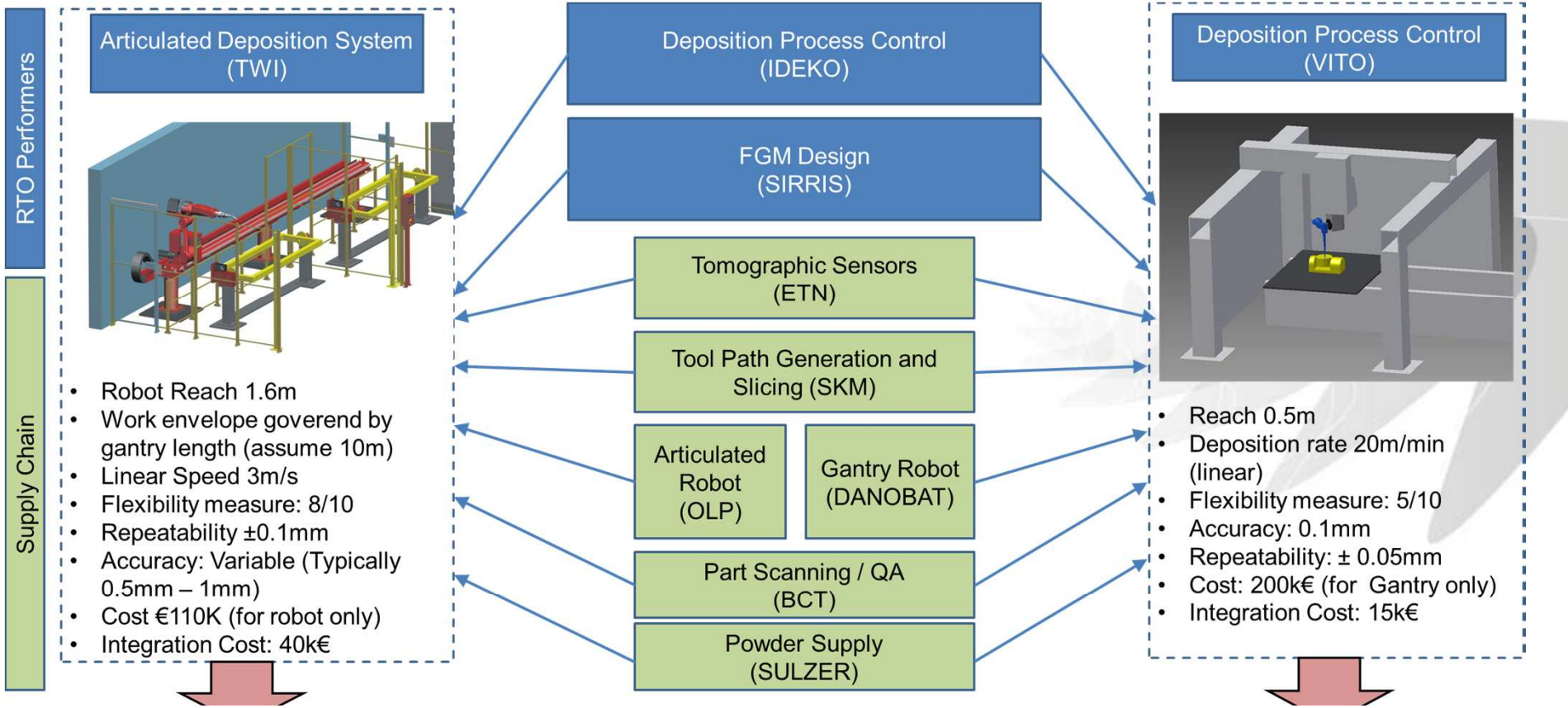


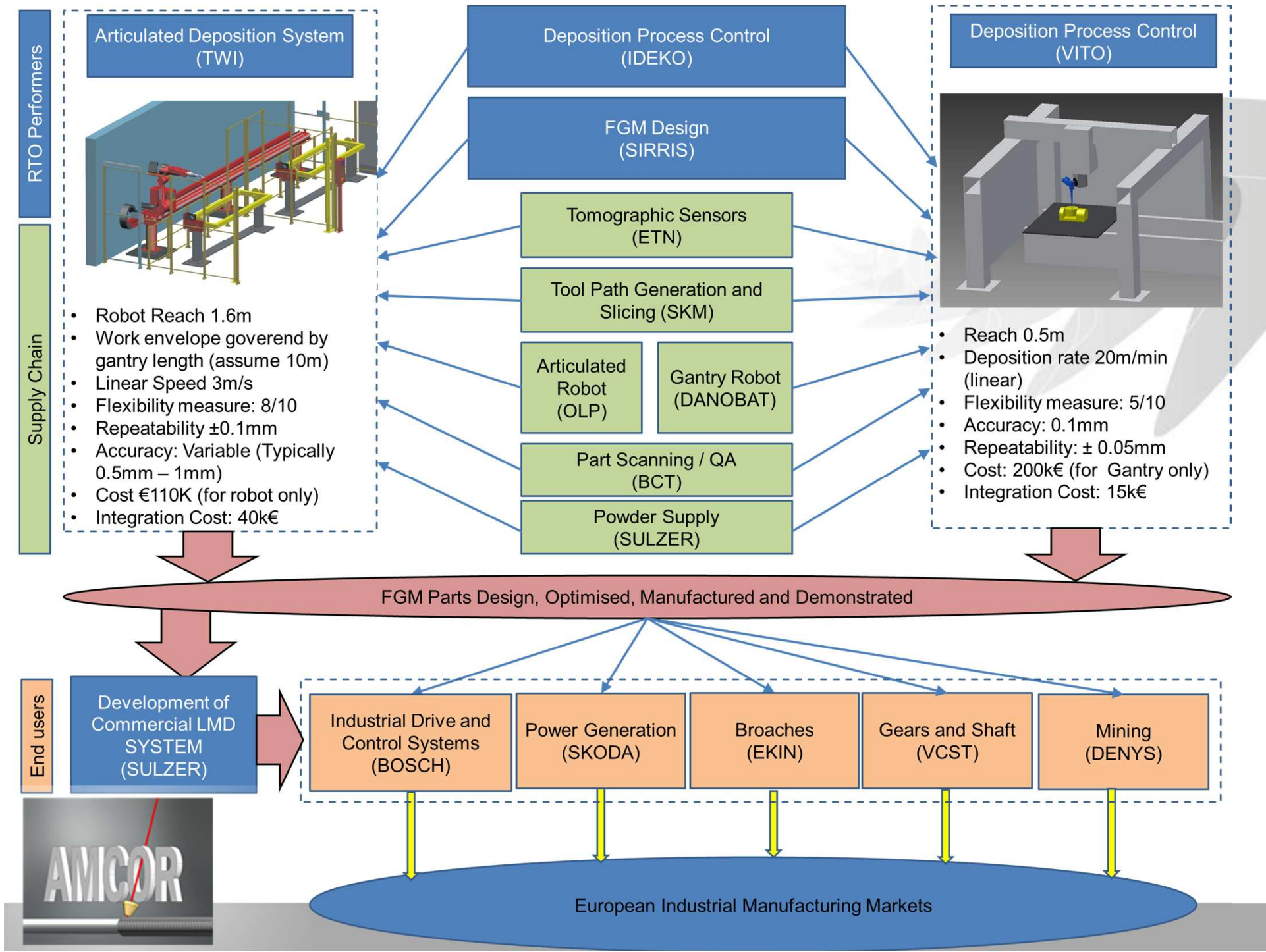
Layer by layer
Manufacture



Final Component







Factories of the Future



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

PREVIEW aims to provide the injection moulding industry with a process control system which will result in a reduction in mould set up time, a reduction in scrap and energy consumption and an increase in productivity and flexibility by developing the following technologies:



Data
Acquisition
System



Advanced
Predictive
System



Wireless
Capability

PREVIEW

Mould/Machine Data Acquisition system
CPS



Wireless Com



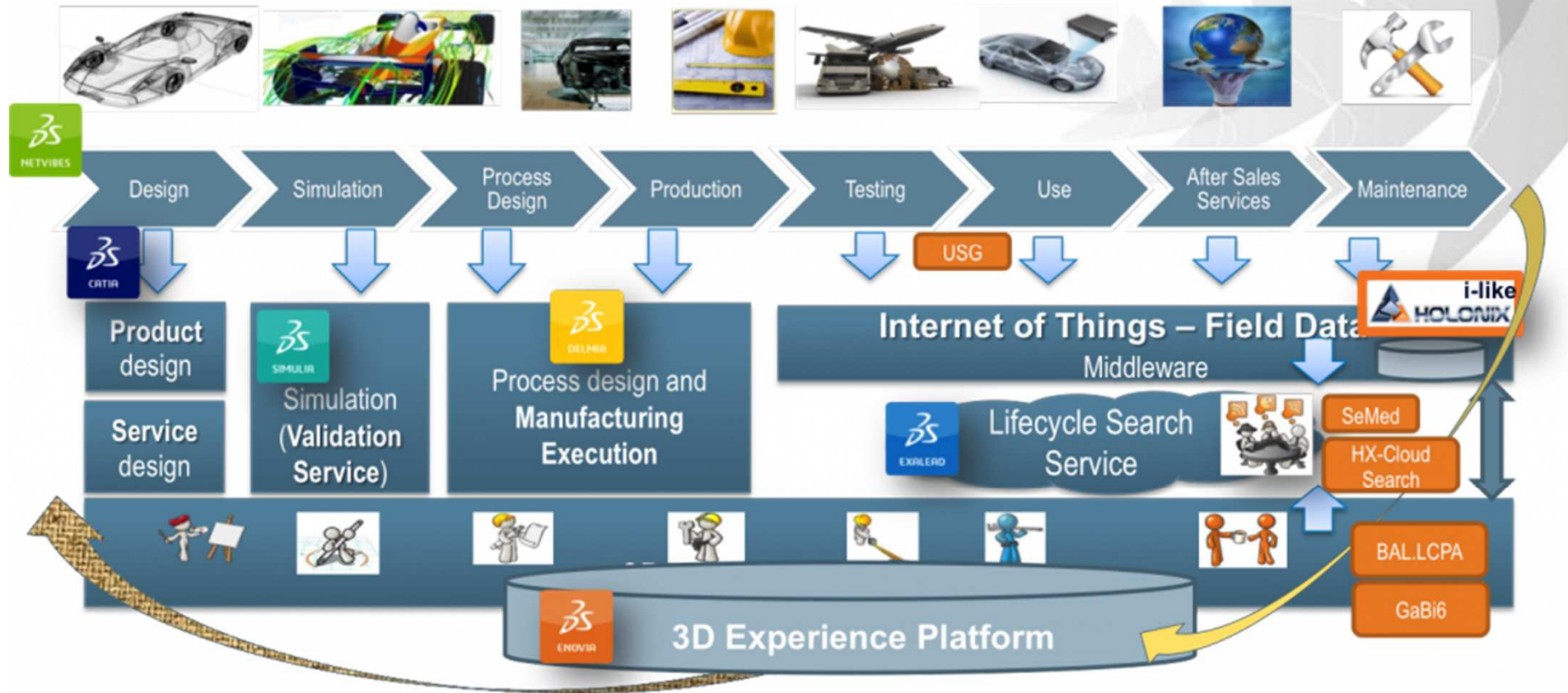
Advanced Predictive System



Location-based content delivery















Factories of the Future Project: MANUTELLIGENCE



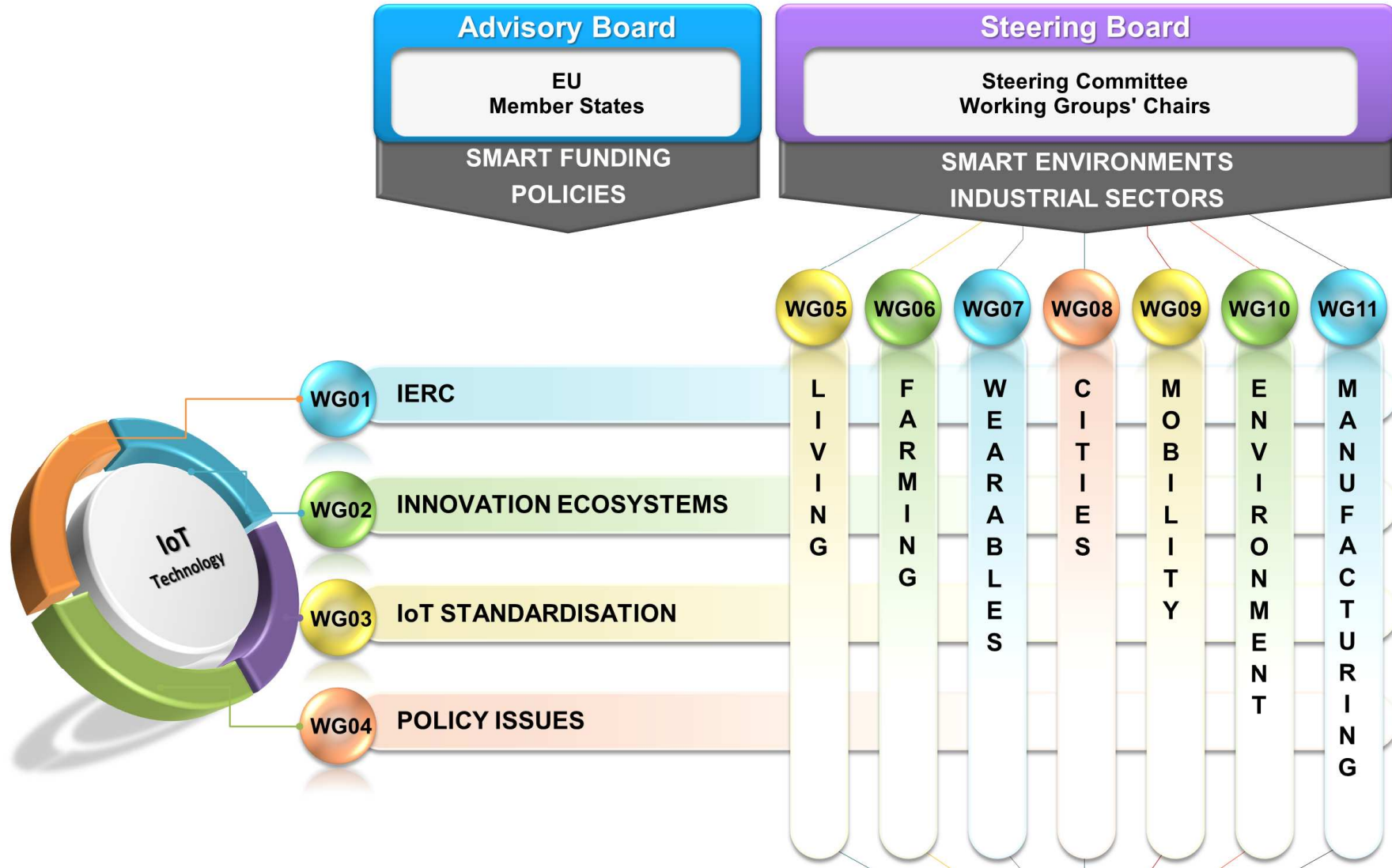
Factories of the Future: Digitisation

ICT Innovation for Manufacturing SMEs

A 'Factories of the Future' Initiative

 Horse Robotics	 ReconCell Robotics	 Fortissimo II HPC	 BEInCPPS CPS
 Appolo Laser	 CloudFlow HPC	 CloudSME HPC	 EuRoC Robotics
 Fortissimo HPC	 INTEFIX Sensors	 LASHARE Laser	 EFFRA EUROPEAN FACTORIES OF THE FUTURE RESEARCH ASSOCIATION a MANUFUTURE 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.

"As part of its growth strategy, Europe must boost digital, data-driven innovation across all sectors of the economy."
European Council conclusions 24/25 October 2013

european-council.europa.eu

© European Union, 2013



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



RESEARCH ASSOCIATION
a MANUFACTURE 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.

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).

Factories of the Future: Key Tool EFFRA Innovation Portal

The image displays three overlapping screenshots of the EFFRA Innovation Portal. The top screenshot shows the 'Cloudflow' logo and a 3D visualization of a green cylindrical component with internal structures. The middle screenshot features the 'COMET' logo and a 3D model of a robotic arm. The bottom screenshot shows a search and filter interface with the following elements:

- Sort by: acronym
- Sort order: Descending
- Instrument: [dropdown menu]
- Programme: FoF - Factories of the Future
- Monitoring: clustering, standardisation, international, spin-offs, patents

At the bottom, a table header is visible with columns for 'Project end date', 'website', and 'Duration'. A row of data is partially visible below the header.

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

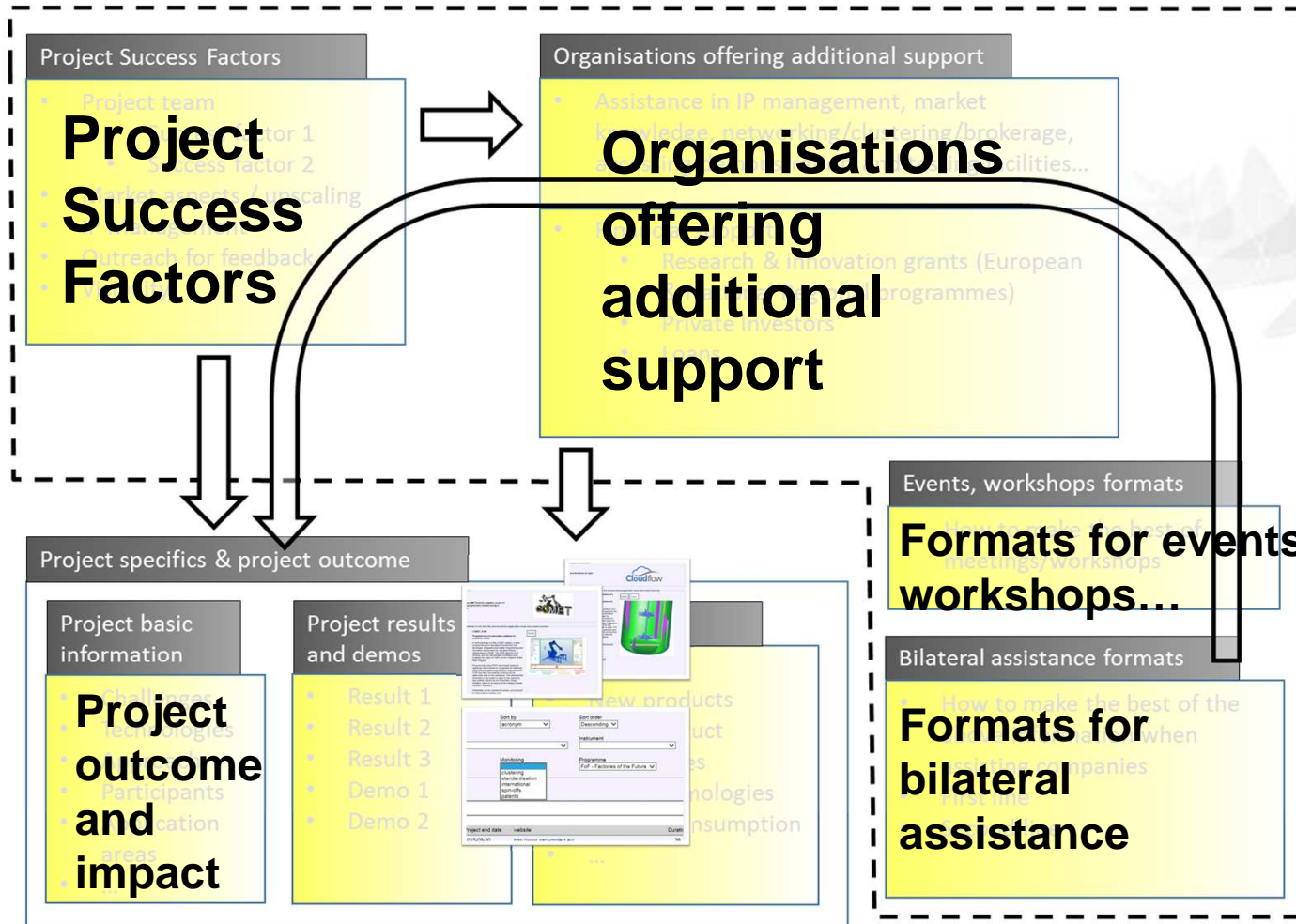


Factories of the Future

Inspiring for and inspired by national and regional programmes



Key activity: stimulating exploitation of project results



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



Key activity: stimulating exploitation of project results

Project Success Factors

- Project team
- Success factor 1
- Success factor 2
- Project aspects / upscaling
- Success
- F



Organisations offering additional support

- Assistance in IP
- Q

17 February, Brussels
Turning success factors into
Factories of the Future
A technology transfer experts
workshop
Check out www.effra.eu/impact

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Thank You

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Public Private Partnership