Factories of the Future PPP
Strategic Multi-annual Roadmap

ICT Enabled Intelligent Manufacturing
High Performance manufacturing

Sharing and integrations of the roadmap of “Factories of the Future” between Innovation Clusters and EFFRA

Fulvio Rusinà
COMAU Advanced Engineering Director

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New development paradigm from **Cost-cutting** to…

**High Adding Value (HAV) and Knowledge based Industry,** in order to achieve a **Competitive Sustainable Manufacturing (CSM)**

CSM requires the transformation of the European Manufacturing Industry into a High Adding Value (HAV) and Knowledge-based Industry, aiming at global leadership, through HAV Knowledge-based products / services, processes and business models.
Factory of the Future

General Requirements of the Research

In today’s economic situation any research in technology in Europe would need to comply with two requirements:

- the results of the research should start to pay back tax payers’ money after 4 years
- should make a significant contribution to the sustainability of society in Europe

Main Industrial Drivers and R&D Challenges

- Cost efficiency
- Low Time to Market
- Processing technologies and materials
- Convertibility/re-configurability
- Product quality
- Higher Productivity under better safety and ergonomics conditions
- Energy efficient machinery
4 Sub-Domains identified for the Future Strategic Multi-Annual Roadmap (2010-2013)

SD1 Sustainable Manufacturing

SD2 ICT enabled intelligent manufacturing

SD3 High performance manufacturing

SD4 Exploiting new materials through manufacturing

Next generation of high added value production technologies will be applied within 2 years after conclusion.

Factory of the Future
ICT Contribution

The ICT contribution to the Factories of the Future aims at improving the efficiency, adaptability and sustainability of manufacturing systems as well as their better integration within business processes in an increasingly globalised industrial context.

ICT technological solutions related to

- High-speed to market
- Manufacturing systems complexity reduction
- Fast re-configuration and wide re-toling capacity of production systems
- Ease-to-use systems
- Advanced shop-floor management
- Production network and Integrated Enterprise Management
ICT Topics

- **SMART Factories**, ICT for agile manufacturing and customisation including process automation control, simulation and optimisation technologies, robotics, and tools for sustainable manufacturing.

- **VIRTUAL Factories**, to support value creation from global networked operations including global supply chain management, product-service linkage and management of distributed manufacturing assets.

- **DIGITAL Factories**, ICT for better understanding and design of manufacturing systems and for better product life cycle management including simulation, modelling and knowledge management from product conception level down to manufacturing, operations, maintenance and disassembly/recycling.
Road Map ICT for Manufacturing

from Data-driven Factories…

Grid Manufacturing
Advancement of Grid Computing for Manufacturing purposes

Multimodal Interfaces
Human-machine interaction

Control Systems
Cognitive control modelling languages and architectures

Pervasive and Ubiquitous Computing
Adaptive, evolvable, ubiquitous manufacturing systems

Software Engineering
Modelling, simulation, prediction of large, distributed multi-scale socio-technical systems

Configuration Systems
Manufacturing specific architectures for embedded platforms

Computing Systems
Embedded Systems
Intelligent industrial process control manufacturing shop floor and logistics and distribution

Human-machine interaction

to Real-time, Knowledge-based and Networked Manufacturing

European ICT Environment for the Next-generation Manufacturing
Context

Future production sites with a large variety of sophisticated production equipments will offer high flexibility, low manufacturing cost, low ramp-up and high efficiency. Lean and intelligent strategies will be applied to guarantee such targets.

Industrial driven R&D activities

- Advanced process automation and control technologies
- Novel robotics-based manufacturing and intelligent automation
- Plug-and-produce connection, thus providing scalable factory solutions.
- Novel control applications for high yield performance and energy efficiency
- New tools and methods for real-time handling of manufacturing information
- Laser applications
- Standardized assessment of manufacturing equipment
- Intelligent production machines supporting scalable advanced automation
Expected Impacts

- Higher level of intelligence on the shop floor
- Opening up of new market areas for next-generation automation equipment and advanced industrial robots
- Development of an early European market for advanced technologies
- The penetration of advanced automation into small-scale manufacturing and crafts
- Increased productivity in labour intensive industries through a scalable automation approach
Mechatronics Applications
SD2
ICT Enabled Intelligent Manufacturing

Context

ICT if integrated end-to-end can provide clear insight and exact knowledge from data thereby supporting decision making and creating value from global networked operations.

VIRTUAL Factories

Industrial driven R&D activities

- Increasing management efficiency of global networked manufacturing
- ICT for sustaining the value of products
- Integrated product/service systems
- Managing volatile manufacturing assets
VIRTUAL Factories

Expected Impacts

- Enabling advanced product-centric services through leveraging the improved efficiency of (embedded) product intelligence
- New business models and capabilities for improved management of global networked manufacturing and logistics
- Improved sustainability of product value for customers by offering solutions instead of single products and new product support services
Extended Enterprise

Increasing management efficiency of global networked manufacturing

New paradigm of extended enterprise
Context

Address the front-end stages of manufacturing: in particular early concept modeling, simulation and evaluation, thus ensuring greater acquisition of knowledge earlier so that better informed manufacturing decisions can be taken.

**Industrial driven R&D activities**

- Knowledge and analysis
- Enhanced, interoperable model
- Design environments
- Lifecycle management

**Expected Impacts**

Maintaining Europe's leadership in providing knowledge-driven platforms, tools, methodologies and lifecycle orientation to product development and manufacturing.
Integrated Design and Simulation Environment

Yesterday

- Mechanical design
- Pneumatic design
- Electrical design
- Software design
- Machine assembly
- Testing

Today-Tomorrow

- Mechanical design
- Pneumatic design
- Electrical design
- Software design
- Machine assembly
- Testing
EU-PPP “Factory of the Future” and Innovation Clusters

September 30th, 2009

RI-MACS is the acronym for Radically Innovative Mechatronics and Advanced Control Systems. The main objectives of the RI-MACS R&D program are the definition of a radically innovative manufacturing control open architecture based on state-of-the-art ICT technologies (in particular wireless technology) and modular mechatronics.

- Make open approaches more robust and demonstrate their applicability in the industrial automation (mechatronics control technology with embedded intelligence);
- Exploit wireless technology in networking and in novel architectures;
- Develop data flows to support the design and operation of the manufacturing plant of the future with particular attention to the simulation of the mechatronic objects interaction and automatic code generation for control;
- Develop industrial strength test beds.
HPM contribution

The research activities under this area aim at enhancing European leadership in product engineering and manufacturing systems development.

<table>
<thead>
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<th>Key factors</th>
<th>Constraints</th>
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<tbody>
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<td>Cost efficiency</td>
<td>Increasing product variants</td>
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<tr>
<td>Performance of manufacturing</td>
<td>Highly variable production</td>
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<tr>
<td>Robustness of manufacturing</td>
<td>Discrete and continuous production</td>
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HPM technical solutions

- To be based on light and adaptive systems, with an increased role of human workers, with more human/machine interactions
- To plan progressive production investments
- To integrate new IC technologies, that means simplification and real user friendliness

Expected Impacts

- Reduction of rejected components and amount of material used
- Reduction of cost and weight of manufactured assemblies
- Increase throughput, tool life and operational speeds with high repeatability and accuracy
- Reduction of waste, power consumption and number of finishing operations
- Minimize or eliminate the use of coolants, reducing environmental pollution around factories
- Extend maintenance intervals
Main 5 topics have been selected for short term

- Flexible machines and systems for rapid (re)configuration
- High precision manufacturing by plug and play, components based on adaptive smart material
- Planning tools for open reconfigurable and adaptive manufacturing systems
- In-situ process simulation
- Adaptiveness of production systems for optimal energy consumption

Further 3 topics for long term

- New high performance manufacturing technologies
- Zero defect manufacturing
- Sustainable production technologies and systems
Main Objective

New, self-adaptive machine structures with online self-optimisation, based on mechatronic modules

Expected Results

- Tools and methods for mechatronic manufacturing systems and components modelling, set-up and use
- Demonstrating applications for mechatronic modules and their usage in machines and production systems
- Demonstrating application of friendly human machine production cooperation

Context

Mechatronic components are widely used in end-products, e.g. automotive, aerospace industries. With their relevant performances and reliability they will become promising objects for the construction of flexible production environment.
Sub Assembly Machine (SAM) Cell

- High Density Welding Systems Processes
- Assembly system for all industries
- Flexibility (new model, architecture, volume)
- Reuse (100% S-A-M)
- Floor space reduction
- Zero Loss Launch (one day)
- Program timing improvement
- Retained Value
- R&M
- Training
Main Objective
Creation of active plug-and-play components, based on intelligent materials or combinations of passive and active materials (engineered materials) to increase the adaptiveness of production systems.

Expected Results
Simplification and user friendliness of the systems with distributed and decentralized controls.

Context
The intelligent plug and play systems can feature sensing and actuator structures, adaptive control and energy harvesting to allow a high accuracy, self-adaptive and self-optimizing of production systems under different conditions.
Traditional Serial Assembly System

Smart Cell Parallel Assembly System

To Scale

Value to Customer:

- Investment 20% below traditional systems cost
  - Reduction in:
    - Engineering
    - Manufacturing
    - Installation & Launch
- 40% Reduction in floor space
- Downtime impact reduced
- Retool investment for future products reduced
- Investment Scalability
Context

Process planning and process engineering and integration are parts of the chain from design to manufacturing. Taking into account new solutions for configurable manufacturing systems, it is necessary to develop new and knowledge based tools for the support of planning.

Main Objective

Development of new and knowledge based tools for the support of planning, by implementing a platform for process planning, which is integrated in the information and execution system of factories.

Expected Results

Acceleration of planning processes for fast and reliable manufacturing engineering in all manufacturing sectors.
Context

Simulation is usually an analytic instrument used for planning and optimizing systems under the constraints of usage. Future capabilities of real-time control will allow the integration of simulation in the systems to compensate deviations or to control manufacturing processes by learning for the future.

Main Objective

Integration of simulation in Manufacturing Execution Systems (MES) as well as in machine and process control to analyze the behavior in relation to situations. These systems must be smooth (smart and fault tolerant) with human workers.

Expected results

These simulations should enable the assessment of the business model together with the ROI of production investment plan scenarios.
**Context**

A higher performance (speed, acceleration) is usually limited by a higher installed electrical power. But energy cost share in product prices increased significantly in the last years and energy prices still increase on the market.

**Main Objective**

The main objective is the flexible adaptation of electric-fluidic energy resources for high performance drives both to production system and to process needs to overcome traditional efficiency limitations of local energy sources.

**Expected results**

New generations of adaptive production systems with increased drive or process performance of adaptive production systems by 20% and decreased local power consumption by 25% represent one of the valuable outcome in this area. Reducing waste of European energy resources in local industrial energy generation and motion consumption of production systems can be achieved as well.