



*Assuring the future of a competitive  
and sustainable manufacturing in Europe*

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## **European research and innovation in manufacturing beyond 2013**

### **1. The importance of manufacturing for Europe**

***Manufacturing demonstrates a huge potential to generate wealth and jobs.*** In 2006, the total number of manufacturing enterprises in the EU-27 non-financial business economy was estimated as 2.3 million, representing a little over one in every ten (11.5 %) enterprises within the EU-27 non-financial business economy. Manufacturing enterprises provided employment for 34.4 million persons. This was equivalent to 27 % of the employment in the EU-27 non-financial business economy. The EU-27 manufacturing sector generated EUR 6 816 billion of turnover in 2006, of which EUR 1 712 billion was value added. This was equivalent to 30 % of the value added in the EU-27 non-financial business economy. On average, EUR 49 700 of value added in manufacturing was generated by each person employed. Total investment by the EU-27 manufacturing sector was valued at EUR 238 billion in 2006, equivalent to almost 14 % of the manufacturing sector's value added.

[Eurostat Yearbook 2010], [Eurostat, Statistics in Focus, Industry, trade and services, 62/2009]

***The European manufacturing is a dominant element of the international trade.*** The 27 Member States of the EU exported manufactured goods to the value of EUR 3 512 billion in 2007 (NACE Sections C to I and K). Extra-EU trade in manufactured goods resulted in a trade surplus of EUR 107 billion in 2007.

Indicatively, the European Machine Tools industry is leader on the global market. The global market for the production of machine tools amounted to 55 billion € in 2008, 44% of which was produced in Europe. European Machine Tool builders exported 71% of their production in 2008, amounting to 55% of total global exports (17.6 billion €).

[Eurostat, Statistics in Focus, Industry, trade and services, 62/2009], [CECIMO Statistics 2008].

***Manufacturing is a substantial activity with respect to its environmental impact.*** Manufacturing addresses today a constantly increasing demand for consumer goods, since living standards are on the rise. As a consequence of this trend, the consumption of raw materials and energy from the manufacturing industry keeps increasing. In 2005, the energy consumption of manufacturing industry was 297 Mtoe (million tonnes oil equivalent), which accounted for 27.9% of the total energy consumption in Europe [European Commission, 2020 vision: Saving our energy, 2007] [European Environment Agency, Energy & Environment Report 2008]. Moreover, manufacturing is one of the primary sources of hazardous emissions and waste generation. Manufacturing industry emitted the equivalent of 910 million tonnes of carbon dioxide (CO<sub>2</sub>) in 2000 [Eurostat, Statistics in Focus, Environment and Energy, 16/2006], while 32.7% of the overall waste generated in Europe comes from the manufacturing industry [Eurostat, "Waste generated & treated in Europe", Edition 2005].

***Manufacturing activity is important for SMEs.*** SMEs are in fact, the backbone of the manufacturing industry in Europe. Micro, small and medium enterprises provide around 45% of the value added by manufacturing, while they provide around 59% of the manufacturing employment [Eurostat, Statistics in Focus, Industry, trade and services, 62/2009].

***Manufacturing is critical for emerging markets.*** New markets, driven by advances in science & innovation, will revolutionise Europe's capability to span manufacturing across traditional and new industries. Building on an excellence in Europe's scientific capability and burgeoning industry base, such markets as industrial and medical biotechnology, plastics electronics and regenerative medicine, are areas where Europe can become dominant in high value manufacturing through new processes and business models. These new markets offer significant environmental and social benefits, with industrial biotechnology providing alternative production processes to oil and gas based chemicals and regenerative medicine delivering improving healthcare and possibly cures for degenerative diseases. Forecast global markets are £150-360bn by 2025 for industrial biotechnology [Maximising UK Opportunities from Industrial Biotechnology in a Low Carbon Economy, IBIGT 2009] and \$ US 20bn by 2025 for Regenerative Medicine [Scientia Advisors report 2010], with great opportunity for Europe to lead because of its regulatory framework.

***Manufacturing is critical for research, education & innovation.*** Manufacturing accounts for 82% of the total business enterprise sector (BES) R&D expenditure. In 2004, manufacturing accounted for 101,132 EUR million. Indicatively, in 2006, DaimlerChrysler and Siemens total R&D investment was 5,234 and 5,024 EUR million respectively. Also in terms of number of researchers, manufacturing is by far the most important sector of economic activity in 2004 in the EU-27. In 2004, it made up 70.0% of the entire BES. Manufacturing accounted for 426,748 business enterprise researchers, while overall R&D personnel in manufacturing enterprises totalled more than 800,000 (in Full-Time Equivalent). In 2005, 2,357,666 students were participating in tertiary education in engineering, manufacturing and construction (EU-27). That accounted for a 3.7 % of population aged 20-29. At the same year, there were also 73,001 doctoral students in these scientific fields. Manufacturing pursues innovation, as well. A high level of industrialization results in a high number of patent applications. In 2004, Germany, France and UK accounted for two thirds of all patent applications to the European Patent Office from the EU-27. At the same year, 41.5% of all European enterprises in industry were engaged in innovation activity. 37.4% of those engaged in innovation activity introduced new or improved products to the market.

[Eurostat, Science, technology and innovation in Europe, 2008 & 2009 Editions]

## **2. Strategic synergies of the public-private sectors – A success story**

The European Technology Platform on Future Manufacturing Technologies (MANUFUTURE ETP) was launched in 2004. Its mission is to define and implement research and innovation strategies, capable of speeding up the rate of industrial transformation in Europe, securing high added value employment and winning a major share of world manufacturing output in the future knowledge driven economy. MANUFUTURE is industry-driven. Over 100 organizations, from more than 20 countries, are directly engaged in the ETP, including large OEMs, SMEs, Industrial Associations, Research Institutes, Universities, and National Authorities. Under the ETP's umbrella, 26 MANUFUTURE National & Regional Technology Platforms are active today with more than 1.800 member organizations around Europe. The European Factories of the Future Research Association (EFFRA) was launched by MANUFUTURE ETP in 2009. EFFRA's key objective is to promote pre-competitive research on production technologies within the European Research Area by engaging in the *Factories of the Future* (FoF) Public Private Partnership (PPP) with the European Union. Both MANUFUTURE and EFFRA are horizontal initiatives and have been open from the very beginning to other European Technology Platforms with stakes in manufacturing in a very broad sense.

The MANUFUTURE / EFFRA communities have a successful track record of fruitful co-operation and synergies with the European Commission (EC). The FoF PPP is a characteristic example.

Public Private Partnerships in research are a powerful instrument for addressing major issues that impact on Europe's competitiveness and the ability to respond effectively to major socio-economic challenges. Their importance for the long-term, sustainable development of the EU has been widely recognised [European Commission, 2009. Mobilising private and public investment for recovery and long-term structural change: developing Public Private Partnerships, COM(2009) 615].

The *Factories of the Future* is one of the three PPPs included in the European Economic Recovery Plan. Its objective is to help EU manufacturing enterprises, in particular SMEs, to adapt to global competitive pressures by improving the technological base of EU manufacturing across a broad range of sectors. The European Commission and the MANUFUTURE / EFFRA communities have engaged in this partnership for jointly developing and implementing a research programme of 1.2 billion euro to support the manufacturing industry in the development of new and sustainable technologies.

Following a European-wide, open and transparent stakeholder consultation process, the co-ordinated strategy between the public and private partners has been developed into the “FoF Strategic Multi-Annual Roadmap 2010-2013”. MANUFUTURE ETP, EFFRA, 7 MANUFUTURE sub-platforms, the network of 26 MANUFUTURE National and Regional Technology Platforms, and 11 other manufacturing related ETPs have been involved in the process, which lasted 16 months. Following a call for proposals, the initiative has embarked with the launch of 25 research projects. The FoF PPP achieved a proposals success rate of 26% (7-11% in the NMP 2009 call, depending on the instrument) and an average “time to grant” of 8.5 months (in average 12 months in FP7). The launched projects have brought together 216 stakeholder organizations, which are working across borders on the basis of a total R&D investment of 141 million euro. Industry receives around 54 % of the funding allocated to the selected projects (in average 29% in FP7 2009 Calls), with SMEs representing 32% of the funds (11,7% in the FP7 Cooperation Programme). [EFFRA, Developing Technologies for FoF, Projects Overview Report, November 2010], [European Commission, New public-private partnerships for research in the manufacturing, construction and automotive sectors, Progress Report: July 2010], [Interim Evaluation of the Seventh Framework Programme, Report of the Expert Group, November 2010], [European Commission, Third FP7 Monitoring Report, July 2010].

The fruitful and efficient collaboration with the EU institutions has been fundamental to the success of this joint initiative so far. Multi-level interactions have taken place between the MANUFUTURE / EFFRA communities and the European Commission, in particular with DG RTD and DG INFSO. Some major milestones have been achieved in the context of this process, such as the meeting with the President of the European Commission Jose Manuel Barroso in July 2008 and the meetings with the Commissioners Janez Potocnik and Viviane Reding in July 2009. Interactions have also taken place at a political level, such as the recent meeting with MEP Prof. Maria da Garca Carvalho in November 2010.

Taking under consideration the PPPs’ developments so far, JTI’s Sherpa Group has recommended that EC should continue and strengthen its cooperation with the legal entities representing the private sector within the research PPPs under the European Economic Recovery Plan. The EU ministers have also recognised the progress of these initiatives and given continued support to them in the Competitiveness Council meeting of May 2010.

### 3. Future vision & way forward

On the basis of the very positive outcomes from the strategic synergies with the EC, **MANUFUTURE community strongly believes that the joint EC-industry cooperation and investment on cross-disciplinary manufacturing research must continue within the FP8 timeframe and that it should be extended to complementary areas, covering the entire innovation cycle.**

To this direction, a wide cross-DG intervention from the EC would be necessary for, not subsidizing but, supporting the broad European manufacturing industry in contributing with its huge potential in the achievement of the EU Grand Societal Challenges and the respective EU 2020 headline targets.

In the preface of “Europe 2020” one can read: “... *That is the purpose of Europe 2020. It's about more jobs and better lives. It shows how Europe has the capability to deliver smart, sustainable and inclusive growth, to find the path to create new jobs and to offer a sense of direction to our societies ...*” [José Manuel Barroso, Preface to “EUROPE 2020, A European strategy for smart, sustainable and inclusive growth, COM(2010) 2020”]. Fully in line with this vision, European manufacturing industry primarily aims at a fundamental impact on “Growth and Jobs”. “Growth and Jobs” is a prerequisite for a societal sustainability addressing the needs of the citizens and the

environment, and as such it is considered a major enabler to the achievement of all EU Grand Societal Challenges.

More specifically, the MANUFUTURE community envisages that the continuation of the joint EC-industry investments on cross-disciplinary manufacturing research would allow the achievement of the following ambitious social-driven targets for European manufacturing by the year 2020:

- ❑ *Employment: 3,500,000 new jobs in manufacturing by 2020*
- ❑ *Value added: EUR 2,800 billion of value added by manufacturing in 2020*
- ❑ *Environmental impact:*
  - *an equivalent of 200 million tones of carbon dioxide (CO<sub>2</sub>) emissions less green house gases by 2020*
  - *100 million tones of oil equivalent less energy consumption by 2020*
  - *100 million tones less waste by 2020*
- ❑ *Research & Development: EUR 180,000 million of business enterprise R&D expenditure in manufacturing in 2020*
- ❑ *Innovation: 70% of all manufacturing enterprises engaged in innovation activity by 2020*
- ❑ *Education: 99% of manufacturing engineering graduates & doctorate holders into manufacturing employment by 2020*

The MANUFUTURE community will pursue the achievement of these targets through seven (7) cross-disciplinary pillars. A co-ordination framework is being set to manage the synergies among these pillars.



The pillars pursuing the social-driven targets of European manufacturing

### 3.1. Innovation pillar: The *New Industry* European Innovation Partnership

In response to the Innovation Union strategic objectives, an Innovation Partnership called *New Industry* is currently under preparation. The EIP *New Industry* (N-I) will be “responding” to the Grand Challenge of Sustainable Consumption and Production. Sustainable Production and Consumption can maximize 'business' potential to transform environmental and societal challenges into economic opportunities, whilst providing a better deal for consumers and an increased employment. This will require

- ❑ a fundamental shift: i.e. from “value for customer” to “sustainable value for citizens”, supporting a smart, sustainable and inclusive growth
- ❑ a re-configuration and re-positioning of the European Innovation Eco-System (EIES), hence a partnership capable to develop innovative and dynamic models.

The EIP N-I will focus on RTD and innovation domains, which impact on sustainability and growth, such as:

- ❑ high-added value products and services addressing societal needs and improving quality of life

- ❑ new models for doing business that enable industry to respond quickly and effectively to changes in markets
- ❑ key enabling and converging technologies contributing to sustainable knowledge-intensive innovation-led competitiveness

On that basis, it will further pursue the fast introduction of high added value products into the market, by identifying and removing the “innovation” bottlenecks.

The Innovation Partnership will bring together and forge an active and sustained commitment of all Europe's major stakeholders, including EU and Member States' authorities and regulators, standardization bodies, procurement professionals, industrial companies and associations, including a major involvement of SMEs from within all industrial sectors, Universities and Research Institutes. The Governance structure – involving main stakeholders - will be business led, lean, efficient and effective, capable to interact bottom-up as well as to deliver monitoring and reporting to the EC, the MS and relevant representatives of the Society.

### **3.2. PPP Pillar: The *Factories of the Future* Public Private Partnership**

PPPs are crucial to face the Grand Challenges. In the context of the Europe 2020 strategy, the Factories of the Future PPP will play a strategic role in the implementation of the EU 2020 flagship initiatives, such as the “Innovation Union”, the “Resource-efficient Europe” and the “Industrial policy for the globalisation era”. The PPP will

- ❑ support the *New Industry* EIP, and further contribute to other EIPs in key areas of the Innovation Union addressing major societal challenges
- ❑ provide conditions for increasing the R&D investment by the private sector to achieve the target of investing 3% of GDP in R&D
- ❑ prepare the ground for future knowledge-based and low carbon EU economy, including contributing to 20/20/20 climate targets

The public and private partners of the Factories of the Future PPP are currently defining the content of the FoF cross-thematic Calls for Proposals for 2012-2013. A detailed definition of focused research topics is jointly carried out, on the basis of the strategic research priorities defined in the PPP’s “Strategic Multi-Annual Roadmap 2010-2013”.

In parallel, the MANUFUTURE / EFFRA community, i.e. the PPP’s private partner, has already started working on the identification of strategic industrial research priorities for 2014- . The process will build upon the knowledge and experience derived from the PPP’s “Strategic Multi-Annual Roadmap 2010-2013”, an open and wide stakeholders consultation process, the results of the FoF cross-thematic Calls for Proposals launched by the EC, as well as the forthcoming interim evaluation of the PPPs by the EC. Preliminary industrial consultations already indicate some new emerging R&D priorities for the Factories of the Future, such as the “new products / new business models for the FoF” and the “integration of FoF technologies”. The aim of the process is to develop a new “Strategic Multi-Annual Roadmap 2014- ”, which will serve as the framework for the PPP’s Work Programme from the year 2014 and onwards. Based on the accumulated experience, the goal is to deliver this roadmap within the next twelve (12) months.

### **3.3. FP8 Pillar: The MANUFUTURE *Strategic Innovation Agenda***

The MANUFUTURE *Strategic Innovation Agenda 2030* is currently under preparation. A major objective of the Agenda is to contribute to the structure and contents definition of the manufacturing / production related thematic priorities within the 8th Framework Programme. A hybrid approach is used in order to ensure the *social and technological relevance* of the agenda’s priorities.

A *top-down approach* aims to identify the “demand” priorities, which reflect the perspective of future markets (market pull). The Grand Societal Challenges of Europe will be the starting point for the identification of major manufacturing R&D priorities, bringing-in opportunities for new markets and products / services in the years to come. A number of recent and forthcoming societal foresight studies will further contribute to this process. The output of this approach will include the future

manufacturing enablers for the smart, sustainable and inclusive growth, the progressive technologies, the products and solutions that will be needed in the future by the European society.

A *bottom-up approach* aims to identify the “supply” priorities, which reflect the perspective of future technologies (technology push). The Strategic Research Agendas of the manufacturing related European Technology Platforms, as well as the EC strategy for Key Enabling Technologies (KETs) in the EU, will be used as the basis for the identification of major technology perspectives. Relevant technological foresight studies will be further used to complement the process through the identification of key technologies evolution milestones. The output of this approach will include a set of new and emerging technologies being relevant for future manufacturing in Europe.

Surveys and round tables involving industrial stakeholders will complement the output of this hybrid approach and confirm the business relevance of the agenda priorities. The process will deliver as final outputs a set of top manufacturing innovation and R&D priorities and respective road maps, being relevant for the definition of FP8 Call topics. The first draft of the Strategic Innovation Agenda is planned for the July 2011.

### **3.4. Education Pillar: The MANUFUTURE initiative on *Manufacturing Education of the Future***

Manufacturing education addresses significant challenges in view of preparing the human capital of the Factories of the Future: new skills for “knowledge workers”, new life-long learning schemes to keep up with the pace of change, transformation of new knowledge into innovative products and processes, integration of education, research and innovation. Thus, investing in the manufacturing education emerges as a strong requirement. In view of these challenges, a MANUFUTURE Work Group has been working on envisioning the Manufacturing Education of the Future and launching relevant pilot actions at European level.

Already at its SRA, MANUFUTURE has identified the Teaching Factory as a promising future conceptual framework for manufacturing education. The objective of the Teaching Factory is to seamlessly integrate research, innovation and education activities within a single initiative, offering engineering activities and hands-on practice under industrial conditions for university students, as well as take-up of research results and industrial learning activities for engineers & blue-collar workers.

In the context of a Teaching Factory, new technology frameworks are required to address future challenges and support the needs of tomorrow's "knowledge workers". Future technology frameworks for education and training should provide engineers & blue-collar workers with ICT-based tools to practice content within digital environments, including activities, such as management of manufacturing knowledge, interactive hands-on training and skills development and web-based team work and collaborative decision making.

The Work Group activities on both the conceptual & technology frameworks are on-going. Possible synergies with DGs and vocational training initiatives are currently investigated for jointly planning and launching relevant pilot actions in the context of FP7 and FP8.

### **3.5. Industrial Policy Pillar: The *Advanced Manufacturing Systems KET***

The European Commission has identified the Key Enabling Technologies (KETs) that strengthen the EU's industrial and innovation capacity to address the societal challenges ahead [EC, 2009, "Preparing for our future: Developing a common strategy for key enabling technologies in the EU" (COM(2009)512)].

*Advanced Manufacturing Systems* (AMS), have been recognized as a cross-cutting KET, which will enable, across sectors, the efficient, sustainable and environmentally-friendly production of products that rely on the other KETs. In the supply chain of KETs, advanced manufacturing systems are important to produce high value marketable knowledge-based goods and the related services. A big challenge is to respond to the paradigm shift in manufacturing technologies towards the production of a new generation of products on micro/nano scales and with increased productivity. AMS provide an effective response to societal challenges of the 21st century such as energy efficiency, climate change

and resource scarcity by offering sustainable production methods. AMS are at the heart of economic development and the sustainability of environment in Europe.

This pillar will contribute to the development of appropriate policy measures to promote the industrial deployment of AMS. In the context of the KETs HLG activities, a set of measures to improve the related framework conditions will be proposed. As such, it forms part of the development of EU industrial policy and of the preparation for the new European plan for innovation.

### **3.6. Eureka Pillar: The *MANUFUTURE Industry Eureka Cluster***

*MANUFUTURE Industry* (MF.IND) Eureka Cluster has been promoting downstream R&D on new high added value production systems.

The overall programme plan of MF.IND extends up to 2013. Its main phases include the identification of specific strategic and operational industrial needs, the identification of networks of EU industries (technology suppliers, system integrators, manufacturers) and research actors, the launch of cluster calls for project proposals, the evaluation of proposals and label assignment, the execution of projects and their monitoring, the industrial validation of developed solutions by means of pilot factories/systems, their exploitation for global market opportunities, the definition of business plans, promotion and transfer actions at EU level for effective exploitation of the project results.

MF.IND has already published two Cluster Calls for Proposals. In the first Call, the cluster has generated 7 project proposals with a total budget of 55,108,600 € 12 EUREKA member countries, 51 participants including technology providers, user industries, research centers and universities. The second (MF.IND) Cluster Call for Proposals is currently open.

Within the ERA context, *MANUFUTURE Industry* is

- ❑ co-operating with EU FP7 programmes, and in particular, with the “Factories of the Future PPP”, as a short/medium term RTD initiative
- ❑ interacting with MANUFUTURE ETP and the national MANUFUTURE Platforms
- ❑ co-ordinating a number of synergies with Umbrellas, such as Pro-Factory, and Clusters operating in complementary technological areas
- ❑ pursuing international co-operation, following EUREKA strategy

### **3.7. National & Regional Initiatives Pillar**

The transformation of European industry requires the capability to address and actively involve stakeholders at national and regional (NR) levels, particularly SME’s. Efficient information and knowledge channels need to operate both upstream and downstream, thus ensuring a true European coverage and impact. This transformation also calls for the alignment and complementarities between European and NR research and innovation policies, programmes and projects, in order to build a effective European Research and Innovation Area that is capable of: gathering all the necessary resources; providing the right entry point for each kind of project; and ensuring the coverage of the entire innovation cycle. Such a framework generates the capability to both address the grand EU challenges and allow for national/regional specialization.

MANUFUTURE ETP perceived the strategic importance of the NR levels since its creation. Its first NR Technology Platforms (NRTPs) were created in 2005, and today this group is composed by 26 NRTPs, with more than 1.800 direct members. This network acts as the MANUFUTURE ETP’s “Implementation and Valorization Army”, providing the means to:

- ❑ Interact with a very large number of stakeholders at NR levels, including companies, universities, research organizations, national and regional authorities and funding agencies.
- ❑ Mobilize new participants to the European research and innovation programmes and initiatives, and disseminate and demonstrate their results.
- ❑ Collaborate and align roadmapping activities and research priorities with complementary trans-national/trans-regional programmes, such as ERA-NETs (e.g. MANUNET) and EUREKA (e.g. PRO-FACTORY).

- ❑ Promote and/or support the development of MANUFUTURE inspired initiatives, at NR levels, including complementary research and innovation funding programmes, clustering activities, etc. The *MANUFUTURE Village* concept is a relevant example. It has been launched as a regional initiative with the objective to promote the MANUFUTURE strategic intelligence in South Eastern Europe. It acts both as a thematic network for manufacturing and as a Public Private Social Partnership for the implementation of the MANUFUTURE paradigm.

#### 4. Conclusions

Manufacturing is a fundamental generator of high added value solutions to societal challenges, related to jobs, growth and quality of life, providing sustainable value for European citizens.

**The joint EC-industry investment on cross-disciplinary manufacturing research and innovation must continue beyond 2013, because**

- ❑ it directly addresses all EU priorities identified in Europe 2020 strategy report, i.e. employment, innovation, education & skills development, climate & energy, competitiveness, digital society and fighting poverty
- ❑ there is a successful track record (e.g. FoF PPP, R&D roadmaps, NMP consultation, EUREKA clusters etc.) of fruitful co-operation with EC, which ensures the success of future synergies
- ❑ there is a big momentum from European manufacturing industry (large organizations and SMEs) that needs the EU intervention in order to turn the economic crisis into an opportunity for competitive and sustainable development