Impact of the Factories of the Future Public-Private Partnership

Final Report on the Workshop held on March 15-16, 2012, Brussels

Contents

Executive Summary

Factories of the Future (FoF) Public-Private Partnership (PPP) projects cover a very diverse range of RTD activities, relevant to many aspects of manufacturing, its sectors, and with the potential to impact upon a very wide range of criteria important to the future prosperity and competitiveness of manufacturing.

The workshop demonstrated that projects are moving towards developing their thinking and plans with respect to exploitation of results, with different levels of maturity evident concerning this. Exploitation planning is addressing a wide range of issues, many of which are not normally addressed in Framework Programme project exploitation plans.

There are many potential barriers to achieving impacts, which, if these can be successfully and collectively addressed by the PPP, via inter-project collaboration and collective dissemination activities, should help projects to strengthen their impacts.

Enhancements to the operation of the FoF PPP are possible and necessary, both in the short-term (up to the end of 2013) as well as for transitioning to Horizon 2020. These improvements will help to improve the effectiveness of the PPP and the projects.

Developments to the PPP can come in many forms, such as: cooperation among the funded projects to undertake collective dissemination; and clustering around important dimensions to address, for example, common barriers to exploitation. These are all pre-competitive issues which provide a framework for collaboration, while avoiding sensitive issues such as concerns about intellectual property that arise when projects are asked to cooperate on more technical matters.

Looking longer term, the FoF PPP has the potential to be developed, beyond the end of the Economic Recovery Plan in 2013, into a PPP that aligns with the challenges that will need to be addressed in Horizon 2020. It evident that by building on the strengths and achievements of the FoF PPP, while also adding new features, a very potent mechanism for address manufacturing innovation could be created; one that will enable a more holistic and effective approach than would be possible with normal Framework RTD projects.

Socio-economic studies are recognised as necessary in order to systematically establish the longer-term impact. It is crucial however that timescales for the assessment of impacts are set appropriately to take account of the quite long period of time needed to undertake and complete many post-project exploitation activities.

Improvements to the roadmap and the roadmapping process are also desirable. This is necessary to bring into play a wider range of expertise, and also to expand the range of topics considered, as it is evident that there may be some topics that are important to industry's future competitiveness, which, for various reasons (for example, lack of knowledge), might not be given priority by industry.

Specific recommendations are focused on actions that the various stakeholders, including the European Commission, the *Ad-hoc Industrial Advisory Group*, the European Factories of the Future Research Association (EFFRA), and the funded projects and their participants could take.

The main recommendations are:

- a bottom-up project driven initiative aimed at inter-project collaboration, complemented by more strategic and structured collaboration framework that is based on developing an understanding of projects' (as customers of the PPP) actual needs;
- a common framework for reporting progress towards development of exploitation thinking;
- development of a dissemination plan at PPP level;
- further development of the roadmap, addressing more elements than would emerge from a purely industry driven process, and involving a wider range of stakeholders to achieve a more relevant roadmap suited to Horizon 2020.

Introduction

Factories of the Future (FoF) is one of three Public-Private Partnerships (PPPs) launched in 2009 as part of the European Economic Recovery Plan, and which has a duration until the end of FP7.

The European Commission undertook an interim evaluation of the effectiveness of the PPPs in early 2011. Prior to that assessment being undertaken, the European Commission organised a workshop for the FoF PPP participants, to consider matters relating to impacts, in terms of both the funded projects and well as the PPP itself, with the resulting workshop report[1] providing input to the PPP interim evaluation exercise. Following on from this first workshop, which was held in November 2010, the European Commission decided to hold a second impact assessment workshop, which took place in March 2012.

Specific workshop objectives were to:

- promote networking and exchange of information among the research projects funded under the FoF PPP and to promote the message that the FoF projects are part of community that is driven by common interests;
- foster links among projects of similar scope and to identify potential synergies among projects aiming at similar activities;
- provide a forum for discussion about the added value and impact of the FoF PPP from the perspective of the stakeholders; and
- collect inputs and information from the stakeholders, with a view to considering how the PPP can be further developed and taken forward, beyond 2013, into Horizon 2020.

The workshop was held at a time when the strategic planning for Horizon 2020 was at the stage of consultation among the relevant European Institutions, with much detailed feedback on initial proposals already received, and a strategic position paper being prepared by the PPP Industrial Association, with the summer of 2012 set as the target for its completion. A continuation in Horizon 2020 of the existing PPPs may be proposed, with the FoF PPP being positioned within the Industrial Pillar.

With this prospect of continuation in mind, and with the results of the Interim Assessment of the PPPs[2] available, there was a need to undertake a critical examination of the current PPP, and to consider how best to transition this from Recovery Plan status to a model of organising manufacturing sector related research as one key element of research programme implementation within Horizon 2020.

The purpose of this report is to present the main views and insights that emerged from the workshop discussions and to identify conclusions and recommendations that arise from the discussions.

[1] Impact of the Factories of the Future Public-Private Partnership
http://www.effra.eu/attachments/article/125/FoF_PPP_Workshop_Final%20Report.pdf
[2] Interim Assessment of the Research PPPs in the Economic Recovery Plan
http://ec.europa.eu/research/industrial_technologies/pdf/research-ppps-interim-assessment_en.pdf

Workshop Methodology

With regard to workshop methodology, members of the FoF PPP *Ad-hoc Industrial Advisory Group*, along with project co-ordinators, were invited to attend the workshop. A number of European Commission officials also participated. A list of workshop participants is given in Appendix 1.

The agenda for the workshop is included in Appendix 2. The workshop started on the Thursday afternoon, with three Project Thematic Presentations (run in three parallel sessions). The three themes were: Sustainable Manufacturing; ICT for Manufacturing; and High-Performance Manufacturing. These sessions were aimed at fostering links among projects of similar scope. Participation of projects in these sessions was pre-assigned. Each project was asked to prepare a 5-min presentation addressing the question: How will societal and economic impact be achieved? (Innovation aspects, exploitation intentions, PPP added-value).

Following these Project Thematic Sessions, a further three parallel sessions were run, based on project presentations addressing innovation. The themes for these sessions were: Sustainability and Energy Use; Standardisation; and Effectiveness of Results Take-up. These parallel sessions were aimed at fostering synergies among projects aiming at similar activities and likely to lead to innovation via the impact created. Project representatives attended one of the three sessions of their choice. They had been asked in advance to prepare 5-min presentations explaining how their project was addressing the session topic.

Session rapporteurs subsequently presented feedback from the parallel activities at a plenary session held on the following day. This day began with welcome and contextual comments and observations from Herbert von Bose, Director for Industrial Technologies, DG Research and Innovation, and Zoran Stančič, Deputy Director General, DG Information Society. Herbert von Bose also chaired the Friday morning plenary sessions.

The opening remarks and observations were followed by a presentation of Industry's Expectations for the Impact of the FoF PPP. In the afternoon there was a Panel Discussion, chaired by José-Lorenzo Vallés, on the topic of the Added Value and Overall Impact of FoF Projects, and the questions used to stimulate the panel discussions are given in Appendix 3. The workshop rapporteur then provided some preliminary observations and conclusions, and this was followed by several closing statements.

A networking dinner was also held on the evening of the first day, to facilitate building contacts among the project representatives.

Expected Impacts of FoF Projects

Innovation Potential

In total 50 projects were presented in three parallel sessions. Under the banner of Sustainable Manufacturing, 17 projects provided insights into their focus and objectives. These projects are very diverse, ranging from traditional areas such as machine tool control, through to RTD that deals with targeting specialised markets (for example, health

related needs), with customisation being used to provide the unique selling point (for example addressing the special needs of bariatrics, the elderly, etc.). Other projects, addressing more traditional markets and issues (for example, production planning), but often with a new focus, for example, on energy efficiency, also presented.

In the session addressing ICT for Manufacturing, 19 projects presented, covering topics such as: platforms for leveraging product lifecycle management data for improving design, simulation and productivity; application of robotics in new domains; collaborative virtual networks for holistic manufacturing value chains; and collaborative environments for knowledge transfer among internal departments and external stakeholders.

The session on High-Performance Manufacturing provided an opportunity for 14 projects to present. Some of these projects covered robotics subjects, such as simulation, learning systems, human-robot interaction, human-like robots, and mobile robots. A number of projects addressed the domain of zero-defect manufacturing, covering subjects such as statistical process control for small batch manufacturing, multi-stage defect reduction, and real-time adaptive control. The remaining projects were focused on the topic of new manufacturing technologies, such as customised ceramics, nano manufacturing, and three-dimensional integration of microelectronics.

This portfolio of projects represents a very diverse range of activities, with potential impacts across the whole manufacturing supply chain, from the customer, including consumers, to component and material suppliers, as well as addressing manufacturing industries and those that supply these businesses with manufacturing related equipment (ICT, machine tools, etc.). These projects have the potential to deliver impacts across a broad range of criteria, ranging from more traditional ones such as improved productivity, reduced costs, less waste, and so on, through to criteria such as cost-efficient customer responsiveness, improved process equipment with more relevant features and functionality, as well as enhanced quality of work content for manufacturing employees, and improved health and safety. Importantly, there will also be impacts on criteria related to newer concerns, such as reductions in operational energy consumption, carbon emission abatement, and more efficient use of raw material resources. The multi-sector nature of the projects means that these impacts have the potential to be realised across a broad spectrum of European manufacturing activities and supplier sectors.

The projects presented are at different stages in their lifecycle as a consequence of being the results of different Calls and also different starting dates. All projects have a clear idea of what they are aiming to deliver in terms of potential impacts. Those projects addressing sustainability, on the whole, are taking an approach that is not just driven by a singular focus on environment, but are seeking instead to contribute simultaneously to society, economy and environment, which is undoubtedly very challenging.

Taken collectively, there is good potential to contribute towards the achievement of the Europe 2020 objectives, specifically those related to employment and climate change/energy.

Progress in Exploitation Planning

The timeline for the delivery of clear tangible impacts in terms of sales of new products, services, licensing of new technologies, etc., will be different across these projects as a result of specific market characteristics such as conservatism, the readiness of markets to accept the need for new approaches, investment priorities of customers, difficulties in explaining new concepts to customers, the time needed to take results of varying complexity to market and the level of investment needed to do this, etc. The different levels of maturity in the project execution phase also points to different stages in the development of thinking in terms of how to transform the emerging results into market ready products, and what needs to be done to make this happen.

The project presentation addressed a variety of business related issues, including: market drivers; exploitable results and their translation into improvements to existing products and services, or the creation of new ones; actions needed within the project funding period to smooth the way towards exploitation; global actions that will assist with exploitation (for example, standardisation); target customers; time needed to move to market; target costs and prices; and the amount of investment needed.

Most project presentations showed that their thinking is focused on addressing some of the above matters, for example, they demonstrated some development in thinking concerning the clarity in terms of the exploitable results they will be delivering, or showed increased understandings of the barriers to exploitation that will need to be addressed, or were beginning to see what dissemination actions will need to be undertaken, etc. No single project clearly demonstrated a high degree of maturity in their planning concerning exploitation by being able to clearly articulate their thinking about all the matters mentioned in the preceding paragraph. A few were at a stage where such clarity is still at the stage of aspirations, mostly because they did not start the execution phase until late in 2011. However, the expectation is that all projects will eventually move towards circumstances where there will be more complete thinking about exploitation and the next steps that will need to be taken beyond the project funding period.

The above circumstance is in line with normal project lifecycle thinking, where exploitation matters tend not to be given full attention until the second half of the project, but, encouragingly, in the case of the FoF projects, there is a strong indication of more holistic thinking concerning exploitation, as is evidenced by the long list of relevant business matters that form the components of exploitation planning reported in the presentations; matters which generally are not mentioned at all in classical Framework Programme project exploitation plans.

Of note is that two projects mentioned that they had already made patent applications, which is a very positive and encouraging sign. Other projects may also, in the future, be in a position to make patent applications.

Maximising and Improving the Impacts of FoF Projects

The matter of how to maximise and improve the impacts of FoF projects was addressed in three parallel sessions, considering three innovation related foci:

- Sustainability/Energy Use;
- Standardisation;
- Effectiveness of Results Take-up.

Innovation Focus: Sustainability/Energy Use

This session was targeted at considering how projects related to sustainability are assessing energy-efficiency, carbon emissions abatement, or both. An important question in this respect, is: How to optimize and measure a project's contributions to energy-efficiency and carbon emissions abatement? Projects reported that they are using a number of criteria to measure contributions to energy-efficiency and carbon emissions abatement. These include:

- Energy consumption per part/hour;
- CO2 emission per part/hour;
- Water consumption per part/hour;
- Volatile organic compound (VOC) emissions per part/hour.

The criterion of energy consumption per part/hour is the one most adopted by projects. Typical indicators which are used to provide a measure of these criteria are: reduction in the use of materials or the production of scrap; reduction of cost; reduction of time; and reduction of tool wear.

However, discussions revealed that there are a number of elements that are making it difficult to measure and optimize contributions to energy-efficiency and carbon emissions abatement:

- The high cost of the available solutions and systems, and the associated high cost of implementation, which leads to a circumstances of a poor Return on Investment.
- The availability of relevant data, its fusion as appropriate, and sometimes matters of confidentiality that prevents data from being used;
- Complexities that arise at Brownfield sites (as opposed to Greenfield sites) where there is a legacy of existing systems and equipment and resulting difficulties with interfacing, made worse by a lack of standards and plug-and-play capability;
- Technological and modelling limits, which point towards areas for further research;
- The difficulties of making on-line and real-time measurements, and also making appropriate interventions.

In order to improve impacts in this area several actors need to be involved. These include academia, to undertake the research needed to develop better models; technology and

service providers, to develop plug-and-play solutions; system and machine managers, to address accuracy matters and to take preventative actions; plant managers, to deal with performance certification; management accountants, to provide the cost saving certifications; and standardisation bodies, to bring about the development of the necessary standards-based approaches (for example, for reporting carbon emission reductions, and for interfacing equipment).

To move forward, it will be necessary to consider issues that are currently beyond the scope of existing projects. An example of such an issue is the adoption of a more holistic and life-cycle based approach, which encompasses environment, society and economy (true sustainability). Standardisation activities will also be necessary to overcome (often common) barriers, and to reduce the costs of development and implementation. Ensuring access to knowledge, and relevant data, will also be key. In these respects, the European Commission will have a strategic role as a facilitator, working in partnership with other relevant stakeholders.

Innovation Focus: Standardisation

This session was directed at the contribution projects are making to interoperability and standardisation, and illustrated several longstanding, and, as yet, unresolved challenges. Of particular note are the reoccurring themes of controlling access to data and the difficulties in achieving interoperability, and the reality that these problems are often, still not resolved within companies, but now need to be addressed across some of the ICT-based projects within the PPP.

Several projects are creating platforms of various kinds, and one obvious synergy lies with these types of projects who could begin to address matters of interoperability among these platforms. One possibility might be an integrating platform, possibly cloud-based, although it was recognised that such work is, to some extent, being addressed within the Future Internet PPP in the FI-ware project. This project brings together relevant stakeholders, and has developed a reference architecture, with several use cases being implemented. The project would benefit from a manufacturing use case, so there is an opportunity here for collaboration with the FI-ware project.

In the long term, development of new standards will help to address matters of interoperability, but in the short term, greater dialogue among projects will aid in ensuring a better fit, and such a dialogue could be the starting point for collaboration among some of the more ICT-based projects.

The standards development process could also be improved by taking advantage of social networking, specifically tapping into the wisdom of the crowd. However another possibility is not to have a formal standard, but a *de-facto* one achieved through wide adoption of high impact commercial systems based on a common approach.

Discussions identified that there are many ways in which the matter of standardisation can be addressed:

- A project-led approach where each project follows its own agenda towards standards;

- A collaborative approach whereby several projects work together to pursue common standardisation issues;
- Use of a Coordination Action to provide the framework and the resources to address standardisation matters;
- Common demonstration activities with a standardisation focus;
- Contract research whereby the European Commission requests the development of specific components/standards;
- Some mixture of the above.

Evidently standardisation is a difficult matter to address, and there is always the danger that too much emphasis is placed on this topic.

Open access to data is also an issue that needs attention, especially with respect to providing facilities for managing data and enabling SMEs to gain access to the data that they need.

Discussions also considered collaboration among projects, which could be centred on commonality in results, rather than activities, as how to commercialise results is perhaps a more important matter for the industrial stakeholders than standardisation, with its inevitable longer term bias. The challenge however is how to identify synergies, and to do this it is necessary to have both an overview of projects and insights into the specifics of each.

The matter of synergies among projects also needs to consider commercial sensitivities, and also significant differences in technical approaches, both of which can hinder collaboration. In this respect it is sometimes difficult for projects working on very similar issues to collaborate. Identifying complementarities among projects is therefore essential for creating synergies. Inevitability however, there has to be some focus on activities to create a basis for collaboration, and the best ones to focus on may be activities such as, common user needs, basic system functionality, and dissemination. In this respect, some learning might be possible from the Future Internet PPP, specifically the FI-ware project, which has already addressed agreements that provide a framework for inter-project collaboration based on well defined complementarities.

Innovation Focus: Effectiveness of Results Take-up

This session addressed how best to achieve a significant uptake of expected project results, and sought to identify best practices for achieving impacts beyond the immediate project stakeholders.

Many barriers to achieving the above were identified:

- Complex technologies with the consequence of high prices for the resulting products, with a subsequent need to ensure wide applicability to enable lower costs to be achieved;
- Short term perspectives in markets where it is difficult to get customers to think longer term;

- The danger of projects becoming just an exercise in collaboration among RTD people;
- The risks associated with projects raising expectations in the market, but then not being able to deliver as a result of unresolved challenging problems;
- Software based products can be perceived as being less tangible and therefore more difficult to sell to industry;
- Confidentiality and Intellectual Property protection issues acting as barriers to co-operation and knowledge sharing among projects, thus holding back inter-project collaborations;
- Low propensity to risk taking, reluctance to adopt new concepts etc., and a conservative environment with regard to the adoption of innovative solutions;
- Lack of skills in terms of adoption capabilities and implementation;
- The reality that many research projects fail in exploitation, especially those adopting a technology push approach;
- End users unwilling to share information because of fear of leaking information to competitors;
- The need for post-project financing.

Several suggested means of trying to address these barriers were proposed:

- Pilot cases are seen as important and very necessary as they can provide convincing data which helps to overcome reluctance to adopt;
- Integration of consumers into projects to help ensure greater relevance, this being a particularly important matter for projects working in consumer markets, there being also an important role here for point-of-sale stakeholders such as retailers;
- Technology proof-of-concept opportunities such as Living Labs, and regional or local demonstration facilities, especially ones targeted at SMEs;
- Greater adoption of the open innovation approach;
- Gathering together all the necessary competencies, skills, functions, resources, information, etc.
- Dissemination activities that not only use the traditional instruments and training sessions, but which also use social networking to create communities of interest;
- Multi-stage exploitation strategies which, if appropriate, begin within the project execution phase;
- A knowledge-based approach which addresses formalisation, protection, adaptation to specific applications, and greater transfer of knowledge through licensing agreements.

A number of incentives for impact creation were also suggested as open questions for consideration:

- Should projects be subject to a post-project exploitation follow-up audit by the European Commission?
- Is there a need for a European Commission programme that supports the take-up of project outcomes via the integration of results from different projects to develop new products, processes and services?
- If consortium partners do not exploit project results within a certain timescale after project completion, should the results become public?

The clear outcome of this session was that there are many horizontal issues that need to be addressed, both by individual projects, and by the PPP.

Taking the FoF PPP Forward into Horizon 2020

Industrial Vision of the Value and Benefits of the PPP

The main purpose of the FoF PPP for the industrial participants is to strengthen manufacturing through innovation, leading to improved competitiveness.

The FoF PPP was launched to have a direct economic impact on innovation and research in manufacturing industries by focusing on the needs of European manufacturing companies, especially SMEs. For industry, the main goal is wealth creation through a competitive market position and increased added value. Additional benefits also come from closer cooperation among European research organisations and other businesses, including multi-sector collaboration. Benefits can also be expected at regional level through, for example, regional clusters of interconnected companies that provide their regions with employment and wealth. In the context of the global economy, additional impacts will be an increased export share of the European manufacturing equipment industry, which should, if the equipment is designed with sustainability in mind, also lead to environmental benefits, especially when this equipment is supplied to developing countries.

Industry is also looking to address objectives related to sustainable manufacturing, specifically reductions in emissions and the consumption of material resources. ICT is also important, and industry looks to the application ICT to intelligent manufacturing to increase its competitiveness. Improvements in performance, and in production flexibility, are both critical aspects for the European manufacturing industries to enable them to improve productivity. Factories of the Future will facilitate the development of cost-effective, safe, affordable, and friendly technology, as well as production equipment for processing new materials with improved properties. This latter aspect is important as it is also necessary to be able to exploit improvements taking place in the materials domain, in order to be able to use these for competitive advantage in European Manufacturing industries.

The question for all stakeholders involved in the PPP is: how to achieve greater impact? One of the keys to achieving greater impact for manufacturing industry from the FoF PPP and the funded projects, is to be more holistic, for example, considering also elements such as strategy, market, and financing, in addition to the more traditional technology

focus of research projects. There is also need to address technology development and demonstration, as well as system development. To create value it will be necessary to better understand how technology will evolve in the future, how markets might change, and how the customers' needs will evolve, so that industry is in a better position to develop products and services that will deliver technological assets that provide competitive advantages.

The discussions also reconfirmed the value of the PPP for industry through its achievement of a high-level of industrial participation, the cross-sector nature of the projects with a focus on producing exploitable results, short time from proposal to project, the multi-thematic (NMP/ICT) nature of the Calls, and the multi-annual roadmap providing clarity and stability concerning topics to be funded, which enables better forward planning. The PPP also provides a basis for addressing pre-competitive research as well as delivering working prototypes and operational demonstrations. Such practical outcomes also provide a basis for sharing knowledge.

Indicators for Measuring the Impact of the PPP

Discussions concerning how best to measure the longer term impact of the PPP led to a suggestion that indicators should not be too complicated to measure and should cover both inputs to the PPP as well as the outputs. It was also mentioned that tracking specific RTD contributions to products poses some potential difficulties, especially in the case of complicated software based products, where many RTD contributions are combined together. Other impacts are also difficult to measure, such as the sustainability of employment and increases to the added value per employee. Nevertheless, these are important ways of measuring impact. It is also important to have the right timeline for measuring impacts, as (for example) it can take as long as 15 months to conclude a technology transfer agreement. Hence, impact measurement needs to extend for a significant period of time beyond the formal end of the Economic Recovery Plan. Several possible indicators were suggested as being relevant:

- Number of industrial participants;
- Patents applied for;
- Licence-based revenues;
- Leverage of private funds;
- Venture capital funds raised to commercialise project results;
- Results taken up into pre-commercial procurement activities;
- Spin-off companies created to exploit project results;
- Number of technology transfer agreements signed;
- Contribution towards developing human-centred manufacturing (for example, quality of work content).
- Percentage of manufacturing business turnover reinvested in ICT/NMP related RTD;
- Time taken to achieve payback of the investment costs of participation in FoF projects.

Cleary, for the above to be meaningful measures there is also a need for benchmarks (for example, comparison with traditional FP7 projects), otherwise it will be difficult to determine the success of the FoF PPP.

Collaboration and Dissemination

Collaboration among projects is recognised as important, but the challenge is how to bring this about. There are several possibilities. One is based on synergies (as mentioned elsewhere in the report), but another is to focus on one specific goal (which could be broad or quite specific). Calls for Proposals provide a bottom-up process whereby proposals are selected, which creates the portfolio of projects within the PPP. Another approach could be a more top-down one, building a portfolio of projects that have to address a number of a predefined and *very specific* topics.

Dissemination is widely recognised among the PPP participants as important, and good traditional dissemination activities are already visible. Some innovation in the way dissemination is tackled might however be useful, which might include some new activities. Already there are many project specific dissemination activities, but perhaps too many, so consideration could be given to delivering fewer, but more high quality dissemination activities. To do this however, the PPP needs a dissemination plan. The participation in the 2012 CeBit is an example of a dissemination event addressed more at PPP level, so the open question is: what other activities can be initiated and how can these be best undertaken to maximise impacts for the projects?

New Opportunities for a Post Economic Recovery Plan PPP

Transitioning the PPP model to Horizon 2020 needs to be addressed. Sel-evidently, the FoF PPP is well aligned with the Europe 2020 Objectives (as highlighted in the report of the Interim Assessment of the PPPs[3]), and also has a clear place in the Industrial Pillar of Horizon 2020. However, there are two distinct options with regard to the future of the FoF PPP, one being to leave it as it is, while the other is to move it forward into something that builds on its strengths and achievements.

An open issue for the future development of the PPP is whether it should be sector based (why does manufacturing need to have a PPP?), or if it should be based along other dimensions (themes, technologies, etc.), so that there is an appropriate strategic alignment for the future.

There is a need to develop digital skills, which means adapting curricula in universities to the needs of Future Factories, which will have a significant element of ICT. So should skills development be part of the PPP? New forms of products also need to be considered, especially services, for which further development of business models is needed. Such new considerations point towards specific content for the new, post-2013 roadmap, and a need to develop some criteria by which topics are included. This is an important matter as the roadmap needs to include topics that will lead to wealth and job creation, that is to say

[3] Interim Assessment of the Research PPPs in the Economic Recovery Plan
http://ec.europa.eu/research/industrial_technologies/pdf/research-ppps-interim-assessment_en.pdf

have commercial potential, but identifying what will have a business impact is not so easy (even for industry).

Further issues that need to be considered with respect to the roadmap are its alignment with both the Manufuture 2030 Vision, as well as the pressing needs of SMEs. The megatrends identified by Manufuture are clearly important in defining the roadmap, and could provide a basis for moving from programme level to specific projects.

One matter that should be considered is the need to consult with individual experts beyond the technical domains. Traditionally, these technical experts are the people who have made inputs to the development of roadmaps, but there are other groups of experts such as industry analysts, business thinkers, innovation researchers, who could also provide valuable and different inputs, resulting in a broader spectrum of views, deeper insights, and an improved process of roadmap definition, as well as a more relevant roadmap.

The European Commission is working with several stakeholders to develop a new concept called Innovation Partnerships, which will contribute to better coordination of European level and national level activities, facilitate exchange of knowledge and information, create dialogue among stakeholders, and facilitate the exploitation of research results (for example through Pilots and Demonstrations), helping to bridge the gap between RTD and the creation of new products and services. All of these features would be beneficial for the FoF PPP.

There was agreement among the workshop participants that Innovation Partnership will be important for the FoF PPP, especially as Pilot and Demonstration sites are seen as fundamentally important to helping sell new ideas and technologies, and to overcome some of the barriers mentioned elsewhere in the report. Such Pilots and Demonstrations could be set-up and run within the context of an Innovation Partnership. Participation in the Innovation Partnerships might also help to develop the FoF PPP's vision. Moreover, many of the Innovation Partnerships can be expected to be addressing topics where manufacturing will have a role to play in delivering products. It was also suggested that there could also be a Manufacturing Innovation Partnership.

There is obvious potential within these Innovation Partnerships for collaboration among several PPPs and it was recognised that cross PPP interaction would be valuable, and that in the case of manufacturing, this opens up new opportunities, since proposals for new PPPs, for example those proposed for renewable energy, or mobility, would given rise to new manufacturing needs and market opportunities for the manufacturing sector, and this therefore should be taken into account when developing the new roadmap, rather than just focussing on the needs of existing or well established manufacturing activities and markets.

It was also highlighted that there is a huge gulf between manufacturing related software developers and those engaged in the development of what are know as *apps*, and here there is potential to bring-in new communities with different perspectives and market experience to enhance manufacturing innovation. Such matters need to be considered in the development of the roadmap and when considering the future shape of the PPP.

Conclusions and Recommendations

Conclusions

Conclusions from the workshop can be grouped under the heading of:

- Potential Impact;
- Exploitation;
- Challenges and Barriers;
- Collaboration Opportunities; and
- Transitioning the FoF PPP into Horizon 2020.

Potential Impact

- FoF projects possess the potential to deliver impacts across a broad spectrum of manufacturing-related sectors, and along the whole manufacturing supply chain, from the customer, including consumers, to component and material suppliers.
- Impacts can be divided into those that are more traditional, such as improved productivity, reduced costs, less waste, and so on, and those that are more market oriented, for example improved customer-responsiveness, and new equipment with features and functionality better suited to market characteristics.
- Importantly, some projects will also impact upon the working environment by delivering enhanced quality of work content for employees and improved health and safety. Crucially, there will also be impacts in areas relating to newer concerns, such as reductions in operational energy consumption, carbon emission abatement, and more efficient use of raw material resources.
- Of particular note is that, those projects addressing sustainability, on the whole, are taking an approach that is not just driven by a singular focus on environmental issues, but are seeking instead to contribute simultaneously to society, economy and environment. This is very a very positive development as it provides evidence that sustainability is being taken seriously and is being properly addressed.
- The workshop identified a number of business related indicators that could be used to measure the impact of the PPP. Importantly though, the measurements must be taken over an appropriate timescale to take account of the realities involved in taking project results to market. These exploitation timescales are often measured in years. Moreover, for the indicators to be meaningful there is also a need for benchmarks, such as a comparison with traditional FP7 projects, otherwise it will be difficult to determine the success of the FoF PPP.
- Taken collectively, there is good potential among the projects to contribute towards the achievement of the Europe 2020 objectives, specifically those related to employment and climate change/energy.

Exploitation

- The individual projects that presented in Sessions 1, 2 and 3 demonstrated that they are addressing, to different degrees, a variety of business issues related to exploitation, and the main conclusion is that projects are engaged in a process of developing their thinking and plans with respect to taking project results forwards beyond the project execution phase, into a post-project exploitation phase.
- There is a strong indication of the emergence of holistic thinking concerning exploitation, as is evidenced by the long list of relevant business matters that form the components of exploitation planning reported in the presentations; matters which generally are not mentioned at all in classical Framework Programme project exploitation plans.
- What is needed is for each project to develop its thinking to a level of maturity that will provide the confidence that, by end of project execution phase, matters relevant to exploitation have been satisfactory defined.
- To encourage a more harmonised and a good practice model of exploitation planning for FoF PPP projects, it may be beneficial to define a framework of business related issues that these projects should be expected to address. This could be based upon the many business issues mentioned during sessions 1, 2, and 3. This would help to both encourage the development of a higher degree of maturity in thinking and planning concerning exploitation, and also tap into the collective wisdom of the PPP participants; in effect exploiting the potential for synergies that exists among such a diverse range of projects.
- Such a framework would help the newer projects, where clarity of thinking concerning exploitation is still at the stage of aspirations, to better understand what is expected of them. It would also help to ensure that all projects will eventually move towards circumstances where there is more complete thinking about exploitation, including the next steps that will need to be taken beyond the project funding period.

Challenges and Barriers

- Collectively, Sessions 4, 5 and 6, identified a wide range of issues, many of them non-technical in nature, or horizontal (i.e. running across many projects), which have the potential to act as barriers to achieving impacts. These are matters which, if successfully addressed collectively, could however provide a means of increasing the impact of projects, and this is a clear example of how the PPP can add value to the individual projects by providing PPP-level support.
- Several of these barriers are very familiar and to be expected, for example, standardisation and interoperability relating to ICT, lack of an innovation culture in many manufacturing businesses arising from a reluctance to adopt new concepts, a propensity to avoid risks, and so forth. These barriers reinforce the message which

emerged from the first workshop, where the importance of *technology management* was highlighted[4].

- There is a clear case for projects to develop inter-project collaborations to deal with these common issues. Indeed it is evident that many of these barriers can be regarded as being pre-competitive, where projects can share useful knowledge and work on the development of appropriate responses. This would deal with the concerns that the industrial partners have with regard to inter-project collaborations, as it would also avoid having to cooperate in areas where there is a need to protect intellectual property, or where technical approaches may be so different that cooperation would be extremely difficult.

Collaboration Opportunities

- One of the main conclusions of the workshop is that there is a wide range of subjects where inter-project cooperation is desirable and feasible. This is not just confined to barriers to achieving impacts, but also to matters such as common approaches to dissemination. The workshop also identified the desirability of cooperation with other PPPs (as well as with the emerging Innovation Partnerships). These not only provide new opportunities for collaboration and synergies, but also the basis for learning from the experiences of other PPPs with a view to innovating the PPP into a more effective tool.
- Cooperation with other PPPs and the need to achieve synergies in dissemination was also discussed at the first workshop held in November 2010[5]. This reconfirms the importance of such matters and points to a need to make progress in addressing these issues so that projects can reap the benefits to be gained from these activities.
- The workshop demonstrated that inter-project collaboration is a complicated matter, and is a sensitive issue for the industrial partners. Thus, while individual projects can and should be initiating collaborations among themselves in a bottom-up fashion, a more strategic and structured approach could also be helpful.
- Given the complexities, a simple clustering of projects based on apparent similarities may be too simplistic. Consequently, a more customer-centric (project-centric) approach may be better, which involves actually talking with projects on a one-to-one basis to establish the foundations for structured collaboration. This will also help establish a dissemination plan for the PPP, which at the moment is not evident.
- The above points can be summarised by two themes: *managing projects for greater impact*, and *innovating the innovation process*. The former is essentially about projects addressing, during their execution phase, matters which later act as barriers to taking results to market. The latter is in effect a recognition that innovation

[4] Impact of the Factories of the Future Public-Private Partnership
http://www.effra.eu/attachments/article/125/FoF_PPP_Workshop_Final%20Report.pdf
[5] Impact of the Factories of the Future Public-Private Partnership
http://www.effra.eu/attachments/article/125/FoF_PPP_Workshop_Final%20Report.pdf

processes need to be improved so that they are better adapted to the challenging circumstances faced by RTD projects.

Transitioning the FoF PPP into Horizon 2020

- A key issue for the FoF PPP is whether the present model is directly transferable to Horizon 2020, given that the PPP, as it stands, is the product of the circumstances and needs of the Economic Recovery Plan. Many of the issues mentioned above suggest that this is not the case, and that a transitioning is needed.
- This transitioning should build on the widely recognised and appreciated strengths and achievements, while increasing openness and relevance to a wider community of stakeholders, tapping into the many different skills that are needed to address manufacturing innovation in a more holistic and effective manner.
- The above also has implications for the roadmap. During the course of the workshop it was mentioned that there are subjects (for example, those connected with energy efficiency models) that point to an expanded role for academic and research institutions. There are always areas where industry will, for various reasons, not support research. This may be because the importance of a topic has not yet been recognised, or because there are specific areas where industry has less expertise and financial resources to address key topics.
- Academic and research institution contributions could be required in several areas to: develop education and training courses; undertake research into the social (and psychological) issues (for example, relating to consumer behaviour); develop methods and metrics for, and to undertake independent studies of costs, benefits, and wider impacts; and development of advanced energy consumption models, etc.
- During the course of the workshop, it was proposed that the PPP would benefit from consulting with individual experts beyond the technical domains. Traditionally, technical experts have been the ones primarily responsible for the development of roadmaps, but there are other groups of experts, such as industry analysts, business thinkers, innovation researchers (and perhaps also experts not traditionally involved with manufacturing RTD such as ecologists, energy efficiency specialists) who could also provide valuable and different inputs, resulting in a broader spectrum of views, deeper insights, and an improved process of roadmap definition. This is an example of *innovating the innovation process*, leading to a much more broadly based and more relevant roadmap, as well as suggesting how the PPP could be restructured and improved to fit into Horizon 2020.

Recommendations

Several actors are involved with the FoF PPP: the European Commission; the *Ad-hoc Industrial Advisory Group,* individual projects and their participants; the European Factories of the Future Research Association (EFFRA). All of these have a role to play in moving the PPP forwards, with the *Ad-hoc Industrial Advisory Group* providing the vision and leadership to transform the PPP into more effective and more powerful partnership, suited to the challenges that need to be addressed in Horizon 2020.

Several recommendations arise from the workshop:

- There is a need for individual projects to take the initiative to deliver, in a bottom-up way, synergies among the projects, which is something that can to be addressed immediately (Action for the individual projects);
- Development of a more strategic and structured approach to inter-project collaboration could be initiated (over the period up to summer 2012) using a customer-driven approach where, based on one-to-one discussions with individual projects, the collaboration and collective dissemination needs of the projects are established (Action for EFFRA);
- Based on identified project needs, the PPP should provide a proposal for a more structured approach to collaboration, as well as a dissemination plan for the PPP. This should be completed by the end of 2012 in time for implementation in 2013 (Action for the *Ad-hoc Industrial Advisory Group* and EFFRA).
- Given the need to transition the PPP to something that fits the needs of Horizon 2020, consultation with a wider stakeholder group (for example, industry analysts, business thinkers, innovation researchers) could be undertaken, and to this end the FoF PPP stakeholders should propose individuals and organisations that could be invited to participate (Action for the European Commission; the *Ad-hoc Industrial Advisory Group,* individual projects and their participants; EFFRA).
- To encourage a more harmonised and a good practice model of exploitation planning for FoF PPP projects, it may be beneficial to define a framework of business related issues that these projects should be expected to address, for example in project reviews (Action for the European Commission and the *Ad-hoc Industrial Advisory Group*).
- A framework of indicators needs to be proposed to help measure the impact of the PPP, and those indicators identified during the workshop could form the basis of a starting point for the construction of such a framework (Action for the European Commission; the *Ad-hoc Industrial Advisory Group,* and EFFRA).
- Given the need to expand the roadmap so that it is broader and more relevant, the roadmapping process itself probably needs to be redesigned to be more inclusive and open (Action for the European Commission; the *Ad-hoc Industrial Advisory Group,* and EFFRA).

Appendix 1 – List of Workshop Participants

Name	First name	Organization	Project
Ferrara	Paolo	FerRobotics Compliant Robot Technology GmbH	CustomPacker
Lazaro	Oscar	Innovalia Asociacion	ComVantage
Kiritsis	Dimitris	EPFL	LinkedDesign
Dokken	Tor	Sintef	Terrific
Knuth	Martin	Fraunhofer IGD	FFD
Lezama	Thomas	Volvo Group Trucks Technology	I-CONIK
Usatorre Irazusta	Luis	Tecnalia	KAP
Majumdar	Anirban	SAP Research	ActionPlanT
Prinsen	Ludwig	SAP Research	PREMANUS
Bröchler	Raimund	INTRASOFT International	IMAGINE
Lentes	Joachim	Fraunhofer Institute for Industrial Engineering IAO	amePLM
Agirre Ibarbia	Jon	Tecnalia Spain	PLANTCockpit
Armijjo	Alberto		EPES
Gusmeroli	Sergio	TXT group	MSEE
Bischoff	Rainer	KUKA Laboratories GmbH	TAPAS
Maurtua	Iñaki	Tecnalia	ROBOFOOT
Hollacher	Markus		QCOALA
HENTZ	Jean-Bernard	Airbus Operations SAS	FOFDATION
Laclavik	Michal	Institute of Informatics Slovak Academy of Sciences	VENIS
Wang	Jiasheng	CAS Software AG	GloNet
Campbell	Stuart	TIE RDI	ADVENTURE
De Panfilis	Stefano	Engineering Ingegneria Informatica S.p.A.	BIVEE
Elorriaga	Aitor	INNOPOLE	EXTREMEFACTORIES
Mahaut	Steve	CEA LIST	SIMPOSIUM
Gorecky	Dominic	German Research Center for Artificial Intelligence (DFKI)	VISTRA
Stellmach	Dieter	DITF-MR	CORENET
Stampfl	Jürgen	TECHNISCHE UNIVERSITAET WIEN	PHOCAM
Maneia	Gian Mauro	Ce.S.I. Centro Studi Industriali	HARCO
Wögerer	Christian	MSc – PROFACTOR GmbH	LOCOBOT
Ghidoni	Stefano	University of Padua	THERMOBOT
Perez Bilbatua	Joseba		DYNXPERTS

Urreta Prieto	Harkaitz		MIDEMMA
Rodríguez	Mariola	Tecnalia	CABLEBOT
De Cristofaro	Sarah	Mach 4	MUPROD
Myklebust	Odd	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	IFaCOM
Calefati	Paolo	PRIMA POWER	ENEPLAN
Gunnink	Jan Willem	Delcam plc	COMET
MOGUEDET	Maël	PEP	IMPRESS
Zhou	Quan	AALTO-KORKEAKOULUSAATIO	FAB2ASM
González	Juan Carlos	Insituto de Biomecánica de Valencia	Fashion-Able
Gault	Rosemary	The University of Sheffield	REFORM
Pedrazzoli	Paolo	University of Applied Science of Southern Switzerland	S-MC-S
Nicolescu	Mihai		POPJIM
Semere	Daniel		POPJIM
MOURTZIS	Dimitris	University of Patras	E-CUSTOM
Papachristopoulou	Konstantina	ATC S.A.	MICRO-DRESS
Friedrich	Jens	DMG ELECTRONICS GMBH	AIMACS
van Ravenswaaij	Remco	PHILIPS CONSUMER LIFESTYLE B.V.	MEGAFIT
EYTAN	Amit	Centro Ricerche Fiat S.C.p.A.	AUTORECON
Susperregi	Loreto		MAINBOT
Ippolito	Massimo	CENTRO RICERCHE FIAT SCPA	EMC2-FACTORY
Schlaich	Peter	Robert Bosch GmbH	PRACE
Diterlizzi	Antonio	BASE PROTECTION SRL	MYWEAR
Hargreaves	Ben	NetComposites Ltd	NANOMASTER
Chryssolouris	George	University of Patras	
Hanisch	Christoph	FESTO	
Annamalai	ARUN JUNAI	TNO	
Decubber	Chris	EFFRA	
Peters	Kai	VDMA	
Kapadia	Ajay	TWI Ltd	
Rabino	Edoardo	Centro Richerche Fiat	
Kubach	Uwe	SAP	
Caldeira	José	INESC	
Kennedy	Patric	EFFRA	

Lindahl-Miskimin	Maria	VOLVO	
Carton	Michel	CETIM	
Flaig	Katharina	VDI Technologiezentrum GmbH	
MATTUCCI	Massimo	COMAU	
PAZIN	Zeljko	EFFRA	
Sol	Egbert-Jan	TNO	
Colombo	Armando Walter	Schneider Electric	
Beltran de Guevara	Eduardo	MONDRAGON	
Bessey	Eberhard	DAIMLER	
Bueno	Ricardo	Tecnalia	
Kidd	Paul	Cheshire Henbury	
Goirigolzarri	Andere	ERANET MANUNET II	
Maidagan	Xabier	ERANET MANUNET II	
Garczynska	Magdalena	CECIMO	
Gumusdere	Gokalp	CECIMO	
Menezes	Joakim	EFFRA	
Beernaert	Dirk	European Commission	
Filos	Erastos	European Commission	
Von Bose	Herbert	European Commission	
Valles	Lorenzo	European Commission	
Soede	Matthijs	European Commission	
Gentili	Andrea	European Commission	
Cleuren	John	European Commission	
Salonna	Roberta	European Commission	

Appendix 2 – Workshop Agenda

Workshop
Impact of the Factories of the Future PPP

Date: 15-16 March 2012
Place: Brussels, Belgium

15 March, Thursday

Venue: Av. de Beaulieu 31-33, 1160 Brussels, BU31-BU33 Buildings

13:30 **FOF PROJECT THEMATIC PRESENTATIONS (3 PARALLEL SESSIONS)**
The session will aim to foster links between projects of similar scope. Participants (around 20) attend one of the three sessions to which their project is pre-assigned. They are asked to give a 5-min presentation of their project addressing the following question: How will our project achieve societal and economic impact? (Innovation aspects, exploitation intentions, PPP added-value).

Session 1: (BU33 0/54)
Key Project Focus: Sustainable Manufacturing
Chair: Andrea Gentili, European Commission, DG RTD/G2
Rapporteur: Edoardo Rabino, Member of FoF AIAG

Session 2: (BU31 0/82)
Key Project Focus: ICT for Manufacturing
Chair: Erastos Filos, European Commission, DG INFSO/G2
Rapporteur: Dr Uwe Kubach, Member of the FoF AIAG

Session 3: (BU33 0/58)
Key Project Focus: High-Performance Manufacturing
Chair: John Cleuren, European Commission, DG RTD/G2
Rapporteur: Prof José Caldeira, Member of FoF AIAG

15:30 **COFFEE BREAK AND NETWORKING**

16:00 **FOF PROJECT PRESENTATIONS ON INNOVATION (3 PARALLEL SESSIONS)**
The session will aim to foster synergies between projects aiming at similar activities, likely to lead to innovation via the impact created. Project representatives (around 20) attend one of the three sessions of their choice. They are asked to give a 5-min presentation how their project is addressing the session topic.

Session 4: (BU33 0/54)
Expected Innovation Focus: Sustainability/Energy Use
How will our project assess energy-efficiency and/or carbon neutrality?
Chair: Andrea Gentili, European Commission, DG RTD/G2
Rapporteur: Edoardo Rabino, Member of FoF AIAG

Session 5: (BU31 0/82)
Expected Innovation Focus: Standardisation
In what way will our project contribute to interoperability and standardisation?
Chair: Erastos Filos, European Commission, DG INFSO/G2
Rapporteur: Dr Uwe Kubach, Member of the FoF AIAG

Session 6: (BU33 0/58)
Expected Innovation Focus: Effectiveness of Results Take-up
How will our project achieve significant uptake of expected project results and best practices beyond the immediate project stakeholders?
Chair: John Cleuren, European Commission, DG RTD/G2
Rapporteur: Prof José Caldeira, Member of FoF AIAG

17:30 CLOSE

19:00 NETWORKING DINNER
Location: "La Brasserie Van Maerlant"
Rue Van Maerlant, 2, 1040 Brussels

Welcome Address
Herbert von Bose, European Commission, Director DG RTD

Networking Dinner

21:00 END OF DAY 1 PROGRAMME

16 March 2012, Friday

Venue: Av. de Beaulieu 25, 1160 Brussels, BU25 Building (0/S1 Room)

PLENARY SESSION
Chair: Herbert von Bose, European Commission, Director DG RTD

9:00 WELCOME AND WORKSHOP OBJECTIVES
Zoran Stančič, European Commission, Deputy Director General, DG INFSO

9:15 LATEST INFORMATION ON HORIZON 2020
Herbert von Bose, European Commission, Director, DG RTD

9:30 **FoF PPP Impact – Expectations of Industry**
Rikardo Bueno, FoF Ad-Hoc Industrial Advisory Group

9:45 **Coffee break**

10:00 **Feedback from the Parallel Sessions**
Session rapporteurs

12:00 **Lunch Break**

Plenary session
Chair: José-Lorenzo Vallés, European Commission, Head of Unit, DG RTD/G2

13:00 **Panel/Roundtable Discussion: "The Added Value and Overall Impact of FoF Projects"**
How can we ensure that impact can be achieved? (Indicators, reporting, statistics etc.) Initially 6 min. interventions (on the first two/three questions) by each panellist followed by an open debate with 1 min interventions.

Panellists: *Eberhard Bessey, DAIMLER*
Eduardo Beltran de Guevara, MONDRAGON
Armando Colombo, SCHNEIDER-ELECTRIC
Uwe Kubach, SAP
Moderator: *José-Lorenzo Vallés, European Commission*

14:45 **Coffee Break**

15:15 **Rapporteur's Summary & Conclusions**
Paul Kidd

15:40 **Statement from Private Side of the FoF PPP**
EFFRA Representative

15:50 **Statement from the Public Side of the FoF PPP**
Dirk Beernaert, European Commission, Head of Unit, DG INFSO/G2
José-Lorenzo Vallés, European Commission, Head of Unit, DG RTD/G2

16:00 **End of Meeting**

Appendix 3 – Discussion Panel Questions

1) As compared to FP7/CIP business as usual, do you see advantages in the PPP approach for the private side? … and for the public side?

2) What is the impact of the projects on achieving innovation and the stated overall PPP goals?

3) Which indicators can measure the impact of the PPP and the leverage of private funds?

4) How can we achieve broader dissemination & stakeholder participation and an increased interaction between the projects?

5) How could the PPP achieve a proper cross-over between the objectives of the Recovery Plan and those of the EU2020 strategy?

6) Which criteria should be used to help identify the most suitable research areas in a roadmap for beyond 2013?

7) What barriers need to be overcome to promote market uptake of technologies in this area?

8) How could the PPP contribute to a possible Innovation Partnership?