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Is Technology Still Enough to Change the World?

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Purpose

The EU has a long tradition of legitimating its policies based on its “technical charisma”. The European Commission's initiatives are justified economically and supported politically through a strong link between science and policy-making. In this framework, forward-looking activities and quantitative models play a critical role, even more so in the field of R&D. It thus comes at no surprise that several FTA exercises have been implemented in the industrial technologies area in order to define priorities for research and to set up the R&D agenda.

Background & Context

The European Union has a long tradition of legitimating its policies based on its “technical charisma”. The European Commission’s initiatives are justified economically and supported politically by establishing a strong link between science and policy-making. In this framework, forward-looking activities and quantitative models play a critical role (Rossetti di Valdalbero, 2010). Probably the most illustrative example of such a tradition is the famous “Cecchini Report” published in 1988. This report stressed the “cost of non-Europe” in a prospective way in order to underline the benefits of the single market (Cecchini, Catinat and Jacquemin, 1988). The Cecchini report constituted a pillar of the future economic and monetary union and represented a methodological breakthrough for European integration (Muns, 2003).

Nowadays, some foresight exercises are even compulsory at the EU level. For instance, each new strategy or policy must be preceded by an “ex ante impact assessment” that analyses different future policy options and their potential impact. Forward-looking studies are particularly relevant in the field of research, where scientific and technological trends, objectives and options are the basic premises to define strategies and policies in a commonly accepted framework.

Europe is facing a double challenge. It must maintain or increase its competitiveness in the globalised economy while tackling the so-called “grand challenges”. This is now happening in the context of a financial and economic crisis, which implies severe budget restrictions for the public sector. These elements are clearly considered in the *Europe 2020 Strategy* (COM (2010) 2020 final), which puts forward three mutually reinforcing priorities for the current decade: ‘*smart growth*’ (developing an economy based on knowledge and innovation), ‘*sustainable growth*’ (promoting a more resource efficient, greener and more competitive economy) and ‘*inclusive growth*’ (fostering a high-employment economy delivering social and territorial cohesion).

To attain these interrelated goals, research on industrial technologies should play a relevant role. According to the European Union’s definition, industrial technologies cover *nanosciences and nanotechnologies, materials and new production technologies* (NMP). They are part of the “key enabling technologies” that “*will be at the forefront of managing the shift to a low carbon, knowledge-based economy*” (COM (2009) 512/3). In fact, traditional European manufacturing can hardly compete with the low wages in countries like China; yet, the current crisis has also shown that industrial economies, such as Germany, have been more resistant to crisis and/or have been quicker to grow again compared to economies strongly reliant on the service or the construction sector (Beck and Scherrer, 2010; Deutsche Bank Research, 2011). This alerts us to the still important role of industry for our economies. In any case, the only way for European industry to be competitive is through high added-value products: for instance, through the use of new materials and processes.

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Forward-looking Activities on Future Research Priorities, Sustainability and Societal Challenges

In the NMP area, several actions are implemented to contribute to strategic thinking and to define priorities for research:

– ***Specific forward-looking projects*** in this respect are the FP6 Futman, NanoForest, Sust Prod Consum, Clevertex, I*Proms or Mantys amongst others. They range from forecasting exercises, roadmaps, foresights, etc. focused on specific sectors to very comprehensive analyses covering socio-economic aspects and manufacturing trends (Alquézar and Anastasiou, 2010). Some of these projects have been at the basis of other initiatives, which guarantees a certain continuity and consistency of the main policy orientations. For example, Manvis and Futman were the pillars of the European Technological Platform Manufuture.

– ***The NMP Expert Advisory Group (EAG)*** is composed of 25 international experts from the various R&D domains of the NMP research programme. Its role consists in presenting the state-of-the-art in the respective NMP fields, reflecting on the research priorities, directions and required synergies with other thematic priorities (Kiparissides, 2010).

– ***Intelligent Manufacturing Systems (IMS)*** is an industry-led, international business innovation and R&D programme established to develop the next generation of manufacturing and processing technologies. It includes companies and research institutions from the European Union, Mexico, Korea, Switzerland and the United States. IMS manages IMS2020, a project funded by the European Commission under the NMP theme, aimed at creating roadmaps towards “intelligent manufacturing systems” by 2020, in areas like sustainable manufacturing, key technologies, standardisation or education (http://www.ims2020.net/).

– ***European Technology Platform (ETP)***, such as Manufuture (2006) or SusChem (2005). They aim at proposing, developing and implementing strategies for research and innovation in the fields of manufacturing, chemical engineering and industrial biotechnology. They were both launched in 2004 with the aim of speeding up the rate of industrial transformation to high-added-value and sustainable products, processes and services and providing solutions to critical societal demands.

Smart Adaptation and Social Responsibility of Innovation Systems

What are the main conclusions of these forward-looking initiatives? Two different but interrelated dimensions merit analysis:

- Conclusions related to science and technology development of industry
- Socio-economic conclusions

From the ***technological point of view***, a competitive industry must adapt its products very quickly to changing customer needs. This means that operations and, consequently, machines and tools have to be more and more flexible. As a consequence, manufacturing must be *self-adaptive, reconfigurable, multi-functional* and *cross-technological*, with a user-friendly human-machine interaction. The role of ICT will continue to increase since industrial processes are becoming more and more complex, which implies the need for computer-aided modelling and simulations.

As mentioned above, forward-looking studies consider that the use of new materials can allow traditional industries challenged by low-wage economies to be competitive by creating new products or giving better properties to existing ones. The FP6 projects CLEVERTEX (2005-2008) and NANOFOREST (2004-2005) showed how traditional sectors, such as the textile or forest products industry, can still compete if they are able to innovate. “Smart” textiles, such as conductive materials and lighting fibres, electronic components and sensors, or materials generating energy and power supply, amongst others, can be applied in sectors such as healthcare, automotive, protective clothing, interior textiles, and communication and entertainment. Experts estimate that intelligent textiles could account for around 10% of the total textile market by 2020, especially in the clothing branch. Something similar can be said about the forest industry, where the refinement of wood-based raw materials, with improved performance and added-value, has the potential to maintain or even increase European competitiveness in this sector.

In industrial technology foresights, *integration* is the keyword: integration between different technologies and materials, integration between production and services, integration between different stakeholders towards a common goal, integration between different sectors and activities. Such integration creates a number of difficulties. For instance, suppliers are not always ready to adapt to the needs of innovative enterprises. This issue is very common in the field of nanotechnologies where suitable raw materials and equipments are still very expensive while final products often need to follow arduous legal procedures to be approved, with uncertain public acceptance.

The consequences of such a need for integration (and innovation!) go beyond the technological aspects. ***Management styles*** need to be renewed. First of all, manufacturing has to meet technical demands (adaptability, economic performance, reliability) while being environmentally friendly and taking into account safety. New business models increasingly have to take into account social and environmental responsibility while being open to innovation. On the other hand, competitiveness requires innovation, which relies on the capacity of organisations to anticipate and prepare for changes, "*looking for options and opportunities for change before the business is forced to change*" (Willenius, 2008: 67).

Skills are a basic condition for the economy and society of the future: "*Human capital will replace physical capital at the core of competitive advantage"*, the FP6 FUTMAN project stated. The importance of human capital is underlined by several foresight projects in the field of industrial technologies, mainly as an obstacle for development. From a quantitative point of view, the low attractiveness of scientific and engineering careers is often evoked (see the FP6 projects MANVIS or SMART). Consequently, capacities for high-technology manufacturing are decreasing at a time when industry's technological needs are increasing (Johnson and Jones, 2006*;* Kiparissides, 2010). Something similar can be said about vocational education and training, the attractiveness of which continues to be challenged while European industry needs highly qualified workers (Cedefop, 2010). These trends are not just European, but their impact on our economies and societies can be particularly dramatic since one of the main competitive advantages of Europe over our competitors is our educated people (Salhberg, 2010).

From a qualitative point of view, forward-looking studies on industrial technologies are not very precise. While there is a consensus about the relevance of human capital for competitiveness and sustainability, critical questions are not answered: What kinds of human capital (i.e. which skills, attitudes, values) are necessary? Which reforms, which education models are needed to move towards a sustainable economy and society? How are they to be implemented?

There is a debate amongst education specialists and practitioners on these topics, which is also more and more present in the mass media. Some consider that, to increase economic competitiveness, education and training (and even research) have to be based on market principles: competition amongst pupils, amongst schools and universities, amongst teachers, amongst researchers, and amongst education (and research) systems. Market values are therefore embedded in education and training systems. As a corollary, standardisation and accountability are proposed as solutions to improve the quality and effectiveness of education almost everywhere, under the influence of Anglo-Saxon countries (Salhberg, 2006). Probably the best example of this so-called Global Education Reform Movement is the OECD's Programme for International Student Assessment (PISA), which is presented as the main international comparison tool between "good" and "bad" education systems, leading to policy reforms in national systems (Grek, 2009). Such principles are contested by other authors, who consider that standardisation and accountability may be counterproductive for enhancing economic competitiveness. In today's changing societies, principles such as flexibility, interpersonal skills, risk-taking and creativity, essential to promoting innovation, may be more efficient than just focusing on numeracy, literacy and scientific competences (Salhberg, 2006). The basic idea rests on a paradox: to enhance the economic competitiveness of our societies, education and training systems should be based on less competition. Education should be founded on principles such as collaboration, mutual trust and social interaction (Salhberg and Oldroyd, 2010).

Forward-looking studies on industrial technologies do not participate in this debate, but they provide some clues rarely taken into account by education and training specialists. Basically, a competitive industry requires innovation, integration and adaptability. These principles hardly match with standardisation and accountability. When foresight studies mention user-friendly worker-machine interactions in industry and open management styles, a new role is attributed to workers. This new role requires their *technical* skills to be accompanied by a large set of *soft* skills, such as communication, creativity, risk-taking, problem-solving, interpersonal skills, etc.

Towards a New Social Paradigm?

The previous analysis focused mainly on competitiveness. What are the trends and challenges of industry to maintain its competitiveness? Little has been said about global challenges, amongst them sustainability. Are science and technology applied to industry enough to tackle societal challenges? This is indeed one of the arguments of climate change sceptics.

According to the NMP forward-looking studies, the answer to such a question is no. A sustainable economy is unrealistic without the development and adoption of ***new socio-political paradigms*** and, consequently, of both new production *and* consumption patterns (FUTMAN). There is a clear gap between dominant social paradigms and values (i.e. consumption sovereignty in a market economy) and sustainability (SCORE!). In sum: we need to live, work and consume in a different way. Such a ***social paradigm shift*** requires extended efforts, shared between citizens/consumers, political leaders, researchers and industry. The idea of science- and technology-supported unlimited progress and growth, the dominant paradigm since the Enlightenment, is therefore challenged. Research and innovation can help to tackle grand challenges by developing and applying resource-efficient technologies, but they can hardly solve them on their own. Without social innovation the technical developments might not be put into practice because they do not correspond to the problems generated by human behaviour. Therefore, social innovation requires bottom-up innovation and a participatory approach involving the citizens, as formulated by a business panel on future EU innovation policy:

> *"People centred innovation is crucial in our way of thinking about policy, actions and instruments. It means that public policy can link people to opportunities, infrastructures, competencies and incentives. Innovation policy to reinvent a new Europe in the future will involve many actors. It is not about the government running or doing things alone." (European Commission, 2009).*

Thus, some of the forward-looking studies focus on the emergence of social innovators, such as "creative communities", i.e. active, enterprising people who invent and implement new ways of dealing with everyday problems – childcare, care for the elderly, alternative means of transport, shared facilities and services, etc., or the Slow Food Movement (EMUDE, SCORE!). A top-down approach or the need for leadership is also mentioned: policy-makers could create incentives to move towards new "meta-values", through higher transparency about environmental and social performance or with actions to make working patterns more flexible, facilitate the use of public spaces, devise new forms of taxes for alternative economies, etc. This emphasises the fact that the interaction between the innovators and the environment they are working in is crucial. A good example are the current "wikirevolutions" in the Arab world (Castells, 2011). Democratic movements have not been produced because of technologies, but through using them (i.e. Facebook, Twitter, Youtube) – in an absolutely decentralised way without a central strategy. Social change can come at any moment – especially, when people have not been allowed to take part in shaping their society for decades. Social innovation plays a considerable part in shaping and reshaping society as a more participatory arena where people are empowered to act as in a functioning democracy. Therefore, to close the parallel, there is a democratisation of innovation needed in order to be able to change the world.

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