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Emerging S+T Priorities in the Triadic Regions

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Purpose

The objective of this Platform Foresight project is the analysis of emerging science and technology priorities in public research policies of the European countries, the US and Japan. The aim is to provide the European Commission and the member states with policy recommendations as to become leaders in these emerging technologies.

Context and Challenges Addressed

The study helped identifying scientific and technological developments and research priorities in which Europe could take the lead in the years to come. By providing recommendations for public policy support to emerging science and technology priorities, the study aims at contributing to research and innovation policies of the European Union.

Methodology and Main Steps

The global approach of the project comprises 3 major stages. Two main drivers have thereby been used as analytical focusing entry points: technology and public policy. The first stage deals with the identification of emerging issues in science and technology developments. Members of the consortium using existing foresight literature carried out this task through **desk research**.

The second stage consists of identifying potential leadership areas for Europe among the emerging science and technology developments. This stage is based on primary research in the form of an **expert panel survey**. This survey is thereby divided into two rounds. While the first round aims at identifying science and technology priorities for Europe, the objective of the second round is to analyse potential areas of leadership for Europe on the basis of an assessment of both the continent's strengths and weaknesses in the identified science and technology areas as well as the socio-economic factors for public policy support. The relative position of Europe compared to that of the USA and Japan is of utmost importance in this part.

The third stage aims at defining policy recommendations in support of the development of potential leadership areas for Europe. This stage is also based on primary research in the form of **expert interviews** as well as collaborative work arrangements favouring multiple interactions and exchanges.

The EFMN is financed by the European Commission DG Research. It is part of a series of initiatives intended to provide a 'Knowledge Sharing Platform' for policy makers in the European Union. More information on the EFMN and on the Knowledge Sharing Platform is provided at WWW.EFMN.INFO

Priorities in the 'Classical Fields' - Nanotechnologies, ICT, Environmental Technologies & Life Sciences

By means of a questionnaire sent to more than 300 experts, a list of 104 technologies – established by scanning foresight literature - has been evaluated. Four priority fields have been retained: nanotechnologies and new materials, information society technologies, life sciences and technologies for sustainable development. 40 technologies have been selected as the main priorities for the future.

Among the priorities identified in the fields of **nano-technologies, knowledge-based multifunctional materials, new production processes** are:

- Bio-active materials and surfaces based on bio-polymers, bio-compatible materials, bone replacement materials, nano-structured surfaces for implants, Titanium dioxide nano-particles for anti-bacterial surfaces, silver nano-particles as antibiotics, etc.
- Complete modeling for the transformation of materials and integration in databases - virtual chemistry.
- Nano-composites and nano-metrical-nano-scale reinforcements in electronics, chemistry and medicine.
- Design of structures with intelligent behaviour and response.

Among the priorities identified in the fields of **information society technologies** are:

- Software technologies for transport of digital data
- Computer-aided surgery
- Multipurpose intelligent and mobile robots
- Image sensors for robot perceptive systems and other image processing applications.

Among the priorities identified in the fields of **sustainable development, global change and ecosystems** are:

- Capture and storage of CO2
- Low-cost high-efficiency solar cells
- More efficient energy consumption based on technologies such as hybrid cars, diode-based lighting technology, new technologies for monitoring and controlling heat and ventilation.
- New energy storage technologies using new approaches such as those based on flywheels, super-caps, supra-conducting magneto-electrical storage.

Amongst these 40 technologies, the highest priorities belong to the **life-science field including genomics and biotechnology** for health, such as:

- Cell therapy
- New tools for in-vivo diagnostics such as contrast media for ultrasonic technologies and nuclear visualization methods
- Application of stem cells in the treatment of different diseases such as neurodegenerative
- Active packages, such as bio-degradable packaging and micro-sensors for food security and transparent food information.

The Economic Paradigm

The economic factors provide the most important rationale impacting public R&D support policies in virtually all priority fields with the partial exception of the field of Sustainable Development, and almost regardless of the geographical area.

Even though the relative importance of the economic variable may differ between countries, the related issues of international competitiveness, economic development and job creation form an integral part of most countries' public R&D policies.

The defining characteristics of the US public R&D policy are:

- An even stronger impact of the economic factors than in other geographical areas,
- The enormous influence of defence-related research activities and
- The importance given to the high potential areas made up of converging technologies.

In the Japanese context economic issues play an equally dominant role motivating public R&D support policies in virtually the entire range of high priority technology fields. Moreover, the awareness of a number of the country specific conditions such as demography and geographic location provides additional but socio-environmental rationales.

Of the triadic regions, Europe is one most strongly influenced by societal factors. As a matter of fact, ecological and quality of life issues generally provide a unifying and defining element in European public R&D support policy.

Europe is faced with policy rigidities that have an important impact on the efficiency of public support. This influences both the form in which support is provided and the structure of the research organisation itself. In the USA, defence-related R&D activities and the creation of the NNI increase the efficiency of public policies. Europe does not have any such support mechanisms. What is more important, the key role of the environmental factor expressed through the precautionary principle and the relative weakness of policy institutions at European level seem to represent further obstacles to the creation of efficient public support structures.

Europe Sets Priorities in Sustainable Development

The field of information society technologies is to a large extent a reflection of present market realities and the corresponding presence of leading enterprises notably in Europe, especially in the area of mobile communication. This field provides an important potential for Europe, particularly as regards the newly emerging health sector applications, which is not least due to the relative importance accorded to societal factors in Europe.

Although sustainable development is considered an important issue by all governments it constitutes the field in which country specific differences are most significant. Whereas most countries agree on the importance of sustainable development, there is no consensus on the technologies that are likely to promote this type of development. In the area of energy for example France favours nuclear technologies, Germany favours solar power and Spain favours wind.

The field of life sciences constitutes the potentially most important research area. In spite of a slight head start of the USA, the sector remains an area with competitive positions still being largely undefined and in which there are no strong differences on the specific technology level. Public support can thus make a real difference, ideally being targeted at the entire sector. Taking into account the relative importance of social-environmental factors, Europe has the potential of occupying a leading role in the future life-sciences scientific field.

Policy Recommendations

To prevent a decline of Europe S&T positioning in the eventuality of a failure of the Lisbon strategy combined with the consolidation of current trends that emphasise economic factors for the support of R&D, the corrective strategies for Europe could include:

- The promotion of public and private partnerships,
- Fostering industrial R&D strategies based on technologies where **potential for leadership** exists in Europe,
- The promotion of '**centres of excellence**' at regional level,
- Development of **research centres** to create the conditions to **attract foreign researchers** in key technologies in which Europe or a majority of European countries needs extra competencies.

1. Additional specific actions - transfer activities, 'trans-national' research and provision of venture-capital should aim at **enhancing the transfer** process management from R&D to application/innovation in Europe. Specific technologies that are very dependant on such links could be targeted. Examples are provided by smart materials, ultra-thin functional coatings, micro-sensors and nano-sensors.

2. Establish a strong industrial European strategy as a basis for an R&D **strategic policy linked with economic issues**. As long as Europe will not have such strategy, R&D targeting on economic issues will depend on national will and national environment and opportunities.

3. Enhance the **participation of SMEs** - which constitute the basis of European industrial environment - in R&D projects. A first step could be to simplify public support procedures today often analysed as 'too bureaucratic, too formalistic, too rigid' or 'complex proposal procedures, slow administrative processes and high administrative expenses', at European level and often at national level.

4. Access of small research intensive companies to **venture capital** should be strongly supported - incentives, organisation, networks, pools - mainly in the field of ICT, Life-Sciences and nanotechnologies. A specific recommendation could be to support at political level the creation of a venture capital line at the European Central Bank.

5. Launch a programme to overcome the significant differences in the views of European countries with regard to technologies that **promote sustainable developments**.

6. Organize some awareness raising campaigns **targeting the public** at large in order to promote a better understanding of the potential applications of some key technologies, such as stem cells or protein engineering.

7. S**upport sustainable development know-how** throughout Europe by means of conferences, CD ROMs and other media.

8. O**rganize awareness** of the scientists of what happen elsewhere in applications' focused R&D

9. Promote legal frameworks to to favour the development of R&D on key emerging technologies by:
   - Encouraging national legislation to **facilitate approval** procedures for tissue engineering products
   - Strengthening legal protection of the European **cultural collections**
   - Proposing **EU regulations for nanotechnology** and nano-particle use in therapy
   - Adopting a **clear position at European level** on the patenting of human DNA and human stem cells

10. O**rganise networking** between scientific communities to foster convergence: micro-robotic, virtual reality and computer aided surgery, mobile communications and health services, neurology-nano-sensors, neuro-informatics.

11. Use applications' targeted projects to **reinforce convergence**: in domains such as nano-computers, applications of multi-purpose robots and micro-robotics applied to biology.

12. F**acilitate cooperation** between research institutes and very small firms or associations through European Research programs: groups of artists for research in virtual realities, artists and industries, SMEs in FP7.

13. Foster the field of sustainable development in the years to come. It seems necessary to underline that **external costs are real costs.** This needs to be done permanently, on the basis that externalities often have a strong local impact.

14. Face issues at worldwide level. Europe could foster broad **dissemination of results**. In the area of sustainable development, this could take the form of support for R&D projects in which research activities are carried out in Europe and demonstration activities are carried out in developing countries.

15. A strong focus in the public support should **target molecular imaging technologies**. The USA has clearly taken the lead on these. It is of great importance to keep companies' imaging research potential within Europe. Already we can observe the start of a brain drain in this domain.

16. Beyond legal initiatives to encourage national legislators to facilitate approval procedures **for tissue engineering**, there is a real need for clinical and economic studies on this technology. These studies should be included in the EU Framework Programmes.

17. It is necessary to enhance the **GEN-AU** program for **GEN**ome Research in **Au**stria. Mainly to attract researchers back to Europe to work in the human genomes and proteomes field. The same recommendation can also be made for protein engineering through a **European HUPO** project to tackle **HU**man **P**roteome **O**rganisation.

18. It is necessary to ensure **continuity** in the European Union framework programs as biotechnology research needs long-term activities to attract private companies.

Informing the general reflections regarding the structure and content of the 7th Framework Program, the results of the project are likely to have a high level impact on both national and international level.

The detailed findings will be made accessible through the publication of the Final Report which the European Commission is currently preparing.

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