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Nanosciences and nanotechnologies: what future for research

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When looking at science, technology and industrial innovation, we count ourselves lucky to be living in such an exciting period. Increasingly, important changes are introduced rapidly in our daily life with great advantages and unexpected challenges.

Together with the development and introduction of new technologies, globalisation is having a multiplying effect, boosting dynamism and potential.

However, like other big changes, globalisation and new technologies are also generating discontinuities in our economic systems: (i) in economic models, (ii) in the approach to production and (iii) in the skills demanded of people. I now propose to draw your attention briefly to some considerations on these three discontinuities, which are at the same time three great challenges for us all.

The first discontinuity and challenge is a transition from a "traditional economy" to a "new economy", from an economy based from traditional resources to an economy based on knowledge. In standard textbooks on economics, the triplet of “land-labour-capital” corresponds to the generation of wealth. In our new perspective, the binomial couple “knowledge-capital” is replacing this traditional triplet.

This transition has multiple and powerful effects: moving from an economy of "quantity" to an economy of "quality", from an economy of "use and waste" to a sustainable economy, where we become able to produce without destroying or depleting the quality of life for our next generations.

Information technologies first and biotechnologies launched this fast-developing and self-catalysing process. Most of society's activities were heavily affected, most of all manufacturing industry. Products, services, work and production routes became more brain and capital intensive, and less labour and resources intensive.

Materials sciences and nanotechnology allow us now to go one big step further, adding added value and "intelligence" to materials, components and systems. This will offer great

benefits to society and boost the shift from production-oriented approach to a use-and-performance-driven industrial society.

This consideration inclines me to comment to you on the second discontinuity and challenge: the possibility of abandoning the linear, Taylorist (and historically “top-down” approach) towards more complex, simultaneous, “bottom-up” approaches. We all know that this transition presents a disruptive potential. It also requires radical changes (and engenders resistance) in industry's organisation and ways of production. To change or to be replaced? The famous doubt expressed by Hamlet is ever present when Nature or Mankind face big changes.

Novel activities, and the new generation of high-tech industries are showing up on the market. The shift from labour-intensive to brain-intensive operations modifies jobs and the skills required of engineers and the workforce.

This then is the third discontinuity and challenge that I want to propose to you today. During the industrial boom, linearity was also introduced in the production of knowledge. Researchers did research; engineers and technicians came along later to adapt and apply it. The move towards complex, simultaneous, bottom-up approaches will reward those scientists and technicians who will be able to produce the knowledge, to adapt and use it, and to have an entrepreneurial spirit all at the same time. Many more multi-disciplinary skills are needed to be "a winner" from now on.

This Conference will give to each of us the occasion to learn about new progress and to confront him- or herself with the best that is being developed, in Japan and in the world.

Indeed, nanosciences and nanotechnologies have the potential to play a paramount role in revolutionising many of our traditional ways of thinking, working and producing. They can revert the traditional scientific approach and production method of proceeding, from “big” to “small”, used since the dawn of human beings.

The new goal today is to shift from “small” to “big”, adding together atom by atom and molecule by molecule. Conceptually, this is easy: it is just an imitation of nature. In practice, it is a huge revolution that is allowing us to create higher performance products and processes, within an ideal context of sustainable development.

Industry will be one of the major beneficiaries of nanotechnology, approaching it in a rather “top-down” direction. Universities, on the other hand, are engaged in exploring “bottom-up”, self-organising, self-assembling routes. Both ways need huge investment in terms of people, research, infrastructures and financial resources. The more we generate knowledge and understanding at the nanoscale, the quicker we will be able to use these in industrial production.

In 2010 or 2015, if future forecasts are to be believed, we can expect nanostructured materials and products to generate income of the order of magnitude of one trillion of € (or $): from electronics to telecommunications, from materials science to biotechnology. To achieve this we necessarily need a new generation of some 2 or 3 million engineers, technicians and operators able to innovate and work in the new nanotechnology-based industries. Who is already thinking about educating all these newly skilled people?

To pass from a “macrocentric” to a “nanocentric” system, we need a vast multidisciplinary knowledge, a strong ability of integration and a positive attitude to complexity. We need

the courage to leave rigid and pre-determined schemes and the ability to develop new excellence in research and education, through new study courses and curricula vitae.

We have reached the intrinsic limit of the rigidly sub-divided, mono-disciplinary and linear science, which has marked several centuries of development. We are going further.

It is difficult to foresee the necessary time for implementing this new technological approach. Apart for a new scientific/technical culture, more entrepreneurship, long term capital, responsible behaviour and clear “rules of the game” are required for entering the “nanoworld”.

There are many barriers and challenges. A large critical mass is required in terms of both human and material resources. This implies a new way of co-operation being more open, reinforced, transparent and verifiable.

More knowledge means more power. More power demands more responsibility. The potential offered by control at the nano-level must be matched by an appropriate analysis and control of the possible risks. The education of the new players should be underpinned by a sound ethical consciousness and by responsible attitude.

At all levels, great potential impacts also demand collective responsibility. We cannot overlook that “nano” will also stimulate worry and incomprehension among ordinary people. I guess - for instance - that the first nano-related science-fiction movies will soon appear.

The discussion on the ethical and social aspects of nanotechnology is part of a large dialogue with the public. It may result in regulations that take into account societal values and demands. Launching broad discussions on this matter is, therefore, also a means to guarantee that new products have a marked, since they will be built following citizens’ requests and expectations.

Sound, science-based information is due. Transparency is necessary: What are we doing? How do we intend to use the results? Social acceptance and the trust of the general public will depend crucially on this.

Appropriate “rules of the game” are also needed, on the one hand to secure industrial property rights and the return on the money invested in research and development, and on the other hand to avoid the creation of “technological paradises” where dangerous technologies and applications could be developed.

With the research efforts and resources invested, we can expect that nanosciences and nanotechnologies will progress well. This implies the possibility of a “nano-divide” with many countries in the world that risk to be left out. There is, therefore, also an ethical priority to grant everybody interested a way of access to knowledge, since a new “knowledge apartheid” could lead to unacceptable differences in the social-economic development among different regions of the planet.

Europe has accepted all these challenges.

Public funds devoted to research in Europe come from the Member States and from the European Union (via the Research Framework Programmes). Research funded by the Union, although less in quantity, plays a pilot role and acts as catalyst of a much larger

critical mass. In the case of the recently launched 6th Framework Programme (period: 2003-2006), nanosciences and nanotechnologies are a priority, and the role played by the Union's initiatives is proportionally of paramount importance here. In broad terms, we can estimate the grand total for the European investment in nano-research being now of the order of some 700M € per year.

The 6th Framework Programme has been tailored to help better structure European research and to cope with the strategic objectives set out by the European Heads of State and Governments in Lisbon in 2000. This should enable Europe to become the most dynamic and competitive knowledge-based economy of the World within the next 10 years. The commitment is clear: a sustainable development.

Top-quality research in very advanced and promising priority technological areas is vital to foster such a transformation of European industry and society. Nanosciences and nanotechnologies are one of these priority areas.

Research will be long term and highly challenging, but oriented towards industrial breakthrough applications. Special emphasis will be given to education and training to create the required pool of multi-disciplinary skilled personnel, without whom any "nano-revolution" will be impossible. Hence the need to increase awareness for these new scientific and technological challenges.

However, Europe does not plan to go alone. We are ready to gather a critical mass whenever and wherever appropriate in order to achieve our goals more effectively and more rapidly. Indeed, another peculiarity of the 6th Framework Programme is its openness to international co-operation. Researchers from virtually all countries of the world can participate. Reinforced co-operation is enforced with those countries which have a bilateral scientific/technical agreement incorporating nanotechnology, such as the USA, China and Russia.

Within such an ambitious vision ahead of us, we must reflect and ask ourselves: which are the best conditions for helping this change and for driving it forward towards the best in the interest of well-being of all people? Such a complex question will hopefully find valuable elements of an answer in this Conference, which gathers so many researchers, industrialists, investors and stakeholders of the highest world-class level. This is an opportunity not to be missed. We must grab it with both hands.

Note: *More information about nanotechnologies and FP6 industrial technology research may be found on the industrial technologies website at: http://europa.eu.int/comm/research/industrial_technologies/index_en.html*