CONCLUSIONS

EuroNanoForum 2003: a high-level, unique debate on the development of nanosciences and nanotechnologies in Europe

The EuroNanoForum 2003 event (conference, workshops, posters sessions, exhibition, media briefings, and youth initiative) has gathered key players and specialists in research, education, industry, financing, social sciences, journalism and public administration, with the participation of many top-level scientists and stakeholders, and has had a very good international dimension, with more than 1000 participants from the 5 continents. Moreover, about 1000 students participated in an ad-hoc event of the Nanotech-Young initiative especially organised in parallel to the Forum. Five ancillary specific workshops were held, covering research, financing and venture capital, national nanotechnology initiatives, and international collaboration, including several minor ad-hoc events dedicated to foster contact with "INternational COoperation Countries" (INCO) and their participation in the European 6th Framework Programme for Research and Technological Development. An exhibition of 20 stands highlighted EU and international nanotechnology initiatives, programmes, projects and companies. Six dedicated press events have been organised for the almost 50 journalists who participated; a much greater number of papers has been issued in the international press to date.

The Forum has proposed an integrated approach to nanotechnology, through 15 sessions devoted to key issues. It enabled the definition of elements targeting a common strategy for the future of nanotechnology research and technological development in an enlarged Europe supported by a strengthened international co-operation.

The previous chapters of these Proceedings illustrate the many high-level contributions to the Forum, in both the oral sessions and workshops, and highlight a number of key cross-cutting issues for action and follow-up:

1. Nanotechnology research and development is intellectually challenging and exciting, economically profitable and generates products and services with higher added value and better in-service performance to the benefit of the European citizens.
2. There is a need for developing new knowledge in nanosciences, including instruments for manipulation and characterisation, and metrology. Interdisciplinarity (including the "converging technologies" model) is a main challenge, as well as, for instance, self assembly, in-service performance and stability of 3D nanostructured systems. Also for the possible drawbacks there is need for additional knowledge. No "moratoria" were requested at the Forum.
3. Due to the intrinsic complexity and the high technological risk, public funding is essential at the present stage. It is necessary to fund integrated, ambitious nanotechnology research projects with application ("breakthrough") potential.
4. Availability and access to world-class infrastructure (from big science to fabrication) in Europe is essential. A coherent approach at Community level would be greatly beneficial.

5. Research teams are called upon to play a crucial role by taking ideas from basic research and turning them into innovative production schemes. Many researchers are thus turning into entrepreneurs.
6. To attract capital, new nanotechnology companies are requested by the financing bodies to prove scientific and technical excellence, clear property of their rights (IPR), management skills and operation in fields that do not present ethical or environmental problems.
7. New entrepreneurs would like financing bodies to provide more assistance when supplying risk capital (rather than credit), as well as for management tasks. The "death valley" effect is always a risk for new companies.
8. Existing, well established industries may be hesitant in the face of nanotechnology. On the one hand, missing the pace of progress in nanotechnology may leave them vulnerable to lose competitiveness, and on the other hand, they might be able to devote only limited funding to research and innovation. A change of culture is also usually a challenge.
9. Interdisciplinarity and outreach are two challenges for researchers, educators and students. Specialisation in traditional disciplines should be accompanied by interdisciplinary opening ("sandglass model") so to allow new ideas being developed in research and production. New university courses could be launched at European level, particularly in synergy with new infrastructure. "Hands on" approaches are encouraged in teaching (e.g. the "teaching in hospital" model or the "learning factory"). It is never too early to start with the interdisciplinary approach !
10. Researchers should take into account the demands of the civil society, first of all responsibility in their actions and due information. New forms of dialogue should be explored. Transparency builds trust. However, nanotechnology can be very complex and this presents a challenge to science communicators.
11. International co-operation has great potential to achieve larger critical mass where appropriate, such as in studies on health and environmental impact and, possibly, to establish a "code of conduct" at global level (some mechanisms were proposed such as an international high-level advisory group). The avoidance of a "knowledge apartheid" is also essential to allow all Countries to profit from the benefits of the nano-approach.

The Forum has also addressed key technological fields and nanotechnology applications in specific technical sessions. The state-of-the art in the most representative areas has been presented and discussed.
Enormous progress has been made by nanotechnologists and a strong knowledge base has been created worldwide which has now to be exploited and developed:

✓ Nanotechnology has made already remarkable progress in the healthcare area with (i) targeted drug delivery, (ii) biocompatible tissue regeneration and (iii) new sensors. Early cancer diagnosis and its treatment are a primary goal.

✓ In electronics, nanotechnology offers remarkable possibilities for progress and the industry is already well advanced in the production route. In the long term, spintronics, quantum computing, molecular and biomolecular electronics, photonics and plasmonics are ambitious research domains.

✓ Design at the atomic or molecular level is leading to remarkable improvements in material functionality and improved in-service performance of the final products (e.g. in energy, transport, textiles, surface sciences, optics, security, etc.), and this also under extreme

conditions (e.g. in space). Interdisciplinary approaches and manipulation tools are main challenges for the near future.

✓ In the manufacturing field, conceptually speaking, there are two main paths that can be followed: further miniaturisation of devices ("top-down" approach) or development of new devices starting from the atoms or molecules to build micro-, mini- or macro-structures, somehow mimicking nature ("bottom-up" approach). The former can be linked to manufacture via assembly and the latter to manufacture via synthesis. Once self-assembly technologies will be realised, the introduction of totally new production routes will be formulated. This puts forward a true new and revolutionary way of processing and represents the ultimate challenge to the transformation of industry.

Towards a European strategy for nanotechnology: a Communication from the European Commission

The outcome of the Forum and the success of the full integrated approach proposed have enabled the Commission to define, at the beginning of 2004, the key elements for a common strategy for the future of nanotechnology research in an enlarged Europe supported by a strengthened international co-operation.
The set of recommendations to the Member States are the subject of a recently published Communication from the European Commission, "*Towards a European strategy for nanotechnology*", *COM(2004) 338*.
Adopted on 12th May 2004, the document seeks to bring the discussion on nanosciences and nanotechnologies to an institutional level and proposes an integrated and responsible strategy in an enlarged European Research Area, to enhance knowledge creation and investment in nanotechnology R&D and turn it into better quality of life, competitiveness and jobs.

The main action lines of the Communication are summarised in its executive summary, which we reproduce hereunder.
The full text can be downloaded in several languages from the web site www.cordis.lu/nanotechnology.

Nanosciences and nanotechnologies are new approaches to research and development (R&D) that aim to control the fundamental structure and behaviour of matter at the level of atoms and molecules. These fields open up the possibility of understanding new phenomena and producing new properties that can be utilised at the micro- and macro-scale. Applications of nanotechnology are emerging and will impact on the life of every citizen.

Over the last decade the European Union (EU) has established a strong knowledge base in nanosciences. Our ability to maintain this position is in doubt since the EU is investing proportionately less than its main competitors and lacks world-class infrastructure ("poles of excellence") that muster the necessary critical mass. This is despite the fact that investment in national EU programmes is growing in a rapid but independent way.

European excellence in nanosciences must finally be translated into commercially viable products and processes. Nanotechnology is emerging as one of the most promising and rapidly expanding fields of R&D to provide new impetus towards the dynamic knowledge-based objectives of the Lisbon process. It is crucial, however, that a favourable environment for innovation is created, in particular, for small and medium sized enterprises (SMEs).

Nanotechnology must be developed in a safe and responsible manner. Ethical principles must be adhered to and potential health, safety or environmental risks scientifically studied, also in order to prepare for possible regulation. Societal impacts need to be examined and taken into account. Dialogue with the public is essential to focus attention on issues of real concern rather than "science fiction" scenarios.

This Communication proposes actions as part of an integrated approach to maintain and strengthen European R&D in nanosciences and nanotechnologies. It considers the issues that are important to ensure the creation and exploitation of the knowledge generated via R&D for the benefit of society. In this context, the time is right for launching a debate at an institutional-level in view of coherent action to:

– increase investment and coordination of R&D to reinforce the industrial exploitation of nanotechnologies whilst maintaining scientific excellence and competition;

– develop world-class competitive R&D infrastructure ("poles of excellence") that take into account the needs of both industry and research organisations;
– promote the interdisciplinary education and training of research personnel together with a stronger entrepreneurial mindset;

– ensure favourable conditions for technology transfer and innovation to ensure that European R&D excellence is translated into wealth-generating products and processes;

– integrate societal considerations into the R&D process at an early stage;

– address any potential public health, safety, environmental and consumer risks upfront by generating the data needed for risk assessment, integrating risk assessment into every step of the life cycle of nanotechnology-based products, and adapting existing methodologies and, as necessary, developing novel ones;

– complement the above actions with appropriate cooperation and initiatives at international level.

The actions described in this Communication are also in line with the European Councils of Lisbon 2000, declaring the commitment to develop a dynamic knowledge-based economy and society, of Gothenburg 2001, aiming at sustainable development, and of Barcelona 2002, targeting 3% of GDP funding for research[1]*. It also contributes towards the development of the European Research Area (ERA)*[2] *and profits from it.*

The extensive debate held at the Forum contributes to the definition of several initiatives and international collaborations that the Commission could launch in the field.
The great enthusiasm created suggests that the event could become the first one of a series. The integrated and responsible approach to nanotechnology has appeared to be determinant to support nanotechnology in Europe within a vision of sustainable development.

---

[1] Presidency conclusions can be downloaded from http://ue.eu.int/en/Info/eurocouncil/index.htm

[2] "The European Research Area: Providing new momentum - Strengthening - Reorienting - Opening up new perspectives" COM (2002) 565 final.