

FOREWORDS

Die großen Herausforderungen unserer Zeit – Klimaschutz, zukunftsfähige Energieversorgung, Bekämpfung von Krankheiten – werden wir nur bewältigen, wenn wir unsere Kräfte in der Forschung noch stärker bündeln und gemeinsam nach Lösungen suchen. Insbesondere Nanomaterialien können bei der Gestaltung unserer Zukunft eine wichtige Rolle spielen. Sie liefern Bausteine für neue Technologien und ermöglichen damit nachhaltige Energiekonzepte und Transportsysteme, eine effizientere medizinische Versorgung und neue Informationstechnologien. Eine europäische Strategie für Nanowissenschaften und Nanotechnologien, die alle relevanten wissenschaftlichen Disziplinen berücksichtigt und neben Universitäten und außeruniversitären Forschungseinrichtungen auch Partner aus der Industrie einbezieht, wäre ein wichtiger Schritt auf dem Weg zur Entwicklung solcher maßgeschneiderter Nanomaterialien.

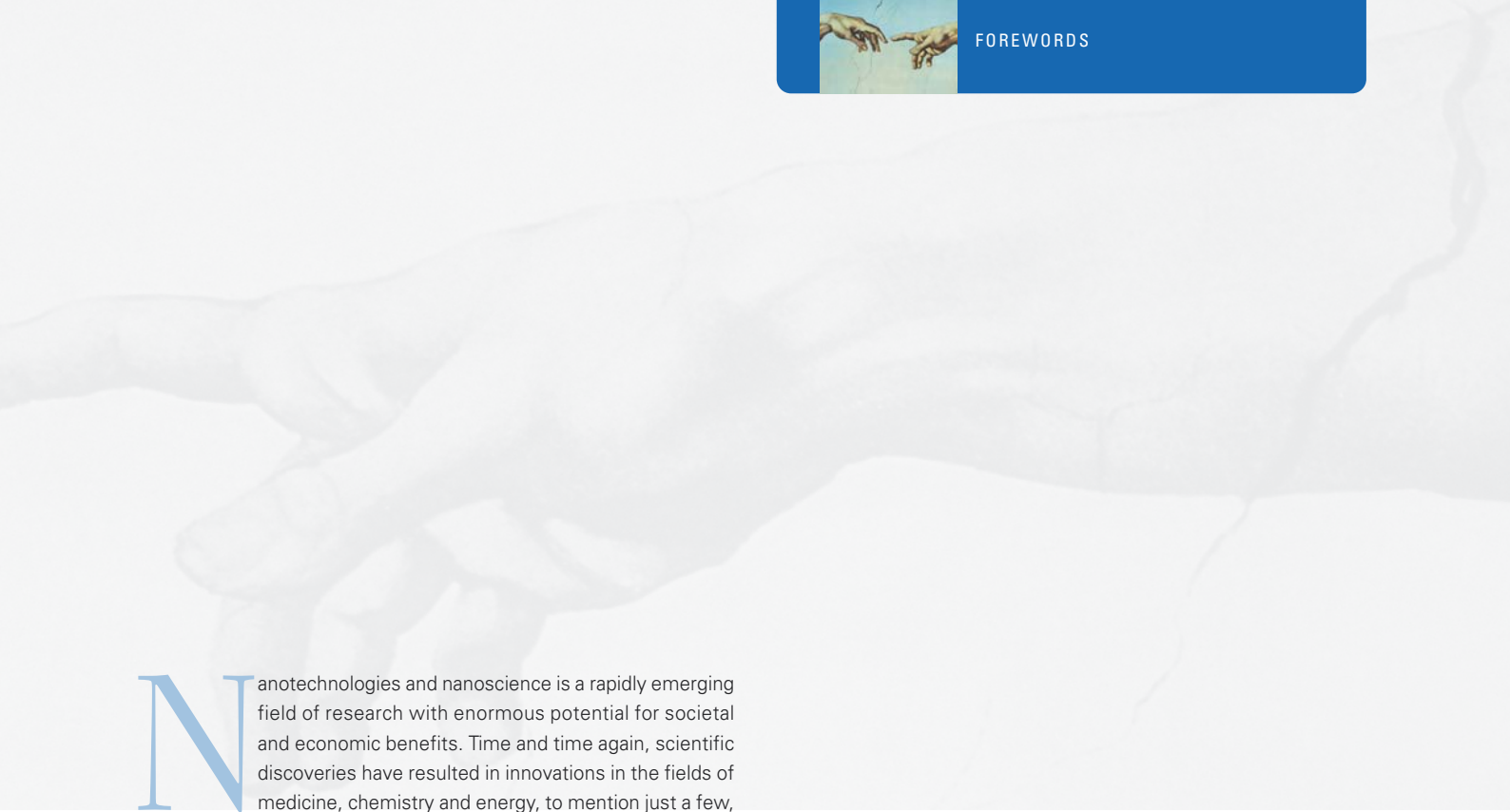
Die GENNESYS-Studie ist ein Meilenstein in den Nanowissenschaften und Nanotechnologien. Unter der Leitung des Max-Planck-Instituts für Metallforschung in Stuttgart haben Wissenschaftler mit unterschiedlichem Hintergrund und Wirtschaftsvertreter verschiedener Branchen gemeinsam mit den Betreibern der europäischen Forschungsinfrastrukturen dieses – für die nächsten Jahrzehnte wegweisende – Referenz-Dokument zusammengestellt. 800 weltweit führende Materialwissenschaftler und Ingenieure identifizieren in ihren Beiträgen Forschungstrends und -bedarfe. Und sie benennen die Herausforderungen, die wir meistern müssen, damit Europa seine globale Spitzenposition in den Nanowissenschaften und Nanotechnologien behaupten und weiter ausbauen kann.

GENNESYS zeigt, dass Schlüsseltechnologien bahnbrechende Innovationen hervorbringen können. Eine entscheidende Rolle spielt dabei die europäische Forschungsinfrastruktur mit ihren Neutronen- und Beschleuniger-basierten Röntgenquellen. Ihr einzigartiges analytisches Potenzial ermöglicht eine neue Strategie für nachhaltiges Wachstum in Europa.

Ich danke der Max-Planck-Gesellschaft, die dieses ambitionierte Projekt ermöglicht hat, und allen, die an dieser Studie mitgearbeitet haben.



Annette SCHAVAN
Bundesministerin für Bildung und Forschung
Federal Minister for Education and Research, Berlin (DE)



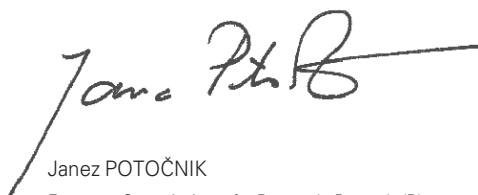
Nanotechnologies and nanoscience is a rapidly emerging field of research with enormous potential for societal and economic benefits. Time and time again, scientific discoveries have resulted in innovations in the fields of medicine, chemistry and energy, to mention just a few, that have a profound impact on our daily lives.

Although the pace of development is very fast, fundamental science still plays a significant role due to the unique challenges of manipulating and characterising matter at the nanoscale.

World-class research infrastructures often play a key role in unlocking the mysteries of fundamental science. However, research infrastructures are expensive. In current times of global economic downturn, it is more important than ever to overcome the fragmented infrastructure spending across the EU and even to increase the overall investments. Within the European Research Area (ERA) we have the ambition to maximise the effectiveness of resources available.

The European Strategy Forum on Research Infrastructures (ESFRI) has compiled a roadmap for pan-European research infrastructures. In December 2008, there were 44 proposals being developed for new large-scale or European distributed research infrastructures and no fewer than seven of these directly address materials sciences. This highlights the importance of the field of science that the GENNESYS report represents.

To achieve high added-value in an emerging knowledge economy, outstanding knowledge is fundamental. In this respect, Europe needs bright scientists, supported by efficient research infrastructures, to deliver on the promise of nanotechnology. I therefore welcome the GENNESYS study which has been drafted in the spirit of ERA and which will certainly become a landmark document in its field.



Janez POTOČNIK
European Commissioner for Research, Brussels (B)



European academic institutions are rich in tradition and have contributed significantly to the present state of advanced technologies and the competitiveness of European industries. However, these institutions often have difficulties competing for technological leadership against rivals in the USA and Asia. We therefore should aim at further enhancing the creativity and efficiency of the output of research and the investigative talent of young scientists at these institutions. This can be achieved by promoting coordinated collaborations between European universities and research centres, particularly in fields expected to create new opportunities for European industry.

Nanomaterials science is one such field. The compiling of this GENNESYS study is a welcome step in bringing the nanomaterials scientist's message to a wider audience. It shows the important role of nanomaterials science in modern technological development and the necessity of top-class university training necessary for innovative products of tomorrow. It will help to raise the profile of nanomaterials science as a discipline.

Europe needs students with training in multi-disciplinary themes: materials, physics, chemistry, biology, mathematics, informatics, and engineering and they require extensive experience with capital-intensive, large-scale research instrumentation specifically in the fields of synchrotron radiation and neutron sources. Highly trained and talented students, scientists and researchers are needed at all levels of nanomaterials, from industry to academia. We have to make this field attractive in Europe. Obstacles hindering students and researchers coming here from outside Europe should be removed and the European research infrastructures in this field should be highly competitive.

GENNESYS proposes a model approach to the challenges in the field of nanomaterials and that is why I give my wholehearted encouragement to this initiative.



Pascal COUCHEPIN

Former President of the Swiss Federal Council
Head of the Federal Department of Home Affairs (DHA), Bern (CH)



Europe has staked its future prosperity and social well-being on its ambition to become the world's leading knowledge economy. In order to achieve this it must improve its performance in each dimension of the "knowledge triangle" of education, research and innovation. In particular, this involves building better linkages between each of these domains and between the actors involved: the leading edge universities and research institutions and the most visionary enterprises.

In my capacity as European Commissioner for Education and Culture, I have sought to promote dialogue and interaction between these worlds which have, in Europe, too long tended to stay apart. I set out the message in a 2006 communication on modernising higher education that Europe's universities have a potentially huge role to play in driving the knowledge economy and that it will help them greatly to do so if they link with enterprises to create new curricula and open new research fields. More recently, in 2008 I set up the EU University-Business Forum as a space for the two sides to air their specific concerns and to create the ground for joint working.


Most importantly, I launched in 2006 the idea of creating a European Institute for Innovation and Technology (EIT) to be a centre where, addressing frontier, vital fields of knowledge, the best European minds could work together to deliver excellent education, ambitious programmes of research and, ultimately, life-changing innovations. The key underlying principle of EIT is partnership between Europe's centres of excellence, wherever they exist. I'm happy that EIT has moved rapidly from being an idea to reality, with the first generation of operational entities, the Knowledge and Innovation Communities (KICs), starting work in 2010.

As I look at the GENNESYS study, I find strong echoes of the objectives which I have sought to promote in these different initiatives. GENNESYS is opening up an area of frontier knowledge which holds the capacity to impact very strongly and positively on our future. It is built on partnership between leading institutions drawn from the worlds of academia, research and enterprise. And it has declared its goal of using the knowledge generated to address real needs, of turning knowledge into innovation.

I want to take this opportunity to salute the approach taken and the important work done. Europe needs more ventures like GENNESYS. May the spirit of enquiry and partnership which it has launched continue and flourish.

Ján FIGEL'

European Commissioner for Education, Training and Culture, Brussels (B)



GENNESYS is a wonderful initiative; it not only presents a thorough overview of the nanomaterials science and technology spectrum worldwide but it also clearly highlights the research needs which Europe needs to undertake during the next 10 to 20 years if it is to achieve invaluable breakthroughs in this fascinating field of nanomaterials – breakthroughs which will enable Europe to place itself amongst the top-ranking competitive industrial regions in the world. Compiled by the Max Planck Institute for Metals Research in Stuttgart with contributions from many leading scientists in Europe, GENNESYS is not just about reporting research; its primary intention is to provoke a discussion of all issues related to nanomaterials science in Europe, including such issues as social and political awareness, research infrastructure priorities, and the uptake of new technology by industry.

In our dynamic and competitive world, we must meet contemporary demands for a better quality of life, whilst reducing our dependence on natural- and energy resources and the burden we place on the environment. As an interdisciplinary field, the domain of nanomaterials science will act both as a basis as well as a force of momentum for a great number of future discoveries, underpinning many of the technologies which are essential for their development and success in areas such as nanoenergy, nanomobility, nanochemistry, nanoelectronics, nanobiology, nanomedicine, nanosecurity, and so forth. Tomorrow's technology cannot be developed by simply extrapolating our current knowledge. There is no escaping from the fact that the breakthroughs necessary for achieving these goals can be achieved solely through substantial investment in fundamental research and its associated research infrastructures.

It is our firm conviction that the proposed GENNESYS European research centres, in joining forces, present an excellent blueprint as to how European centres of excellence can be created in a new and modernised way – centres which will be seen to attain a status of global leadership which will benefit the whole of Europe. GENNESYS will have a great impact in the future successes of the European large test facilities, providing scientists and industrialists of the new member states with the opportunity to participate in these fore runners of research. Moreover, this initiative presents industry with the necessary challenge of realising new ideas for technology transfer. In addition, GENNESYS will be an excellent school for students and young

scientists, preparing them for brilliant careers. Finally, GENNESYS is in full line with the EERA-initiative, and it is a great example in which the cooperation of all European research efforts will be foreseen.


GENNESYS is addressed to all nanomaterials scientists and scientists from related science disciplines in Europe, as well as regional, national and European policy-makers and managers in industry. It serves as a call to European politicians to upgrade investment into GENNESYS science- and technology centres of excellence to a level at least comparable with that in other industrialised countries, notably the US and Japan, so that European industry can remain competitive well into the future. Only then can we pass on a culturally, scientifically and economically flourishing Europe to future generations.

GENNESYS is a great initiative and will become the motor of the nanoscience and nanotechnology community in Europe. For this reason, we believe that GENNESYS should be supported wholeheartedly by all policy-making bodies and research institutions throughout Europe.




Philippe BUSQUIN

Member of European Parliament, Committee on Industry
External Trade, Research and Energy (ITRE)
Chairman of the Scientific Technology Options Assessment Panel (STOA)
Former European Commissioner for Research, Brussels (B)



Jerzy BUZEK

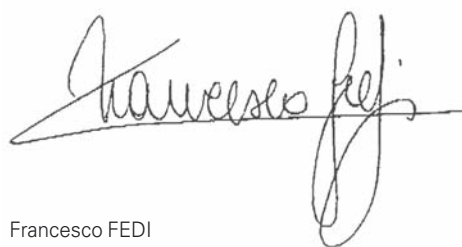
Member of European Parliament, Committee on Industry, External Trade, Research
and Energy (ITRE), Brussels (B)



Today, society is faced with the challenge of globalisation. This particularly affects Europe's industry, economy and academia. With conventional manufacturing dominated by developing economies, the future of industry for Europe must rely on its capacity for innovation, rather than on improving existing technologies and products. We live in a knowledge-based and information driven society in Europe. We are currently witnessing worldwide competition to establish the very best centres of excellence to generate new knowledge and technologies: interacting with these centres is a must for European industry to gain global leadership.

This is why the GENNESYS initiative to establish Europe at the forefront of nanomaterials is extremely important for our future economic prosperity. The field of nanomaterials is one of the fastest growing and most important scientific developments in the last half-century and European industry has recognised its significance to many industrial sectors in Europe. In view of its novelty and complexity of the technology at the atomic level, the importance for industry to engage in partnership with the scientific community is obvious, requiring the best brains and the most advanced facilities.

COST – the acronym for European CO-operation in the field of Scientific and Technical Research – was the first and is the widest network to coordinate nationally funded research activities. Established by a Ministerial Conference of 19 European states in November 1971, COST is at present serving the scientific communities of 35 European countries and is a cornerstone for the development of the European Research Area. The more than 200 research COST Actions are coordinated by the COST committees in nine scientific domains. One of these nine scientific Domains is “Materials, Physical and Nanosciences” and in October 2006 COST organised in Brussels a “European Forum on Nanosciences” in cooperation with the European Commission, the European Science Foundation, the European Parliament and the ERA-NET Consortium on Nanosciences. The recent increased financial support for COST established in the Seventh Framework Programme makes COST a very interesting opportunity for the European scientific community to cooperate in selected topics in the field of nanosciences and nanotechnologies.



Francesco FEDI

Chairman of the EU-COST Senior Officials Committee, Brussels (B)

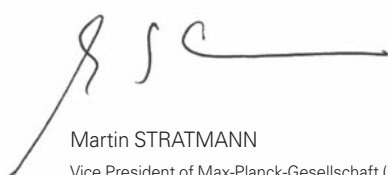


This European foresight study has been carried out during the last five years chaired by the Max Planck Institute for Metals Research in Stuttgart. The GENNESYS document is a worldwide unique reference document, as it has successfully achieved to develop a sustainable action plan for the development of nanomaterials and nanotechnology in Europe that underpins the various technology roadmaps with the necessary knowledge base on the nano level. Knowing how diverse and complex this field is, I can only congratulate all authors and contributors to this study for making this truly remarkable effort.


The conclusion and recommendations of GENNESYS go significantly beyond any other European strategy in nanoscience and nanotechnology and can solve several of the most vexing problems we currently have, if we turn these ideas into reality. One of the key problems is the multiple fragmentation of efforts in Europe which goes across scientific disciplines and sectors and across the European member states. Also very high up in the "European To-Do-List" are the strategic integration of the existing research infrastructure and the development of a interdisciplinary education strategy for the nanomaterials scientists and engineers we need in order to tackle the problems of tomorrow.

I specifically welcome the GENNESYS recommendation to create European science and technology centres of excellence for the targeted development of novel nanomaterials in order to solve most urgent problems of our society, as new materials for environmentally friendly energy concepts. The Max Planck Society already established successful research structures that now may serve as inspiration to these new European centers.

So, I am extremely pleased with the final results and I would like to thank the Max Planck Institute for Metals Research for embarking into this effort and for pushing it to this fine result.



Martin STRATMANN
Vice President of Max-Planck-Gesellschaft (DE)



More than 20 years ago, I switched my scientific interest to nanotechnology, nanoscience and in particular to nanomaterials. At that time, the field of nanomaterials was rather small, narrow and unknown, but unexplored and, therefore, challenging. The developments have, however, surpassed most of our early predictions of the future and today nanomaterials is a broad, advanced, but still challenging, field of science.

The present study, GENNESYS is an impressive and comprehensive documentation of the status and foreseen future of nanomaterials. It is outstanding in its coverage, beautifully presented and gives easy-to-understand descriptions of the different nanomaterial technologies research issues and challenges of today. It will most certainly become the reference work for students at universities, as well as for professionals in the field: professors, research managers, academic researchers and industrial researchers. In the attempts to make Europe competitive with other major players in the field like US and Japan, GENNESYS is a good basis for strengthening the competition, collaboration and, when needed, coordination of the sometimes scattered nanomaterials research in Europe.

In particular, I find the ambitious approach to cover the whole value chain from basic research, through engineering and technology, to industry and the required infrastructure, and to implications for society including ethical and environmental implications, very impressive. It is rare to find such a comprehensive description of a field and its present challenges, and it is a great pleasure to read it.


The results of the GENNESYS project are many new ideas, guidance for possible scientific breakthroughs, and important recommendations. Of particular importance for the European science community are the proposals to create new institutes or centres for nanomaterial research. In Sweden this has e.g. been discussed in relation to plans for large research infrastructures such as synchrotron and neutron facilities. Another interesting recommendation is the creation of a new College of nanomaterials. The project also highlights breakthroughs and future applications of nanomaterials in fields such as energy technology, global climate change, security and safety as well as for cultural heritage.

GENNESYS is a very impressive overview of the nanomaterials research and is also an ambitious forward look covering the decades to come. Because of the inclusions of all parts of the research chain – academia, industry and society – it forms a good basis for informed discussions on priorities, opportunities, strategies, limitations as well as potential risks. The GENNESYS study is therefore a most welcome document which most likely will have a great impact on the European research agenda.



Pär OMLING

Director General of the Swedish Research Council (SE)
Former President of EUROHORCS



Nanomaterials science requires a whole new mindset to understand the possibilities that these materials potentially offer to society. There is a simple analogy that I find useful. It is the comparison between the freedom of an individual person walking on their own compared with a well-drilled army marching in unison. For many years we have dealt with materials as agglomerates of atoms. Even if randomly packed, the average properties of a bulk assembly are relatively easy to determine although there is still ample scope for new bulk materials to be developed. However, when we are down at manipulating individual atoms, there are a whole new set of characteristics that come into play which we are still at the start of exploring.

X-ray and neutron sources can give us atomic information both at the electron and nuclear level. They have provided amazing breakthroughs in structural biology, magnetic materials and in our understanding of chemical processes, for example. The worldwide investment in synchrotrons has blossomed since the first dedicated synchrotron was commissioned at Daresbury in the UK over 25 years ago. Upgrades to both the European neutron and high energy x-ray sources in Grenoble are being pursued to ensure they will be fit for purpose for the next decades. Proposals for a next generation neutron spallation source are being actively championed in Europe and similar facilities are coming on stream in Japan and the USA.

Ultimately, we need to observe the dynamics of nanomaterials both as they are processed and as they are applied. X-ray free electron lasers offer the promise that we can directly observe atom to atom interactions. The LCLS in California is now performing and the agreement to build the European XFEL is on the verge of being signed by several countries. Early results from the FLASH facility in Hamburg are demonstrating the effectiveness of resolving processes at the few tens of femtosecond time period. With the higher energy machines, watching movies of atoms and molecules interacting is a very exciting possibility. Many of the potential applications are outlined in this book. While the majority will be in entirely new fields, we should not overlook the application of these machines to observe the first elements of corrosion or bio-fouling for instance. A time-resolved understanding of the first few microseconds of these reactions could well lead to significant cost savings in many industries in addition to improving safety.

It is also important to realise that alongside these hardware developments, petascale nanomaterials modelling and simulation will be in place and gridlinked to the facilities. Both will inform each other possibly in real-time. A key question is, just how will researchers control such interactions and how will they deal with the data deluge? I firmly believe that there needs to be a new paradigm shift in the way new researchers are trained if we are to maximise the benefits of these interactions.

The future of this field is exceptionally bright and many treasures lie before the researcher at the start or midway through their career. This work of GENNESYS is a “Tour de Force” and is a monumental milestone in the future of all things nano.



John WOOD

Former Chief Executive of the Council for the Central Laboratory of Research Councils, Chilton (UK)
Former Chairman of the European Strategy Forum on Research Infrastructures, Brussels (B)
Professor at Imperial College, London (UK)
Chairman of EC Research: ERAB, Brussels (B)

Today, we must embrace the fact that society is being faced with the challenge of globalisation. This particularly affects Europe's industry, economy, and academia. With conventional manufacturing increasingly being pursued by developing economies, future European industry must rely on its capacity for innovation, in the sense of breakthrough innovations as well as the improvement of existing technologies and products. We live in a knowledge-based, information-driven society and are currently witnessing worldwide competition to establish the very best centres of excellence to generate new knowledge and technologies.

It is for this reason that the GENNESYS initiative, which aims to establish Europe at the forefront of nanomaterials, is of such importance to our future economic prosperity. The field of nanomaterials is one of the fastest growing and most important scientific developments in the second half of last century and European industry has recognised its significance to many industrial sectors in Europe. In view of its novelty and the complexity of technology at the atomic level, the importance for industry to engage in partnership with the scientific community is obvious, requiring the best brains and the most advanced facilities.

The opportunity for science/industry partnerships envisaged by GENNESYS is warmly welcomed. Moreover, the spin-off of science to technology will pave the way for close collaborations between industry and Europe's large scientific test facilities, such collaborations being crucial to the commercial success of nanomaterials. The proposed "GENNESYS" European centres of excellence will provide access for industry to advanced synchrotrons, neutron sources and other facilities in order to help tailor materials, optimise processing conditions both in-situ and non-destructively, and characterise their behaviour in service. GENNESYS presents the unique opportunity for talented scientists from both industry and research to work side by side to specify industry's requirements and assist in the development of production processes and manufacturing techniques that can be readily adopted by industry.

GENNESYS will benefit many industrial sectors vital to securing Europe's future. Nanomaterials will act as a driver for discovery and innovation, helping to maintain Europe's position in the field of leading-edge technology for many years to come. Europe should join together and support the GENNESYS initiative. The fostering of col-

laborations between regional, national, and European institutions, industry and funding agencies will prove crucial in building a strong base for European success.

GENNESYS offers great potential to industry, presenting it with the opportunity to enter into a partnership with science in the new centres of excellence. These centres of excellence represent a new kind of technology transfer that will benefit all materials and industrial sectors. In addition, the centres will serve as an excellent training ground for future recruits to industry.

In order to promote the GENNESYS initiative in European industry, familiarise the industrial researcher with the potentials of large test facilities in the broad field of nanomaterials, and to optimise large test facilities' capabilities and uses for industry, industrial federations and national technology academies may play a key role under the umbrella of national governments, the European Commission, and international organisations.

In conclusion, the GENNESYS initiative should be applauded for its plans to strengthen the bonds between the nanomaterials science community and industry, as it offers an efficient way to perform experiments at the large test facilities, within a European framework. The GENNESYS research centres will become ideal think-tanks for industry in the nanoworld and these advanced analytical test facilities will be vital tools for discoveries and innovations.



Rüdiger IDEN

Senior Vice President, BASF S.E. (DE)
Co-Chair of the European Technology Platform for Sustainable Chemistry (ETP SusChem), Ludwigshafen (DE)



Jean-Claude LEHMANN

Former President and Current Member of the "Académie des Technologies Française", (NATF), Paris (FR)
Former Vice-President of Research and Development, Saint-Gobain, Paris (FR)



As Chairman of ESFRI, and as a materials scientist, I welcome the publication of the GENNESYS foresight study as a major contribution to the development of a coherent and effective policy in research and research infrastructures in Europe. The ESFRI action, to help the European countries and the European Commission in integrating their efforts to reach a world level competitiveness, is greatly enhanced in all those fields where the scientific communities are capable of developing and proposing science-based foresights and roadmaps. These proposals give strong and useful support to policy makers, helping them to invest the limited available resources in the most effective way to increase the capability of European research.

The development of nanoscience and nanomaterials research in Europe is critically dependent on the availability of instruments for the analysis and synthesis of materials, from metals to biological materials, at levels and volumes not normally available in university and research institutions. This requires a number of multipurpose research infrastructures, service-oriented and capable of offering excellent support to researchers, with free access open on the basis of quality only. These infrastructures also act as multi-disciplinary and international meeting places, opening new and important opportunities for researchers and technicians coming from different environments.

Materials sciences are eminently multi-disciplinary, and the research environment is very important to allow the collaboration with the right mixture of specialised knowledge which may lack in smaller groups. The synchrotron and laser, as well as the neutron beam based laboratories, each serving hundreds to thousands researchers every year, are meeting places of this kind. However, they should not act in isolation but need to be integrated in a larger network of facilities offering several complementary features and specialised laboratories, allowing the control on the needed extensive ranges of phase parameters, like pressure, temperature, magnetic fields etc., or integrating the photon and neutron probes with other complementary probes like in electron microscopy and with nano-foundries to support frontier research in novel nanomaterials.

The availability of an integrated foresight and landscape, as in the GENNESYS report, allows to understand and explain, at policy level, how it is possible to develop multiple partnerships and joint projects

between various different laboratories, building an integrated “overall infrastructure” in Europe. It will be very important that the scientific communities involved in materials sciences and in the nanoscience activities become vocal and organised at a European level on a more long-term basis, to develop a reference capable of suggesting priorities and choices at the EU policy-making level.



Carlo RIZZUTO

President of ESFRI (B)
President Sincrotrone Trieste (I)



GENNESYS is most welcome; it gives an excellent overview of the large spectrum of nanomaterials science and technology, pinpoints and prioritises the important areas for future research and highlights the role of synchrotron radiation and neutrons in helping to achieve breakthroughs in nanomaterials science and technology.

A valuable roadmap has been developed to bridge the contacts with industry; it enlightens the importance of many areas of nanomaterials in health and industry which wait for breakthroughs: medicine and foods; energy, transport and environment; safety and security etc. where nanotechnology is in its infancy. This strategy study does not only assist policy-makers and funding agencies in their decisions for targeted funding, it will also help research- and industrial managers to adjust their research strategies and directions. In addition, it will be a useful tool for researchers and students to select topics which guarantee success in their studies/work.

Nanomaterials science and technology has a worldwide interest; it will affect the welfare and play a key role in the future economy. It encompasses a broad field of applications and offers enough possibilities for all research and development laboratories in the world to take part in groundbreaking research. In addition, it is a most complex and new topic which demands for an international collaborative effort in order to reach scientific breakthroughs, to promote industrial innovation, to evaluate risks of global consequences and to establish nanomaterials standards for world markets.

GENNESYS is a wonderful European initiative of which it is hoped that it will become the nucleus for international collaborations in this important domain of nanomaterials science between laboratories, research institutes and large test facilities in Asia, the America's and the whole world. GENNESYS may also have an impact in developing countries where nanomaterials may have an impact in the areas as agriculture-, food, energy, water treatment, drugs delivery systems etc.

Nanomaterials offer challenges for a world common education philosophy in this new materials field; it contains elements which have scope for an international education programme, providing opportunities for exchange programmes for young students and scientists between laboratories worldwide. GENNESYS is a unique initiative in the

sense that it sets out a possible education/research infrastructure for worldwide education in the field of nanomaterials.

GENNESYS should receive the attention and the involvement of governments all over the world as well as international organisations: UNESCO, the United Nations, International Energy Agency (IEA), and OECD. These organisations should foster worldwide collaboration in this new and evolving field.

Japan has also sizeable nanomaterials programmes of which NIMS (National Institute for Materials Science) are coordinating the activities and "SPRING8" has great potentials for synchrotron radiation. In this context, the GENNESYS initiative is a great idea and I wish that the ambitions for international collaborations will be realised and NIMS will be a strong supporter.

Teruo KISHI

President of the National Institute for Materials Science (NIMS), Tsukuba (JP)
Former Vice President of the Japan Science Research Council, Tokyo (JP)



Europe operates some of the best large-scale scientific facilities (LSF) in the world – with an increasing impact on nanoscience and nanotechnology. Most notably, synchrotron and neutron sources produce world-class scientific contributions in many domains relevant to nanomaterials such as physics, chemistry, biology, and materials science. The GENNESYS initiative can put Europe at the cutting edge of nanoscience and nanotechnology by an effective and coordinated use of these facilities.

The impact of synchrotron and neutron techniques on nanoscience will rapidly expand in the next decade: they will discover new phenomena, probe the secrets of nanomaterials, and yield general results that will strongly influence future technologies. The behaviour of nanomaterials will be examined at unprecedented levels of complexity and nano-microscopic control. The results will help nanoscience and nanotechnology to move beyond fundamental research and produce materials and systems that will impact our everyday life. This evolution requires a better understanding of electronic and optical phenomena, complex assemblies of atoms and multicomponent nanomaterials, non-equilibrium phenomena and nanobiology mechanisms; the corresponding technological frontiers ranging from nano-electronics to structural nanomaterials and nanomedicine.

Broadly speaking, synchrotron and neutron facilities will enable researchers and industries to investigate increasingly complex and diluted nanosystems with increasingly smaller dimensions and lower cross-sections. The use of such facilities, however, is not immune from problems. They are large, complex and rather expensive. Furthermore, progress in nanomaterials research depends on the ability to synthesise, characterise, manipulate and control nanomaterials from the atomic level to bulk structures. The necessary equipment becomes increasingly sophisticated and requires high-level human resources in scarce supply. The corresponding investments often put these activities beyond the capabilities of individual companies and academic institutions.

GENNESYS can provide the solution for these problems with a strategy based on large-scale facilities and centres of excellence. Large national facilities are indeed ideal hosts for European-level GENNESYS centres for nanoscience and/or technology.

This approach is particularly important for the scientists and industries located in less-favoured regions. At present, most large-scale facilities are concentrated in a subset of European countries. The integrating activities supported by the European Commission are very successful in opening these instruments to scientists from all over Europe, with a selection based on merit and no financial discrimination. The most positive consequences are the increase in scientific output of less-favoured countries and the elimination of the need to emigrate. These results are specifically important for a competitive area such as nanoscience and nanotechnology.

The GENNESYS strategy can become reality if supported by the necessary political and funding decisions. The financial resources required to equip and support major facilities at specific European locations can be provided by exploiting a significant portion of the funding for nanomaterials research by regional, national and EU agencies. The centres so established will become contact places for experimentalists and theorists, for scientists from different disciplines, and for harmonising the educational and research role of universities and national laboratories to industrial needs. These exciting breeding grounds will certainly attract many of the world's leading scientists.

In summary, the GENNESYS strategy will boost the role of European large-scale synchrotron facilities in nanoscience and nanotechnology by making them more user-friendly, by welcoming scientists from a variety of disciplines and creating additional strong links with industry. It is, therefore, a wise and effective strategy which deserves full support.



Giorgio MARGARITONDO

Vice-President for Academic Affairs, Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne (CH)

President of the Council: 'European Integrating Initiative for Synchrotron Radiation and Free Electron Laser (IA-SFS), Brussels (B)