Industrial Technologies conference: integrating nano, materials and production.

The Industrial Technologies conference, held in Brussels on 7-9 September 2010 was the first to cover the full scope of the NMP (Nanosciences, Nanotechnologies, Materials and new Production Technologies) Theme of the EU Seventh RTD Framework Programme.

Organised under the patronage of the Belgian EU Presidency, the ‘pan-NMP’ Industrial Technologies 2010 conference replaced previous years’ separate events on nanotechnologies and manufacturing, with the specific intent of drawing attention to the need for innovation on a more integrated geographical and technological scale.

An audience of almost 1000 delegates gathered in the appropriately industrial ambience of the capital city’s Tour et Taxis complex, a recently renovated 19th century goods station for the canal port of Brussels.

The programme comprised two days of plenary presentations by high-level speakers from industry and the research community, interspersed with a series of parallel sessions discussing the social, economic and environmental perspectives of European industry, as well as the underlying horizontal issues. A third day provided match-making opportunities for the participants to make contact with potential research and business partners throughout the Member States, with support from the NMP team and National Contact Points to foster such collaborations and advise on funding sources.

Several of the presenters covered similar ground, notably in describing future applications for nanotechnologies and enumerating the perceived needs for public support of R&D. This condensed report therefore seeks to summarise the main points of general interest to the various stakeholders. PowerPoint presentations for the individual speakers can be found on the conference website.

Robert-Jan Smits, Director General of the European Commission’s DG Research, formally opened the proceedings with a declaration that industry represents the future for Europe – and that, in the emergence from economic crisis, ‘business as usual is no longer an option’.

European industry has to strengthen its knowledge-base to remain competitive, he said. Research and innovation are crucial elements in the Europe 2020 strategy for a smart, sustainable and inclusive economy. Creating an ‘Innovation Union’ is one of seven proposed flagship initiatives to support the strategy in addressing the ‘grand challenges’ facing society: climate change, energy and food security, health and an ageing population

To achieve this, Smits proposes three areas for action:
• Remove all the barriers that hamper innovation – including deciding on an EU patent; speeding up the standardisation process; introducing better regulation and less red tape; and a more intelligent use of the public procurement system.
• Work more closely in partnership – between member States and the EU, and between industry and academia, via mechanisms such as the European Technology Platforms and public-private partnerships to define needs and ensure that the results of research are applied in the real world.

• Invest more in research and innovation, to reach the targeted 3% of GDP. The EU itself has committed €6.4 billion to new calls for proposals under FP7, of which €430 million will go to industrial technologies

Following welcoming remarks by Marie-Carmen Bex on behalf of the Belgian Presidency, Heinrich Flegel, Chairman of the Manufuture High Level Group and Member of the Daimler Supervisory Board, observed that manufacturing industry is now high on the political agenda as a real basis for economic recovery and fulfilment of the Europe 2020 goals.

Flegel noted that European industry already accounts for 34.6 million direct jobs, plus a further 70 million in related services. Its 2.3 million enterprises generate €6.3 billion of turnover, 70% of which comes from six major sectors: transport equipment, electrical and optical equipment, food and beverages, chemicals, basic metals and metal products, and machinery and equipment. Further growth will come from knowledge-based and highly productive manufacturing, which is resource- and energy-efficient – and capable delivering innovative products with high added value to serve new and emerging markets.

The global crisis has shown the importance of sustainable development. Tomorrow’s industries must simultaneously address economic, social and ecological dimensions, with processes that are as lean and clean as possible. Zero waste and zero emissions will be the goals for the ‘factories of the future’. Growth must also be inclusive, leading to high employment and to social and territorial cohesion.

All of this demands high-tech equipment and a highly skilled workforce. Currently, around 20% of the people in industry are engineers, and Flegel predicts a dramatic rise in this figure over the coming years.

To meet the grand challenges, the focus of European policy must change; technology ‘push’ will be replaced by market ‘pull’, leading to a complete paradigm shift for FP8 to enhance the economic impact of public research.

Innovation means turning ideas into marketable products and services. Providing a positive climate for this to flourish involves a complex mix of factors and actors: the policy and regulatory framework, well-functioning markets, finance, skills and dynamic entrepreneurship must all fit seamlessly together.

As well as strong links between research and innovation, bringing ideas to market requires the right strategy, a focus on topics responding to market demand, stringent attention to execution detail, and the right set of technological tools. It is like a long-distance steeplechase, in which success depends on the last mile. Europe’s ability to seize the market opportunities will depend on setting the right priorities for manufacturing industry, and forging strong public-private partnerships to ensure their realisation.
Nano to change the world?

In a first keynote speech, Flemming Besenbacher, Director the Interdisciplinary Nanoscience Centre at Aarhus University, Denmark, considered how nanoscience and nanotechnologies could change the world by 2025.

Nanoscience represents a convergence of the traditional scientific disciplines. Besenbacher considers it equally important to support fundamental and applied strategic research, both of which are essential to the discovery, development and modelling of promising new materials in the nano-domain. To break down the interdisciplinary barriers, he also advocates the creation of educational programmes designed to foster a new generation of more broadly-based researchers able to deal with the manipulation of atoms and molecules.

Like the internal combustion engine and the semiconductor revolution, nanotechnologies are likely to bring radical changes in our way of life; the full the extent of their impact is as yet unknown, but the possibilities are huge in areas such as medicine, information technologies, food, automotive and aerospace, security and the environment.

Nanoelectronics have already arrived, in the form of integrated circuits with nanoscale transistors that pack more and more functionality into compact mobile devices. Robotics is also beginning to emerge. Within a few years, robots will replace tedious manual labour in factories, hospitals, universities and the home.

Emission-free energy

Among the most promising additional areas in which nanotechnologies could contribute is in the provision a future sustainable energy supply. Under the pressure of rising world population and increasing lifestyle aspirations, global energy consumption is expected to double from the present level of 15 terawatt by 2050, and to triple by 2100. This will put a massive strain on Earth’s resources – not only in terms of the available hydrocarbon fuel reserves, but also in strategic materials such as platinum for fuel cells.

A greater EU effort in nano-related R&D effort would help to reduce greenhouse gas emissions through more efficient use of existing resources, and by the development of new and improved energy production and storage methods.

Nanomaterials and devices could markedly improve the efficiency of wind turbines and solar energy capture (the latter tapping a resource that is, in principle, capable of meeting global demand many thousands of times over). Energy storage in the form of batteries and hydrogen generation systems, thermoelectronics and fuel cells are more areas in which nanomaterials are already showing considerable promise.

Solar generation will be the preferred long-term choice, but at present it remains too expensive for large-scale deployment. While second generation thin-film solar panels had broken through the €1/Watt barrier by 2009, further cost reduction by a factor of four or five will realistically be needed.
With further improvements in efficiency, technology based on the deposition of dye-sensitised nano-particles on flexible plastic substrates may eventually replace silicon for the manufacture of panels. These could then, for example, be incorporated directly into the windows of buildings.

At present, catalysis remains a major application of nanotechnology, applicable to many chemical synthesis processes such as the desulphurisation of mineral oil, which is facilitating environmental protection in the period before more radical energy strategies can be adopted.

**New approaches to medicine**

As Europe’s population ages to the extent that over-65s will represent 42% of all citizens by 2020, joint problems and chronic diseases are placing an increasing burden on the region’s healthcare systems. Nanotechnologies are being investigated as routes to safer, more cost-effective solutions for detection, prevention and treatment of many such conditions.

With greater involvement of the medical community in research, the emerging nanomedicine will have a significant impact on accelerating the transition of laboratory discoveries ‘from bench to bed’ in the fields of drug design and delivery, imaging, diagnostics and cell therapy, Besenbacher maintains.

Nanomedicine will permit increased usage of individualised treatments to replace today’s practices, where patient groups with the same diagnosis receive the same prescription regardless of whether the drugs will actually benefit them personally. The technologies may be considerably more expensive, but their greater efficacy could avoid the costs of extended after-care.

**Technology convergence**

The convergence of traditional scientific disciplines is a natural evolution made possible by the ability to work at the atomic-scale. Bringing together nano-, bio-, informatic and cognitive science (NBIC) will bring many more exciting possibilities through opportunities to learn from nature. Nanotechnology can provide miniaturised devices such as sensors that help neuroscientists to determine how the mind works, while biotechnology and IT advances make body and machine connectable. Combining insights from the various fields opens the door to more intelligent machines and robots, providing a powerful impetus for R&D in many domains likely to improve the quality of human life.

**Formula for growth**

In a presentation considering the prospects and needs for the future of a knowledge-based European industry, Jean Stéphenne, Chairman and President of GSK Biologicals, defined six key factors for growth:
1. Making important strategic choices.
2. Managing talents and organisational models.
3. Mergers and acquisition/openness to international markets.
4. Believing in the strength of partnerships.
5. Promoting innovation for added value.
6. Favourable environment

To be successful, Stéphenne suggests, businesses must have a clear purpose, a clear mission and passionate people. In the global economy, even SMEs need to take a world view and be open to change.

Developing the right competences for the future requires a transformation of the education system to reduce the separation between schools and companies, he states. It is not a problem to recruit researchers, but business development managers who can move between science and business are difficult to find.

Learning is not just acquired from books; it is important to be outward looking, ready to break down barriers and open to influences from foreign cultures and other companies. Participation in collaborative and transnational R&D projects is one useful way to maintain an open culture.

Another prerequisite is to change the organisational model by adopting integrated structures linking research to marketing, globalising the business, encouraging management mobility and enabling the workforce to participate in company results. Modern communications make it possible to develop worldwide markets, but enterprises should strive to keep the essential knowledge and investment within Europe.

**Overcoming the obstacles**

Although factors such as complicated legislation and complex social regulation can hamper faster growth, there are ways to overcome these obstacles. One practical approach is to build strength by forming clusters of companies. Moreover, entrepreneurs should not isolate themselves, but rather be ready to join forces with universities and research centres around the world, to construct networks in critical technological areas. The European, national and regional authorities play an important part by brokering such partnerships (e.g. through events like the match-making day at this conference).

Innovation through research requires synergy between different complementary actors to blend scientific knowledge with the technological competences of engineers in creating products of added value to overcome the disadvantage of high labour costs.

Because nanotechnologies represent a radical new approach to manufacturing, failure to respond to its challenges will threaten the competitiveness of large sectors of the economy. To arrive at the stage of nano-enabled products, industry will need to develop the tools, essential equipment and software necessary to visualise, characterise and manipulate materials at the nanoscale. Future development will also depend on consumer acceptance of the resultant innovations; attention must thus also be paid to their ethical, social and safety implications. Industry has a duty to inform the general public about the benefits and possible inherent risks. Misapprehensions can trigger unfounded fears that nanomaterials are toxic. Dealing with these issues requires thorough investigation by industry and sensible science-based regulation from the authorities, backed by substantial funding from all sides.
Economic growth will come from innovation, and innovation is the result of combining research, risk and investment.

**Ultra-precision manufacture**

Paul Shore, of Cranfield University, UK, and Vice President of EUSPEN, the European Society for Precision Engineering and Nanotechnology, traced the advances being made in ultra-precision manufacturing as the enabling technology for new generations of products in sectors ranging from energy and environment to medicine and consumer products.

The concept of ultra-precision shifts with time towards ever-higher levels of accuracy, Shore explained. He recalls that nanotechnology pioneer and Nobel Prize winner Richard Feynman first predicted nanoscale information writing with electron beams in the late 1950s. By 2000, the wafer stepper machines employed for integrated circuit production were achieving overlay accuracies of around 4 nm. The optical components used for this purpose had a form accuracy of about 1 part in $10^8$. Ten years later, with a shift from transmissive to reflective optics, overlay accuracy had improved to around 2 nm, equivalent to a form accuracy of around 1 in $10^9$.

Large modern telescopes require similar levels of capability; for these, spin-off companies established by Cranfield and using specially constructed machines for grinding, polishing and plasma surfacing are now manufacturing 1-m sized optical units to the same accuracy as that required for the next generation of wafer steppers. Furthermore, these can now be produced ten times faster than was previously possible, cutting the unit cost from €120 000 to €12 000. A telescope planned for production in Europe will contain 1 000 of the units.

**Business opportunities**

Some telescopes, known as ‘earth orbiters’, are assembled in space to look inwards at the Earth and monitor environmental conditions. These are made from materials that are highly inert, but difficult to process. Earth orbiters are a growing business for the optical industry, which in coming years could also benefit from demand for large components for a maturing fusion energy sector.

In the latter application, exposure to high energy levels causes rapid wear of the focussing optics, so the ability to manufacture or refurbish quickly and reproducibly will provide competitive edge in what could in the longer term become an important mode of sustainable energy supply.

Ultra-precision techniques are now also being used to make diamond-cut moulds for low-cost imprinting of nanometric structures onto flexible films that can be employed for the manipulation of light in brightness enhancers for flat panel displays, and potentially in solar concentrators. Typically, these have feature sharpness down to around 200 nm. The flat film can readily be moulded into a form suitable for incorporation into a concentrator to enhance the photovoltaic energy generation performance. Shore estimates a market potential for 7 million m² of such film over the next few years.

Another commercially promising application is the rapid manufacture of prototypes for large companies involved in areas such as the development of new 3D imaging displays. More fields under investigation at Cranfield are reel-to-reel production of microfluidic device structures,
microlens arrays and plastic electronic systems; precision bearings; atmospheric monitoring and aero-engine turbine blades.

**Manufacturing matters**

Prefacing the second day of proceedings, Richard Dick, Chairman of the engineering industries association Orgalime, stressed the importance of a supportive culture, strong leadership in companies and a holistic outlook to sustain the momentum of innovation, which has become increasingly complicated over the years.

How have the Framework Programmes, in particular, measured up to industry's needs? Dick recognises both positive and negative points. Overall, he regards the R&D efforts as good, with ample scope for engineering companies to participate and benefit from the integration of interdisciplinary skills. Though the creation of the European Technology Platforms, opportunities for networking have increased, with common priorities set by the roadmapping processes.

FP7, with a budget of around €50 billion, marks a substantial increase in support compared with the €17 billion allocated for FP6. Orgalime is particularly enthusiastic about the Factories of the Future (FoF) public-private partnership (PPP), created as part of the European Economic Recovery Plan. For the first time, FoF earmarks finance exclusively for research into production technologies and brings the public and private sectors together. Dick regards this as a major step forward, which could serve as a model for more future initiatives.

The complexity of procedures for grant application remains something of a deterrent, especially for SMEs and new candidates – which may be have been a reason for the decline in industrial participation between FP4 and FP6. Subsequently there has been some simplification and speeding up of the processes, but industry believes still more could be done. More flexibility in the financial arrangements is also highly desirable, as is a reduction in the divergence of requirements from different Directorates General.

Promoting SME involvement in NMP projects has resulted in a participation increase to almost 23% in FP7, but enterprises in the 250-1 000 employee range are considered to be less well served – leading to a call for more latitude in the size classification.

Concerns are also voiced by small companies about the large size of many projects and consortia, and the focus on breakthrough, rather than the stepwise advances and market innovations that can be just as essential.

Orgalime concurs with the view a strong manufacturing sector is vital to continuing European competitiveness, and that the support for R&D must be strengthened in the present difficult times. Dick sees encouraging signs from the work of EFFRA (the European Factories of the Future Research Association) – which, in cooperation with the Commission, could help to fulfill more of industry’s wishes in the run-up to FP8.

**Technologies for the ‘Factories of the Future’**
Massimo Mattucci, Chairman of EFFRA and Executive Vice-President, Comau Group, attests to the great deal of work carried out over the past 15 months to structure the FoF partnership. The PPP addresses the same goals as Europe 2020, and Mattucci insists that it is a logical way to derive maximum benefit from limited resources.

As the representative of the private sector, the association supports the call for simplicity, speed and better assimilation of SMEs. An industrial participation of 50% and a strong SME showing in the first FoF Call for Proposals indicates a move in the right direction.

**New paradigm**

The FoF research roadmap looks beyond the lean manufacturing paradigm of a few years ago, to embrace a concept of innovation based on more sustainable production, intelligent manufacturing through full integration of ICT, high performance and productivity, and the use of new materials to conserve resources.

While retaining the above four strategic pillars, progressive updating of the roadmap in the light of actual experiences provides an informed input to assist the Commission in selecting priorities for the annual FoF Calls.

Topics proposed in July for the 2011 Call were:

- **The Eco-Factory**: cleaner and more resource-efficient production in manufacturing
- **Cooperative machines** and open-architecture control systems
- **Smart Factories**:
  - Integrated process automation and optimisation for sustainable manufacturing
  - Applications based on context-aware ICT and scalable networks of sensors
  - Robotics-enabled production processes
  - Laser applications
  - Plug-and-produce components for adaptive control
- **Supply chain approaches for small series industrial production**
- **Towards zero-defect manufacturing**
- **Manufacturing chains** for nano-phased components and coatings
- **Intelligent, scalable manufacturing platforms** and equipment for components with micro- and nano-scale functional features

For the remainder of FP7 (2012-13), the requirements have provisionally been assessed as:

- New human-robot cooperation in advanced factory environments
- Sustainable maintenance of production equipment
- Innovative re-use of equipment and integrated factory lay-out design
- Production using environment-neutral materials
- Manufacturing of engineered metallic and composite materials

So far, the PPPs have been effective in challenging the underinvestment in research, Mattucci concludes. By keeping the strategic roadmap up-to-date and close to real-world needs, and by working closely with the Commission in defining targets and improving the modes of operation,
EFFRA can play a valuable part in ensuring the research will be on course to underpin continuing industrial competitiveness.

**Towards intelligent manufacturing**

For Hendrik Van Brussel, Professor in mechatronics and automation at the Catholic University of Leuven, Belgium, European manufacturing industry can only succeed if it simultaneously satisfies market needs (quality, cost-efficiency and short time-to-market) and those of society (sustainable products and processes). This, in turn, implies substantial improvement in the ‘intelligence’ of products and manufacturing systems, by the incorporation of features that confer human-like attributes of autonomy and social behaviour.

Van Brussel proposes a ‘holonic’ model of integration, together with appropriate enabling technologies, as the ideal framework within which to achieve this goal. A holon is defined as ‘something that has integrity and identity at the same time as it is a part, or subsystem, of a larger system. A holonic manufacturing system thus consists of a society of autonomous, cooperating agents working together to achieve global strategic goals such as those described by Massimo Mattucci (see above).

According to Van Brussel, the new systems will have to cope with a number paradigm shifts:

- towards a drastic reduction of time-to-market;
- towards a broader vision on ‘performance’;
- towards mass customisation and a service economy;
- towards ‘co-creation’; and
- towards the ubiquitous (pervasive) machine.

**Faster to market**

The automotive sector, for example, has seen product introduction times shrink from 60 months to 20 months over the past 15 years. This is a major achievement, but substantial reductions will be necessary for all industries to sustain their competitiveness.

This is now possible with the aid of design and engineering approaches such as concurrent engineering of products and production systems; and mechatronic design methodology, which combines machine design, control engineering, electronics, physics, informatics, etc., in a synergetic way that gives rise to superior products.

Modular, reconfigurable, multi-functional and high-speed machine concepts are required to implement the new manufacturing methods. In addition, new processes like laser-based techniques reel-to-reel printing and net-shape manufacturing must be introduced to win the desired time and cost savings.

**Enhanced performance**

Life cycle design, embracing factors such as materials choice; ease of manufacture, assembly, use and disassembly; packaging; maintenance and ecological impact will become the code of good
practice to assure sustainability of products and manufacturing systems. Here, too, mechatronic
design will contribute by delivering more robust, resilient and high-precision products.

**Personalised products**

Offering a more personalised response to customer demands necessitates an ability to produce in
small batches at mass production rates and costs. To provide the required flexibility, machines
must become modular and reconfigurable, with compatible ‘plug and play’ sub-systems and
distributed control (the holonic model).

**Co-creation**

Industry has evolved from one-off craft manufacture, through standardised mass production, to the
increasing provision of tailored specifications and options. The trend is towards growing
involvement of the customer in design decisions. Interactions with suppliers are facilitated by
advanced use of ICT in the factories, to permit open communication and work-sharing between
production modules in what can be described as ‘virtual enterprises’. In addition, the customisation
of products is being streamlined by the emergence of new ICT-based technologies – for virtual and
rapid prototyping to eliminate time-consuming traditional methods, augmented reality for design
and diagnosis, and even the planning and layout of complete factories.

**Ubiquitous machines**

Machines, like computers, are becoming ever more closely woven into the fabric of everyday life: a
phenomenon that Van Brussel likens to an ‘Internet of Things’, in which all objects in the world are
interconnected. This is already becoming reality on the factory floor, where machines are becoming
‘intelligent beings’ capable of ‘understanding’ instructions. When linked into holonic or biologically-
inspired systems, they open a whole new dimension in plant control and management.

This calls for more naturalistic methods of human-machine interfacing, such as learning by
demonstration and control though physical interaction – both to reduce programming time and to
make machines perform in a human-like way. Input from the cognitive sciences will be needed to
make the machines themselves more intelligent, and to accelerate their acceptance in human-
centred industrial environments.

**Addressing the eco-efficiency challenges through research and innovation**

Michael Hauser, CEO of GF AgieCharmilles, Switzerland, and President of CECIMO (the
European Association of the Machine Tool Industries) points out that limited access to key natural
resources makes it crucial for EU enterprises to invest in new eco-efficient technologies. Reducing
primary energy demand is one of the easiest, cheapest and cleanest ways to address this issue,
he claims.

The importance of the environment to the European economy is underlined in the Lisbon and
Europe 2020 strategies, and supported by a number of EC Directives – including recent new
regulations on construction and consumer products. Industry backs the strong environmental
legislation, but needs standardised tools to implement eco-efficiency. Hauser notes that third
countries are moving ahead in regulatory as well as competitive terms, so Europe must to move faster to maintain its position.

**Self-regulation initiative**

From 2012, EU machine tool manufacturers serving the European market will have to comply with a new eco-design regulation that could include some areas of innovation not yet covered by standards, which could create extra technological burdens and administrative costs. CECIMO has therefore opted for a self-regulatory initiative to meet the requirements of the directive.

In the 2005 EUP (energy-using products) Directive, the Commission had already promoted self-regulation as an efficient solution to reduce the administrative overhead and foster innovation. It means that matters such as the identification of best practices and target-setting for environmental improvements will be in the hands of the industry. The objective is to increase the environmental performance of all machine tools, without limiting the innovative potential of their manufacturers.

The initiative was developed without any external funding. Its modular approach enables constructors to calculate the environmental improvements in their products, without having to compare them directly with competitors’ machines.

Attention to energy-efficiency has only a short history in this industry, so some topics are not yet addressed in the research agenda at EU level. PPPs such as Factories of the Future are important in filling this gap.

**Investment targets**

Although the R&D investment of top companies is on a par with that of their US counterparts, Europe as a whole still lags behind in innovation. If the 3% of GDP goal could be reached, Hauser believes it would be possible to outperform the global rivals – but only if the budget is spent wisely in areas that merit further expenditure.

There is a need for appropriate techniques to evaluate the energy-efficiency of products, which is not always a simple matter, given the diversity and complexity of machine tools. More investigation of nanotechnologies and ICT in this sector could also contribute in the fight against climate change.

While pursuing increases in energy-efficiency, it is equally essential to seek improvements in productivity, quality and the precision of manufacture. More considerations are reductions in resource use, and in unproductive time in the workplace.

It should not be forgotten that European industry has been seriously impacted by the economic crisis; the machine tools sector saw a decline in orders of more than 50%, and is only now showing some signs of recovery. Against this background, the stimulation of innovation depends on the support of policy-makers and the encouragement of creative corporate cultures able to bring more intelligence into the processes of production.

**Innovative technologies in compressed air and vacuum**
Robert Michael Fielding, Professor at Newcastle University, UK, and council member of Pneurop (European Committee of Manufacturers of Compressors, Vacuum Pumps, Pneumatic Tools and Air & Condensate Treatment), presented compressors and vacuum pumps as essential enablers of many innovative and viable environmental challenges.

The versatility, flexibility and safety of compressed air as an energy transmitting medium has long ensured its use as an essential service in all kinds of industries. Pneurop has now introduced its ‘Green Challenge 2020’ as a means to build awareness of the savings in energy and cost that can be gained in a modern sustainable manufacturing context.

Compressed air is increasingly used as an integral raw material in processes that make use of its intrinsic properties. Some new bio-based industries, for example, exploit its 76% nitrogen content as an inexpensive and low-maintenance alternative to cylinder gas. Indeed, air is fast becoming a preferred source of on-demand high-purity nitrogen.

Similarly, vacuum deposition processes can replace electrolytic deposition, eliminating the use and disposal of hazardous chemicals. Low pressure, low temperature distillation, as opposed to steam distillation, also reduces the thermal energy demand, while vacuum degassing of specialty alloy steels improves purity and again saves energy when compared with traditional steam degassing.

Some applications, such as the pneumatic braking systems in trucks and railcars, leave no room for errors. Pneurop members have therefore played an active part in continuously improving standardisation, and establishing codes of practice to ensure safe usage and storage of air. Many of the standards relating to purity and equipment efficiency have originated in Europe and subsequently been adopted as ISO norms.

Among the advances being made, a nanotechnology-based hollow fibre filter for contamination removal is currently being assessed as a route to ultra-pure air for high-end applications that cannot economically be addressed by current technologies. This will provide access to new growth areas such as vaccine manufacture, respiratory air supply and oxygen concentrator systems.

The Pneurop Green Challenge 2020 is thus providing a good example to other industries, for the benefit of all.
PARALLEL SESSIONS

The following outlines the content of parallel sessions discussing the social, economic and environmental aspects of European manufacturing industry, together with the underlying horizontal issues. Details of the individual speakers and their presentations are accessible on the Industrial Technologies 2010 conference website.

**Track A: Horizontal**

**A1: Research and innovation, and education and training**

There is apparent consensus about the relevance of education and training for research, innovation and competitiveness – yet, the form they should take remains a topic for discussion. Education, research and industry remain too separate. Young students must be motivated by scientific research as soon as possible, which requires better communication of research achievements and the value derived from its results.

Current educational models are inefficient because they based on simplistic premises and/or old economic models. Open innovation requires openness to new ideas, multidisciplinarity and increasing cooperation with a diversity of actors. ‘Learning factories’, similar to today’s teaching hospitals, could help to promote a new form of manufacturing education that breaks down boundaries between the student experience and industry.

**A2: Towards European standards and metrology to support transfer of innovation to industry**

Metrology and standards play a key role in transferring knowledge to innovative products, processes and services. Standardisation is essential for safety issues, but also crucial for emerging technologies, where new methods of measurement – and, in some cases even new units – have to be defined to better understand and compare their relative performance. A reasonable aim would be ‘one standard, one test, accepted everywhere’ to ensure fair trade and safe products.

**A3: Financial engineering in research and innovation**

In particular, the session explored the financing schemes and available research opportunities in industrial technologies. The lack of strong identification of nanotechnologies as a sector for investment, and a shortage of visible success stories, were seen as limiting factors. Support initiatives in Sweden and the Czech Republic were quoted as positive illustrations.

**A4: IPR issues and technology transfer models**

New technology-based companies are confronted with important Intellectual Property Rights issues, and it is important to establish models for mastering them. The problems are especially acute for nanotechnologies, which may be applicable in a wide variety of sectors and applications. Local organisations (clusters, technology transfer centres, business innovation centres) can help in the establishment of suitable protection and sharing mechanisms. Agreements involve consensus
between increasing numbers of partners regarding both technological and environmental issues. Examples were provided from Belgium, Finland and Spain.

**Track B: Human dimension**

**B1 Industrial technologies for health perspectives**

The mission and vision of the ETP Nanomedicine is to maximise the contribution that nanotechnologies can make to the development of more efficient new drugs and therapies. Collaborations between all stakeholders, including academia, SMEs, large industry, clinics, patient groups, regulatory bodies and decision makers, are considered crucial for optimal development in the field.

Open innovation in a transparent setting is essential to guarantee success across the whole value chain. Furthermore, training and education, access to infrastructure and market creation are other aspects that stimulate the use of nanotechnologies in medicine. Regulatory issues, IP policies, risk assessments and evaluation of the new systems must also be addressed. Projects exploring nano-enabled drug delivery targeting and tissue regeneration were cited.

**B2: Research and innovation, and industrial safety**

The contribution of innovation and sustainable growth to a competitive Europe can best be achieved by progressively embedding safety principles and risk management into research programmes. As well as occupational safety and health, process safety and major hazard issues such as explosion should be addressed by industry. Cross-sectoral approaches are of great value, in aiding the transition from research to application, making new technologies more rapidly accepted as a basis for procurement and business. Precautions must be taken to ensure that the shift towards renewable energy, clean technologies and ‘green’ products does not in itself give rise to new risks that need to be anticipated in order to ensure healthy, productive and sustainable workplaces.

**B3: Research and innovation, and consumer safety**

A communication strategy relating to the risk and safety management of nanomaterials is important to public perception and acceptance. The main messages should be transmitted through traditional media, with good scientists on hand to provide a balanced view. Social media may be valuable, but should not be overestimated – and company websites can also be used to explain the benefits. In the research context, visible inter-laboratory comparisons and clear codes of conduct are important. A basis for a good regulation is international consensus, which could set benchmarks for self-policing voluntary industry standards.

**B4: Research and innovation, and a worker-friendly production environment**

Europe has long supported R&D to reduce hazards in dangerous environments related to specific production sectors. Although major advances have been made, the perceived attractiveness of jobs in manufacturing industry has declined sharply, which could cause major problems for the future labour supply. Additional efforts are therefore required to ensure continuity for the affected
sectors. Automation and robotics are proposed as solutions in areas where the work is dangerous, tedious or physically demanding, while positive communication of the ‘up-skilling of jobs is again a means of motivating new recruitment.

Track C: Employment and growth

C1: Research and innovation, and globalisation

Globalisation of outlook can strengthen a company on several levels: innovation, employment, growth … It is not just confined to large companies, but can be equally applicable to SMEs. Research and innovation without globalisation only yields results on a local scale, which in turn limits growth and employment opportunities. Taking a global view can overcome this restriction. Even simple measures such as new management tools, process improvement tools and participation in ‘knowledge communities’ can broaden a company’s horizons. In some cases, international partnerships may be a prerequisite for success; world awareness and match-making skills are therefore valuable assets for the entrepreneur.

C2 and C3: New approaches for emerging and traditional industrial sectors

New businesses can have many origins: a disruptive innovation in a production system; exploiting the needs of a small niche market; bringing existing technologies to a new market; or enhancing new business development in old companies. Each raises its own specific hurdles and requires specific approaches in order to achieve success.

For traditional businesses, the need is rather to adapt to changing circumstances. The chemicals industry, for instance, must be agile enough to move from bulk commodities to the flexible batch manufacture of high-value specialties. In other sectors, too, a focus on established patterns should not be allowed to stifle the creativity of emerging ‘green shoots’. Remote communities can also make a virtue of their isolation by adapting the nature of their activities to provide radical solutions that are sustainable on a local scale, and could eventually provide a blueprint for wider deployment.

Nanotechnologies are having a profound impact in long-established sectors such as the automotive and construction industries. Here, the ability of regulation to keep pace with innovation is a notable concern. The eventual savings in energy and materials consumption will certainly justify a lowering of the barriers to progress.

C4: Research & innovation and the challenge of more variants and small lots: perspectives?

To cope with tomorrow’s demands for products that are more capable, customisable, user-friendly and sustainable, Europe must create new ‘factories of the future’. These will be based on novel production concepts and production technologies employing robotics, flexible plug-and-play tooling and rapid manufacturing techniques for one-off or mass-customised production.

Track D: Environment and climate change

D1: Towards Environmentally Sustainable Production
Technology alone will not be sufficient for the transition towards environmentally-sustainable production. A holistic approach is needed to achieve a long-term balance between the environmental, societal and economic aspects in a commercially competitive Europe. This should take account of whole value chains, infrastructures, transportation/logistics and other relevant factors requiring completely new business propositions. Demonstration programmes are important to accelerate the implementation of breakthrough technologies, but their subsequent scale-up often requires huge investments with high risks that are outside of reach even of large companies and individual Member States. The EC should provide both the long-term vision and funding to move beyond short term goals to strategies with a 2040-2050 time horizon. Carbon capture and storage, low-energy steel production and electrification are identified as key topics for the focus or research attention.

**D2: Sustainable resources for a green and more competitive economy**

Innovative technological solutions must be found to reduce Europe’s heavy dependency on foreign sources of raw materials. Alongside the introduction of innovative alternative materials, the answer lies in better extraction and processing (including a renewed focus on mining possibilities in Europe), more recycling and increased resource-efficiency across the whole industrial chain. A list of critical raw materials must be seen as a key input for future R&D roadmaps, and help in resolving materials supply problems is especially important to SMEs.

**D3: Life cycle approach and eco-design of products**

Eco-design is a complex process aimed for sustainable production and consumption. It requires a systemic, holistic approach embracing whole innovative systems and the business models within which they are used. This requires a redefinition of relationships within the supply chain and with customers, in order to provide added value for all the stakeholders.

One quoted option to reduce society’s carbon footprint is the replacement of fossil-fuel-based plastics with alternatives of renewable biological origin. However, caution should be exercised in verifying manufacturers’ claims of bio-content and recyclability, which are often exaggerated in marketing hype.

**D4: Energy-efficient production**

Energy-efficient production not only reduces environmental impacts, but can also lead to cost savings and other competitive advantages. Indeed, radical action could well be necessary to avert a new industrial crisis triggered by rising energy prices. Energy consumption must be considered at plant, process and product levels, as a basis for manufacturing strategies and the application-related choice of energy sourcing. There is room for dramatic improvement in some of the more energy-intensive industries – through the adoption of new furnace designs, alternative heating technologies (plasma, microwave, high resistivity, etc.) and enhanced recovery systems. Complete simulation projects and large-scale demonstrations are necessary to generate new knowledge and stimulate further development.
Conclusions

Reviewing the preceding two days, Herbert von Bose, European Commission Director of Industrial Technologies, Research DG, began by thanking the Belgian Presidency for its outstanding organisation of the event, and the speakers for their interesting and stimulating contributions.

“We have been strongly reminded that innovation is crucial, not only to secure Europe’s growth, employment and competitiveness, but also to meet the global grand challenges of climate change, an ageing population, health and social inclusion. Moreover, the processes of innovation are becoming increasingly complex, evolving from new product creation, to integrated product-service concepts and completely new business models. Sustainability, in terms of energy-efficiency, resource use and life-cycle performance is now as important a criterion as technological breakthrough.”

Industrial transformation

Manufacturing is the essential basis of a ‘real economy’, Von Bose insists; service providers alone will not ensure a strong recovery from the economic crisis. The transformation of European industries into knowledge-based enterprises delivering high added value is the way to overcome cost-based competition from the developing countries, and thus to maintain a high quality of life for EU citizens.

Research under the NMP theme is at the heart of this transformation, but – especially with the emergence of nanotechnologies – its nature is becoming increasingly interdisciplinary and ground-breaking. In today’s business environment, results must also be translated more quickly into commercially exploitable products and services, to be faster to market and meet ever-increasing customer expectations.

Multilateral effort

The scale of effort required clearly demands transnational cooperation at all levels: between the different disciplines of academia; between academia and industry; and between the EU, Member States, regions and the private sector.

There has been much discussion of industry’s need for easier access to funding, simpler administrative procedures and a more favourable regulatory framework. The Commission has responded to these requests, with increasing budgets for the Framework Programmes and progress in the reduction of bureaucracy.

Just as necessary, however, is a matching commitment by industry to higher levels of private investment. Meeting the target of spending 3% of GDP on R&D, as reiterated in the Europe 2020 strategy, would enable European researchers to compete more effectively with the strengths of the USA and Japan – and also help Europe to attract and retain the brightest talents.
At the same time, full involvement of the academic community is vital, both as the source of new discoveries and as educators of the generations of scientists and technologists who will become the ‘knowledge workers’ of the future.

**Partnership model**

The public-private partnerships set up under the European Economic Recovery Plan have won considerable support as the means to mobilise these resources and involve the stakeholders in aligning research directions with real-world priorities. This model could well be taken up more widely in the future.

“Europe 2020 sets a demanding agenda,” von Bose acknowledges. “As we look ahead in planning for the forthcoming FP8, Industrial Technologies' collaborative research and innovation will be powerful drivers for its realisation.”