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The Chemical Industry in Flanders – Towards 2010

Foresight Brief No. 025

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Sponsors: Flemish Science and Technology Policy Council,
FEDICHEM – The Federation of the Flemish and Belgian Chemical Industry

Type: A Regional-national foresight process covering various subfields of S&T relevant to the chemical sector, taking account of socio-economic and cultural trends

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Duration: 2002-2003 **Budget:** €35,000 **Time Horizon:** 2003-2010

Motivation

The chemical sector in Flanders-Belgium is among the largest in Europe and the petrochemical centre around the port of Antwerp is the second largest in the world. This foresight study intends to contribute to maintaining and even strengthening the competitiveness of this sector in the future. The approach was to:

- Identify and map future scientific and technological developments in the chemical sector from a socio-economical perspective,
- Offer companies in the chemical sector in particular their R&D managers, a window-of-opportunity through which to gain a long-term perspective on the industry and anticipate their future needs in terms of RTD capacity.

The Importance of the Chemical Sector

The chemical sector is one of the most important industrial sectors for Flanders and Belgium in terms of both employment and export. On the basis of turnover per inhabitant, Belgium is the absolute leader in the chemicals sector in Europe. The region of Flanders has a long history in the area of chemical production. Already by 1759 there was a well established industry for the production of acid and artificial fertilizers. By 1861 the Solvay-process for the production of soda had received international acclaim. Today Flanders is recognised as hosting one of the most chemical industry concentrations not only in Europe but in the World.

The petrochemical centre around the port of Antwerp is of strategic importance to the Flemish, Belgian and European economy.

Shaping the Future - a Collective Process

Future studies are a recent phenomenon in Flanders. About 6 years ago a first study was carried out in which worldwide foresight exercises on the chemical sector were analyzed and synthesised. Subsequently a foresight methodology tailored to the Flemish environment was developed. Based on this methodology, a number of foresight studies were carried out.

This study responds to a strategic ambition of the Flemish Science and Technology Policy Council or STPC to develop a long term strategy for technological innovation in Flanders.

The **EFMN** is financed by the **European Commission Directorate General for Research** as part of a series of initiatives intended to provide a **Foresight Knowledge Sharing Platform** for foresight practitioners and policy makers in the European Union. More information on the EFMN and on the Foresight Knowledge Sharing Platform is provided at **WWW.EFMN.INFO**

This study was intended not only to take account of worldwide trends in related sectors but the Flemish socio-economic context as well.

This study has contributed to the development of strategic priorities as well as the creation of a '*common ground*' for future decision making in relation to the sector.

The objectives of the study were to:
- Identify and map possible future scientific and technological developments from a socio-economic perspective.
- Identify and analyse those factors that would facilitate timely anticipation on these developments. Such factors include research capacity, infrastructure and other economic issues such as labour costs.
- Offer companies and policy makers in and around the chemical sector a 'window of opportunity' based on consensus.

This project was divided in two phases:
- An internal analytical phase which aimed to identify topics and developments of major importance for the future of the chemical sector,
- An external phase, where a refinement and feasibility analysis of the issues identified in phase one was carried out. In this phase consensus-building, communication and awareness creation play an important role.

In phase one a detailed analysis of the available foresight literature was conducted in parallel with 18 face-to-face interviews involving experts from academia, the private sector including major chemicals companies in Flanders as well as NGO's.

The interviews touched upon issues such as:
- Technological and scientific developments and trends,
- Market trends,
- Knowledge needs and knowledge gaps as well as other
- Socio-economic factors of importance.

Based on the vision that 'shaping the future is a collective process', a short e-mail Delphi-questionnaire involving national and international experts was carried out. The developments identified in phase one of the foresight exercise were formulated in over 100 statements and sent out to 33 experts for evaluation on the following dimensions:
- Feasibility and timing,
- Impact on society and on competition,
- Confidence to realise and implement, and the
- Expected role of government.

This last issue related to issues such as support for R&D funding and the development of infrastructure. This process resulted in expert opinions on different aspects of identified future developments.

Essential to this study was the development of a three-dimensional conceptual viewpoint, involving:
- Socio-economic forces around the chemicals industry,
- S&T developments and effects,
- Impact Area or sub-sector affected.

Technical and Societal Changes affecting the Chemical Industry in Flanders

Chemistry is a science pioneered by Avogadro, Lavoiser and Liebeg more than 200 years ago. Today the field has evolved and chemistry is conducted on the microscopic and even nanoscopic scale of single atoms and molecules. The chemical sector today draws its knowledge from different fields such as biology, physics, agriculture and the sciences. It is a complex sector with many sub-sectors and niches. The products of the sector vary from basic chemical production to specialty chemical production exemplified by the pharmaceutical industry. The main influences on the development of the chemical industry are as follows:

- **Supply side**: The chemical sector is strongly integrated; and about 1/3 of the output of the chemical sectors finds its way back in the form of intermediary supplies. As a result, there is a strong dependency and risk as a result of fluctuations in the availability of crude oil and partnerships are important to deal with this situation.
- **Economic climate**: The demand for chemical products depends to a large extend on industrial production levels in other sectors such as construction, automobile and electronics.
- **Globalisation**: Increasing globalisation has lead to increased competition. In specialty chemicals, we can expect increased competition from upcoming countries like China, Mexico and India.
- **Environment and the regulatory framework**: Increasingly, the chemical sector is stimulated to search for alternative technologies and processes. Regulations and initiatives laid down in EU white and green papers, Kyoto protocol etc. empower this search.
- **Substitution factor:** Technological developments in areas such as biotechnology and new materials enable the substitution of existing chemical components in products and industrial processes.

Technological development increasingly offers an adequate response to upcoming socio-economic demands and expectations. For example the expectation and demands of society in relation to environmental protection can be met to a large extend by developing new production methods and by

speeding up existing processes towards a more efficient use of materials and energy.

Opportunities offered by the field of biotechnology seem quite promising. Technological developments can not only address societal issues such as care for the environmental but they can also provide competitive advantage as well.

Promising fields and Anticipated Developments

1 - Chemical Synthesis with a Focus on Catalysis: In future:

- Catalysts will be customized and put together from single components.
- It will be possible to combine the high selectivity of homogeneous catalysis with the robustness of heterogeneous systems by supporting molecular species on the surface of solids such as zeolites and silica.
- Mesoporous solids - new robust solids with hollow channels the dimensions of which can be controlled in the molecular assembly process will have many uses including vehicle exhaust cleaning.

Chemists will apply natural processes such as these to industrial chemicals and materials to achieve higher efficiency and improved safety.

2 - Bioprocesses and Biotechnology based Materials Technology: In the future:

- Metabolic pathways will be fully understood.
- Low cost raw materials for bioprocesses will be derived from agricultural and forestry wastes and, to an increasing extent, cultivated feedstock.
- Biotech-based processes will enable the manufacture of chemicals with greater energy efficiency and environmental care.

3 - Materials Technology: It will be possible to:

- Design and predict material properties from the molecular through to the macroscopic level relying on easy-to-use computational tools.
- Precisely manipulate materials from the nano- to the macro-scale.
- There will be increased acceptance of methods for disassembly and reuse and widespread use of polymer synthesizing processes that use renewable resources instead of conventional petrochemical processes.
- Surface coatings will change colour with temperature.
- Special polymers are even now being tested for fire-proof cushions and panels in aircraft and cars. The emphasis right now is on applications that improve human safety.

4 - Process Science & Engineering Technology: Process design will be viewed more comprehensively and will focus on the principles of:

- Concurrent engineering,
- Design from first principle,
- Improved energy efficiency,
- Protection of human health, safety, and the environment.

Some precise developments include:

- Zero Net Life-Cycle Waste,
- Intelligent Control Systems,
- Model-based failure and mitigation and
- Many new commercial processes will use recycled raw materials as feedstock.

5 - Chemical Measurement & Analysis: Non-specialists in the scientific community will be able to use research-grade analytical measurement instruments. Some specific improvements include:

- All critical process chemistry will be measured accurately on-line in a manufacturing environment. Interfaces, particulates, and aerosols will be accurately and precisely characterised.
- Large combinatorial chemicals will be routinely measured and characterized.
- Analysis cycle time will be reduced by a factor 10 of what it was in 1990.
- Crystallography and resonance spectroscopy will be used routinely to determine macromolecular structures.
- Sample preparation will no longer be needed for routine analytical measurements.

6 - Computational Technologies: These will lead to:

- Shortened product-process development cycles,
- Optimised processes to improve energy efficiency, and
- Efficient design of new products and processes.

Highly reliable atomic modelling will allow companies to rapidly design new materials that address environment, health and safety issues. Process modelling and optimisation will be an integral part of the development and implementation cycle. Coupling process science and engineering with the basic sciences will ensure rapid development, design, and scale up. Design methods will include sampling thousands of variations of chemistries from a library to find candidates for development.

7 - Energy and Feedstock: Global partnerships involving customers, carriers, feedstock suppliers, co-producers, and third party service providers, will structure marketing and distribution operations from a global perspective. The safe and efficient distribution of chemical products will continuously improve generating major benefits for the chemical industry in terms of economic and environmental

gains. The responsiveness of chemical companies to the changing requirements of their customers will increase.

The underlying detailed developments (in statements) were presented to a panel of experts for further assessment. This has lead to a detailed insight on how different developments affect internal competition in the sector, society in general and the confidence companies have on their ability to implement.

This insight, together with the information obtained during the face-to-face interviews, has enabled the formulation of a number of precise policy recommendations.

Policy Recommendations and Effects

In the past decade the chemical sector has become one of the most important sectors in the Flemish and indeed the Belgian economy. This foresight exercise has shown that in order to stay competitive the government and industry should take action on a number of challenges that are not only scientific and technological socio-economic as well. These non-technical issues include the reputation of the sector, the impact of globalisation and competition, the cost of energy and the need to protect the environment. Technology foresight studies are a means to identify these challenges and formulate an adequate response. The first findings have been achieved on the basis of a careful and rigours process involving industry and other stakeholders. A series of recommendations have been brought to the attention of the Flemish Government and to the Ministers concerned. Companies from the sector together with the federation FEDICHEM have taken a number of initiatives to implement and further refine these recommendations, for example on the basis of university–industry collaboration on specific R&D topics. R&D managers within companies have had an opportunity to compare the findings of this study with their own in-house priorities. The outcome of this study has acted as an impulse for further investigation and thinking about the future of the sector. The main recommendations are as follows:

- With the support of the government the sector has to work on its **reputation** with the broader public. Public opinion is important in many respects. It includes youth perception of the sector and the interest it holds for building a career.
- The availability of HR is an issue of concern. **Sustainable development** is certainly a horizontal issue cutting across every aspect of the sector.
- There is a need for support in the implementation of regulations especially in the case of SME's.
- The future of the sector depends not only on its economic viability but on the availability of qualified staff. This is a seen as a major threat to the sector.
- It is recommended to develop **pre-competitive**, and where possible **competitive**, **knowledge platforms** supporting national and international companies in their R&D efforts.

Further Foresight Activities in the Chemical Sector

In relation to each of the above-mentioned fields, a number of recommendations have been made that vary from support and awareness raising actions to promote public-private cooperation and collaborative research, to the funding of specific initiatives. In some cases the government can and should play a role whereas in other cases the sector should act on its own. Structural involvement in the numerous international S&T foresight initiatives is recommended. The STPC in Flanders is currently carrying out a large regional foresight study in order to identify and evaluate S&T developments and as such support the prioritisation process of the respective Ministries.

Such a window-of-opportunity for policy makers, business managers, R&D managers as well as academics shall facilitate and stimulate coordinated actions and efforts. Foresight increasingly acts as an input for strategic decision making. There is scope for follow-up activities to refine the findings of this study on the basis of new foresight studies within small groups involving companies and research institutes.

In this way foresight can provide a vehicle for *'wiring up the national innovation system'*.

Sources and References

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