

# **CHEMICAL SECTOR**

by

**The Chemical Sector Task Team<sup>1</sup>**

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## Executive Summary

Apart from several notable exceptions, the South African chemical industry has remained static over the last ten years. Indeed, in many cases, it has lost critical manufacturing capacity and skills; it has failed to expand and diversify significantly into higher value-added products; it has missed the opportunity to take a share of the high growth markets of the nineties, including such areas as electronic chemicals, speciality surfactants, active pharmaceutical ingredients, food and flavour additives and adhesives. Notwithstanding a number of strategic processes whose objectives were to increase downstream value-addition and integration, it remains predominantly an upstream, commodity-based industry that has not managed to break through its endemic growth barriers of a small local market, high cost of capital, distance from low-cost raw materials and inadequate human resources.

As a result, the request from National Advisory Council on Innovation (NACI) for novel and highly innovative technology solutions is to be applauded. Despite the limitations of such interventions in being able to achieve single-handedly the necessary growth and diversification, there is precedent to confirm that market-led and highly appropriate technology solutions can make a significant contribution to the growth and diversification of an industry. In this context, the Chemical Sector Task Team (CSTT) proposes the following interventions:

- Development of a new industry based upon the extraction of minerals from coal ash and low-value slag.
- Extension of the South African Nuclear Energy Corporation's (NECSA) expertise in fluorine generation and use in order to generate a range of fluorinated organic chemical intermediates.
- Development of a new range of performance chemicals that will improve the recovery of minerals in the mining sector (such as polymers used in solvent extraction processes).
- Establishment of a new technology platform that will develop technologies to decrease economies of scale for chemical plants and hence enable smaller production facilities to compete against the mega plants.
- Support for existing development efforts in low-cost diagnostics, aroma chemicals production, and development of biodegradable and high-performance polymers, bio-diesel and products from alpha-olefins.

- A major initiative to build South Africa's first generic pharmaceutical actives plant in order to meet future demand for antibiotics and/or anti-retrovirals.
- A highly integrated strategy to fully develop South Africa's ability to add maximum value to its natural products and unique biodiversity.

In addition to requesting support for these projects, it is emphasised that equal attention must be given to how these projects are both implemented and monitored. It is therefore suggested that NACI consider support for the establishment of a Chemical Industry Development Agency (CIDA) that will manage the projects, and elicit a number of similar projects from the industry, based on a more detailed analysis of the various sub-sectors than was possible in this process. CIDA will also be responsible for promoting the needs of all the stakeholders in the chemical industry, including both business and labour.

Finally, it is recommended that NACI continue to use its influence to improve the integration of our National System of Innovation, and the upgrading of mathematics and science education at all levels within the educational system.

### **Acknowledgements**

The Chemical Sector Task Team wishes to acknowledge the contribution of all the delegates and members of the industry who participated in this project, and in particular the following institutions that were able to provide background information and resources: the Department of Trade and Industry, the Development Bank of South Africa, PriceWaterhouseCoopers, Ernst & Young, Chemical Marketing and Consulting Services, ChemCity, African Products, AfricaBio, Bioventures, the University of Natal and the University of Pretoria.

## 1. Background and Introduction

In early 2002, the Department of Trade and Industry (the dti) published a document entitled *Accelerating Growth and Development: The Contribution of an Integrated Manufacturing Strategy*, the purpose of which was to 'invigorate the production of goods and services and create the conditions necessary for the retention and growth of output and employment in other sectors of the economy'. The document identified a number of requirements for micro-economic reform in South Africa, including the promotion of competitiveness and the development of customised services. Furthermore, the chemical industry, in view of its potential for growth and development, was highlighted as worthy of increased attention and a number of specific objectives were defined.

However, the Integrated Manufacturing Strategy (IMS) will on its own not be able to achieve the desired outcomes of growth and development, as indeed is acknowledged in the document. For instance, the outcomes will also require appropriate and effective human resource development and technology strategies. The latter aspect has been a specific focus of the NACI, which is concerned that South Africa's R&D capability is lagging significantly behind competitor developing countries, and that this lag will reduce the country's competitiveness in world markets.

In order to redress this situation, to underpin the new IMS and to stimulate investment in key technology, NACI commissioned an Advanced Manufacturing and Logistics Strategy with the requirement that the recommendations provide some radical, highly innovative and lateral solutions to leverage South Africa's manufacturing industry. The market sectors under review include automotive, metals and minerals, chemicals and biotechnology, textiles and clothing and crafts and culture. The technology domains include Integrated Communications Technology (ICT), Logistics, Product and Process Technology and Cleaner Production. The intention is to produce a holistic set of market-focused, but technology-driven recommendations that will integrate initiatives across these sectors, leverage South Africa's competitive advantage and lay the groundwork for long-term strategic advantage.

The NACI Advanced Manufacturing and Logistics Strategy Team decided to deal with the project in two phases. Phase I required each sector (both market and technology) to provide a starter document for discussion at breakaway sessions

following a Plenary Workshop at which the programme was launched by the Minister of the Department of Science and Technology (DST). Subsequently a progress report was presented to the Minister on Phase I up to the time of the Plenary Workshop.

Phase II involved a deeper analysis of the issues raised and required a significant degree of collaboration and debate with other sectors to ensure a fully integrated approach. This Phase II report is the final submission on behalf of the chemical sector and completes Phase II.

## 2. Definition and Scope

For the purposes of this project, the chemical sector has been defined according to the Standard Industry Classification guidelines<sup>2</sup>, which include the following sub-sectors: liquid fuels and associated products, commodity organic chemicals, polymer and rubber products, commodity inorganic chemicals, fine chemicals, pure functional and formulated speciality chemicals, bulk formulated chemicals, pharmaceuticals, consumer formulated chemicals, plastic conversion and rubber conversion.

Initial guidelines given to the sector coordinators included the recommendation to appoint a task team of three or four industry specialists in order to:

- Undertake a limited trends analysis of the global chemical industry.
- Prepare a profile of the South African chemical industry, indicating its competitive advantages, its weaknesses and its needs, including technology needs.
- Develop an initial set of market-driven, but technology-based, interventions that will assist the chemical industry in South Africa to build and maintain a sustainable competitive position, thereby enabling a quantum leap in the growth of this sector leading to greater global participation.
- Include, considering the options for technology interventions, possible contributions of biotechnology and other enabling technologies.

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<sup>2</sup> It is noted that the same classification has been used by the **dti** in the development of its own industrial strategy for the chemical industry.

### 3. Related Programmes

The chemical sector component of the Advanced Manufacturing and Logistics Strategy project should not be viewed in isolation, but must be seen alongside a number of simultaneous and similar programmes currently being undertaken in the sector, including the following:

- **dti** Downstream Chemical Industry Strategy
- DST Roadmapping Project
- FRIDGE study on the pharmaceutical industry
- National R&D Strategy
- National Biotechnology Strategy
- GODISA Programme (SMME Incubation)
- Chemicals Summit (National Economic Development and Labour Accord (NEDLAC) process)
- Integrated Manufacturing Strategy.

Neither should the proposed NACI funding of the outcomes from this strategic process be viewed as the only support for innovation in South Africa. There are already a number of support schemes and funding sources in this area, including:

- Support Programme for Industrial Innovation (SPII), Partners in Industrial Innovation (PII) and Technology and Human Resources for Industry Programme (THRIP)
- Innovation Fund
- The Biotechnology Regional Innovation Centres (BioPAD, Ecobio and Cape Bio)
- Various funding schemes within the National Research Foundation
- The Competitiveness Fund.

The integration of this initiative with other strategic projects and funding instruments is clearly an important action for NACI in the ongoing implementation of its outcomes. Furthermore, it is clear that considerable effort has been made to both analyse and develop strategic programmes for the industry. It is important that this work should not be repeated in the ongoing NACI initiative.

## 4. Approach

Following the NACI guidelines, a task team<sup>3</sup> to draft the Phase I report was convened and two workshops were held, the first of which was to decide how to approach the project and the second to identify the proposed technology interventions. The results of these deliberations were condensed into a Phase I report that was made available to participants at a chemical sector breakaway group, following the Advanced Manufacturing and Logistics Strategy Plenary Workshop held on 16 August 2002. Invitations to this Plenary were extended to over 1000 stakeholders, including several databases from the chemical sector numbering approximately 200.

The breakaway session was attended by 35 people<sup>4</sup>. A presentation was given on the work carried out so far on the chemical sector, and feedback was requested on some ideas that had been put forward on future needs and initiatives. Comments and suggestions were received and debated. These were incorporated into the final chemical sector Phase I report that was submitted to the NACI Task Team and subsequently the NACI Review Panel. In the meantime, work on the development of a more comprehensive and integrated Phase II report commenced.

Comments on the Phase I report were received from three NACI reviewers; the concerns raised by the reviewers included the representivity of the chemical team and the often all too generic nature of the solutions being proposed. However, the reviewers felt a good start had been made.

Two post-plenary follow-up workshops were convened in Pretoria and Durban in early October. The Phase I report submitted to the Review Panel was circulated to the complete database for comment. The follow-up workshops were not well attended<sup>5</sup>, in spite of extensive follow-up by telephone. Nevertheless, a number of additional points were tabled and these have been incorporated into current thinking. In addition, the authors have consulted widely with other sectors that have direct links with the chemical sector.

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<sup>3</sup> Members of the task team are listed in Appendix A.

<sup>4</sup> See Appendix B for list of attendees.

<sup>5</sup> See Appendix C for list of attendees.

The Phase II CSTT was then changed to address issues of representivity and a concern about the weighting of the CSIR in the team<sup>6</sup>. This team met in late October, and provided key input to the drafting of the Phase II report.

A number of reservations to the above approach, expressed by both reviewers and participants in the workshops and breakaway sessions, should be mentioned in this report. They are:

- The general limitations of a technology strategy to be able to stimulate an industrial sector without simultaneous attention to other important aspects, including human resource development, regulatory environment, investment incentives and security.
- The ability of a small group of people to pinpoint specific technology interventions that will have high market impact, given that such information is generally only available to industry specialists within specific sub-sectors.
- The complexity and diversity of the chemical industry, which on its own dictates against the approach of finding common solutions.
- Insufficient attention was being paid to the capacity within NACI to implement the outcomes from this project. It is strongly recommended that a dedicated resource be identified as soon as possible in order to ensure effective implementation of the proposed technology interventions.

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See Appendix D for list of participants in the Phase II review team

## 5. Global Market Conditions and Trends

The chemical sector is very diverse, ranging from low unit value commodity or bulk chemicals to high-value but small-volume, complex and highly specialised compounds. It has an extremely complex web of interdependencies and linkages as a result of a number of producers from many sectors being processing primary feedstock through synthesis, formulation and conversion into tens of thousands of compounds. There are about 80 000 officially registered compounds.

In order to introduce some segmentation without too much complexity, the chemical sector is divided into four main segments based on margin and production volume (see Figure 1). In general, commodity chemicals are produced at low margin, but in large quantities and against a common specification that is usually linked to composition. In recent years, fine chemicals have also become commodities, and margins have fallen drastically. Higher-margin products include those that have either patent protection or are hard to produce, referred to as designer chemicals (for example, speciality ceramics and ethical pharmaceuticals), or complex formulated products, sold against a performance specification and hence are difficult to copy (examples include flavour mixtures and water treatment chemicals, also referred to as speciality chemicals).

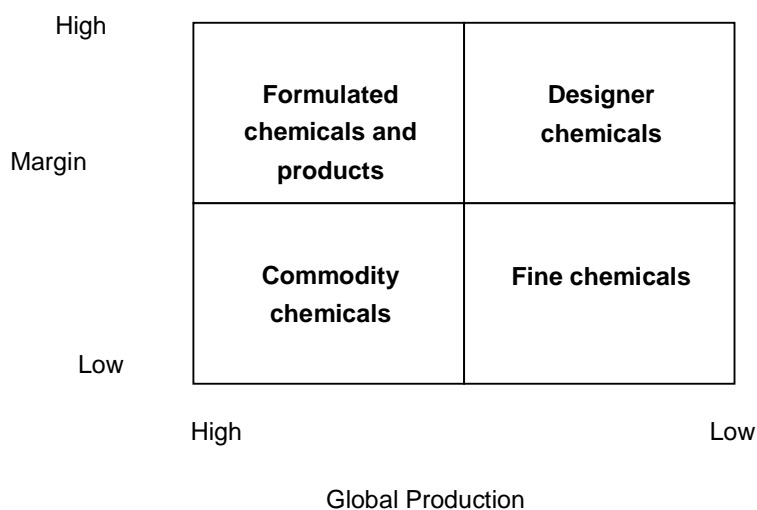


Figure 1: Segmentation of chemical sector based on tonnage and margin

Although slightly dated (1994), the respective positions of different chemical groups within the Speciality Chemicals sub-sector, separated according to size and forecast growth in Western markets, is given in Appendix E. The chart also

demonstrates the complexity in the sector at large. Pharmaceuticals, flavours and fragrances, and electronics chemicals are still seen as high-growth markets.

In outline only, the key characteristics and trends of the global chemical industry include:

#### Market Conditions:

- The sector is predominantly mature and highly competitive with low margins.
- 70% of global chemical production, and 65% of global chemical consumption, are located in Japan, the USA and the EU. The chemical industry is also its own biggest customer with about 60% of production used in downstream manufacturing within the sector.
- In the commodity sector, market share is the determining measure and driver for performance. Currently there is significant overcapacity in the sector affecting ethylene, benzene, styrene, alpha-olefins and phenol.
- There is a cyclical syndrome of “three bad years and one terrible year!”. The recent global downturn hit the global chemical market earlier and harder than other sectors..
- Increased competition from countries with significant competitive advantages (access to markets and/or raw materials) will force down prices and margins. As a result, global production is moving to lower-cost economies.
- Financial markets will continue to demand increased profitability and capital productivity.
- Globalisation and international trade are here to stay, but access to certain markets will be hindered by regulatory compliance issues. In particular, concern for and practices affecting the environment are becoming significant conditions for market access coupled with a greater understanding and requirement of Life Cycle Analysis (LCA) resulting in cleaner production as well as the use of renewable resources.
- Regulatory trends that favour one product or technology over another (such as emissions and thickness of plastic bags) are generally getting stricter and compliance is necessary to stay in the game.

#### Feedstock Trends:

- To a large extent, the chemical sector’s feedstocks are inorganic substances, crude oil and gas, all of which are non-renewable resources.
- There is trend towards the use of natural products and the use of waste streams and multiple feedstock options through multi-step synthesis reactions.

- There is a significant trend towards gas-to-liquid technology for fuel and feedstock production.

#### Manufacturing Technology and Innovation:

- Product substitution trends will result from newer technologies and products.
- Process improvement will be essential in order to meet increasing environmental, efficiency and quality standards - the industry is generally under pressure to improve its environmental record and its sustainability.
- Catalysts will play an even greater role with 60% of chemical production and 90% of chemical processes already dependent on catalysis.
- Strategies to reduce product development times and improve R&D effectiveness will be a prerequisite. Spending levels, as a percentage of turnover, are not expected to change (in the US this varies from 2% in basic chemicals, 4% in polymers and up to 10% in pharmaceuticals. In Germany, the R&D spend has moved from 5,8% in 1995 to 7,3% in 2000).
- Companies in the life sciences will continue to be major drivers of product innovation due to higher R&D expenditure and advances in bioinformatics, genomics and proteomics.

#### Business Processes and Supply Chain Management/Logistics:

- Market channels will become more direct with increasing preference for individual tailoring of products, requiring an increasing level of sophistication, emphasis on customer relations, logistics, inventory management, inbound/outbound resources management and capacity reservation. 80% of value-added costs are associated with Supply Chain Management (SCM).
- There will be an increasing tendency to network and to develop more open and less rigid environments with flatter structures, e.g. more "bottom up" and less "top down" flexibility will become standard.
- e-Business will increase.

#### Knowledge Management:

- Companies are increasingly exploiting their intellectual property (IP) in addition to the sale of products and services.
- The ability to capture, share and use ideas or information generated within the business will increase.
- Database systems to support data warehousing and mining are expanding.

Human Resources:

- The sector employs a significantly high proportion of engineers and scientists, reflecting the highly technical nature of the sector but it is shedding jobs worldwide through technical innovation, consolidation and greater economies of scale.
- People will need to become more informed about a range of issues of not only “what you know” but “how do you apply it” and be quicker to link ideas and action.
- There will be a greater demand for employees with multiple skills.

## **6. A Profile of the South African Chemical Industry**

The South African chemical industry constitutes 25% of manufacturing GDP, which in turn constitute 25% of the total national GDP (i.e. 6% of GDP). It is therefore an important sector, and its fortunes, or lack thereof, have a major impact on the overall performance of the country's economy.

A more detailed review of the sector follows.

### **6.1. Sub-sectors of the Chemical Industry**

A snapshot of the industry showing the importance of the 11 sub-sectors is given in US\$m (Year 2000) in Table 1.

The largest sector is liquid fuels followed by plastics conversion and pharmaceuticals. The import dependence of some sectors is high and these are invariably the more specialised and therefore higher value chemicals. Further information on the importance of different technologies to each sector is given in Appendix F and an analysis of potentially important strategic factors, including such categories as raw materials, growth, product application and risk is given in Appendix G.

It is interesting to note firstly the relative value of the contribution of each sub-sector to South Africa's GDP, and secondly South Africa's relative position in world production (Figure 1). Given that South Africa's GDP is about 0,7% of global GDP, it is noted that three sectors (fuels, bulk formulated chemicals and pharmaceuticals) have a larger output than may be expected based on our GDP. It

could also be speculated that South Africa has some advantage in these sub-sectors.

The comparative data are perhaps more useful in identifying potential growth areas. For instance, the fine chemicals sub-sector is small on both a national and an international scale. This is a concern, given the number of initiatives to stimulate local fine chemicals production, and reflects the general problems of downstream development of upstream import parity pricing, a small local market and lack of clear value-addition opportunities. In the context of the growing dominance by Indian and Chinese producers, it can also be argued that the opportunity to establish such an industry in South Africa has passed.

Table 1: Sub-sectors of the South African Chemical Industry in 2000<sup>2</sup>

<b>Sub-sector</b>	<b>Imports</b>	<b>Exports</b>	<b>Production</b>	<b>Consumption</b>
Sub-sector 1: Liquid fuels and associated products	137	1 091	4 000	3 045
Sub-sector 2: Commodity organic chemicals	383	393	829	818
Sub-sector 3: Polymer and rubber products in primary forms	325	133	965	1 156
Sub-sector 4: Commodity inorganic chemicals	632	630	1 089	1,090
Sub-sector 5: Fine chemicals	400	97	62	364
Sub-sector 6: Pure functional and formulated speciality chemicals	779	360	704	1 123
Sub-sector 7: Bulk formulated chemicals	19	146	601	474
Sub-sector 8: Pharmaceuticals	560	89	1 000	1 471
Sub-sector 9: Consumer-formulated chemicals	103	105	703	701
Sub-sector 10: Plastic conversion	269	124	2 700	2 845
Sub-sector 11: Rubber conversion	241	163	624	701
Total US\$m	3 854	3 337	13 278	13 795

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<sup>2</sup> Figures in US \$ million

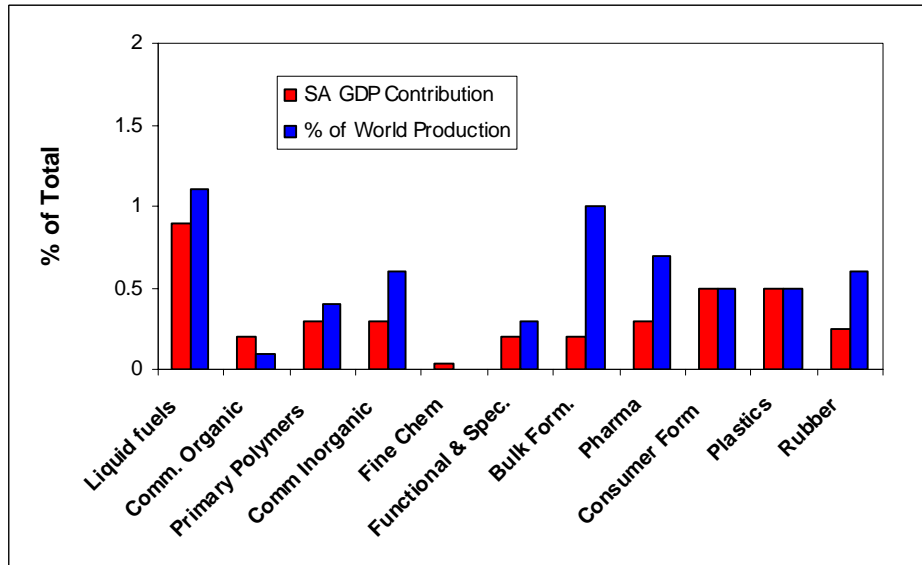


Figure 2. Chemical sub-sectors: relative importance to South African GDP and world production

### 6.2. Performance and Growth of the Sector

Over the last four years, the industry itself has either been static (as measured by employment numbers) or grown slowly, except in industrial chemicals. Employment has also been static.

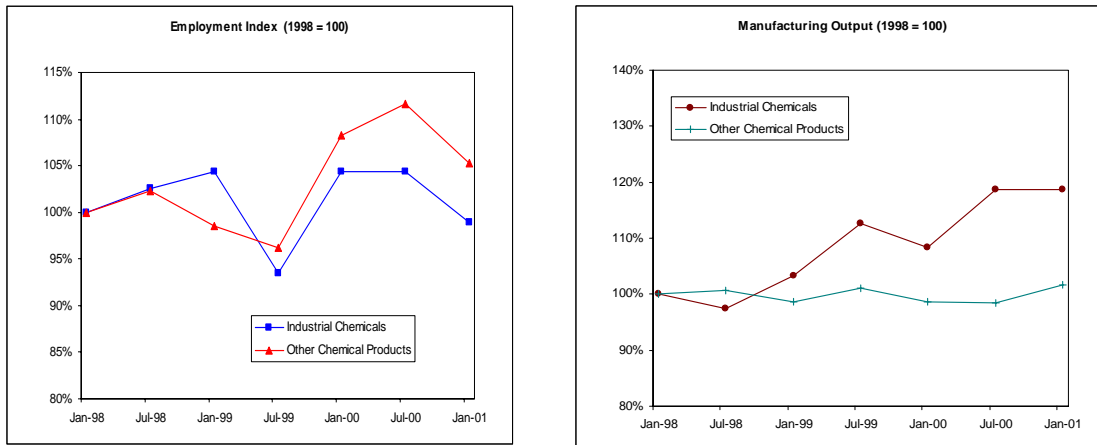


Figure 3: Employment and manufacturing output for the South African chemical industry (1998 – 2001)

Interestingly, the import (26%) and export (14%) gap of 1996 had been largely closed by 2000, but generally South Africa has a weak balance of payments position within the sector. This is because the exports are principally low-unit-value commodity chemicals whereas imports are higher-value speciality chemicals. In some notable cases, South Africa exports low-quality materials and at the same time imports higher grades of exactly the same material.

It should be noted that within a space of 10 years, Sasol has effectively transformed itself into a truly global chemical company and has achieved some impressive results. If the performance of Sasol were removed from the national figures, the performance of the rest of the sector would be very dismal. For instance, with global overcapacity and South Africa being on the periphery of the market, South Africa has not managed to attract sufficient Foreign Direct Investment (FDI) into the sector. Between 1994 and 1999, South Africa attracted R78 bn in FDI, of which only 4,5% was for the chemical sector. In the same period, there were significant offshore investments, with Sasol acquiring Condea and concluding a joint venture with Petronas in Malaysia.

### **6.3. Competitive Advantages and Weaknesses of the South African Chemical Industry**

#### **Competitive Advantages**

South Africa is seen as having a number of competitive advantages including:

- Low energy costs, though whether this is sustainable in the longer term needs to be evaluated.
- Abundant coal, certain inorganic materials and natural products (all of which are key raw materials).
- Pockets of world-class technology (such as fuel from coal).
- Access to a unique slate of chemical intermediates from organisations such as NECSA and Sasol.
- Several world-class tertiary institutions that match their First World counterparts.

## Weaknesses

There are a number of obvious weaknesses in the industry, which include the following:

- The sector has been extensively researched in the past and it is generally accepted that little material benefit has resulted from this work.
- There is a history of bad strategic investments, the collapses of which have had far-reaching impacts on the sector.
- Upstream dominance with limited downstream integration and value addition.
- Absence of a local producer of aromatic chemicals (the so-called benzene, toluene and xylene (BTX) fraction, which are a key raw material for many polymers and speciality chemicals).
- An industry that is located mainly inland, and hence has the disadvantage of an inefficient transport infrastructure and high transport costs to the major international markets.
- For many chemicals, the sector is unable to take advantage of South Africa's strategic position in natural resources because the producers adopt the commercially advantageous practice of import parity pricing. This effectively penalises downstream companies to the benefit of the primary producers.
- The diversity of the sector makes it difficult for the role-players to speak with one voice, and leadership in the sector is generally absent, with notably few exceptions. There is regular criticism that management is cast in the mould of conventional wisdom and is unable to embrace new challenges.
- Many in the sector feel that industry representation is focused on the interests of major operators to the exclusion and detriment of regional, smaller, more diverse and less influential interests. There are allegations of divisive and adversarial positions that prevent the industry at large in engaging in effective and constructive dialogue to develop much-needed programmes required to benefit industry.
- There are over 50 industry associations and professional representative bodies within the sector including paints, plastics, flavours and fragrances, coatings, etc. Each has its own constituency and most operate in silos of sectoral interest.
- There is a major problem with respect to innovation in South Africa, as represented by various statistics (R&D intensity, ageing of the workforce, etc). The sector feels that their recent investment in HRD so far has not yielded the return and increase in "human capital" they had expected. Moreover, the

innovation chasm has prevented the translation of R&D into commercial products and services.

- A key weakness in the South African sector is the shortage of a well-trained and competent new generation of scientists and engineers entering the market. 35% of recent applications to the National Research Foundation for R&D funds for catalysis, supercritical fluid extraction, separation membrane techniques and nanomaterials came from A-rated scientists in the over-55 age bracket. There were minimal “trickle down” or mentoring components in these programmes. There are insufficient applications from the younger generation and unless this problem is addressed, it will get worse.
- There has been little success in the sector in broadening the base and creating SMMEs.
- The R&D spend is reported to be <0.5%, of which a significant portion is placed with external agencies thus reducing the ability of local institutions to service these local needs.
- There are few natural overseas partners due to the limited South African market size and its fit into global operations.

## **Opportunities**

Notwithstanding the above problems, there are a number of existing and growing advantages for the industry, including:

- The availability of a new range of low-cost intermediates (such as linear alkenes) from the increasing use of GTL technology by Sasol.
- There is a strong view that the commodity inorganics as a sub-sector has significant and untapped potential. For instance, South Africa has a strong position in fluorine technology based on significant reserves of fluorspar and rock phosphate deposits, coupled with technology developed at NECSA.
- Less than 2% of South Africa’s sugar production (2,5 m tons) is converted into biochemicals (such as lysine). The National Biotechnology Strategy is an attempt to address the technology needs of additional biochemical facilities.
- The country has a high level of biodiversity which, combined with a global swing towards natural products where demand exceeds supply, has created a major opportunity to capitalise on this wealth of diversity. Rooibos is a success story but there are many other possibilities including buchu and honeybush. A great deal of technology and research expenditure may be required to find the new chemical entities that could lead to future economic opportunity.

- High failure rates in the drug development pipelines of large pharmaceutical companies has created an opportunity for small companies to provide leads that have already passed through early, though less onerous, selection hurdles but which now require more substantial financial investment than is realistically available locally.
- South Africa has the capability to develop generic drugs, thus reducing dependence on costly imports. There is also a need for vaccines for Third World conditions (malaria, cholera, etc.) without First World price tags. South Africa has shown early success in taking drugs off licence and repackaging them successfully and re-patenting them.

#### **6.4. Needs of the South African Chemical Industry**

Based on the above analysis, the Chemical Sector Task Team identified a number of high-priority needs for the industry, following a road map approach as given in Appendix H. A great deal of the information from this exercise has been captured in Appendix I.

The following highlights are presented:

- Government and the public service to considerably improve the business environment in respect of crime, education, the transport and communications infrastructures, and the coordination of, and hence output from, the various segments of the National System of Innovation.
- NACI to commission a more detailed market review of the chemical sector in order to identify further technology interventions not specified in this report.
- The National Research Foundation to undertake the compilation of a register of expertise in order to sponsor networking and R&D projects in South Africa.
- The industry to secure a more effective and visionary leadership across the sector in order to present a common position on industry priorities.
- Universities, government departments and science councils to undertake the general promotion and development of relevant chemical technology in catalysis, synthesis, separation and other areas of chemical production technology.
- Training institutions generally, to assist with the promotion of a culture of innovation and entrepreneurship.
- Government to consider improved R&D and capital investment incentives.

## **7. Key Technology Interventions for the Chemical Industry**

During the process of scanning possible interventions and selecting those that have been highlighted in this section of the report, the Task Team were guided by a number of important criteria, including the need for the interventions to:

- Build on South Africa's comparative and strategic advantage (a given).
- Integrate with other technology and commercial sectors.
- Provide early, tangible and preferably substantive benefits (as measured by social impact, return on investment and other impact indicators).
- Promote the development of relevant and marketable skills.
- Offer opportunities for broader economic empowerment.
- Advance South Africa's interest in a technology-dependant industry.

In the following sections, the identified investment opportunities are explained in more detail.

### **7.1. Chemical Sector Technology Projects**

An initial list of proposed technology intervention projects is presented in Table 2. In each case, the project is described, costs of implementation are indicated, and potential benefits are defined. The projects are not listed in any order of priority. The identification of suitable investment projects for the Advanced Manufacturing Strategy will have to be done in consideration of the requirements for such an investment portfolio. In other words, the final decisions on which projects to sponsor should reflect the desired risk profile and timing.

Furthermore, this list should not be static, but should be refreshed on a regular basis through calls for proposals from R&D institutions and industry players. In a later section, we have proposed the creation of a CIDA. This organisation could be made responsible for the administration of such funds and projects and look to supplement development funds from the private sector and tertiary institutes in attempts to leverage pre-competitive levels in the chemical industry.

Group	Description	Rationale	Financial and Other Benefits	Potential Partners
COMMODITY INORGANICS AND BASE METALS	1. Minerals recovery from coal ash (ASPRO)	<ul style="list-style-type: none"> <li>There are 80 m tons of ash residues with high mineral content in Secunda</li> <li>New optimising application of three known technologies requires innovation and research on processes to improve recovery rate</li> <li>New environmental legislation will require ash producers to clean up</li> </ul>	<ul style="list-style-type: none"> <li>Current estimated recoveries 500 k tons of Al recovery @ 1300 US\$/ton</li> <li>Other by-products</li> <li>Early win potential</li> <li>US\$ 240 m within 5-8 years</li> <li>Environmental improvement</li> </ul>	<ul style="list-style-type: none"> <li>Eskom</li> <li>Minerals and metals</li> <li>Cleaner production</li> <li>Computational chemistry</li> <li>Mintek</li> </ul>
	2. Titanium (Ti) recovery	<ul style="list-style-type: none"> <li>SA produces ±1 m tpa of slag containing ±250 k tons of TiO<sub>2</sub> at Highveld Steel and Vanadium Corporation</li> <li>Earlier R&amp;D resulted in technology that is now ready to be piloted to produce TiO<sub>2</sub> pigment</li> <li>Recent innovation identified routes to produce Ti metal without Na or Mg precursors</li> <li>Environmental legislation may force a clean-up programme shortly</li> <li>Australia has started a similar programme</li> </ul>	<ul style="list-style-type: none"> <li>Ti is a valuable light metal and could easily result in downstream secondary industry</li> <li>TiO<sub>2</sub> pigment recovery can yield US\$800 m pa after a gradual phase-in over several years. Ti metal can add a further US\$120 m p.a. in export revenue</li> <li>World market for TiO<sub>2</sub> is 4 m tons p.a. and for Ti sponge is ±70k tpa</li> <li>Low electricity cost a major advantage over Australia since 1 ton Ti production requires 15 –37 MWh</li> <li>Environmental improvement</li> </ul>	<ul style="list-style-type: none"> <li>Minerals and metals</li> <li>Cleaner production</li> <li>Supply chain management</li> <li>Process technology</li> <li>Highveld Steel</li> <li>Mintek</li> <li>NECSA</li> </ul>
	3. Fluorine cluster	<ul style="list-style-type: none"> <li>SA has significant skills in organic and inorganic fluorine chemistry in NECSA</li> <li>SA has ample raw materials in fluorspar, phosphates, etc.</li> <li>NECSA has opportunity to develop fluorine-based speciality chemicals used in electronics, high-voltage electrical and pharmaceuticals</li> </ul>	<ul style="list-style-type: none"> <li>Adds to the fine chemical profile</li> <li>Potential global market size is R15 bn p.a. with the South African market potential at R1bn</li> <li>Potential linkage into agro-chemical and pharmaceutical active ingredients</li> </ul>	<ul style="list-style-type: none"> <li>Minerals and metals</li> <li>Process technology</li> <li>Cleaner production</li> <li>NECSA</li> </ul>

Group	Description	Rationale	Financial and Other Benefits	Potential Partners
COMMODITY INORGANICS AND BASE METALS	4. Chemicals for mining extraction	<ul style="list-style-type: none"> <li>SA has unique and significant skills in mining</li> <li>As % grain decreases so extraction rate becomes critical</li> <li>Many metallurgical processes are inefficient at low % grain levels</li> <li>Improving extraction rates through new technology and processes will greatly improve returns</li> </ul>	<ul style="list-style-type: none"> <li>Improved extraction rates on precious metals (Au, etc.) will improve profitability</li> <li>Increasing share of global market chemicals of R200 m</li> </ul>	<ul style="list-style-type: none"> <li>Minerals and metals</li> <li>Process technology</li> <li>TEIs</li> <li>Cleaner production</li> </ul>
	5. Downscale plant design	<ul style="list-style-type: none"> <li>Several production processes need plant scale below minimum world scale</li> <li>Feedstock volumes are often sub-critical</li> <li>Ability to handle small volumes competitively will be advantageous to SA scale production</li> </ul>	<ul style="list-style-type: none"> <li>Lower capital costs</li> <li>Niche production capability at competitive levels</li> <li>Share of fine chemicals global production</li> <li>Production flexibility</li> </ul>	<ul style="list-style-type: none"> <li>Process technology</li> <li>Supply chain management</li> <li>Cleaner production</li> <li>Sugar industry</li> <li>Private sector</li> </ul>
BIOTECHNOLOGY	6. Aroma chemicals from paper effluent	<ul style="list-style-type: none"> <li>Paper and pulp industry produces significant suitable waste streams</li> <li>Aromatics, flavours and fragrances are niche markets</li> </ul>	<ul style="list-style-type: none"> <li>High value-added market</li> <li>1% potential market share of R2,5 bn gives R25 m</li> </ul>	<ul style="list-style-type: none"> <li>Cleaner production</li> <li>Process technology</li> <li>Biotechnology</li> </ul>
	7. Diagnostics for health and environmental sectors	<ul style="list-style-type: none"> <li>Diagnostics needed for effective health care in SA environment</li> <li>Need for remote tests with on-line diagnosis</li> </ul>	<ul style="list-style-type: none"> <li>Improvement in human health and QOL</li> <li>Local care centre with access to remote specialist skills</li> <li>Local market estimate is R400 m</li> </ul>	<ul style="list-style-type: none"> <li>Process technology</li> <li>Product technology</li> </ul>
	8. Bio-degradable products	<ul style="list-style-type: none"> <li>Need to create novel biodegradable materials, e.g. bio-polymers</li> <li>Packaging industry under environmental pressure over plastics</li> </ul>	<ul style="list-style-type: none"> <li>Alternative materials</li> <li>Less cost to the environment</li> <li>Market potential R1,2 bn</li> </ul>	<ul style="list-style-type: none"> <li>Cleaner production</li> <li>Product technology</li> <li>Process technology</li> </ul>

Group	Description	Rationale	Financial and Other Benefits	Potential Partners
BIOTECHNOLOGY	9. Pharmaceutical feedstocks	<ul style="list-style-type: none"> <li>Generics API and intermediates cluster focusing on ARVs</li> <li>Post-patent reformulation into new delivery modes</li> <li>Delivery of Phase I and II products to major pharma companies</li> </ul>	<ul style="list-style-type: none"> <li>Impact on human health</li> <li>SA strategically placed with bio-diverse material</li> <li>SA market potential including HIV is R5 bn</li> </ul>	<ul style="list-style-type: none"> <li>Biotechnology</li> <li>Process technology</li> <li>Pharmaceutical companies</li> </ul>
	10. Natural products	<ul style="list-style-type: none"> <li>Natural products in medicines, food and cosmetics is a growing global sector</li> <li>Synthetics not acceptable</li> <li>SA has significant bio-base</li> <li>High-value chemicals</li> </ul>	<ul style="list-style-type: none"> <li>Global market is US\$363 m</li> <li>Total SA market is R50 m</li> </ul>	<ul style="list-style-type: none"> <li>Biotechnology</li> <li>Agro-processing</li> <li>Health market</li> </ul>
ORGANICS	11. Develop alternatives to high-risk agro-chemicals	<ul style="list-style-type: none"> <li>DDT still be used in quantity in SA</li> <li>Ability to create an agent that will break down DDT will revolutionise use of DDT</li> <li>Need to limit environmental and human risk of acute toxic chemicals</li> </ul>	<ul style="list-style-type: none"> <li>Risk to environment and applicator reduced</li> <li>Allow continued use</li> <li>Crop protection market is US\$25 bn</li> </ul>	<ul style="list-style-type: none"> <li>Cleaner production</li> <li>Biotechnology</li> <li>Department of Labour</li> <li>Department of Health</li> </ul>
	12. Products from alpha-olefins	<ul style="list-style-type: none"> <li>Large and cheap supplies of Sasol feedstocks provide significant volumes of pentene (unique to SA)</li> <li>Challenge is to convert through bio-catalysis to nylon and plastics</li> </ul>	<ul style="list-style-type: none"> <li>Competitive advantage in raw materials</li> </ul>	<ul style="list-style-type: none"> <li>Cleaner production</li> <li>Process technology</li> </ul>
SYNFUELS	13. Bio-diesel Production	<ul style="list-style-type: none"> <li>Crude oil imports significantly affect balance of payments</li> <li>Farm crops can produce vegetable oils for synthesis</li> <li>Labour intensive</li> <li>Renewable sources</li> </ul>	<ul style="list-style-type: none"> <li>Reduce imports of oil</li> <li>Can be used as supplement/additive to existing supplies</li> <li>NATREF interested in supporting locally in Vaal Triangle</li> <li>SA diesel market is R1,4 bn. 2% saving is ±R30 m</li> </ul>	<ul style="list-style-type: none"> <li>Bio-technology</li> <li>Process technology</li> <li>Bio-processing</li> <li>Cleaner production</li> <li>DEM</li> </ul>

Table 2: List of Potential Technology Interventions for the South African Chemical Industry

## 7.2. The Chemical Industry Development Agency

A common feeling expressed throughout this project was the need to ensure that a specific organisation, representative of all the role-players in the chemical industry, be established in order to own, manage and ensure the success of this process and the proposed interventions. Without such an organisation, it is clear that this document will be yet another set of good intentions whose implementation will either fail or be non-existent.

It is therefore proposed that NACI should create a CIDA in order to promote and coordinate the future development needs in the chemical sector. The CIDA will be responsible for the following functions:

- Provide the vision and leadership through the interpretation of the sector's needs in relation to the government's R&D strategy, the Integrated Manufacturing Strategy, the GODISA Incubator Programme, the National Biotechnology Strategy, the ICT Strategy and the Advanced Manufacturing Strategy.
- Administer the NACI-sponsored projects on technology interventions for the chemicals sector (section 7.1) with special attention to potential for innovation and entrepreneurship.
- Create and maintain a relevant database of the sector including skills, technologies, products and materials.
- Develop strategies and programmes to provide technology flow and key development needs in process technology and platform skills including catalysis, synthesis, extraction, computational technology, beneficiation and value-added opportunities, in order to exploit South Africa's competitive advantages.
- Run a national public awareness and PR programme to support the development of mathematics and science in education and training and more specifically to promote the importance of, and career opportunities in, the chemical sector through linking with all relevant institutions and bodies including the Department of Education, tertiary educational institutions and professional institutes, and actively lobby government
- Assist the Chemical Industry Education and Training Agency (CHIETA) with training and development in the sector, such as occupational training in previously disadvantaged communities.

- Evaluate and formulate specific projects that will benefit and develop the sector by seeking government and private sector support.
- Integrate and cooperate with other sectors to ensure the most efficient and effective deployment of resources and skills development.
- Promote the strategic purpose to all interested and relevant parties.

## Implementation

It is recommended that the Minister establish a board and appoint suitably qualified directors from industry, government, unions, academia and such relevant bodies which could offer a strategic contribution. The board would appoint an executive manager whose task would be to set up and run the agency. A proposed organisational structure is presented in Figure 4.

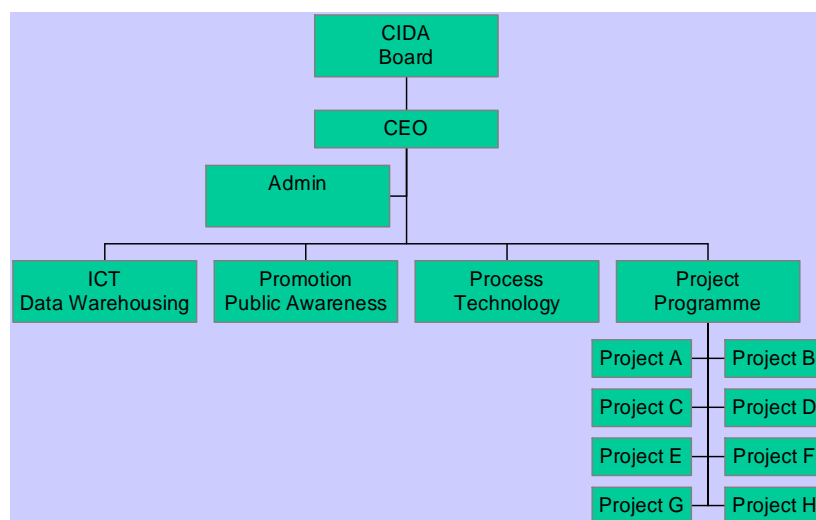


Figure 4: Proposed structure for CIDA

## Benefits

Benefits arising from CIDA will include:

- strategic vision and direction for the future
- greater consensus on issues that need to be resolved
- contribution to the development of S&T and in particular chemically trained graduates
- positioning of the chemical sector as a key contributor for the future.

CIDA will be expected to implement the following projects and actions:

### **7.2.1. Programme 1: In-Depth Sub-Sector Analysis and Technology Development**

The objective of this project will be to conduct an in-depth analysis of the 11 sub-sectors in the chemical sector with the most potential in order to:

- Provide a detailed situation analysis of each sub-sector and an assessment of the opportunities, including those not currently on the radar screen.
- Identify areas where South Africa has the competitive advantage and is successful.
- Establish how these successes can be improved, advanced and complemented.
- Prioritise potential development options and determine where government can invest to support the sector.
- Get agreement in the sector on the opportunities identified.

An initial scan has produced some 80 chemicals, products and initiatives that are beyond the scope of this project to evaluate.

#### **Benefits**

Identification of those innovation components of the chemical sector that offer a clear assessment of the opportunities and the best opportunity for investment.

### **7.2.2. Programme 2: Establish a Chemical Sector Information, Skills and Capability Database**

#### **Description**

- Coordinate multiple sources of information into one access point.
- Identify all participants and stakeholders in the industry, their activities and their interests.
- Locate centres of excellence and specific expertise.
- Maintain a current database on the sector.
- Provide a single point of entry for chemical sector information.

## **Implementation**

The creation of the database should not duplicate existing information but rather access information from a variety of sources. This information can be housed in real or virtual conditions. To achieve an effective system the ICT group inputs will be vital.

## **Benefits**

- Better opportunity to identify empowerment opportunities on a broader basis than currently.
- A single point of entry will reduce inefficiencies and enquiries will be effectively handled.
- A greater understanding of the national position on competencies and where the gaps are.
- Identification of centres of excellence and unique skills.

## **8. Cross-Cutting Technology Interventions**

### **8.1. Implementation of a Supply Chain Management Programme**

#### **Description**

The chemical sector will participate in the functions of a Centre for Logistics (Supply Chain Management) initiated by NACI in which it will benefit from the development and adoption of SCM techniques, including:

- Customer relations management (CRM).
- Service levels.
- Cost-reduction programmes.
- Systems integration.
- e-Business adoption.
- Continuous replenishment and other distribution techniques.

## **Implementation**

The emphasis will be on changing industry perceptions of collaboration and cooperation. It is paramount that the parastatal transport facility, in which there are gross inefficiencies, should be part of this programme. Key focus areas will include:

- Optimisation of bulk chemical flows.
- Policy and regulation issues.
- Firm-level improvements.

## **Benefits**

South Africa will experience benefits and savings from more efficient material flows, resolution of conflicting policy and regulation, and improvements at local level (assuming logistic costs make up 10% and assuming a 10% improvement, the savings would amount to R1,3 bn). Future benefits could include substantially increased export revenues through incentive schemes into new markets and the availability of market information.

## **8.2. Implementation of a Clean Technology Programme**

### **Description**

The chemical sector will engage in a programme to develop clean technology in its business and production processes through involvement with the recently approved **dti**/UNIDO Cleaner Production Centre.

### **Implementation**

This programme will be driven by the CIDA with participation of the chemical sector and suitably qualified consultants. The main thrusts will be:

- Drive behaviour change through an awareness programme on financial and environmental benefits; focus on “hot spots” .
- Introduce scoring systems.
- Implementing audits.
- In-house process improvement adaptations.

- Life cycle assessments.
- Extend recycling and effluent management.

## **9. Generic Interventions**

### **9.1. Maths and Science for Human Resource Development**

#### **Description**

CIDA will support NACI and other relevant institutions that will engage with the broader government structures including the Department of Education and the Department of Labour to develop a comprehensive strategy to promote and develop interest in mathematics and science to achieve the following in the immediate to long term:

- Identification of, and investment in, high-potential teachers capable of teaching this subject at all levels.
- Development of maths and pure and applied sciences as the preferred disciplines in the primary, secondary and tertiary education systems.
- Development of incentive schemes to encourage interest in maths and science, i.e. teachers to teach the subjects, learners to learn them.
- The development of appropriate business skills that will help South Africa overcome the debilitating baggage and attitudes of the past.
- Promotion of multi-skilling in the workforce to improve flexibility.

#### **Implementation**

Targets must be established for all categories of science graduates passing through the system. It will take 15 to 20 years to turn the situation around completely.

## **9.2. Integrated and Coordinated R& D Strategy**

### **Description**

CIDA will support NACI to engage with the relevant government structures with a view to integrating and coordinating the government's R&D strategy specifically to address:

- Coordination between all government sources of R&D funds to ensure strategic alignment and market focus.
- Getting an appropriate balance between HRD and transformation needs, government S&T infrastructure and the innovation or enterprise funding missions.
- Ensuring that investment in R&D is done on a basis that utilises the established and grade A skills but with appropriate mentoring and trickle down to ensure skills development in the younger generation of scientists.
- Identification of nodes of excellence with a view to facilitating capacity building and deploying the capability more extensively.

## **9.3. Integrated and Coordinated R&D Strategy**

### **Description**

There are a number of important interventions that could assist the chemical sector. These include:

- Ensuring that the NACI leadership is capable of leading and driving forward complicated and multi-stakeholder processes with the support of all factions.
- Introducing supply side measures to stimulate development and investment in the sector.
- Including the mining sector in this process at an early stage because of its importance as an upstream supplier of material for a number of potential sectors.

## 10. Conclusions

In this report, the global trends in the chemical industry have been described. Such trends, together with internal market changes, have created new opportunities and challenges for the South African chemical industry. While acknowledging that relevant technology-driven, but market-led, interventions will not be the only solution, the CSTT has identified a number of such interventions that are considered to have a major potential benefit for the local industry, including:

- Development of a new industry based on the extraction of minerals from coal ash and low-value slag.
- Extension of NECSA's expertise in fluorine generation and use in order to generate a range of fluorinated organic chemical intermediates.
- Development of a new range of performance chemicals that will improve the recovery of minerals in the mining sector (such as polymer used in solvent extraction processes).
- Establishment of a new technology platform that will develop technologies to decrease economies of scale for chemical plants and hence enable smaller production facilities to compete against the mega plants.
- Support for existing development efforts in low-cost diagnostics, aroma chemicals production, development of biodegradable and high-performance polymers, bio-diesel and products from alpha-olefins.
- A major initiative to build South Africa's first generic pharmaceutical actives plant in order to meet future demand for antibiotics and/or anti-retrovirals.
- A highly integrated strategy to fully develop South Africa's ability to add maximum value to its natural products and unique biodiversity.

In addition to requesting support for these projects, it is emphasised that equal attention must be given to how these projects are both implemented and monitored. It is therefore suggested that NACI should consider support for the establishment of a Chemical Industry Development Agency (CIDA) that will manage the projects, and elicit a number of similar projects from the industry, based on a more detailed analysis of the various sub-sectors than was possible in this process. CIDA will also be responsible for promoting the needs of all the stakeholders in the chemical industry, including both business and labour.

Appendix J indicates schematically the inter-relationships of the various intervention programmes with other market and technology sectors for the short to medium term. The areas in pink are high priority and the yellow and green are medium and low respectively.

Finally, it is recommended that NACI continue to use its influence to improve the integration of our National System of Innovation, and the improvement of maths and science education at all levels in the educational system.

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Directorate of Chemical and Allied Industries. Department of Trade and Industry. *National Strategy, Chemical and Allied Industry, August 2000*.

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**Appendix B. List of Attendees at Chemical Sector Breakaway Group of the Plenary Workshop of 16 August 2002**

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**Appendix C. List of Attendees at Follow-Up Workshops in Pretoria and Durban on 3 and 7 October 2002**

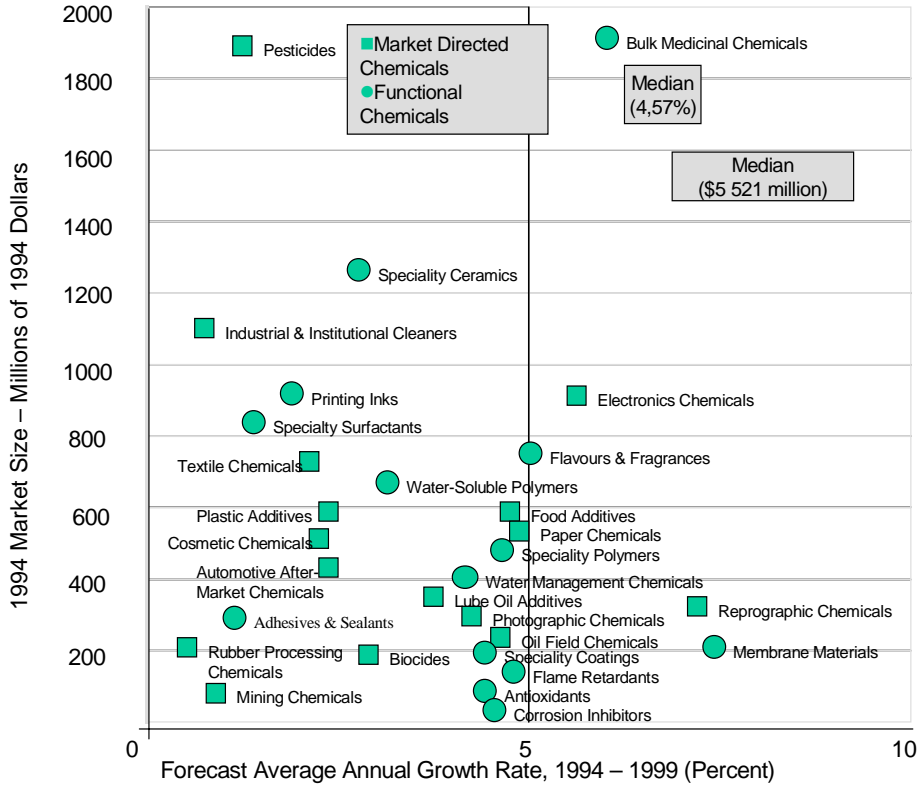
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## Appendix E. Chemical Sub-Sectors and Growth

Relationship of US, Western European and Japanese Markets: Size & Projected Growth Rates for Speciality Chemicals



## Appendix F. Importance of Different Technologies in Different Chemical Sectors

Sector	Contribution Million US\$	%	Computational Technologies	Chemical Measurement	Process Science and Technology	Chemical Synthesis	Bioprocessing & Biotechnology	Materials Technology
Liquid fuels	4 000	30,1	High	Medium	High	Medium	Low	Low
Commodity organics	829	6,2	High	High	High	Medium	Low	Low
Primary polymers	965	7,3	Medium	Medium	High	Medium	High	Low
Commodity. inorganics.	1089	8,3	Medium	Medium	High	Low		High
Fine chemicals	62	0,5	Medium	High	Low	High	High	Low
Functional and speciality.	704	5,3	Low	Medium	Medium	Medium	Low	Medium
Bulk formulation	601	4,5	Low	Medium	Low			Low
Pharmaceutical	1 000	7,5	Medium	High	Low	High	High	Low
Consumer formulation	703	5,3	Low	Medium	Medium		Low	Low
Plastics	2 700	20,3	Low		Low			High
Rubber	624	4,7	Medium	Medium	Medium	Medium		High
TOTAL US\$ m	13 277	100						

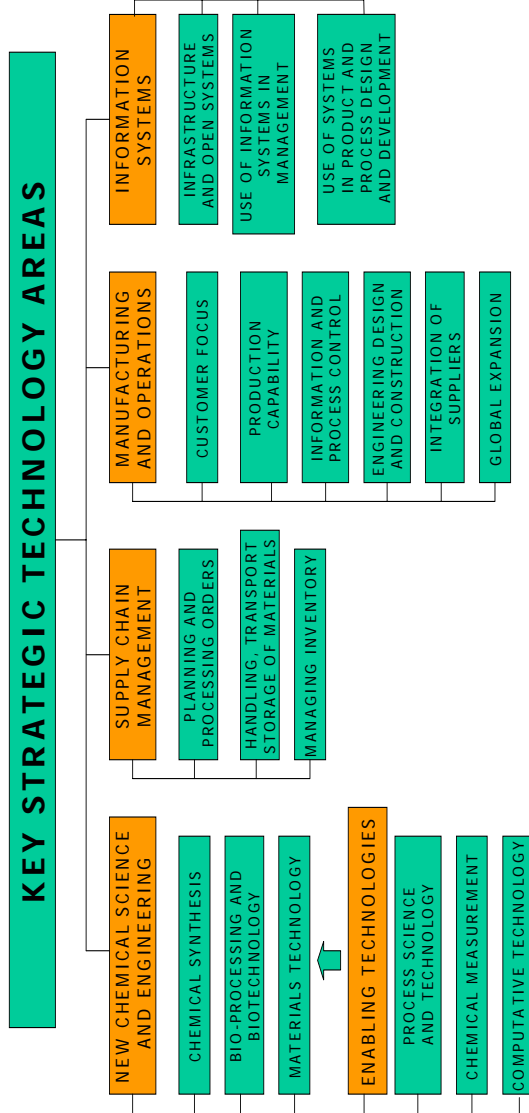
### Appendix G. Potentially Important Strategic Factors

Sector	Technological self-sufficiency of industry	Growth	Raw material advantage	Unrealised beneficiation potential	Application in products	Major Risk	Potential synergy with other sectors
Liquid fuels	High	As GDP	Low (oil) High (coal)	Low	Low	Oil price environment	Comm organics
Commercial organics	High	High but limited	Linked to Sasol	Medium	High	Limited by syngas base Take-over of Sasol	Polymers
Primary polymers	High	High but limited	Linked to Sasol	Medium	High		
Commercial inorganics	Fragmented	High	TiO <sub>2</sub> , ZrO <sub>2</sub> , Mn, Sb, Au, P, F Pt group	High	High	Backlash from existing customers if products are benefited	High
Fine chemicals	Low	Low to negative	Low	Low	High	Chinese competition	Unique raw materials from Sasol
Funct. & special	Intermediate	Unsure	Limited	Low	High	Marketing	Intermediate
Bulk form.	High	Low	High	Low	Low	Markets are at risk	Low
Pharmaceutical	Intermediate	Unsure	Biodiversity	High	High	High development costs	Low
Consumer form	High	Intermediate	Low	Low	High	Marketing	Low
Plastics	High	High	Linked to Sasol	Intermediate	High	Environmental and legislative pressure	Low
Rubber	High	Low	Low	Low	High	Lack of competitive advantage	Intermediate

## Appendix H. Chemical Sector Roadmap

# CHEMICAL SECTOR ROAD MAP

FORCES SHAPING THE FUTURE      BROAD GOALS FOR IMPACTING FORCES      STEPS NEEDED TO GET THERE



## **Appendix I: Needs of the South African Chemical Industry**

The chemical industry is both complex and diverse. As a result, there is no such thing as a universal need. Moreover, some of the needs unique to the sector can be described as New Chemical Science and Engineering, while other aspects such as supply chain management, information systems, manufacturing, and operations are shared across a number of sectors. Ideally, they should be accommodated on a shared platform or in a cluster of initiatives. Here we consider each separately. In addition, we have listed a number of generic needs that impact on the sector but can only be resolved at national government level.

The task team has briefly indicated why these needs are important and refers to linkages to identify the main groups that will be impacted and affected by these needs.

### **A. Specific Needs of the Chemical Sector**

*A more detailed market review of the chemical sector is required, particularly in respect of identifying opportunities and building on existing successes in the 11 sub-sectors*

This is needed because the complexity and uniqueness of the sector and sub-sectors has to be better understood in relation to the connections, linkages, products and processes, players, trends and opportunities. South Africa has limited financial resources so there is a need to prioritise and select opportunities. There are also widely differing views on the attractiveness of many initiatives, e.g. bio-diesel, fluorine technology, fine chemicals, biopolymers, etc.

This will involve cross-sector and technology linkages with metals and minerals, cleaner production and biotechnology.

*There is a need for more effective and visionary leadership across the sector so that it can express a unified position on broadly based interests such as development and policy at a macro level.*

Currently the sector is largely disparate and insular. There is no common voice that can engage government on a representative basis and this is a severely limiting position. There is a significant gap between the large global organisations who are able to engage and lobby, compared with much of the sector that is

conservative and divided and still grappling with a new world order. Finally, much of the sector has not transformed. There must be a more effective and efficient mechanism to engage the stakeholder base in determining future technical needs.

*There is a need for the promotion and development of relevant chemical technology in catalysis, synthesis, separation, computational capability and metrology to ensure that South Africa develops competencies and expertise and maintains a significant “critical mass” of intellectual capability.*

The following are fundamental competencies that are necessary to the sector:

- Catalysis: 60% of all chemical production and 90% of processes are dependent on catalysis. Particular emphasis should be placed on “transition metal catalysis”, focusing on mining, metals and minerals.
- Synthesis: This could be focused on “fine chemical process development and scale-up” or “batch chemical process R&D”. New processes are needed to meet new opportunities, standards, etc. across applications in biology, physics and computation.
- Chemical process (formulation and application) development targeted at functional (frothers, anti-oxidants, flocculants) and market or application-directed chemicals (e.g. mining, adhesives, textiles, paper processing).
- Computational technology: using modelling and simulation to develop new products and processes in shorter times. Evaluation of alternative complex molecular structures, etc.
- Process technology: using processing and equipment, automation and control and intelligent systems.
- Chemical measurement (metrology): investigating real-time measurement tools, production and process controls, refining product specification, increased product specifications.

Linkages will be made with biotechnology, process technology, cleaner production, ICT and the educational institutions and R&D systems.

*A culture of innovation and entrepreneurship must be promoted and rewarded. There is a need to challenge conventional wisdom and consider highly novel and innovative opportunities.*

New technologies and new approaches must be developed including:

- Alternative use and re-use of abundant inorganic materials and waste streams to create new feedstocks.
- Programmes to identify beneficial areas of synthesis for the application of catalysis and bio-catalysis.
- National expertise in functional and performance effects of chemicals focused on selective sub-sectors.
- New materials through bio-additives, e.g. biopolymers.
- New concepts in “flexible” process technology and manufacturing for high-performance materials and structures.
- Chemicals in alternative (non-traditional) reactive extraction and distillation media, e.g. milling, gas plasma, photochemical, microwave, supercritical, cryogenic.
- Production and use of membranes.
- Mining chemicals.
- New technology allowing greater extraction and separation leading to better recoveries.
- The development of small-scale plants at a significant capacity reduction compared with world-scale plants. Recent successes include the reduction of alcohol plant (oxo-alcohol, methanol and distillation) and vessel reactors down to 1/6<sup>th</sup> of original design.
- Utilisation of waste stockpiles to reduce impact on the environment.
- Improving the “sustainability index” for South Africa in international markets.
- Replacing of traditional materials with light, durable, higher performance, flexible, efficient, etc. materials.
- Utilising of significant and cheap South African feedstocks now and in the future feedstock profile.
- Import replacement opportunities.
- Potential beneficiation of exports.
- Suitable empowerment opportunity where SMMEs can develop.
- Utilising South Africa’s strategic advantage in low-cost electricity.

Linkages will include metals and minerals, biotechnology, cleaner production, process technology, and TEIs.

*The sector needs to implement a range of new technologies and methodologies to increase its efficiency, reduce waste and energy consumption and improve its quality and output.*

The global market is getting more competitive so every opportunity must be taken to work smarter, harder, faster and more efficiently by:

- Introducing “lean production” technology.
- Reviewing resource and energy use.
- Assessing seven types of waste streams, namely overproduction, motion, WIP, waiting, over-processing, defects and transport.
- Value stream mapping.
- Reducing time to market.

There are also likely to be benefits of partnering and collaboration with other players in the upstream and downstream activities.

Linkages will be developed with process engineering and cleaner production.

*An Expertise Register needs to be created.*

Chemical sector expertise in South Africa is fragmented and the pockets of excellence are difficult to find by an uninformed outsider. This results in considerable search times for information and expertise that needs to be reduced. Often the resource resides in silo-like structures known to only a few. There is benefit in developing a mutually supporting network with a link to skills and experience and common sharing.

Linkages here include the **dti**, DST, TEIs, science councils, cleaner production, process technology, metals and minerals

## **B. Cross-Cutting Needs**

*Supply Chain Management (SCM) and Logistics are considered essential business processes that will lead to greater efficiencies and customer focus.*

The commercial importance of SCM is greater than the importance of branding! Customer Relations Management (CRM) is becoming incorporated into the

business process as is the process of inventory reductions and streamlining the supply and delivery links. Cost reductions and service level improvements are also badly needed. There are also significant shortfalls in the integration of systems, including the IT supply chain and electronic connectivity between suppliers and customers. E-business is limited, and the industry runs the risk of being caught on the wrong side of the digital divide as it becomes a compulsory business process.

There is opportunity to establish producer networks to take advantage of mutual and compatible feedstock and waste streams. Clustering then becomes a viable model to exploit these links and to share the benefits of the value chain. Collaboration is at a low level and the value of strategic partnerships has yet to be appreciated.

Assistance is also needed in building sales channels in new markets. Finally, there is a need to improve the distribution efficiency of bulk chemicals that is exacerbated by the collapsing transport infrastructure.

*Evaluation of "value addition" products and the development of a new generation of biomaterials from biotechnology must be examined for potential.*

Bioprocesses are becoming increasingly important as sources of pharmaceutical feedstocks, aromatics and flavours, and as prospects for new-generation materials such as biopolymers.

Biotechnology is a new and undeveloped technology in which Western nations are investing heavily. Although South Africa can never compete on equal terms, advantage must be taken where niche or pockets of excellence can be developed.

Linkages are likely to be between biotechnology, cleaner production, process technology and advanced materials.

*Cleaner production techniques are becoming vital in the approach to production and consumption of chemicals. Adoption of the requirements is seen as a necessary condition to get into the market place.*

Changes in environmental awareness are leading to a radical re-appraisal of chemical processes and products through improvements in:

- Waste management.
- Efficient use of resources such as water and energy.
- The replacement hazardous products.

The main tools of this technology are:

- Life-Cycle Analysis to identify opportunities for improvements.
- Energy, material, and process audits to identify opportunities for financial savings and reduction of the impact of environmental and human health.
- The use of funds and financial incentives to develop infrastructure and establish waste minimization clubs and demonstration projects.

Adoption of these is now seen as a necessary condition to be in the business.

### **C. Generic Needs**

There are a number of generic needs that impact on not only the chemical sector but also all other sectors and South Africa at large, and that must be addressed as part of a broader initiative in pursuit of NACI objectives. No sector can survive in isolation so there is a shared and common interest in establishing a comprehensive programme to address these needs.

The needs expressed require a coordinated national approach involving all stakeholders, including business, government, unions, civil society, educators and learners.

*Human Resource Development is a critical need for maintaining a reliable and sustainable supply of appropriately trained and qualified people.*

The supply of maths and science skills coming out of the educational system is totally insufficient to meet the scientific and technical needs of South Africa, which is a developing country hoping to pin its economic success on its manufacturing sector. Maths and science disciplines are in heavy demand and must have an elevated status so that they can become an automatic career choice for most young South Africans. Measures must also be taken to retain these vital skills,

prevent further loss and also attract more skilled people to the country if only to bridge the gap until South Africa becomes self-sufficient.

*Management of the R&D portfolio and resources must be re-examined to ensure more appropriate linkages, more effective allocation of resources, and improved coordination.*

Currently, government's approach to R&D is fragmented with many types of R&D funds and programmes that are not integrated and coordinated. In addition, government needs to realign some anomalies where R&D spend is not focused on developing an appropriate skill base with the required profile to meet South Africa's needs. There is a serious need to create local capacity that can be benchmarked against international standards. Resources must be targeted at the new generation with appropriate mentorship.

There must also be a high level of integration with other national initiatives, including the Integrated Manufacturing Strategy, Technology Stations, National Biotechnology Strategy, etc. Piggybacking on existing initiatives is more likely to yield greater results at marginal cost.

*Government must consider incentives and streamline the planning and regulation processes into a more "investor friendly" environment.*

South Africa has the potential to be a "favoured" destination notwithstanding the shortcomings of the rest of the continent. There are many countries in the world that offer attractive and immediate packages of incentives to investors, and these are seen as "friendly" and supportive. South Africa has consistently avoided setting any precedent on this matter and is seen as "investor unfriendly". To attract world-class investment that will make South Africa competitive in world markets, supply side incentives must be seriously considered. In addition, the planning and regulatory statutes must be regularised to provide a level playing field for all participants and players. Response must become timeous and be in accordance with government's commitment to Batho Pele principles to avoid unnecessary delays and lost opportunities.

If this is not addressed, South Africa will fail to attract consistent and major opportunities and will pick up only the incidental and peripheral opportunities.

*South Africa needs world-class integrated communication and infrastructure systems.*

In today's trading world the ability to communicate through a number of communication channels is vital as responsiveness is becoming a vital customer-relations asset. South Africa's telecommunication monopoly on data transmission capability, coupled with restricted bandwidth and an unwillingness to provide state-of-the-art networks is seriously hampering South Africa's competitive position.

The same applies to the transport infrastructure. The near collapse of the railways as a service provider places an additional burden on a road infrastructure that was never intended to handle the increased traffic. The cost to the country will become increasingly significant unless the railways, roads and ports are managed more effectively.

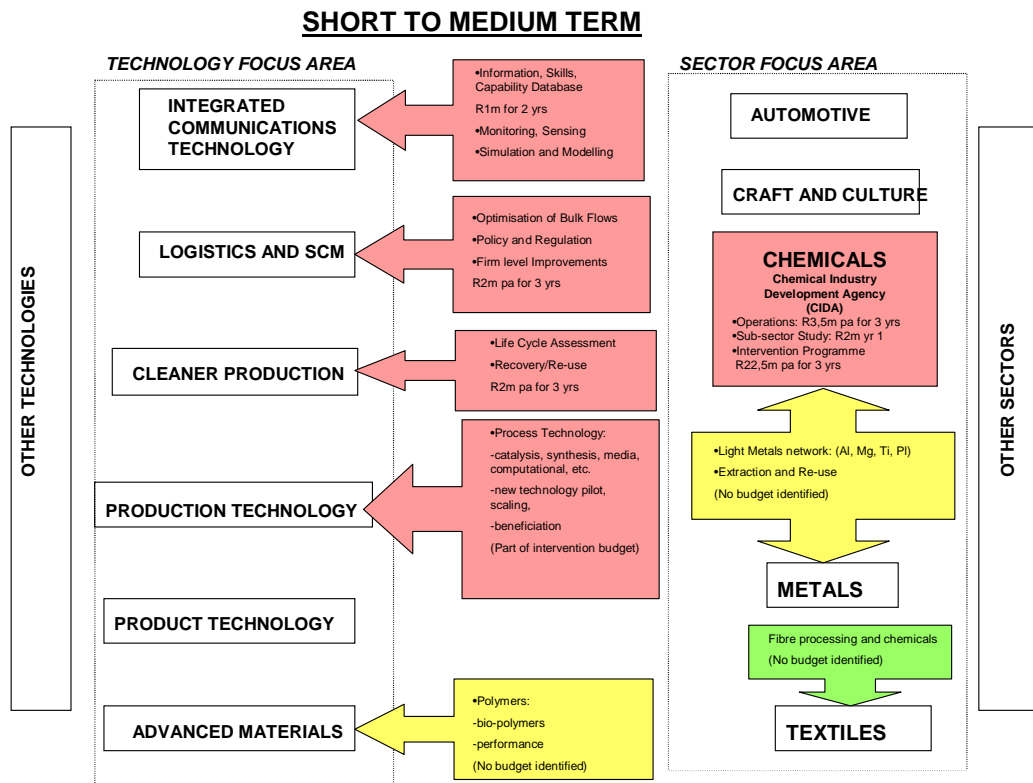
### **NACI Process Management**

The chemical sector welcomes this NACI initiative and other government processes designed to improve South Africa's economic and competitive position. However, all this will be to no avail if the implementation of the NACI process is not given the due attention and support that will be required to embed the changes. A visionary and charismatic leader, a "rainmaker", will be required to get buy-in, drive the process and achieve the results which so far have been lacking in many of these government processes.

Many of the above generic needs are a pre-requisite before any directed investment into the chemical sector per se can have any long-term effect. These include:

- Support for maths and science at the secondary education level, including curriculum development and teacher selection and training.
- Increased support for Tertiary Education Institutions (TEIs) especially in pure and applied sciences.
- Fiscal incentives to companies for R&D expenditure.
- Measures to retain and attract skills to South Africa.

## Appendix J. Linkage between Chemical Industry and Sectors



Priority

- High
- Medium
- Low