1. THE DEVELOPMENT OF SOUTH AFRICA'S CHEMICAL INDUSTRY AND ITS IMPLICATIONS FOR CHEMICAL SECTOR DEVELOPMENT IN SOUTHERN AFRICA

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Introduction

In previous work, South Africa's industrialisation has been usefully interpreted by using the concept of a Minerals-Energy Complex (MEC)[1]. The concept considers the interaction of a set of distinct sectors around mining, energy and energy-intensive productive activities which have acted to shape industrialisation. The MEC concept also views this process as part of a system of accumulation which has involved, shaped and has been shaped by, the interaction of various public and private interests in and around the specific sector and sub-sector components of the economy.

Using the MEC analytical framework, chapter two of this paper focuses on the chemicals industry, which is diverse and made up of a number of sub-sectors which are interlinked with each other (value chain) and also with other sectors of the economy (input-output relationship). The impact of mining industry demand on the chemical sector is examined.

Institutions and agencies, both private and public, have acted in various ways and at different times to shape the trajectory of the chemical sector's development. Different sub-sectors have developed over different time frames. This paper traces the key features of South Africa's chemical industry development, examining this in terms of the role played by various private sector economic actors (domestic and trans-national) and their relationship with the government of the day, through its associated agencies.

Sections three to six consider the extent to which energy policy, industrial policy and policies towards health, science and technology have influenced the development of the chemical sector.

Section seven concludes the paper, demonstrating that the analytical framework that underpins the MEC approach is useful in understanding how the chemical sector has developed within South Africa and makes suggestions on the extent to which such an approach could be useful if extended to the analysis of the possibilities for growth of the chemical sub-sectors in other countries within Southern Africa.

Chemical sector – economic linkages

The chemical sector is significantly integrated within itself and with other economic sectors and it can be usefully sub-divided according to 11 strategic classification categories which are themselves located according to four different stages of beneficiation, as visualised according to Table 1.

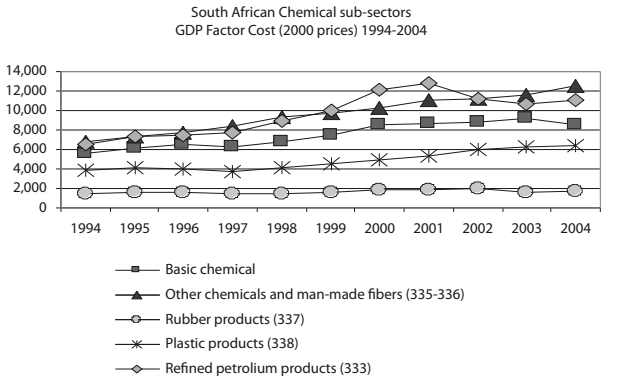
TABLE 1: Chemical Value Chain

Stage 1 Ores / Oil/ Gas	Stage 2 Processed or Refined Ore/Crude oil	Stage 3 Primary Manufacture	Stage 4 Finished Manufactures	Strategic Category sub-sectors
• Agricultural feedstocks (biofuel) • Coal • Crude Oil • Coal • Natural Gas			Refined petroleum products Energy fuels	1 – Liquid fuels
	Basic Chemical Products	Primary Plastic Products (Polymer)	Plastic Products	2 – Commodity organics 3 – Primary Polymers&Rubbers 10 – Plastic prods 11 – Rubber prods
Minerals			Other Chemical products – Organic & Inorganic Paints, Glass Products Rubber Products, Fertiliser, Pesticides, Agro-chemical, Paints, Soap, Cleaning Compounds, Polishes, Waxes, Explosives, Adhesives, glues	4 – Commodity inorganics 5 – Fine chemicals 6 – Pure functional and specialties 7 – Bulk formulated chems 8 – Pharmaceutical 9 – Consumer formulated

The largest components of South Africa's chemicals sector, in terms of contribution to GDP, are the Refined Petroleum Products, Other Chemicals and Basic Chem-

icals sub-sectors. (Figure 1). These are capital intensive and fall within Stages 2-3 of the beneficiation value chain.

FIGURE 1: RSA Chemical subsector relative size



Source: Quantec

The various chemical sub-sectors exhibit particular linkages with other sectors of the economy. In South Africa, these relationships have evolved over decades and are illustrated in Table 1.

Policy importance of linkages

South Africa's chemical sector, which has evolved over many decades, can be considered relatively well developed in comparison with other SADC countries. Despite this, the above analysis of linkages suggests that the following aspects are important for economies with less developed chemical sectors (Table 2):

- The chemical industry is not homogeneous and the evolution of its component parts has followed different development paths which will be traced below
- Forward and backward linkages exist within the chemical sector with other chemical sub-sectors, such that a large proportion of chemical sector outputs are consumed within the sector itself.
  - A large proportion of the output of each sub-sector is, in turn, consumed by other sub-sectors of the manufacturing sector. If one considers Basic Chemicals, for example, 65% of the output of the sector is consumed as intermediate inputs into other manufacturing sector processes with the balance (35%) being exported. Consumers purchase only 1% of the output directly.

– In contrast, 78% of the output of the Soap sub-sector is purchased by consumers.

- Strong forward and backward linkages exist with other economic sectors
  – 31% of pharmaceutical products are consumed by the Government Health and Social Services sector
- Such linkages are useful guides to considering strategies for other economies. The availability of such data is extremely useful for the development of sector policy and strategy, especially if it is regularly collected.

TABLE 2: Linkages between RSA Chemical Sector and the rest of the economy

	Agriculture	Mining	Manufacturing	Building & Construction	Transport Services	Govt incl. Health & Social Services	Exports	Consumption Expenditure	Other Sectors + Changes in inventory
Petroleum products	5	2	18	3	17	3	14	38	– 1
Basic chemical products	0	3	65	0	0	1	35	1	– 5
Fertilisers	52	3	19	0	0	1	15	1	10
Primary plastic products	0	0	81	0	0	0	11	0	8
Pesticides	32	1	36	0	0	2	21	18	– 9
Paints	1	1	51	8	4	4	4	0	28
Pharmaceutical products	5	0	17	0	0	31	4	47	– 4
Soap products	0	1	11	0	1	1	5	78	5
Other chemical products	0	26	33	0	1	3	14	12	10
Rubber tyres	1	6	0	0	24	4	13	66	– 14
Other rubber products	2	14	63	0	6	1	11	2	2
Plastic products	1	1	60	5	0	0	6	4	23

Source : *Statistics South Africa*,2000.

Impact of the mining Industry on the chemicals sector

Explosives and mining chemicals

Large scale mining provided the first major driver for chemical industry development in South Africa. The geographic location of diamond and gold mines several hundred kilometres from any sea port in the 19th century was an important factor which drove the development of the explosives and mining chemicals industry.

In the case of explosives, apart from economies of scale, these were difficult and dangerous to transport. A number of policy-related lessons can be drawn from the history of dynamite production in South Africa, including:

- The importance of scale economies
- Impact of intellectual property/patents and competition on pricing
- Technological change

- Military security policy
- The influence of vested interests on policy
- Role of various national and provincial state-controlled institutions and agencies on policy

Dynamite was initially imported by an individual who secured a 16 year concession from the Boer Republic in 1887 and sold the product at a huge profit. After objections by the powerful Chamber of Mines in 1892, the exclusive concession was withdrawn, and the ensuing competition led to price reductions. This was also fuelled by the expiry of the dynamite production patent held by the Nobel Trust which, together with the Societe Centrale de Dynamite of Paris, controlled the world's production and trade in dynamite.

Behind the scenes, a number of other factors drove domestic manufacture. In 1893, the Boer Republic made the import, manufacture and sale of explosives a government monopoly but transferred this to an individual who had originally been a partner in the 16 year concession company. The biggest explosives factory in the world, producing 240,000 cases per year, was built in Modderfontien in 1895 in a joint-venture with the Nobel Trust. It followed the discovery of gold 10 years before. It was built largely by German engineers and skilled labourers and managed by Germans and Austrians. Even the packaging staff were immigrants from Italy, founders of the Johannesburg Italian community. The relationship between government, the Nobel Trust and domestic private business is reflected in the following observation:

> "Although the government officially owned the monopoly the plan was so designed that the profits went to individuals and companies abroad. It is obvious to anyone who has studied the documents that it could not have been established without the connivance of high officials of the State."[2]

The domestic production of dynamite, while reducing prices to the Chamber of Mines considerably compared to imports, still reflected a high import propensity. 1 ton of explosives required 4 tons of raw material including glycerine, sulphur and nitrates. Sulphuric acid and nitric acid were made from imported sulphur and nitrate of soda.

The conflict between the Boer Republic and the British also influenced government policy. Although there was a strong controlling British influence on the Nobel

Trust, the Boer Republic viewed the dynamite company as being a strategic facility, capable of supplying it with ballistite (charge for ammunition) in a possible war with Britain and thus, Cartwright (1964, p.79) argues, tended to "forgive and forget the shortcomings of the dynamite company even though it robbed the state outrageously." This proved fortuitous since the factory began ballistite production in 1900 and more than 1.5 m rifle cartridges were subsequently made.

In 1898, the major mining houses gave support to De Beers to commence construction of an explosives plant at Somerset West in the Cape Colony. Despite the high import propensity of explosives, De Beers used its influence on the Cape Government Railways to classify the output of the Somerset West factory as "colonial produce" which qualified for a lower freight rate.

The Transvaal Chamber of Mines allocated about 50% of purchases from Modderfontein under an agreement with both dynamite companies, in order to avoid substituting one monopoly for another. Each plant was capable of producing about 250,000 cases/annum, which was roughly the size of the market then. De Beers Explosive Works also changed the fixed price system to a cost plus one.

The mining industry, organised under the Chamber of Mines, was clearly powerful enough to drive the reorganisation of the explosives supply industry.

New explosive market entrants – Kynoch

Following the annexation of the Boer Republic by Britain in 1901, a third explosives factory was built at Umbogintwini, Durban, in 1904 by Kynoch, Nobel's chief British competitor. The plant quickly captured 10% of the mining market. Kynoch had briefly in 1886 taken over and run the Boer Republic's Baviaanspoort powder factory but subsequently supplied the British Army during the war. It had a reputation as an ammunition maker but needed scale economies to justify local production.

By 1911, the explosives industry was the largest sub-sector of manufacturing, the largest importer of raw materials into South Africa, the largest single source of revenue to Natal Railways and a very large source of revenues of the Cape Railways.

Diversification from Explosives

Competition between the three plants led to the beginnings of diversification but it was limited to backward integration. Kynoch began making glycerine from whale oil in 1911 but closed the plant due to explosions. Somerset West did the same by

1914 and, with the rise in glycerine prices on the eve of WWI, began to sell explosives to Australia. It even went as far as buying a ship to avoid the irregular Australian service. The shortage of glycerine led to the development and use of lower grades of explosives.

Diversification into detonator manufacture followed. By 1917, detonator technology had become concentrated in the hands of the global explosives firms. Cape Explosives built a detonator plant between 1917 and 1920. A detonator plant was built in Modderfontein in 1920 but both plants became redundant by 1924 by the development of the Briska aluminium detonator.

In recent decades, mining technologies have demanded increasingly specialised explosives and detonating techniques. The explosives industry began responding to this in the mid-1980s when AECI carried out a R100m decentralisation programme building 4 new plants at Welkom, Klerksdorp, Utrecht and Bethal so that no major customer was more than 80km from a factory (80km being the maximum permissible road transport distance allowed by Chief Inspector of Explosives and the Road Transport Board). This cut handling by 50-75%, eliminated magazines, led to just-in-time daily delivery and reduced customer and AECI inventory.

From explosives to fertilisers

In the early 1900s, although mining was a dominant and growing sector, South Africa's agricultural sector was an important contributor to GDP.

SA originally obtained guano from islands off the Cape coast, but this became inadequate for even the Western Cape's needs and superphosphates were subsequently imported. In 1921, Cape Explosives built a superphosphate fertiliser plant but the factory closed down soon after due to Dutch dumping. The Government refused to raise local prices through tariffs due to "losing ground in the country districts and was not anxious to antagonise the farmers by imposing a duty that would increase the price of fertiliser."[3]

After the first world war in 1918, the European merger of explosives manufacturers of Kynoch and Nobel contributed to the rationalisation of all three South African plants in 1924 to create AECI (African Explosives and Chemical Industries), jointly owned by De Beers and Nobel Industries. Kynoch's Umbogintwini plant was converted to fertiliser manufacture using imported Moroccan phosphates and sulphuric acid to make superphosphates in 1930.

The sulphuric acid by-product from explosive manufacture was railed to Umbogintwini-Durban and used for superposphate fertiliser manufacture. The bisulphite by-product of nitration was dumped. Modderfontein initially did this on waste land at Zuurfontein but later railed this to Durban where it was pumped into the sea through a waste pipeline at Umbogintwini. A superphosphate fertiliser plant was also built at Somerset West. Modderfontein focused solely on manufacturing explosives. Superphosphate demand grew during the second world war. Umbogintwini raised production from 90,000t/a to 120,000t/a by expanding sulphuric acid plant output. It was however, constrained by imports of phosphates from North Africa which was cut off after France fell. But supplies resumed in 1943.

The mining industry provided an important impetus to the 1924 explosives industry merger. At the time, it was experiencing poor market conditions and the merger resulted in reduced explosive prices. In Europe, international competition and scale economies also led to mergers and consolidation of chemical companies with the explosives firms. ICI was born in 1925, as the merger of Nobel Industries, Brunner, Mond Limited, British Dyestuffs Corporation and the United Alkali Corporation. ICI's creation can be viewed as a response to protect the British Chemical Industry against competition from the growth of I.G. Farben in Germany and Du Pont and Allied Chemicals in the USA.

Ammonia Synthesis

New technologies provided the basis for further diversification. The Haber ammonia synthesis from air and subsequent production of nitric acid had been perfected in Europe, dispensing with the need for imported Chilean nitrates. AECI built an ammonia plant in 1930 at Modderfontein under licence from ICI, which provided massive savings for AECI, doing away with the need to import Chilean nitrates and rail them from Durban to Modderfontein. Instead ammonia gas was generated at Modderfontein and liquid ammonium nitrate railed to Somerset West.

There followed a boom after going off the gold standard at the end of 1932. Up to 1939, some 200 new mining ventures were established and led to both Modderfontein and Somerset West factories working at maximum production. Ammonia production expanded from 5,000 t to 25,000 in 1936, 402,000 t in 1948 and 1,450,000 in 1955 of which 50,000 t were used for nitrogeneous fertiliser and urea.

In 1942, the mines accepted the efficacy of ammonium nitrate based explosives instead of the gelignites that ammonium nitrate was used to make.

The relative power of the mining industry was demonstrated by the fact that nitrogeneous fertiliser development was hampered by limited ammonia plant capacity in mid 1930s. Chemical industry growth accelerated after 1945 as follows:

- **Modderfontein.** Ammonia plants were expanded continuously between 1948 and 1960, from 25,000 t/a to 75,000 t/a in 1955. Nitric acid production was expanded and a 110,000 t/a urea plant was built in 1960.
- **Umbogintwini.** Superphosphate capacity was expanded from 120,000 t/a to 320,000 t/a in 1945 and further enlarged to 600,000 t in 1955, with an associated sulphuric acid plant.
- **Somerset West.** Paint and leathercloth factories were built together with an Ammonia/Nitric acid plant and a cyanide plant (which by 1946 was supplying 50% of South Africa's mining needs).

The 1949 sterling devaluation increased mining activity and further stimulated the chemical industry.

In the 1950s, Sasol 1's output provided additional feedstock for fertiliser production and a number of factories were established in and around Sasolburg including the Fisons and Windmill fertiliser factories (1950s), Omnia Fertilisers, which started with distribution of agricultural lime in 1953 and opened its first fertiliser factory at Sasolburg in 1967/68. Fisons also established the Bosveld factory at Phalaborwa, using phosphates.

Industry rationalisation

By 1969 the Windmill and Fisons Sasolburg and Milnerton factories had been amalgamated under the Fedmis group, which subsequently became a subsidiary of Sentrachem.

Omnia later expanded with liquid fertiliser plants at Dryden, Danielsrus and Hectorspruit, a second factory at Sasolburg and a phosphoric acid plant at Phokeng near Rustenburg.

Triomf established its factory at Potchefstroom in 1967. A phosphoric acid factory at Richards Bay followed this in the 1970s. In the 1970s, Triomf and the non-nitrogen interests of AE&CI joined forces (currently AECI Limited)

The lifting of price control on fertilisers in 1984 coincided with the severest drought in two centuries and an economic recession which resulted in rationalisation of the fertiliser industry, including:

- Absorption of Triomf fertiliser assets by AECI
- Triomf initially retained its Richards Bay and Potchefstroom factories but later sold the former to an overseas consortium and the latter to AECI
- Sasol Limited, which previously had been a supplier to other manufacturers only, established its own fertiliser company (Sasol Fertilisers) and started marketing directly to farmers in 1984
- In 1988, Fedmis was dismembered and parts taken over by Sasol, Kynoch and Omnia

In 1990, Foskor vertically integrated through the purchase of IOF. In 1992, Sasol Fertilisers decided to cease its direct marketing to farmers. In 1993, Kynoch Fertilisers took over the nitrogen interests of AECI. Chemfos (a subsidiary of Samancor), which mined rock phosphate at Langebaan, ceased its activities at the end of 1993.

Further rationalisation took place between 1999 and 2002, including:

- Foskor obtained the entire shareholding in IOF, resulting in the latter becoming a fully owned subsidiary of Foskor, and IOF was changed to Foskor Richards Bay.
- Transnational corporation Norsk Hydro obtained the controlling interest in Kynoch, AECI's fertiliser division.
- Sasol Fertiliser, which had been trading as Sasol Agri since 2000, obtained a 100 percent interest in Fedmis of Phalaborwa, which was operated as a 50-50 joint venture by AECI-Kynoch and Sasol Fertilisers.

Agricultural chemicals

The agricultural chemicals market has been more diverse and specialised than the commodity chemicals, using imported and local raw materials, the latter supplied by major local upstream chemical commodity producers.

In 1927, in partnership with established European importers, AECI further diversified its Umbogintwini plant into insecticides and dips with an agreement with

Cooper, McDougall and Robertson, and into paint manufacture in association with UK's Naylor Brothers, but the latter failed during the 1930 depression. In both cases, AECI supplied the product and left marketing in hands of an agent.

By 1991, the SA agricultural chemicals market was valued at R 700 m/a[4], 50% of which was supplied by Sanachem, a subsidiary of Sentrachem. Sanachem had been formed by the merger of FarmAg and Sentrachem's agricultural chemicals division. The sector itself underwent a consolidation during the 1980s. Sanachem manufactured 22 pesticide ingredients at 4 plants including Canelands (Durban), MSMA herbicide (Chloorkop) and Berlin (East London). It concentrated on using expired patents. Sentrachem provided the basic chemical building blocks. 20% of its production was on a toll basis for Bayer, Monsanto, ICI and other pesticide companies.

In 1995, Sentrachem purchased US-based Hampshire Chemicals and, in 1997, announced plans to increase production of glyphosate herbicide at Hampshire with the intention of manufacturing the Roundup herbicide, once its patent expired in 2000. It appears that this was an important factor that prompted Dow to buy Sentrachem in 1998.

Dow's main interest in Sentrachem appeared to be its capability to produce the glyphosate herbicide, allowing Dow to compete with Monsanto's top selling Roundup herbicide. At the time, Monsanto had an 85% to 90% share of the world market for glyphosate but its patent on Roundup was to expire in 2000.

Following the acquisition, Dow dismembered Sentrachem, retaining only the Berlin, Sasolburg and Canelands production facility under the Dow AgroSciences division. The US Federal Trade Commission allowed the merger on condition that Dow dispose of Hampshire's chelant business, which would have led to Dow and Hampshire having 70% of the $140m chelating agent market in North America[5].

Plastics

In 1955, PVC manufacture began at Umbogintwini, the first commodity plastic to be made in South Africa. As a feedstock, it utilised surplus acetylene transported from a carbide plant at Ballengeich in Natal. The PVC plant's associated chlor-alkali plant also supplied chlorine and caustic soda to the South African Industrial Cellulose Corporation (SAICCOR) at Umkomaas.

A polythene plant in a joint venture with Sasol at Sasolburg followed in 1961. A cyanide joint venture was also established using methane from Sasol. Also in 1955, methanol, formaldehyde, and urea-formaldehyde resins were produced at Modderfontein and an igniter cord plant was also built. In 1963, interests in SA Titan Products (now Tioxide SA) and SA Nylon Spinners were acquired.

In 1964, AECI opened a fourth manufacturing site, the Midland Factory at Sasolburg. Using feedstocks from SASOL, the new factory produced initially calcium cyanide and then polyethylene (1966). PVC, CFCs, and chlorinated solvents followed. Adherence to the Montreal Protocol resulted in the phasing out of CFC manufacture in 1995.

Extending coal-based production

In 1974, a 300,000 ton per annum coal-based ammonia plant was commissioned at AECI Modderfontein and the company's dependence on coal as a raw material was highlighted with the commissioning of the Coalplex project at Sasolburg in 1978. A joint venture between AECI and Sentrachem, Coalplex consisted of five linked plants: carbide, acetylene, chlorine, VCM, and PVC. Coalplex also produced caustic soda and lime hydrate.

During the early 1980s, AECI consolidated its position as the major chemical company in South Africa, expanding and diversifying its product range. Acquisition of Chemical Services in 1980 was significant, reflecting an increased emphasis on speciality chemicals. In 1985, after 82 years, explosives manufacture at Somerset West was phased out. A joint-venture soda ash plant was commissioned in Botswana in 1991, and two years later the formation of AECI Bioproducts and AECI Aroma and Fine Chemicals was announced, with plants at Umbogintwini and Richards Bay.

Chemical industry restructuring in the 1990s

In 1993, AECI and SASOL merged assets into Polifin to produce monomers, polymers, chlor-alkali products, cyanide, and peroxides. The carbide-acetylene process producing VCM was replaced with a less costly process using ethylene from SASOL.

In 1998, SASOL attempted a take over of AECI, but the deal was aborted owing to stringent restrictions imposed by the Competitions Board. Subsequently, AECI further restructured by moving out of ammonia and urea production, selling Kynoch

to Norsk Hydro and Fedmis to Sasol. Today AECI focuses on five core clusters: explosives, speciality chemicals, fibers, biotechnology, and agricultural products.

Calcium carbide

Rand Carbide started producing in 1926, and by 1930 was the Victoria Falls Power Company's (VTFPC) largest bulk industrial customer with the exception of a few gold mines. The process used lime and coke in electric furnaces. The major demand for carbide was from the mines but the factory apparently became a major exporter.

A plant at Newcastle was started in the mid 1950s by a company called South African Carbide at the Ballengeich site. From the outset, it became integrated with other components of the chemical industry. From 1955, surplus acetylene from carbide production was transported to Umbogintwini for the production of polyvinyl chloride. SA Carbide was later absorbed into AECI and production continued until 1992.

In the meantime Karbochem, an operating division of Sentrachem Ltd, was also manufacturing carbide in Newcastle as a building block for the manufacture of synthetic rubber. In 1990, the Karbochem calcium carbide operation was closed down.

In 1992, the AECI Ballengeich carbide business and the Karbochem production facility were amalgamated and production continued under the Karbochem name. In 1997 the Dow Chemical Company bought the holding company of Karbochem and the carbide business continued operations until 2003. In June 2003, the business was sold to a management consortium and now trades as SA Calcium Carbide (Pty) Ltd.

History of South Africa's paint industry

Paint manufacture in South Africa began by accident. In 1918, a clerk in the South African office of Berger paints placed an order from the South African Railways, its largest customer, but erroneously transcribed the order by a factor of 100. To avoid deterioration of the 5 year's supply that was delivered, the British parent company sent a second hand paint mill to South Africa and local production began. AECI began paint manufacture at Unbogintwini in 1925 in association with UK's Naylor Brothers but this failed by the time of the depression of 1930.

In 1946, AECI set up another paint factory at Somerset West and expanded this in 1948 in a joint venture with Berger. This was consolidated in 1954 with a single holding company, United Paints.

Impact of industrial policy on the chemicals sector

Industrial financing – the IDC

In 1940, government set up the Industrial Development Corporation to provide financing for industry. Its share capital at the time was £5m equivalent to R730m in 2002 prices. Although the IDC highlights the fact that its first loan was made to a small industry producing "Ouma" rusks, its actions from inception were centred on financing large-scale industrial undertakings.

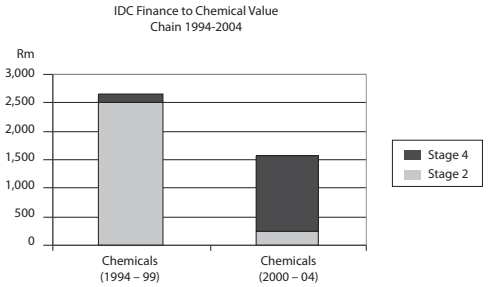
Over the decades, the IDC has been involved in financing the establishment of a number of chemicals-related industries in South Africa, including:

- Agricura animal feeds (1949), jointly financed by IDC, Bonuscor (Sanlam) and Federale Nywerhede.
- Fuel and chemicals (1950). The establishment of Sasol was funded by the IDC. IDC also financed Sasol II and Sasol III
- Insecticides – in 1950, Klipfontein Organic Products (KOP) was set up under IDC ownership to provide chlorine-alkali inputs for insecticides such as DDT and BHC. In 1962, KOP was the only local producer of these insecticides.
- Textiles – Rayon. In 1951, Courtaulds, SNIA Viscosa of Italy and AECI formed SA Industrial Cellulose Corporation (SAICOR) to process wood and produce rayon pulp at Umkomaas using Chlorine from AECI's Umbogintwini chlorine plant. Construction was completed by 1954, and in 1961 capacity was raised from 5,800t/annum to 15,800t/annum. SAICCOR was later taken over by SAPPI
- Pulp and paper. In 1951, a kraft and wrapping paper mill in Natal was financed
- Phosphates. The IDC established Foskor in 1952 to develop phosphate deposits at Phalaborwa to supply a domestic fertiliser industry
- Carbon black (1959), a key ingredient in rubber production at Port Elizabeth

- Synthetic Rubber Company founded to produce rubber from raw materials obtained from Sasol (1962)
- Soekor was registered with shareholding by the IDC and (then state-owned) Sasol to search for oil in South Africa (1965).
- Titanium minerals extraction pilot plant pilot plant from beach sand at Richards Bay – forerunner of Richards Bay Minerals (1972)

In recent years, relatively few large-scale chemical sector mega projects have been executed in South Africa. Exceptions relate to a series of integrated investments made by Sasol in its synthetic fuels and chemicals complexes at Sasolburg and Secunda. Since 2000, the IDC has focused its support on downstream chemical industries at Stage 4 of the value chain, which is in accordance with contemporary industrial policy to focus on more labour-intensive sectors.

FIGURE 2: IDC Financing of the Chemical Value Chain



Source: IDC

Chemicals and the armaments industry

As outlined above, explosives production was also used for producing ammunition. In 1937, the South African government negotiated with ICI to supply a 10 m round/week ammunition plant. ICI supplied the machinery and AECI produced cordite and percussion caps. ICI also built another munitions plant at the Mint in Pretoria and trained staff to run the plant in 1938.

In September 1938, the British War Supplies Board began planning a munitions industry with ICI, who were asked to plan plants for TNT, shell filling, bomb filling, magazine storage, ordinance cordite for heavy gun charges. The chair of ICI met with Defence Minister Pirow in 1938. The goverment provided capital for expansion but

expected the Somerset West plant to provide the TNT. Compared to the scale of production for the mining industry, the requirements were rather small and there were never any problems in meeting ammunition demands (Cartwright, 1964, p. 207). Again, during World War II, Britain's Ministry of Supply requested skilled personnel for training and supervising workers at cordite factories in the UK and AECI released 51 skilled people.

While explosives manufacture was already established, some chemical sub-sectors originated out of war production.

NCP's synthetic acetone/butyl alcohol plant, which provided raw materials for cordite manufacture, was licenced by the Distillers Corporation of Britain in 1940, the latter buying a large minority stake in NCP as part of the transaction. In 1941, the Department of Defence leased an area near Modderfontein, on the Klipfontein farm, and built a chlor-alkali plant to manufacture phosgene and mustard gas. After 1945, Klipfontein Organic Products was transferred to the Department of Commerce and Industries and the plant converted to make DDT and other pesticides. After the war, it was taken over by the Department of Commerce and Industries and production was focused on DDT, insecticides, caustic soda, hydrogen, hydrochloric acid and other chlorine by-products. In 1950, KOP was converted into a State corporation as a subsidiary of the IDC. In 1965, KOP was taken over by a consortium of companies led by FVB Federale Volksbeleggings.

During the 1980s, a capacity to manufacture lethal offensive chemical and biological warfare (CBW) toxins and biotoxins was developed with the Department of Defence. Based on reports surround the prosecution of Dr. Wouter Basson, it appears that considerable financial resources were channelled through a number of front companies, including Delta G Scientific which was established in secret in 1983, purchased by Sentrachem in 1993 and ultimately absorbed by Dow Chemical when it bought Sentrachem in 1995[6].

Atomic weapons production

Uranium oxide

Uranium oxide has been produced by South Africa for many years as a by-product of gold mining. The production of uranium oxide was apparently planned in secret by government in 1950 and implemented in 1952. Some 17 uranium extraction units were built together with associated sulphuric acid plants. AECI supplied

nitric acid and 9,000t of ammonia/a for the production process. The uranium programme was cut back from 1961 onwards and AECI absorbed surplus sulphuric acid in a new superphosphate plant at Modderfontein.

In the 1970s, the apartheid government spent billions of Rand in developing a uranium hexafluoride enrichment facility which was initially used to manufacture the nuclear fuel for the Keoberg nuclear power plant in the Western Cape. The programme was overseen by the state-owned Atomic Energy Corporation, but went further in a secret programme to construct several atomic weapons based on highly enriched uranium. The weapons were destroyed as part of the move to democracy in 1994 and the enrichment facility was shut down.

Fluorine chemicals: However, the associated hydrogen fluoride (HF), fluorine (F2), tetrafluoroethylene (TFE) and fluoro-chemical product facilities have been retained at the Pelindaba/Valindaba site near Pretoria and operated by the state-owned Nuclear Energy Corporation of South Africa (Formerly AEC)

The fuel industry

The fuel industry, the lifeblood of any economy, is an important associated component of the chemical industry (see sections of the other background papers for details of the relationship between oil refining and petrochemical production) Developments in the technology of fuel production and fuel use have been important drivers in the growth of chemical sub-sectors.

The policy-related issues that have impacted most on the development of South Africa's fuel industry, include:

- Economic/military security of supply
- Scale economies
- State-led investment in leading-edge technology
- Relationships between different segments of domestic business and transnational corporations
- Role of various national and provincial state-controlled institutions and agencies on policy

South Africa's synthetic fuel industry has two roots. The first is in the retorting and refining of shale oil deposits (torbanite), discovered and processed in the late 19th

century. The second root lies in the development of synthetic fuel from coal, which began to be discussed as early as 1927[7].

The first torbanite plant was set up by the Natal Mineral Oil Company in 1895 to extract paraffin from shale and this was followed by the Oil Shale Development Company in 1913 with oil shale mines in Natal, Transvaal and Swaziland. In 1934, the first SA oil refinery was set up in Boksburg by a joint venture between a South African firm, Anglo-Transvaal (Anglovaal), and the British Burmah Petroleum Company. SA Torbanite Mining and Refining Company, or Satmar, processed imported crude and shale oil, retorted at its Ermelo shale mine. Satmar can be regarded as a forerunner to the Sasol expansions of the 1970s, supplying the inland market with motor fuels up until the exhaustion of torbanite reserves in 1960, although it continued to refine imported crude oil until the plant's closure in 1976.

Three factors underpinned the plant in the 1930s. First, the natural protection of the inland market through railway freight rates, tariff protection for local manufacture and, during the war years, the irregular imports of crude oil. The main refined products at the time were petrol, diesel and paraffin fuels, which were initially marketed by the SA Motor Traders' Association and subsequently by transnational oil companies who also began setting up refineries on the coast in the 1950s.

Coal Based

In the 1930s, coal to liquids technology developed rapidly in Germany, being at the leading edge and an intimate part of its rearmament program. The German example of an integrated fuels and chemicals industry based on coal caught the imagination of engineers in SA as early as 1927.

A private South African corporation, Anglovaal, set up Satmar, and simultaneously investigated production of liquid fuels using the German Fischer-Tropsch process. One of Anglovaal's reasons was to be able to process the high ash coal which overlay the torbanite. Anglovaal secured two agreements with German companies. First, with Lurgi, for coal gasification technology. Secondly, Anglovaal obtained the Southern African licence for the synthesis of the gasified product into hydrocarbons from Ruhrchemie in 1937 but the planned 33,000t/a plant was never built due to the outbreak of World War II.

In 1947, the Liquid Fuel and Oil Act was passed which effectively reserved what was regarded as a strategic industry for domestic capital. Potential producers had to apply for a licence from the Liquid Fuel Oil Industry Advisory Board and had to demonstrate management by South African nationals.

Alcohol production – Impact of the sugar and maize industry on the chemicals sector

A number of speciality chemical industries evolved around the sugar industry in Kwazulu Natal and, to a lesser extent, the maize industry.

The alcohol sub-sector initially developed alongside the torbanite fuel industry. In 1935, National Maize Products built a plant in Germiston to manufacture alcohol from maize. Rapid increase in the price of maize soon forced a change to molasses as the raw material and, in 1940, the name of the company was changed to National Chemical Products (NCP). Most of the output was sold to Satmar for blending with their torbanite fuel. Benzene by-products from Iscor's steel plants were also blended into Satmar fuel at the time.

NCP was created by a South African entrepreneur, and it also produced methylated and rectified spirits, absolute alcohol, vinegar and dry ice. In 1940, the British Distillers Company bought a large minority share in NCP and provided technology for a synthetic acetone/butyl alcohol plant, which provided raw materials for cordite manufacture as part of the war effort. In 1944, NCP bought Umgeni Distilleries in Durban, which had been established to produce alcohol from sugar in the 1860s, and used this facility as a base for exports of part of its production. In 1959, NCP acquired two yeast manufacturers, Natal Organic Industries (Durban, 1959) and Free State Yeast (Welkom, 1959), yeast being a key input in the production of alcohol.

Poly-resin Products (East London) was taken over in 1956 and, in 1959, NCP began manufacture of diacetone alcohol, hexylen glycol, pentaeryrithritol , and detergent alkylate, using feedstocks from Sasol in a joint venture with Sasol, called Kolchem. Sasol later sold its interest, and Kolchem joined with Shell Chemical to form Styrochem, for the manufacture of polystyrene. By 1960, NCP's Germiston plant had diversified into the production of alcohols, ketones, acids, esters, CO2 gas, mining froth-flotation reagents, phthalate plasticisers, synthetic resins and animal feed supplements.

IDC Support for Sasol (1950)

Satmar obtained a production licence in 1949 but subsequently withdrew from the venture due to its inability to raise the necessary capital and to convince Government to guarantee a US Exim Bank loan. Instead, the Industrial Development Corporation (IDC), bought the project from Anglovaal and financed its development, creating the state-owned Sasol corporation in 1950, which was wholly owned by the IDC.

By then the global technology terrain had changed. Following the end of the Second World War, US chemical and fuel corporations plundered German synthetic fuel technology[8]. This, together with the time lapse and chaos within Germany, necessitated the revision of the Anglovaal-Ruhrchemie and Lurgi agreements. Subsequent US research indicated a comparatively high cost associated with synthetic fuel production and the easing of international oil supply led to a lack of interest in synthetic fuels by 1950.

Sasol then entered into agreements with Lurgi and Ruhrchemie for gasification and fixed-bed Arge technology, which produced diesel, lubricants, chemicals and waxes, and with Kellogg for synthesis technology to produce petrol. However, problems were encountered with the latter and Sasol subsequently developed its own Synthol process. Sasol 1 began production in 1955 at Sasolburg.

The 1973 and 1979 oil shocks, coupled with the oil boycott and apartheid sanctions prompted the Government to intervene decisively in the fuels market to ensure national self sufficiency. The rise in gold prices at the time also provided the fiscal means to do so. The Government, through its Central Energy Fund, and partly supported by IDC financing, constructed the Sasol II and III oil from coal plants at Secunda between 1979 and 1982. A regulatory system was set up to force oil companies to uplift all of Sasol's fuel production on a pro-rata basis to market share. All the crude refineries had to mothball plant to accommodate this but they were compensated for the losses incurred.

Again in 1989, a further synthetic fuel plant was built by the Central Energy Fund, this time at Mossel Bay in the Western Cape to convert offshore gas into liquid fuels.

Crude oil refining

To encourage investment in oil refining, the Government provided certain investment incentives and tariff protection at a rate of about 20% of the fuel price. The first

crude-based oil refinery was built at Durban by Mobil in 1954. This was followed in 1963 by the Durban SAPREF refinery, a joint venture between Shell and BP. Caltex constructed a refinery in Cape Town in 1966. Originally, it intended to locate at Durban, but for supply security reasons, was further encouraged to locate in Cape Town.

The Natref (National Refining Company) refinery was built between 1969 and 1971. The joint venture partners of Sasol, Total and NIOC (National Iranian Oil Company) were provided incentives to locate close to the inland markets at Sasolburg for supply security reasons, even though the economically optimal location was Durban. Imported petroleum was refined and cracked to produce ethylene for plastics, and pipeline gas was supplied in increasing quantities to industry.

A base oil plant, a joint venture between Shell, BP and Federale Volksbeleggings was built in 1967 at SAPREF to produce lubricating oil and in 1972, a second base oil refinery was commissioned at the Mobil refinery, as a joint venture between Mobil, Caltex and Total, making South Africa self sufficient in base oils for lubricants.

The crude oil refineries also produced a range of chemical feedstocks such as ethylene, propylene, benzene, toluene, xylene, sulphur and many others, further deepening and broadening the chemical sector.

Synthetic rubber

In 1960, the IDC promoted the Synthetic Rubber Development Company to investigate the possibility of manufacturing general purpose synthetic rubbers. A major study resulted in the establishment of the Synthetic Rubber Company (SRC) for the manufacture of a range of styrene-butadiene rubbers. Also involved were FVB, three tire companies (Dunlop, Firestone, and General), and the Polymer Corporation of Canada. Production started in 1964 with the Polymer Corporation as the licensor of the process.

The main chemical feedstock, benzene, was sourced from the Sasol 1 plant. In 1967, SRC was absorbed by Karbochem, a division of Sentrachem and entered into a joint venture with Uniroyal to produce rubber chemicals. By 1992 Karbochem was a producer of synthetic rubber and rubber lattices; industrial mining and rubber chemicals; water-based lubricants; and carbide, acetylene, and carbon black.

The isoprene rubber plant at Newcastle was mothballed in 1990 and adapted to produce alkyl amines. It was partly reopened in 1992 after Karbochem acquired AECI's Ballengeich carbide business and rationalised production between Newcastle and Ballengeich.

Phosphate

In 1937, phosphate deposits were found in South Africa at Phalaborwa by Hans Merensky. In 1951, the IDC provided Foskor with an interest-free loan to purchase base-mineral claims. This was repaid through a levy on phosphate concentrate sold. (see fertiliser section above)

Health policy and the pharmaceutical sector

The pharmaceutical industry is an example of a chemical sub-sector (unlinked to mining) that has developed in support of domestic consumption through two main markets, namely the state health sector (see section above on linkages) and private final consumption, as detailed in Table 3.

TABLE 3: Estimated pharmaceutical turnover 1997

Pharmaceutical Drug		Rm	% Share	
Prescription		4 712	62%	(of private sector market)
– Ethical	3 958		84%	(of prescription market)
– Generic	754		16%	(of prescription market)
Self-medication-OTC's		2 888	38%	(of private sector market)
Total – Private Sector		7 600	76%	(of total pharmaceutical market)
Public Medication				
– Ethical		1 200	50%	(of public sector market)
– Generic		1 200	50%	(of public sector market)
Total – Public Sector		2 400	24%	(of total pharmaceutical market)
GRAND TOTAL		10 000	100%	

Source: *Labat Africa/CMCS* (2000)

Major transnational pharmaceutical firms have been established for decades in South Africa. They do not carry out any significant manufacturing, but rather formulate and package branded drugs in the ethical (patented) market using imported active ingredients. In 1999, transnational pharmaceutical manufacturers supplied 73.3% of the total market (by value).

A growing number of South African-owned pharmaceutical firms supply the balance and are actively manufacturing generic drugs.

TABLE 4: Geographic distribution of manufacturers

Province	No. of Manufacturing Companies
Eastern Cape	5
Mpumalanga	1
Gauteng	68
KwaZulu Natal	9
Free State	1
Western Cape	10
TOTAL	94

Source: *Labat Africa/CMCS* (2000)

Important drivers in this sector include the purchasing policies of the public health sector, together with the recent approach taken by medical aid funds to reduce costs to the private health sector.

The role of the electricity industry in Chemical sector development

The electricity sector historically developed to serve the mining industry. Initially privately owned, the state subsequently took full control. Sanctions and the energy crisis of the 1970s led to the government committing considerable resources to achieve a policy objective of self-sufficiency and low electricity prices. South Africa's electricity was based largely on huge reserves of low grade coal and long-term contractual relationships were entered into between mine owners and Eskom to underpin both mining and the very large scale (then state-of-the-art) power station investments.

The Kriel power station was built in conjunction with the Sasol II and III projects, mainly to ensure a stable supply of electricity to Sasol.

Role of Science & technology policy and institutions

Science & Technology Policy

The importance of science and technology has been implicitly acknowledged in industrial policy, particularly after World War II. A number of institutions were

created after 1945 which provided support for scientific and industrial research, including the CSIR.

As outlined in other sections of this report, historically, the apartheid government had strategically targeted the defence, liquid fuel and nuclear industries and provided considerable financial, human capital and institutional resources to develop these sectors. By 1991, 1.04% of GDP was spent on R&D. By 1993, this had fallen to 0.75% of GDP as the nuclear weapons programme was dismantled and defence budgets reduced.

In 1994, science and technology was prioritised as a distinct cabinet-level post, together with a new support department. Since then, science and technology policy has further evolved. South Africa's science and technology policy, particularly its supportive thrust towards research and development (R&D), has evolved rapidly over the past decade. A process of redirecting the national science and technology effort towards economic development objectives was advanced in the 1996 White Paper on Science and Technology which was based on the concept of a National System of Innovation (NSI), which places innovation (rather than the supporting pillars of scientific discovery and technological development) at centre stage.

> "The NSI itself can be thought of as a set of functioning institutions, organisations and policies that interact constructively in the pursuit of a common set of social and economic goals and objectives, and that use the introduction of innovations as the key promoter of change. The idea of "innovation pull" as opposed to "science push" was already well developed in OECD policy forums and championed in the European Union by former French Prime Minister Edith Cresson. However, South Africa was the first country to adopt such a framework as its national policy. Many other countries have subsequently followed suit."

In 1997, a national research and technology audit was carried out, followed by a review of the science and technology institutions in South Africa. A national research and technology foresight programme was initiated in 1999 which, by 2002 had examined 12 sectors, including agriculture, biodiversity, crime, energy, environment, financial services, health, information and communication technologies (ICT), manufacturing, mining and metallurgy, tourism and youth.

Although the chemical sector was not directly covered, it enjoys indirect coverage through linkages and overlaps with some of the segments above. Other noteworthy investigative processes include NACI/NSTF report: Growth & Innovation (2000) and the Integrated Sustainable Rural Development Strategy (2000).

These dovetailed with industrial policy thinking at the time, as reflected in the 2001 Micro-Economic Reform Strategy (MERS) and the 2002 Advanced Manufacturing Technology Strategy (AMTS), which identified certain sectors/technologies such as ICT that, if adopted and adapted more rapidly, held the potential to enable improved efficiency and competitiveness in other productive sectors.

During this period, a systematic reconstruction of institutions to support science and technology was undertaken. The National Advisory Council on Innovation (NACI) was inaugurated in terms of the NACI Act (No.55 of 1997) to advise the Minister of Science and Technology and Cabinet on *"… the role and contribution of innovation (including science and technology) in promoting and achieving national objectives, namely to improve and sustain the quality of life of all South Africans; develop human resources for science and technology; build the economy and strengthen the country's competitiveness in the international sphere."* The 16-20 member Council of NACI is broadly representative consisting of "a spread of expertise and experience regarding: national and provincial interests; scientific and technological disciplines innovation, the needs and opportunities in different socio-economic fields; and research and development in all sectors".

Strategic thrusts adopted by NACI, for which specialised sub-committees have been appointed, include infrastructure for innovation promotion, human capital and the knowledge base, science, technology and innovation for competitiveness and the social dimension of innovation

The NACI is positioned in the national system of innovation alongside other national advisory committees, including the South African Reference Group on Women in Science and Technology (SET4Women), the Indicators Reference Group (IRG), and the National Biotechnology Advisory Council (NBAC). An Innovation Fund is currently offered to support sector-specific support.

The macro impact of science policy on R&D and Innovation

Regular monitoring and evaluation of the impact of science and technology policy is carried out. In July 2005, an R&D indicator was incorporated into official

national statistics. The 2004/5 R&D survey reports that some R12b was spent on R&D, equivalent to 0.87% of GDP, reflecting a real 5% growth per annum since 2001 and falling just short of the 1% of GDP target to be achieved in 2008. Table 5 lists some of the other key indicators which suggest that the policy is achieving success in all of the indicators tracked.

TABLE 5: Key research, development and innovation indicators, 2003-2005

	Value	
Indicator	**2003/04**	**2004/05**
Gross domestic expenditure on R&D–GERD (Rand millions)	10,082.6	12 010.0
GERD as a percentage of GDP	0.81	0.87
Total R&D personnel (FTE)[a]	25,185	29,692
Total researchers[b] (FTE)	14,129	17,910
Total researchers per 1,000 total employment[c] (FTE)	1.2	1.6
Total R&D personnel per 1,000 total employment (FTE)	2.2	2.6
Civil GERD as a percentage of GDP	0.72	0.80
Total researchers (headcount)	30,703	36,979
Women researchers as % of total researchers	38.0	38.3

[a] FTE = Full Time Equivalent

[b] Following OECD practice, doctoral students are included as researchers

[c] Following OECD practice, total employment is now provided by the International Labour Organisation based on the Labour Force Surveys of Statistics South Africa and is not restricted to the formal non-agricultural sectors as previously reported.

Source: Department of Science & Technology,2006.

Sector-specific science & technology support strategies

In 2001, the DST published the National Biotechnology Strategy which proposed a range of institutional, legislative, financial and human resource support measures for the sector. This strategy is being resourced and implemented and oversight is exercised by a specific sub-committee of NACI. A similar strategy to support nanotechnology was also published in 2006, which proposed the establishment of nanotechnology characterisation centres, research and innovation networks, capacity building program and a flagship project program. These examples confirm that the National System of Innovation that underpins South Africa's science and technology policy is increasingly being institutionalised and is playing an increasingly important policy support for sections of the chemical industry.

CSIR

The Council for Scientific and Industrial Research (CSIR) is South Africa's central and premier scientific research and development organisation. It was estab-

lished by an act of parliament in 1945 at Pretoria. Presently, it is the largest research and development (R&D) organisation in Africa and accounts for about 10% of the entire African R&D budget. It has a staff of approximately 3,000 technical and scientific researchers, often working in multi-disciplinary teams.

The CSIR's main areas of research are:

- Food, biological and chemical technologies.
- Building and construction technology.
- Defence technology.
- Water, environment and forestry technology.
- Manufacturing, materials and textile technology.
- Mining technology.
- Roads and transport technology.
- Information and Communication Technologies

Private chemical sector research and development

The largest known private R&D expenditure in the chemical sector is carried out by Sasol, mainly around its gas-to-liquid (GTL) and coal-to-liquid (CTL) technologies. The RSA sugar industry also pools resources to maintain the South African Sugar Research Institute. In order to further encourage R&D, Government recently announced some tax incentives for firms engaging in R&D.

Role of Industry Associations

There are a number of chemical sector industry associations in South Africa. The largest is the Chemical and Allied Industry Association. CAIA is well resourced, representing large and small firms, but with the larger firms inevitably dominating by weight and inertia.

Historically, such associations have evolved as lobby groups, particularly in the environment of heavy tariff protection of industry. In recent times, such lobbying has focused on threats of market entry by foreign industry competitors.

In the case of CAIA, it has recently played a positive role on in environmental and safety issues, particularly as the policies relating to these have evolved domestically and internationally.

Conclusions

The development of South Africa's chemical industry offers guidelines for other countries looking to grow their chemical sector under the following headings:

- Sector linkages – take account of the variation of characteristics across the chemical value chain,
- Build on linkages between the chemical sector and other economic sectors,
- Policy coherence, institutions and agencies,
- Political economy factors

Sector Linkages

Variation across the chemical value chain characteristics

The characteristics of different segments of the chemical sector value chain and their linkages with other parts of the economy are important and may require different policy instruments:

- South Africa's gold and diamond mining industry provided the first and main driver for the development of the chemicals industry (explosives) in the 1890s. Mining sector growth continued to provide the main market for the chemicals sector up to the 1960s, mainly in the form of explosives and mining chemicals,
- Mining demand also drove the diversification of the chemical sector into a range of products, including the rubber and rubber products industry,
- In parallel with this, starting in the late 1950s, the coal-based liquid fuel industry began to produce a range of bulk chemical products and intermediates initially as a by-product and, after the expansion of the synthetic fuel industry in the late 1970s, as the major supplier of bulk chemical commodities and feedstock for further chemical production,
- The above, mainly upstream sectors, were propulsive in establishing the chemical industry,
- However, significant chemical sub-sectors have emerged downstream and around these upstream sectors:
  - The growing consumer market provided a further driver for local manufacture of chemical products,

– Pharmaceutical and other speciality chemicals have also been driven by demand not necessarily linked to mining,

Economies of scale & markets

Scale economies, capital- and energy-intensity are characterisitics of the upstream segment of the chemicals value chain. Had the large-scale mining industry demand not existed, it is unlikely that the explosives industry (starting with the Modderfontein factory) would have been built.

Similarly for liquid fuels, the size of the domestic market in the 1950s supported the investment in basic crude refining capacity at the coast, and these refineries were then also configured to produce bulk petrochemical commodities.

Important synergies are shown to have been captured through the integration of petrochemical and other large-scale chemical plants, with by-products and co-products being combined as feedstock in new plants, either at the existing sites or nearby. The following examples have been discussed above:

- Excess sulphuric acid from Modderfontein railed to Umbogintwini to make superphosphate fertiliser
- Liquid ammonium nitrate from Modderfontein railed to Somerset West to make fertiliser
- Acetylene from Ballengeich to Umbogintwini to make PVC plastic
- Chlorine and caustic soda from Umbogintwini to Saiccor to make industrial cellulose
- Ethylene from Sasol 1 to AECI's Sasolburg plant to produce plastic monomers

Mega-projects

Large-scale capital intensive investments in the upstream part of the chemical sector in South Africa have had a propulsive impact on certain downstream chemical sub-sectors over the decades. In South Africa's case, the prerequisite scale economy conditions were met through linkages with other sectors that provided markets for the products. It worked for explosives and liquid fuels, although in the case of synthetic liquid fuels, it had a cost raising impact on fuel products. This was, however, justified because the project was initiated on strategic self-sufficiency grounds.

Can such an approach be emulated by other developing economies? Clearly, the size of respective domestic, regional and global markets will be critical in assessing the

viability of any such large-scale upstream mega-project. Furthermore, the establishment of upstream and downstream linkages around the respective mega-project are not automatic.

Downstream chemical industries

Once individual upstream plants were established, clustering of facilities evolved over time, in particular at Durban, Sasolburg, Newcastle and, to a lesser extent, at Richards Bay. The availability of commodity bulk chemical feedstock from these facilities created the basis for a broader range of downstream Stage 3 and 4 chemical products.

In addition, many smaller specialist chemical industries emerged independently of these upstream facilities using imported feedstock and feedstock from other domestic sources.

For example, as shown above, a broad cluster of chemical firms emerged around the sugar industry in Natal, manufacturing alcohol and other related products. Similarly, growing domestic consumption stimulated pharmaceutical industries and bulk and consumer formulated industries.

Role of policy, institutions and agencies

Coherence of policy and economic planning

Strong elements of economic planning have underpinned the post-war growth of South Africa's chemical industry, particularly the upstream segments.

The 1950s witnessed astounding economic growth across many sectors. The discovery of the Free State goldfields resulted in huge physical and demographic change in that province, with large expansion of the chemicals sector outlined above to support mining growth. Planning was not only confined to the social and economic infrastructure that mining expansion demanded. The Government consciously set up Sasol 1 at Sasolburg in the Free State and also encouraged TNC oil companies to establish crude oil refineries, with their associated petrochemical output.

Expulsion from the Commonwealth, and the increasing isolation of sanctions prompted further planned chemical industries after 1960, some of which were related to defence. Most notable was the construction of the Sasol II and III oil from coal

plants, financed by a burgeoning fiscus which was bolstered by booming commodity prices. Accommodating Sasol's output was another exercise of active industrial and energy policy. The crude oil refiners were compensated for mothballing large refining capacities until market growth in the 1980s gradually absorbed their output.

Economic foresight and planning continued to underpin the decades of 1970 and 1980, with associated road, water, power, rail, port infrastructure being simultaneously executed on a large scale.

Industrial policy

Industrial policy has, at different times, acted positively on the growth of the South African chemical sector. The instruments used have included import tariffs, transport and logistics pricing, the provision of industrial financing and incentives and direct state creation of industries. In addition to the market-led drivers outlined above, industrial policy intervention provided an important impetus to chemical sector development, particularly in the following areas:

- Defence-related chemical sub-sectors, including explosives, fluoride chemicals (linked to the nuclear weapons programme) and chemical and biological warfare weapons
- Crude oil-based and synthetic liquid fuels and lubricants
- Financial and tariff policy support for large-scale, state-led investments in various chemicals-related industries, including; phosphates and phosphoric acid, liquid fuels, cellulose and wood pulp
- Logistics – Policies and institutions

Tariff/trade policy

Import tariffs played a powerful role in supporting emerging chemical industries in South Africa, in both upstream and downstream segments. This was the mechanism used to protect the Sasol investments and the mechanism continues to be used today. However, different governments over the years have not always supported the interests being protected. The history of the fertiliser industry in RSA shows how in the 1920s, large facilities were built and subsequently made redundant because of dumping by Dutch producers. The government of the day, threatened by looming elections and the possibility of losing farming community votes, chose not to protect the new production facilities.

However, tariff policy was not applied coherently, particularly in the late 1970s and 1980s[9]. Tariff reform and rationalisation in the 1990s restored some coherence to the system, while also reducing overall trade-weighted tariffs significantly.

In future, the detail relating to chemicals in the SADC and other trade agreements, currently being negotiated, will be important in shaping chemical production activity in the region, but is unlikely to be as influential as was the case in the past.

Logistics policies and institutions

The state-owned railways controlled access to the South Africa's inland mining economy market during the 19th century and for much of the 20th century.

Railways freight rate policy has historically been an important industrial and trade policy instrument which has influenced the development of a number of industrial sectors, including particularly bulk, low-value chemical and other commodities. Some examples cited in this study include:

- How lobbying the Cape Colony government in 1898 to reduce freight rates underpinned to profitability of De Beers' Somerset West dynamite factory.
- A number of national logistics pipelines have been constructed which have supported chemical industry activity, including the Gascor industrial and domestic gas network in Johannesburg (the gas itself produced for many years by Sasol as a by-product of coal gasification), a dedicated crude oil pipeline from Durban to Sasolburg to supply the Natref refinery and by converting a crude oil pipeline (originally used to pump crude oil from Durban to the Ogies, Mpumalanga underground strategic reserves) to supply gas from Sasolburg to the coast. The line is now used to pipe Mozambique gas to Richards Bay and Durban

As shown above, the chemicals industry (mainly bulk low-value commodity chemicals) has been significantly shaped by policies that affect logistics costs, particularly between the coast and South Africa's large inland market. The profitability of Somerset West and Umbogintwini at the turn of the century balanced on the concessionary rail tariff that could be wrung from the respective colonial governments. Today, the profitability of the inland Natref crude oil refinery turns on the tariff that is charged for transporting crude oil from the coast.

In subsequent years, the state-controlled railways, ports, pipelines and airline were transferred under a holding company, Transnet. Time has not allowed a more throrough analysis of this issue, but it is important to note that there have been times when the market power held by Transnet has been used in the interest of the company, in a manner that has undermined and discouraged investment in the chemicals sector. Rail freight rates have, in some sectors, prompted a modal shift to road haulage.

In the 1970s, a very large proportion of South Africa's inland market trade was routed through Maputo port, because it was the shortest and least costly logistics route to and from the coast. Sanctions and apartheid destabilisation in Mozambique reduced such trade, but it has been growing in recent times and such logistical costs will continue to be an important supportive potential policy instrument for the chemical sector.

The ability to use state-owned freight agencies as instruments of industrial policy is significantly constrained today. Today in South Africa it is a policy concern that the freight rates charged by state-owned rail, ports and pipeline institutions are not internationally competitive and a move is underway to set up independent regulators to curb the abuse of market power.

However, it is important to note that the capacity of a central, provincial or local government to support the creation of an industry may not be sufficient to overcome the specific interests of relatively autonomous parastatal corporations, agencies, freight concessionaires and private freight terminal operators.

Industrial financing

South Africa's industrialisation, including the development of the upstream segment of the chemical sector, has been characterised by large lumpy capital-intensive investments.

While the traditional industrial policy instrument of tariff protection was effective in supporting investment in the chemical industry for much of the 20th century, it tended to favour those corporations who were in a position to finance their investments.

Norval (1962) justifies the establishment of the IDC by arguing that:

> "(Between 1925 and 1939) … the industries which developed under the stimulus of the customs tariff protection inaugurated in 1925, found very little, if any, organised financial backing on which to rely. Financial institutions such as the industrial banks in the older countries, for instance the

> four D. banks in Germany… the banques d'affaires in France, the organised industrial share and capital market and in particular the investment trusts in Great Britain and the United States of America were wholly absent in South Africa. The larger industrial concerns such as AECI, Stewarts and Lloyds, Lever Brothers, Price's Candles, Cadbury-Fry, Nestle, the motor assembly plants, the tyre factrories and many others, all South African branches of overseas concerns, were, in the main, initially financed by their parent companies, which thereafter… ploughed back their profits to finance further development and expansions… many other concerns in the industrial field in South Africa developed on the strength of financial reserves built up from within and with such other resources as could be obtained from friends or from the commercial banks by the way of overdrafts or other forms of trade credit."

Industrial financing, through the IDC in particular, has been an important support for segments of the chemical sector, particularly the capital intensive segments. The IDC, more often in partnership with private industries, was the vehicle through which the state created new chemical industries and sub-sectors and through which chemical sector restructuring was effected.

In its earlier years, the IDC went further than it does today in pioneering the commercialisation of, and support for, relatively new technologies and industries. IDC and DTI concessionary financing was also used to encourage policy goals, for example investment in export-oriented manufacturing in the 1990s.

In the case of liquid fuels, transnational oil companies were encouraged to invest in refining capacity, with the state simultaneously growing an alternative coal-based fuel industry, later intervening on strategic grounds to expand coal-based fuel production while paying the oil TNCs to accommodate Sasol's output. The cost-raising effect of synthetic fuel products was borne by consumers.

Political economy – State and private sector relationships that have influenced the chemical industry

Sections of this paper trace the growth of the South African chemical sector in technical and economic terms. The evolution of the chemical sector over the past

century can also be usefully viewed through a political economy filter which considers the particular form of corporate ownership and its relationship to Government.

In South Africa's case, industrialisation and the development of the chemical sector has been significantly shaped by large-scale capital. The largest dynamite factory in the world in 1896 at Modderfontein was created by a powerful mining industry, owned by British colonial interests, which acted to destroy a lucrative import concession granted to an individual aligned to the Boer Republic, a concession which had a major cost-raising effect on mining economics. When this factory continued to charge high prices, the mining industry reshaped the industry by building its own factory at Somerset West and later supported the amalgamation of various dynamite producers to achieve economies of scale and to lower mining costs.

Mining capital largely drove the trajectory of the chemical sector until the late 1950s through AECI, a subsidiary of the Anglo American Corporation. AECI was the dominant firm in a range of upstream chemical commodity products. It also involved itself in the more competitive downstream environment, either alone or in joint venture with a number of local producers and import agents of major international transnational chemical firms.

The trajectory of chemical sector development has also been shaped by the historic disjuncture between the economic power of "English-speaking" business and the political power of "Afrikaans-speaking" fractions of the South African capitalist class. Following the scorched earth tactics of Britain during the Anglo-Boer war, at the turn of the century, and the subsequent rampant growth of mineral extraction and associated industrialisation, by the 1930s some 20% (300,000) of white society could be categorised as "poor". Most were of Afrikaans-speaking/Boer origin.[10] In 1948, the National Party was elected to government, with significant support from Afrikaans-speaking white South Africans, and proceeded to enact policies and implement strategies that were aimed at empowering Afrikaners. Some of the policies, associated with apartheid, aimed to increase employment of poor Afrikaners, particularly in state and parastatal institutions. Other policies consciously sought to empower Afrikaner business interests. Bunting (1964) records:

> "That the income per head of the Afrikaner in 1937 was £86, compared with £142 for non-Afrikaner Whites; That of the £220 million invested in commercial banking, building societies, insurance companies and

> savings banks, only between £80 million and £100 million belonged to Afrikaners; That although the Afrikaner owned about 75 percent of the assets in agriculture, his stake in mining and industry was so small that it was impossible even to frame an estimate."

The National Party government initially sought to support the existing Afrikaner small-scale business enterprises through a variety of means, including the purchasing power of the state as well as through favoured relationships with parastatal corporations. But from the outset, there was a recognition that the key to economic empowerment was through involvement in the mining industry and through the creation of large-scale capitalist enterprises. This was expressed in the chemical sector in several ways.

First, through a combination of using the 1947 Liquid Fuel and Oil Act, buying out Anglovaal's torbanite project and using the IDC to capitalise Sasol, a new state-owned corporation producing liquid fuels and petrochemicals was created. Foskor was created in a similar manner.

Second, through the mobilisation of IDC finance and Afrikaans-controlled savings into manufacturing enterprises that, by their nature, tended to be small and medium in scale. (KOP in the herbicide sector and SBR in the rubber sector). After the 1950s, the development path of South Africa's chemical industry was dominated by large scale domestic capital in a close relationship with Government and specialist state institutions, often acting in partnership with leading multinational and transnational corporations. From 1960 onwards, South Africa's corporate structure increasingly took a conglomerate form.

Third, through the active and conscious consolidation of smaller chemical firms into larger capital structures. The creation of Sentrachem in 1967, which then became the second largest chemical company after AECI, was actively assisted by the IDC. Sentrachem was housed under the Fererale Volksbeleggings financial corporation (which later evolved into the Sanlam conglomerate). FedVolks' origins lay in decisions taken at the 1939 National Economic Conference (Afrikaner Ekonomiese Volkskongres). Bunting (1964) records:

> "An extract from the minutes of a meeting held by the executive of the F.A.K. Economic Institute in Johannesburg on 27 September 1940

> provides an interesting commentary on the principles which inspired those who were to be the leading figures of Afrikaner economic development: Federale Volksbeleggings Bpk. operates on the principle that it is a people's institution (volksinrigting), established on the mandate of the Ekonomiese Volkskongres of 1939, to serve as a means of furthering the Afrikaner's drive for economic independence. But the company is nevertheless a business undertaking which wishes to pay its shareholders in clinking silver (klinkende munt) and not just in sentiment"

Even after its creation, Sentrachem was still dwarfed by AECI in scale. Sentrachem followed a strategy of specialisation: It set up joint ventures with transnational/German corporation Hoechst (1969) to produce polyethylene and polypropylene and with Olin Corporation (1974) to produce chlorine-based water sanitisers. The acquisition of Agricura, a formulator of insecticides and herbicides, provided an entry into agricultural chemicals. Subsequently called Agrihold, this company manufactured crop-protection products, animal feeds, and a range of veterinary products. Sentrachem also invested in downstream plastics conversion under Mega Plastics. In 1993, Delta G Scientific was acquired, signalling a new emphasis on research and development. In 1995, Sentrachem internationalised through the purchase of Hampshire Chemicals Corporation in the United States.

It was only in the 1980s that the expanded Sasol behemoth truly was able to challenge AECI economically, as a notional representative of Afrikaner capitalist aspirations in the chemical sector.

During the process, the very scale economies associated with upstream chemical sectors necessitated joint venturing between English and Afrikaans chemical companies, as recorded in various sections above. This resulted in greater penetration of several industries which were formerly the preserve of English capital. The distinctiveness of English capital was further eroded in the 1960s as it bought up shares in industrial companies as foreign capital withdrew and as interpenetration between Afrikaner and English capital increased.

Liquid fuel self sufficiency was the primary motive for creating Sasol in 1950 and in expanding it in 1979. The success of Sasol's technological developments subsequently led the company to diversify away from fuels into a range of upstream chemical commodities and into downstream finished products. In the 1980s, Sasol entered

the explosives market, challenging nearly 70 years of dominance by AECI and its predecessors.

By the 1990s, the economic and political disjuncture had eroded considerably. The then lame-duck government, deep in negotiations with the ANC, had no coherent industrial policy and the environment that prevailed was one of considerable rent seeking and fragmentation of policy in which policy and regulatory institutions found themselves hostage to the powerful large-scale capitalist interests in various sectors. After 1994, the ANC government moved to reduce rent seeking behaviour through the elimination of wasteful incentives like the General Export Incentive Scheme (GEIS) and through tariff reform. The Government also introduced policies to increase competitiveness and to curb the abuse of market power. A new Competition Act was introduced in 1997 and resources were channelled into promoting small and medium enterprises.

Up until early 2000, large-scale interests (mainly in upstream chemical sectors) have continued to enjoy the traditional support of IDC, but the corporate investment decisions are not as dependent on securing concessionary finance as they might have been in the past.

While upstream competitive advantages exists in a number of value chains, it is the contention of the author that downstream competitive advantage has not been reached for a number of overlapping reasons including:

- Limited potential seen by agents of TNCs operating in the downstream sectors
- Sanctions precluded TNCs from using South Africa as a production platform for global sourcing
- Some domestic-owned downstream industries that were more dynamic did begin to leverage their economies of scale and strategic intensions, but were cut short by predatory acquisition by global TNC (for example, see Dow's takeover of Sentrachem)
- For many decades, policymakers and policy implementing institutions like the IDC, together with private vested interests, sought to achieve large scale upstream industry consolidation, rather than leveraging downstream competitive advantage using competitive upstream production facilities
- Consequently, since 1994, an important contemporary industrial policy concern has been that the dominance of large-scale upstream industries have acted to choke the development of downstream industries.

As outlined above, in developing strategies towards chemical sector development, it will be important for policymakers to consider such relevant political economy factors, the coherence of policy and to take account of the variation of characteristics across the chemicals value chain.

The policy implications that flow from this for other countries seeking to grow their chemical sector include:

- The analytical framework of linkages, agencies and political economy that underpins the MEC approach is useful in understanding how the chemical sector has developed within South Africa;
- Such an approach could be useful if extended to the analysis of the growth of chemical sub-sectors in other countries within Southern Africa;
- The specific characteristics and linkages between any individual country's chemical value chains will be different, but this is a good pointer to the potential that exists;
- In particular, corporate and industrial strategies could seek to build on the linkages between the chemical sector and other economic sectors;
- This analysis is usefully complemented with an understanding of political economy factors, which will be specific to different economies.

Notes

[1] Fine, B. & Z. Rustomjee (1996).

[2] Cartwright (1985, p. 50).

[3] Cartwright (1985, p. 163).

[4] *Business Times* 3 March 1991.

[5] *Business Times*, 30 November 1997.

[6] Available at: http://en.wikipedia.org/wiki/Delta_G_Scientific_Company.

[7] Hilsenrath, P.,1991.

[8] Krammer, A. (1981).

[9] See Joffe et al (1995) and Fine & Rustomjee (1996).

[10] For details see Bunting (1964) and O'Meara(1984).

References

BUNTING, B., 1964. *The Rise of the South African Reich*: Penguin.

CARTWRIGHT, A.P., 1964. *The dynamite company : the story of African Explosives and Chemical Industries Limited.* London: Macdonald.

Department of Science & Technology,1996. *White Paper on Science and Technology*: Pretoria

Department of Science & Technology,1996. *National Survey of Research and Experimental Development (R&D): High-level key results, (2004/05 Fiscal Year)*: Pretoria

FINE, B. & Z. RUSTOMJEE, 1996. *The political economy of South Africa – from minerals-energy complex to industrialisation.* London: Hurst & Company.

HILSENRATH, P., 1991. "The development of synthetic fuels in South Africa". *Journal of Energy and Development*, 14 (2).

JOFFE, A. et al., 1995. *Improving manufacturing performance in South Africa – Report of the industrial strategy project*. Cape Town: UCT Press.

Labat Africa/CMCS, 2000. *Pharmaceutical manufacturing sector study*, NEDLAC

KRAMMER, A., 1981. "Technology transfer as war booty: The US technical oil mission to Europe, 1945", *Technology and Culture*, January, p.93.

National Advisory Council on Innovation, Act no.55 of 1997, Pretoria, South Africa

NORVAL, A., 1962. *A quarter of a century of industrial progress in South Africa*, Cape Town: Juta and Co.

O'MEARA, D., 1983. *Volkskapitalisme: class, capital and ideology in the development of Afrikaner nationalism, 1934-1948*: Cambridge University Press.

ROBERTS, R., 2006. "South African industrial development, industrial policy and the implications for Mozambique". Background Paper presented at *Industrial Policy Seminar*, Maputo, Mozambique, 21 June 2006.

StatsSA, 2000. *Supply and Use Tables*. Pretoria: Statistics South Africa.