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WORKING PAPERS

**An Overview of the role of Producer Services in the
Petrochemicals Industry in South Africa:
A Case Study of Sasol**

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INTRODUCTION

This working paper forms part of a broader research programme undertaken by the DPRU and the Christian Michelsen Institute (CMI), Norway, on the inter-relationship between producer services and the mineral sector. The focus of this particular paper is the role of producer services in the development of Sasol - the heart of South Africa's petrochemical industry. The objective is to understand what producer services are spawned by Sasol, what role they play in determining the performance of the company, how Sasol has chosen to organise their provision and what broader impact they have had on the economy.

The first chapter lays the foundation for the paper through a close examination of Sasol and its processes. It begins with a sketch of the development of Sasol from its beginnings as a small, yet strategic, synthetic fuel producer in the 1950s through to the global expansion into the petrochemicals industry in the 1990s. It takes particular note of events that brought about changes in the strategic direction of the company and how those changes have shaped the current corporation. The chapter then continues to describe the unique production processes of Sasol as it uses coal to produce fuel and other chemicals. This is followed by a brief description of the organisation of the Sasol group of companies before assessing the performance of the Group over the past two decades.

The chapters that follow each focus on a different producer service - chapter two on technology services, chapter three on engineering services and chapter four on information technology services. The process of investigation is the same for each of these three chapters. It begins with an analysis of the role that the producer service plays in the Sasol processes and how this impacts on both the nature and levels of demand for the service experienced within the Sasol Group. This is followed by a discussion on the nature of the market for the service itself - concentrating on features such as the extent of economies of scale, asset specificity and capital-intensity. These first two sections of each chapter provide the necessary detail for the next section, which discusses how the Sasol Group has chosen to organise the particular service and how this organisation has changed in response to changing market and demand conditions. The fourth section in each chapter examines the performance of the service for Sasol's purposes. The fifth section tries to assess the broader impact that Sasol's demand for such a service has had on the economy. This may have occurred directly through business units of Sasol or through its suppliers where Sasol has helped transfer technology or create necessary economies of scale.

Finally, each of these chapters ends with an assessment of how the liberalisation of the South African economy in the early 1990s has impacted on both the demand and supply of the producer service. The last chapter makes some concluding remarks.

1. THE SASOL GROUP: PROCESSES, ORGANISATION AND STRATEGIC DIRECTION

Sasol Limited is a diversified group operating in the energy, fuels, petrochemicals and related industries. In 1998, it had an annual turnover of R20 billion, total assets of R21 billion and a workforce of 27 000 (Sasol Annual Report 1998). It ranks as a top 10 South African company and has the second highest market capitalisation on the Johannesburg Stock Exchange. The core of the Sasol Group is the commercial production of coal-based synthetic fuels. This forms 35% of group turnover and accounts for 49% of group profits after tax. Sasol also operates a crude-oil refinery as an adjunct to the synfuel production. In total, Sasol supplies 41% of South Africa's liquid fuel requirements. Sasol's diversity stems from vertical integration both upstream and downstream. Upstream, it has extensive coal-mining operations (with an annual turnover of R2.5 billion) as well as some oil exploration activities. Downstream, the group has developed large petrochemical operations based on feedstocks from both the coal-based synfuel and crude oil refining processes. Over 120 petrochemicals are produced accounting for one-third of turnover and one-quarter of profit-after-tax. The petrochemical operations are very export-orientated and make up most of Sasol's R3.8 billion exports.

In addition to these operating divisions, Sasol has a large technology division that supports the group through research & development and engineering services. The division is fundamental to the profitability of the group as coal-based synfuel production is less economically viable than crude oil refining. It has a string of proprietary technologies and patents for the production of synfuels and petrochemicals. In fact, the Group lists its core competencies as including "...high quality research and development capacities, the ability to commercialise new technologies, proven skills in operating large and complex production facilities and cost-effective project management" (Sasol Annual Report 1997:7).

1.1 A History of the Group's Development¹

South Africa is an extremely mineral-rich country with especially large deposits of low-grade coal. However, South Africa does not have any oil reserves. The Second World War demonstrated the strategic nature of oil and raised local concerns over self-sufficiency in fuels. At the time, technology existed for the processing of coal to oil (Fischer Tropsch technology) and with South Africa's large deposits of coal, this seemed like a viable option (Crompton 1994). A South African company, Anglovaal, already had the license for this technology. In 1947, legislation was passed detailing the establishment of an oil-from-coal industry for South Africa under government support. In 1950, the South African Coal, Oil and Gas Corporation (now Sasol) was founded under ownership of the state through funding from the Industrial Development Corporation (IDC). It was established as a for-profit company from the beginning.

The first synfuels plant known as Sasol 1 was established in Sasolburg (a new town built for the project) in the Northern Free State near significant coal deposits which would be used to produce oil. Construction of the plant and the colliery began in 1951 and was completed and producing petrol by 1955. The Fischer-Tropsch technology that Sasol had licensed did not work and so Sasol was forced to establish research and development capabilities early on in its existence. It spent most of the fifties establishing and perfecting its own synfuel process which was operating satisfactorily by 1960. However, with a low oil price, the production of synfuels from coal was not economically justified and so Sasol began to diversify into other products. The production of synthetic fuels from coal allowed the generation of chemical products as a by-product. In 1963, Sasol moved downstream into petrochemicals with the production of ammonia – an important feedstock for explosives, fertiliser and other chemicals (Sasol Annual Report 1990). The products chosen had a ready market in the mining and agriculture sectors domestically.

¹ This history is compiled from four primary sources: - Sasol's own annual reports, Sasol's publicity material, Crompton (1994) and Arthur Andersen (1995)

The important launch into petrochemicals came with the construction of a naphtha cracker at Sasol 1 in 1965 for which naphtha feedstock was imported and piped from Durban. This enabled 45 000 tons of ethylene production per annum as well as small quantities of styrene and butadiene. In a typical inward substitution industrialisation path, these found local customers in the form of AECI (ethylene for plastics) and Sentrachem (both butadiene for synthetic rubber and styrene for polystyrene). A second cracker was installed by 1970 which increased capacity to 135 000 tpa. Production of propylene followed in the early 1970s to feed a Safripol polypropylene plant.

Sasol's further diversification in the 1960s was into pipeline gas which was another important by-product of the synfuel process. By 1966, a gas pipeline had been constructed linking 250 industrial companies in the Johannesburg area to Sasol 1. The operating division was called Gascor, now Sasol Gas. In 1966, Sasol made the decision to refine imported crude oil. In partnership with Total of France and the National Iranian Oil Company, Sasol established the National Petroleum Refiners of South Africa (Natref), with Sasol as the majority shareholder. The refinery meant that Sasol could now source naphtha from its own refinery rather than import it (Sasol Annual Report 1990).

Two events in the early 1970s presented a critical turning point in the history of Sasol. First, after the OPEC oil shock of 1973, crude prices rose from \$3 to \$12 per barrel. The higher oil prices suddenly made the Sasol synfuel process considerably more viable, though it was still more costly than using crude. Secondly, South Africa was coming under increasing threat of isolation and oil sanctions for its apartheid policies and illegal occupation of Namibia. As early as 1963, the UN General Assembly had passed a resolution calling for oil sanctions (which were voluntary). In 1974, there was a resolution before the UN Security Council that called for mandatory sanctions against South Africa. The resolution was not passed as it was vetoed by the US, the UK and France. However, the threat of oil sanctions remained real for the South African government (Crompton 1994).

The combination of these two forces led to the decision by the government in December 1974 to expand Sasol's synfuel operations. It was decided to build the second synfuel plant at ten times the size of Sasol 1. The location for the plant was at Secunda, in Mpumalanga province close to considerable coal resources (again a new town built for the project). Construction of the synfuel plant and collieries began in 1976 and was operational on 1 March 1980, but only reaching full production capacity in 1982. In the late 1970s, the same two forces that precipitated the decision to build Sasol 2 – rising oil prices and threat of sanctions – surfaced again. The fall of the Shah of Iran caused crude oil prices to rocket from \$12.5 to \$36 per barrel in 1979. South Africa also sourced most of its crude from Iran. In 1977, the UN Security Council imposed a mandatory arms embargo on South Africa making the threat of further sanctions a very real concern. These forces once more led to a decision by government in 1979 to expand Sasol's synfuel operations by constructing a third plant on the Secunda site which was a replica of Sasol 2 (Crompton 1994).

To make the move to synfuel work, the government not only had to protect Sasol, but also had to create space in the market for it to sell its twenty-fold increase in production. The government struck a deal with the oil companies whereby they shut down some capacity at their refineries and bought 91% of Sasol's output in order to let Sasol into the market. In return, Sasol was not allowed to own any petrol stations and could only directly market the remaining 9% of output. The companies would buy the synfuel from Sasol at the prevailing In-Bond Landed Cost (IBLC) – the set price at which refineries sell refined product to the liquid fuel wholesaling and marketing companies. There already existed product swapping between the oil companies in order to lower the distribution costs. Therefore, all service stations in Durban may be using fuel produced by the Shell refinery while those in Cape Town would use the Caltex refinery. Therefore, most of the sales in the Gauteng and surrounding provinces would be sourced from Sasol (Arthur Andersen 1995).

The IBLC of refined oil was also set artificially high by using, as its reference point, the Bahrain and Singapore markets. This effectively acted as a tariff on all refined fuels – synthetic or not. The IBLC also included a 6c/litre transport cost for piping crude from the coast to the interior. As Sasol did not need to pay this cost because it was located in the interior, it gained a cost advantage over other refineries located at the coast. The lower returns suffered by the other oil companies from these arrangements meant they negotiated a levy on petrol retail price of 3.6 cents per litre that was rebated to the oil

companies for buying synfuel from Sasol. Finally, there was an excise duty of 0.9c per litre on petrol for producers from indigenous raw materials (Arthur Andersen 1995).

The dramatic twenty-fold expansion of Sasol's operations in a few short years meant Sasol was going to face an enormous capital and skilled labour shortage. The capital costs of Sasol 2 were R2.5 billion and for Sasol 3 were R3.3 billion at the time. To provide some idea of the scale of these investments, at the time of the decision to build Sasol 2 (1976), the capital costs represented 8.5% of GDP, and for Sasol 3 (1979) they represented 7.2% of GDP. Together they raised the manufacturing capital stock by 10%. In terms of 1998 Rands, this translates into a capital investment of roughly R34 billion over 6 years. To resolve the capital issue, it was decided to restructure Sasol in 1979 and list it on the Johannesburg Stock Exchange to raise capital. This came at a time when Sasol 2's capital spending had reached a peak and the Sasol 3 decision had just been made. Sasol Ltd was listed on the JSE with full ownership of Sasol 1 (they brought out the IDC/Konoil ownership in exchange for cash and share options) and 50% ownership of Sasol 2 and 3. The other 50% of Sasol 2 and 3 was funded and owned by the state and the IDC.

The human resource requirements of the Sasol expansion included both construction and operational staff. South Africa did not have the required skilled personnel on the scale required by such a large capital project. As a national development project, Sasol wanted to limit the import of foreign skills and concentrate on the training of local unskilled workers. Even though contractors were used in the construction, they too were involved in training of local personnel and were limited in the number of immigrants they could use. However, it appears that Sasol took much of the burden and ended up spending R63 million on training to get Sasol 2 and 3 built and operational. Training began in 1976 for Sasol 2 and 10 000 unskilled construction workers were trained along with over 3000 operations staff (Sasol Annual Report 1980). The training programme was extended for Sasol 3 as an overlap in their construction occurred. At one time Sasol 3 had a construction workforce of 25 000. Many staff at Sasol 1 were used to train operational staff and make the plant operational initially. Sasol 2 staff then played the same role for Sasol 3.

The early 1980s again saw a change in the operating environment and priorities of Sasol. In terms of investment, Sasol was committed to buying back the 50% share of Sasol 2 and 3 from the IDC and the State as soon as they could. The need to save funds for buying back shares from the IDC and state limited Sasol's capital investment programme for most of the eighties. The investment priorities in the 1980s were to reinvest in Sasol 1 to keep the aging plant operational and cost down as well as to debottleneck the Sasol 2 and 3 as they become operational. Profitability had to be maintained to repay loans and buy back shares in Sasol 2 and 3. Sasol 2 was eventually brought back in December 1983 and Sasol 3 in 1991.

Another important development was the greater potential for chemicals production from the greater capacity of Sasol 2 and 3. A recognition of this within the group was demonstrated by the formation of a separate chemicals division – Sasolchem. Furthermore, in 1981 Sasol started making a full range of fertilisers and acquired a license to start making explosives in 1984. Sasol 2 and 3 were producing fertiliser, explosives, ethylene and propylene. By 1982, Sasol was producing 80 different chemicals for about 700 clients and sales of chemicals represented 16% of sales. However, the increased capacity of Sasol 2 and 3 combined with a drop in demand for chemicals in the early 1980s saw the closure of all petrochemical plants at Sasol 1, including the styrene and naphtha cracker. Chemicals still remained a small part of the Sasol Group.

Sasol's external environment also started to change in the 1980s. The oil price started to weaken in 1982 and continued to drop after that. By 1985, the oil price was 35% below the 1979 high and it finally collapsed by a further 40% in 1986. Sasol was cushioned to some extent by the drop in the value of the Rand, which lost two-thirds of its value from 1979 to 1986. However, this depreciation also fed into cost inflation, which meant that the company still saw pressure on margins. The South African economy also entered a downturn after the boom years at the end of the 1970s when the gold price hit record levels. The downturn was coupled with a severe drought, which depressed demand for Sasol's chemical products in particular. A final blow to Sasol was the elimination of tariffs on basic feedstocks for fertilisers and plastics (ammonia and monomers) while the downstream derivatives had an ad valorem tariff of 15%-30%. The petrol levy and excise duty protection on synfuel production was also dropped in

1985 when the rand devalued by a third but was reinstated again in 1986 when the oil price dropped by 40%.

The main problem for Sasol remained the price of crude oil, which continued to fall throughout the eighties. These changing times called for a change in strategy by Sasol. First, it introduced a far-reaching quality improvement programme aimed at cost reductions through a debottlenecking programme in all plants and other initiatives. This was known as the Sasol Quality Improvement Programme (SQUIP). Second, it began to diversify more rapidly into chemicals as this would leave corporate earnings less dependent on the price of crude. At the time, synfuels made up 75% of the Sasol group's assets and were effectively making a loss - being subsidised by chemical production. The strategy was that most investment from then on was to be in chemicals with a balance between upstream and downstream chemicals (Sasol Annual Report 1990). This was possible as the synthesis gas that emerged from the gasification of coal could either be fed into the synfuel process or into other chemical processes. Therefore, all it took was a diversion of inputs into newly constructed plants. Finally, Sasol requested greater tariff protection from the government.

The greater diversification into chemicals came initially from a revamp of the Sasol 1 naphtha cracker to crack ethylene and allowed Sasol to enter the polymer market. Sasol also initiated a project to extract propylene, manufacture polypropylene and extend production in hard waxes. Recognising that the local market promised limited demand, Sasol concentrated immediately on the export market and even opened up a European Division of Sasol Chemicals to develop the customer base. The request for greater tariff protection of synfuels resulted in a price floor being placed on synfuels at a level of \$23/barrel. However, the wholesaler brought the fuel from Sasol at the prevailing IBLC and if this fell below the price floor then the difference would be paid by the Equalisation Fund operated by the State which is financed by a levy on petrol. A price floor gave stability to Sasol's earnings on synfuel (Arthur Andersen 1995).

Sasol paid back the last 50% of Sasol 3 in 1991, which suddenly released considerable earnings within the group for new investment. For most of the eighties, Sasol had held back on investment in order to buy back the shareholding. The planning for this surge in investment had already occurred by mid-1990 when a series of significant petrochemical projects were announced. The initial diversification had aimed at basic chemical streams while this new phase of diversification was aimed at adding value to existing chemical streams. All synfuel production at Sasol 1 ceased and instead there was a new ammonia plant built, expanded production of specialised waxes and a plant for paraffin products. Other plants commissioned at the beginning of the 1990s were for n-butonal, anode coke, phenol, normal butonal, krypton, xenon recovery, cresylic acid purification, acrylic fibres, alpha olefins, acetic acid, acrylonitrile. In all, R5 billion was invested between 1989 and 1995 in chemicals.

During this period of expansion, there was still considerable pressure on Sasol to cut costs as international chemical prices were depressed due to oversupply. In addition, the change in government in 1994 brought about a change in energy policy in response to the Arthur Andersen Report. It was decided in 1996 to gradually phase out the price floor in the face of an oil price that was dropping to record lows. The goal was to reach a level of \$17 per barrel over 5 years, which put additional pressure on Sasol to cut costs. This led to a decision to make a significant investment in replacing current Fischer-Tropsch (F-T) reactors with the new version developed in-house which would lower operating costs and enable Sasol to produce synfuels at the lower price.

The decision by Sasol to diversify into high value chemicals meant they had to internationalise their operations because insufficient local demand existed for such products. Sasol's gradual diversification had reached the limits of what the local market could take so globalisation was a natural response (Sasol Annual Report 1997). New chemical product lines were targeted for the export market from the start. In the process of planning the addition of a product line, international market analysis was done. In some cases, specific customers were sought and contracted internationally through SCI divisions overseas, and production plants were planned to be of a minimum efficient scale from the start to ensure price competitiveness. The internationalisation drive represented a significant shift in operating style for Sasol as it moved away from the inward industrialisation strategies of the past.

The shift to being a global company was given a further boost by a window of opportunity in the market that Sasol was in a position to take advantage of. The window of opportunity is the large amounts of natural gas reserves in the world, which far outweigh the oil reserves. There is a need to monetise these reserves and one means to do this is the Sasol new slurry phase F-T technology to economically convert gas into clean burning diesel represents. Alternatives such as liquid natural gas (LNG), ammonia or methanol are currently less profitable because of the market glut. As Sasol itself has no natural gas reserves, it is using its technology as a leverage to enter partnerships with companies that have reserves so they can jointly exploit the opportunities. In addition, Sasol has also started doing exploration work itself to try secure a gas field which it can exploit itself. This represents an upstream diversification move to gain access to a raw material input that will prove important in the group's future. The final leg of expansion that Sasol has taken internationally is to jointly develop, with Statoil of Norway, an offshore FT production facility to enable them to access offshore gas reserves. This represents another leverage that Sasol can use to get a share of the monetisation of gas reserves (Sasol Annual Report 1997).

An important aspect of Sasol's expansion is that it has not been based on buying existing firms using financial reserves but based on gradual diversification around core technological competencies. Sasol has made a couple of small international acquisitions but in the same product markets and designed to reinforce its own technologies and product lines. This is very different to many other South African companies that are going global (e.g. IT companies and paper processing), with the exception of the mining industry.

However, one should not forget that the production of synthetic fuel remains the backbone of the group comprising 49% of its profits and 35% of its turnover. This part of the business is purely focused on local markets and remains subsidised through the price floor. As such, Sasol does remain somewhat vulnerable to changes in the regulatory regime. However, South Africa has too much vested in synthetic fuels (both Sasol and Mosgas) to let the industry be destroyed. Therefore, future regulatory changes may squeeze profits but they will not put the profitability of the company's synfuel operations at risk. Yet the regulators need assurance that Sasol is not using the synfuel production to cross-subsidise any other parts of the business which would lay them open to international trade disputes or penalise domestic competitors. The Arthur Andersen Report (1995) cleared Sasol of all cross-subsidisation charges.

1.2 Sasol Processes²

The production of synfuel and petrochemicals by Sasol is an integrated production process, depicted in a simplistic form in figure 1.1. The process has remained fundamentally the same throughout the years, though there has been radical improvements in the process technology and the addition of plants for the recovery of high value chemical products. The process can be described as follows:

1. *Coal Extraction* – the process begins with the extraction of low-grade coal at Sasol mining facilities located in Secunda and Sasolburg. Sasol generally supplies all its own needs but in recent years has found it necessary to buy some coal on the open market.
2. *Coal Gasification* – the chemical processing begins with the gasification of the coal under pressure and at high temperature. The technology used in this process was originally licensed from a German company, Lurgi. However, over the years Sasol has made such significant improvements to the process in alliance with the company that it is now a joint license holder. The latest version, the Mark V, was commissioned in 1985 allowing a significant reduction in capital and operating costs. Sasol is the only commercial company using the coal gasification process except for one plant in the USA, which Sasol helped establish. The process yields a crude gas.
3. *Gas Purification and Co-Product Recovery* – the crude gas is then cooled and a number of chemical co-products are recovered from it including ammonia, tars & pitches, phenol, cresols and

² This section is based on Sasol publicity material

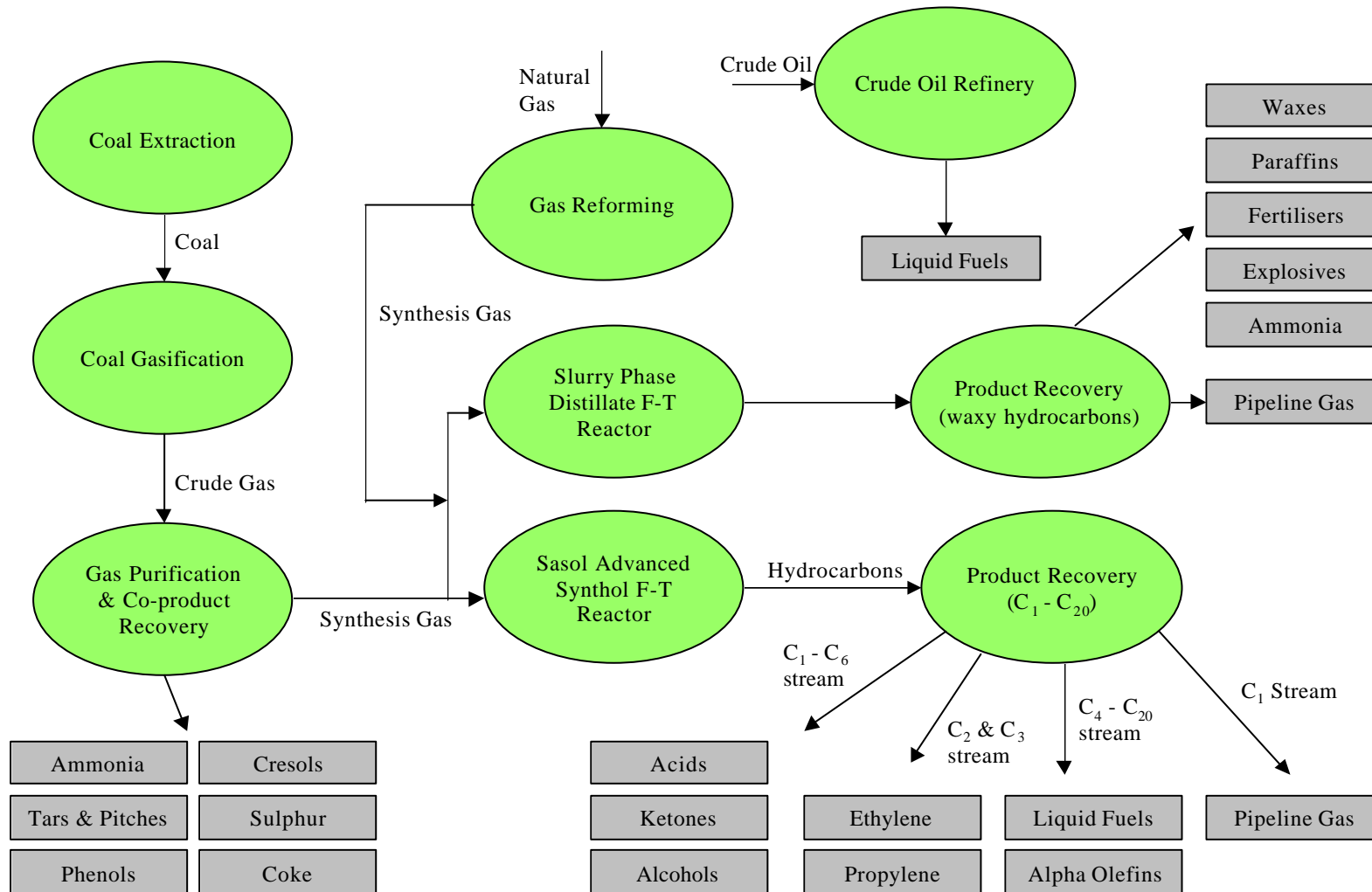
sulphur. Pitch is further processed to form coke. The commercial recovery of these co-products has developed over time. The first to be exploited in the early 1960s was ammonia as it is a key feedstock into the fertiliser and explosives industry. The local industry demand for ammonia existed in SA early in Sasol's development due to the mining and agricultural demand. However, production was mothballed for a while until Sasol re-entered the market for these products in the early 1980s. Sulphur recovery was first introduced in 1986 and phenols and creasotes also saw development in the eighties. The early 1990s expansion in the production of chemicals saw the development of coke as an important product. Aside from the co-products, the recovery plant purifies the gas to create a synthesis gas (mixture of carbon monoxide and hydrogen) which is the basic feedstock for synfuel and petrochemical production.

4. *Gas Reforming* – an alternative method to creating the synthesis gas required for the Fischer-Tropsch (F-T) process, is to reform natural or pipeline gas. This is a mature technology with numerous licensors. It has been used commercially by a wide range of organisations in the processing of ammonia, hydrogen and methanol. Sasol uses an off-the-shelf technology to reform some of its excess pipeline gas that emerges from the F-T process.
5. *Fischer-Tropsch Conversion: the Sasol Advanced Synthol (SAS) reactor* – the Fischer-Tropsch process is the heart of the Sasol synfuel process and where its major technological efforts have been concentrated. The original F-T process licensed in 1950 was a combination of German fixed bed and the American fluid-bed F-T processes – a circulating fluidised bed reactor. After years of research to make the process economically viable, Sasol licensed its own design in 1972 as the Sasol Synthol Process. Since then, the process has been further improved with the most recent innovations leading to the development of the Sasol Advanced Synthol Reactor which is more cost-effective than previous models and is of a much larger scale than was possible with previous reactor designs. Under the F-T process, the synthesis feed gas is sent into the reactor and the hydrogen and carbon monoxide react under pressure in the presence of a catalyst to form a range of hydrocarbons in the C₁-C₂₀ range. The simultaneous creation of fuel and chemical products gives Sasol its cost advantage for the production of high value chemicals.
6. *Product recovery (C₁-C₂₀)* – the hydrocarbons emerging from the F-T reactor are cooled in stages to separate the various chemical streams. The methane-rich gas (C₁) is sold as pipeline gas or reformed to form synthesis gas. The C₂ and C₃ rich streams are worked up into ethylene and propylene respectively. Propylene is further reworked to form polypropylene and acrylic fibres. Ethylene and propylene was first produced in the 1960s using imported naphtha and a naphtha cracker – later mothballed. Production from the SAS feedstock began in the late eighties for ethylene while (poly)propylene began in 1990 and acrylic fibres in 1993. The oil stream is the C₄ to C₂₀ range, which includes large quantities of olefins in the C₅ to C₁₁ range. Sasol proprietary technology is used to extract the alpha olefins, pentene (C₅) and hexene (C₆). These came online in 1993. The remainder of the oil stream is routed to a refinery where standard technology is used to produce petrol, diesel, paraffin, fuel oil, butane, propane and liquefied petroleum gas. This has been the product line of Sasol since the beginning when it was established to produce oils from coal. Finally, the oxygenates from the reaction water in the F-T process are separated and purified to produce a range of alcohols, acids (acetic and propionic), and ketones (acetone, MIBK, MEK). Most of these product lines have only come online in the mid-1990s.
7. *Fischer-Tropsch Conversion: the Sasol Slurry Phase Distillate (SSPD) reactor* – from the beginning Sasol used a tubular fixed-bed reactor to manufacture wax from synthesis gas using the Arge process. Sasol recognised that this F-T reaction was better performed in a slurry phase system and developed the SSPD reactor during the late 1980s and commissioned a full plant in 1993. This F-T process is operated at lower temperature than a Synthol reactor and produces waxy hydrocarbons.
8. *Product Recovery (waxy hydrocarbons)* – in subsequent product work-up and recovery phases the SSPD process allows for production of waxes (hard, candle and speciality waxes), paraffins and high quality diesel. Ammonia is also produced which is either sold or used in the production of explosives and fertilisers. The relative newness of the SSPD process means the wax and diesel

products are only recent additions to the Sasol product range. Ammonia has always been produced as a co-product in the coal gasification stage and so has been around longer. The explosives and fertiliser plants were established in the early eighties as Sasol's initial attempts to diversify its product base in the face of a rapidly falling oil price.

9. *Crude Oil Refining* – Sasol part owns the Natref refinery which was installed initially to provide Sasol with its own source of naphtha for the production of ethylene and propylene. It has kept a stake in the refinery and it continues to produce liquid fuels from imported crude oil. Jet fuel and bitumen are the two products that this process adds to the Sasol product range while its petrol and diesel production has often acted as a cushion for fluctuating output from the Synthol process.

Figure 1.1: Sasol Production Process



Source: Sasol Annual Reports

1.3 Organisation

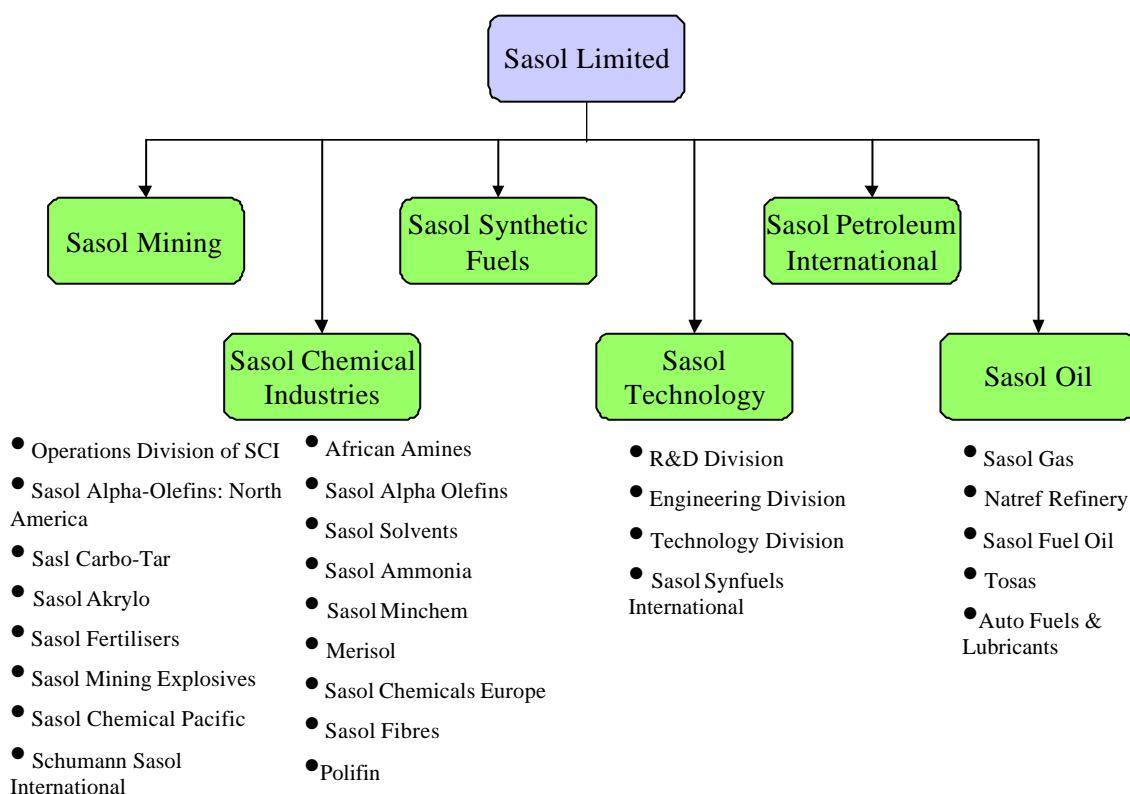
The Sasol Group has restructured numerous times in its history to accommodate its growth and diversification. The current organisation of the Sasol Group (more or less unchanged since 1994) is based upon clear product lines and is depicted in figure 1.2. What follows is a brief description of the functions of each group company and its organisational history.

1. *Sasol Limited* – the Sasol Group head office holding company which co-ordinates the Group's activities and supplies certain specialised services. Included in these services are Group strategic development, finance and information services (GID). A Group holding company only became necessary with the twenty-fold increase in operations under the development of Sasol 2 & 3 in the late Seventies. Initially, Sasol 2 and 3 were part owned by the IDC and government so for accounting purposes there was a need to have them as separate companies to Sasol Industries, making a Group holding company important. Subsequently, diversification has made it important.
2. *Sasol Mining* –this company is responsible for all of the Group's coal mining activities, including the Sigma colliery supplying SCI in Sasolburg and the Secunda collieries supplying SSF in Secunda. Sasol has operated its own coal mines from the beginning due to the central importance of the mineral in its production chain and the importance of being located next to its supplier. It also ensures that Sasol is not subject to short-term fluctuations in coal prices as market conditions change.
3. *Sasol Synthetic Fuels (SSF)* – the core of the Sasol Group which is responsible for conversion of coal into fuels and chemical feedstocks. This currently only includes Sasol 2 and 3 operations at Secunda since Sasol 1 at Sasolburg was converted to produce chemicals only in 1994. Initially, each site was a separate company due to accounting necessity but as the Group brought back the IDC and government shares of Sasol 2 then Sasol 3, these operations have been amalgamated under the same corporate banner as Sasol 1.
4. *Sasol Petroleum International* – responsible for the Group's international petroleum exploration and production. This is a new addition to the Sasol Group and is currently very small. It was formed in 1995 to move Sasol upstream into oil production and away from coal.
5. *Sasol Chemical Industries (SCI)* –the second largest operating company in the Sasol Group which is responsible for the production and marketing of over 120 chemical products. The feedstocks used in production are either purchased from SSF at Secunda or produced by SCI itself through the Operations Division which gasifies coal and converts it to feedstock at Sasolburg. Each significant product line has its own operating division responsible for the production and marketing of that product. Included are also a number of joint ventures, such as Schumann Sasol International (waxes), Polifin (monomers & polymers), Sasol Fibres (acrylic fibres) and African Amines (amines). Also included are 3 overseas operations charged with developing the Group's petrochemical interests there. In the early eighties, there were three chemical divisions, one for fertilisers, one for explosives and one for all other chemicals produced. Only in 1993 were all chemical operations consolidated under one operating company.
6. *Sasol Technology* – a service company in the Group responsible for technology support for the group and the development of new business opportunities. It is home to four divisions. The R&D Division is responsible for group research and development. The Engineering Division is responsible for providing conceptual process design, engineering support and project management to the Group. The Technology Division is responsible for the development of new business ventures and the procurement and

licensing of technology for Sasol. It is also responsible for the licensing and transfer of Sasol FT technology plus technical and operational support to purchasers of technology. Finally, Sasol Synfuels International is responsible for the development and management of the Sasol Group's international business interests based on the application of Sasol's FT technology. The core of this operating company has been the R&D and Engineering Divisions which formerly made up Sastech. The Technology Division was formed separately in the 1980s under the name Technology Transfer Division and served as a vehicle to transfer technology to Mossgas amongst others. The Sasol Synfuels International Division was only formed in the last year or two since the opportunity to exploit abundant natural gas reserves using Sasol technology has emerged.

7. *Sasol Oil* – this company is responsible for the marketing of liquid fuels, gaseous fuels and lubricants. It effectively operates as the distribution and marketing arm for SSF as this function is not done at the Group level and each of the chemical subdivisions handles their own marketing and distribution. However, included in its scope of operations is the operation of the Natref crude oil refinery which is a joint venture with Total. For most of the Group's history each of these parts have been separate divisions and only in the 1993 reshuffle have they been amalgamated.

Figure 1.2: Sasol's Organisational Structure



Source: Sasol Annual Report 1998

1.4 Performance

The performance of the Sasol Group has been impressive since the commitment to expand production of synthetic fuels in the mid 1970s. This section takes a brief look at some of the measures of performance, namely growth, return on assets, diversification, exporting and productivity growth.

1.4.1 *The Operating Context*

When evaluating performance, it is important to take into account the operating conditions that Sasol faced during the last 20 years. The most important of these are the movements in the price of its inputs (coal) relative to its outputs (petrol and chemicals), remembering that the price of its outputs are set internationally (adjusted for tariff protection in the case of petrol). What is important for Sasol as well, is the performance of its input (coal) relative to the input of its competitors (crude oil). Figure 1.3 tracks an index of the rand price of crude oil, coal, chemicals and petrol, deflated by the South African producer price index (PPI). The price index for petrol includes all forms of tariff protection and price floors as detailed in the first section.

It is clear that Sasol has faced rising cost pressure as the increases in the price of its main input (coal) has well outstripped that of its main output (petrol), while remaining more or less on a par with its other main output (chemicals). It has also faced increasing competitive pressure as the changes in the price of its competitor's main input, crude oil, has been well below that of coal.

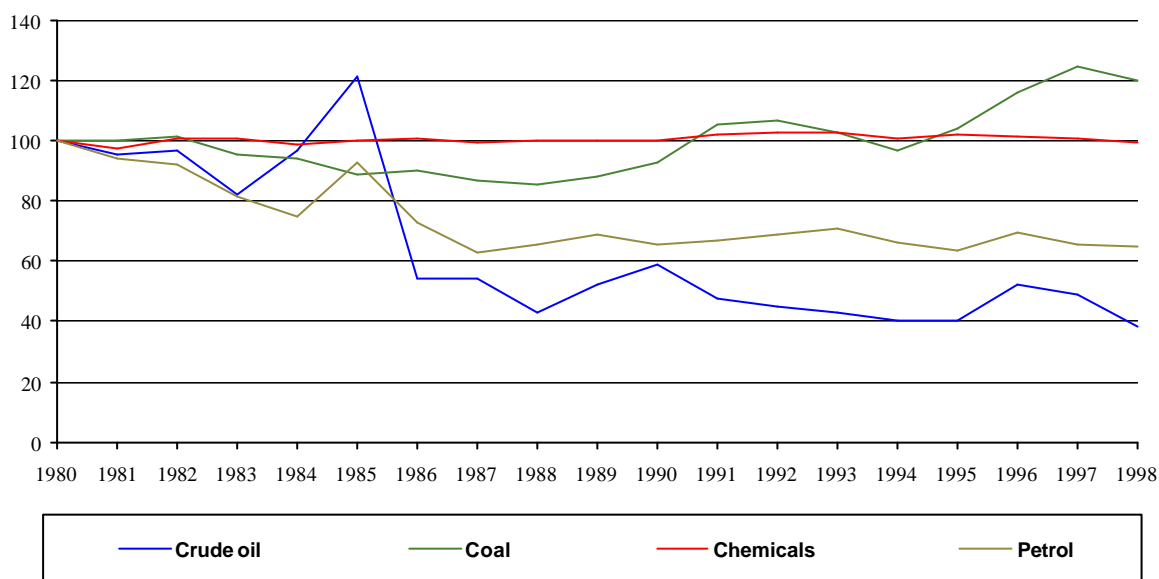
The index of the rand price for crude reflects large movements in both the dollar price and the rand exchange rate during this period. The price dropped after the highs in 1979/80 (from the fall of the Shah of Iran) only for the rand price to increase dramatically in 1985 when the rand had a sharp devaluation. This was the high point before the dollar price of crude collapsed in 1986, recovering only briefly in 1990 with the Gulf War and in 1996 with a further devaluation of the rand. In contrast, the rand coal price, while dropping in real terms during the 1980s as well, did not fall by anywhere near the extent of crude prices. It also recovered in the early 1990s and has since then continued to rise. The result is that real coal prices in 1998 are 20% higher than in 1980 while real crude prices are 60% lower. This represents a considerable competitive challenge to Sasol.

The petrol price tracks the crude price closely with slight deviations as refiners margins change or the rate of protection changes. The SA petrol price has been more stable than the crude price since 1987 due to the introduction of a price floor. However, despite protection, the real rand price of petrol has fallen by almost 40% since 1980. In contrast, the real rand price of Sasol's input - coal - has increased by 20%. This has enormous implications for the profitability of Sasol.

Finally, the rand price of petrochemicals produced by Sasol for mainly the export market has been relatively steady over the past 20 years. Although international petrochemical prices respond more closely to the price of crude, those of Sasol do not as its main input is coal.

Therefore, we can conclude that Sasol faced tremendous pressure to reduce costs throughout the last 20 years in order to compensate for using a different raw material input to other producers.

Figure 1.3: Real Price Index of Crude, Coal, Chemicals, and Petrol, 1980-98 (1980=100)

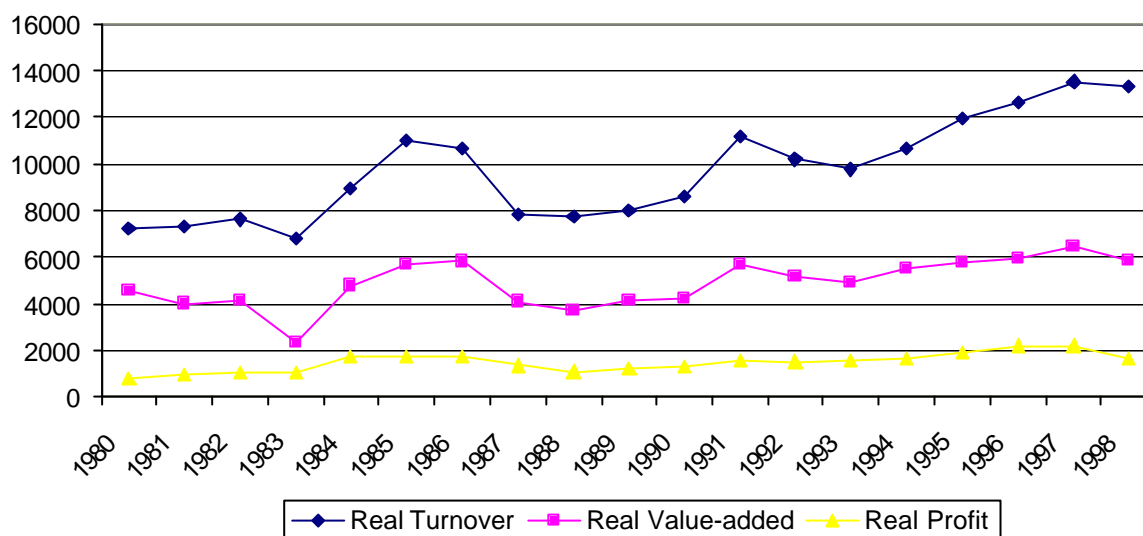


Source: Statistics SA, Producer Price Indices (1980-1998)

1.4.2 Turnover, Value-added and Profits

Figure 1.4 plots the turnover, value-added and profits of the Sasol Group from 1980 to 1998. The growth of Sasol has been shaped as much by the fluctuations in the price of crude as it has by the investments in new productive capacity. Tracking turnover, there was a gradual increase in the value of output until 1983 as Sasol 2 and 3 were completed and commissioned. Turnover increased rapidly thereafter as the plants were debottlenecked to bring them to full production capacity. However, the value of turnover and profits has always been subject to the dramatic shifts in the oil price, which determines the price of Sasol output. The oil price dropped dramatically in 1986 (40%) and again in 1987 (34%) which reduced turnover value several-fold. The result, from 1980 to 1987, the value of turnover increased by only 8.5% (1.2% per annum). After 1987, when the price of petrol stabilised, Sasol managed to grow steadily for the next 10 years. It averaged an annual growth rate of 5.5% and increased turnover by 73%. In all, the Sasol Group has grown at an average annual rate of 3.7% over the last 20 years.

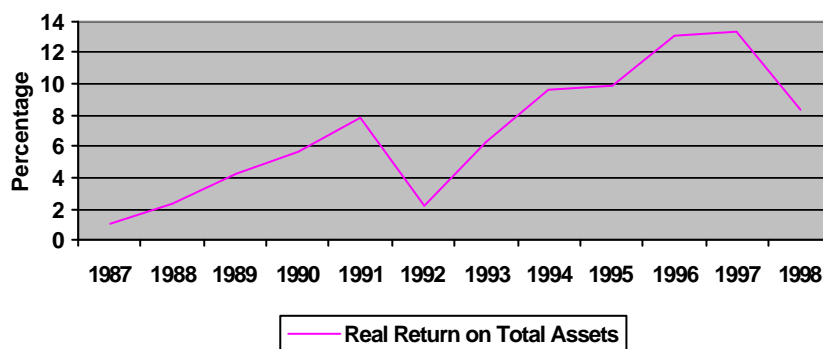
Figure 1.4: Real Turnover, profits and value-added for Sasol Group 1980-1998 (1995 prices)



Source: Sasol Annual Reports 1980-1998

The Sasol Group has also been successful in maintaining profitability during an extended period of adverse price movements for crude. Figure 1.5 shows that profits have grown steadily at an average rate of 5.9% per annum from 1980 to 1997. This growth in profits has enabled Sasol to offer an increase in the real return on total assets from only 1% in 1987 to a high of 13.3% in 1997.

Figure 1.5: Real return on total assets (1987-98)



Source: Sasol Annual Reports 1987-1998

Sasol's performance has been impressive considering the declining petrol price and increasing costs for raw material inputs. The strategy to achieve this has been two-fold:

1. Investing heavily into diversifying petrochemicals which have higher value thereby raising the average output price faced by the group; and

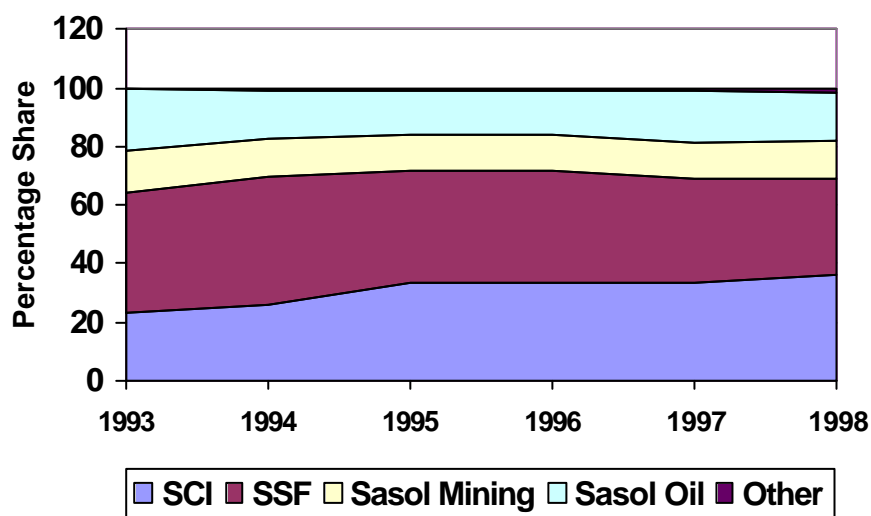
2. aggressively pursuing productivity improvements to protect profitability and increase production capacity

This strategy has enabled Sasol to maintain a relatively stable profit flow despite a weak oil price for much of the last 15 years. What follows is a brief discussion around their success in pursuing these strategies.

1.4.3 Diversification

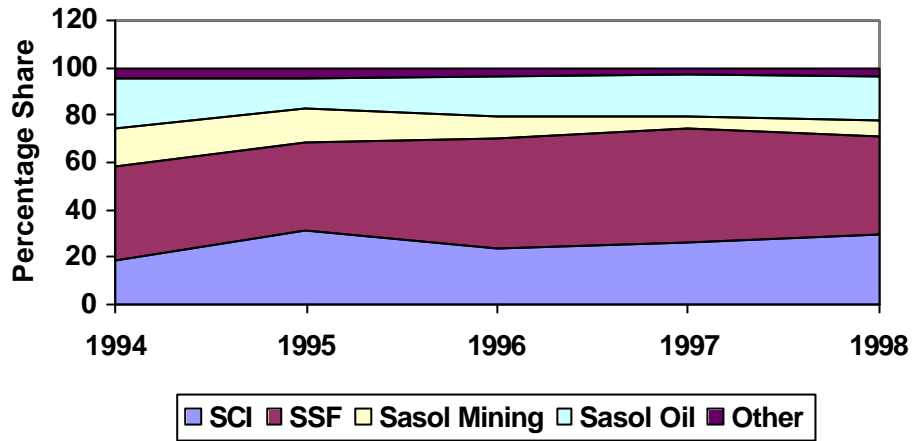
Sasol began to diversify in the early 1980s as it realised that the crude price would remain depressed for a significant time. This initial diversification into fertiliser and explosives was hindered by depressed market conditions and limited cash flow. There was also a need to develop the technology and processes themselves because existing licence technology was often not suited to a coal-based petrochemical complex. However, by the early 1990s, there was considerable energy behind diversification; new technology was either developed or licensed so streams of new products could be bought online. This is reflected in figure 1.6 , which has the turnover shares of each Sasol business unit. Over the period 1993 to 1998, petrochemicals increased their share of output from 23.1% to 36.2%. This was mainly at the expense of synfuel production (shares fell from 41.3% to 32.5%) as common feedstocks were diverted to chemical production. The diversification into chemicals is also reflected in profit shares. Figure 1.7 shows that the share of profits for chemicals increased from 18.4% in 1993 to 29.7% in 1998. However, this has been largely at the expense of profits in the production of the primary input - coal (down from 16.7% to 7%) - rather than in synfuel which has gradually increased its profitability.

Figure 1.6: Turnover shares of Sasol Group Operating Companies, 1993-98



Source: Sasol Annual Reports 1993-1998

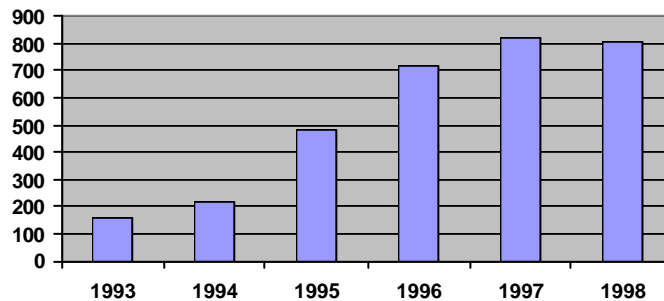
Figure 1.7: Profit shares of Sasol Group Operating Companies, 1993-98



Source: Sasol Annual Reports 1993-1998

The diversification drive has meant that Sasol needed to enter the world market in a more significant manner because of the limited local demand for such value-added chemicals. Successful diversification required success in international markets. This has been achieved as reflected in Figure 1.8. Exports have grown from under \$200m dollars, or 6.2% of sales, in 1993 to around \$800m dollars, or 26.7% of sales, in 1998. Export performance is one measure of efficiency as it involves successful international competition. However, Sasol gains some competitive advantage in petrochemicals from the fact that the feedstocks are generated during the same one-step F-T process that creates the feedstock for synfuel. This single process reduces costs of feedstock production and offers Sasol advantage in high value chemicals. Sasol also gains from product differentiation in the hard wax market. The F-T process creates some unique waxes, which cannot be produced through the usual crude oil processes. These waxes are able to command a premium in the market for their unique qualities.

Figure 1.8: Exports by the Sasol Group (US \$) 1993-98



Source: Sasol Annual Reports 1993-1998

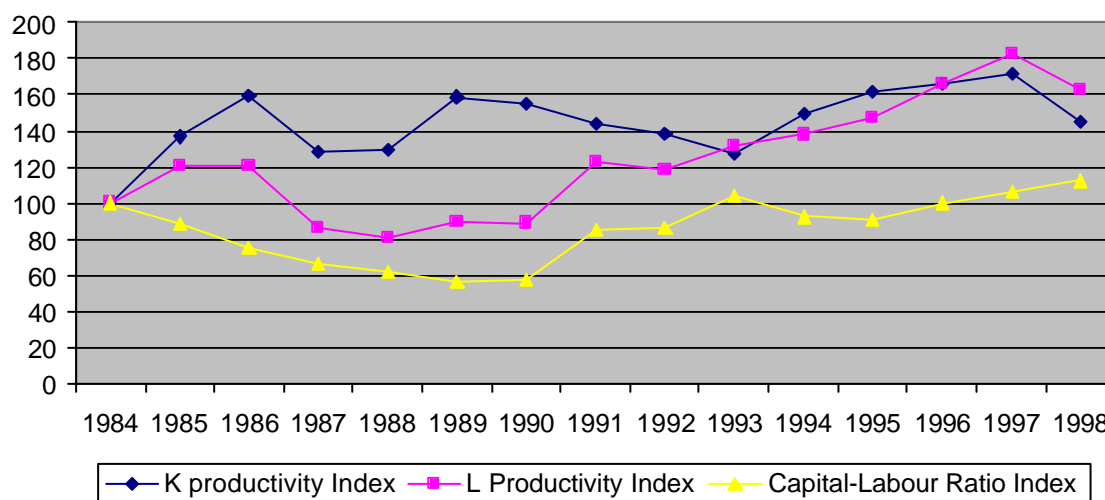
1.4.4 Productivity Improvements

Diversification enabled Sasol to protect itself to some degree from the falling and unstable crude oil price, but the heart of Sasol remains the synfuel production. Sasol has had to cope with a deterioration in the price of crude oil in the early 1980s and again recently as crude oil prices fell to 15 year lows. At the same time, Sasol has seen costs increasing due to the use of an alternative feedstock – coal. The only way to protect profitability in this business has been to make huge leaps in productivity to make the synfuel process far more commercially viable. What has helped motivate Sasol to radically improve its productivity was the certainty that it needed to. By 1985, it became clear that although the crude price would improve, it would not do so significantly or quickly. Some pressure was relieved in the late 1980s when Sasol lobbied successfully for a price floor. However, this only lasted until energy policy was reviewed in 1995. It was decided to gradually lower the floor from \$23 p/barrel to \$17 p/barrel in 1999. This at least provided certainty in market conditions which gave Sasol impetus to make radical productivity improvements.

Figure 1.9 tracks a productivity index for capital and labour from 1984 to 1998 for the chemical industry in South Africa. The industry data is a useful guide to Sasol's own performance as the sector is dominated by Sasol. Pre-1984 analysis is not so useful as Sasol 2 and 3 only began operating at design capacity during 1983, so productivity improvements are exaggerated prior to this year. Also, as output value is used, the productivity index is subject to the swings in output prices even if physical product per unit of labour or capital is unchanged, for instance, the sharp price drops in the mid 1980s and in 1998. For comparative purposes, figure 1.10 contains the same indices for South African manufacturing as a whole.

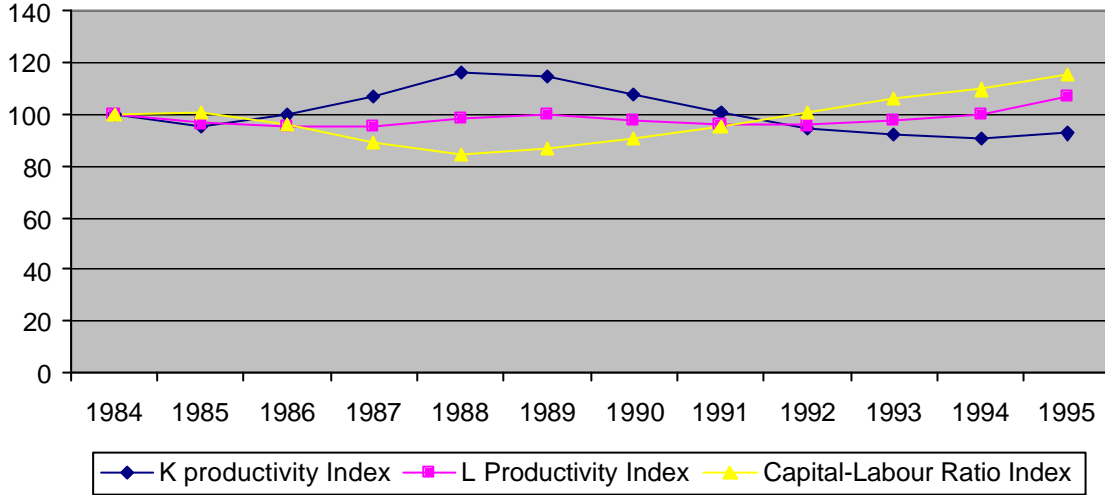
The productivity index for chemicals shows impressive increases in the productivity of both fixed capital and labour since 1984. Taking the high point in 1997, capital productivity has increased by 72% and labour productivity has increased by 83% since 1984. This translates into an average annual growth rate of 4.6% for capital productivity and 5.1% for labour productivity. In contrast, manufacturing as a whole in South Africa saw a decline in capital productivity of 0.8% per annum from 1984 to 1995 while labour productivity grew at only 0.6% per annum in the same period. Therefore, Sasol has far outperformed the market locally and tabled productivity improvements that are impressive on even a world stage.

Figure 1.9: Index of Capital and Labour Productivity in the SA chemicals industry (Real Value of Output per employee or Rand of capital), 1984-1998



Source: WEFA Industry Trends (1984-1995), SA Statistics Manufacturing Statistics

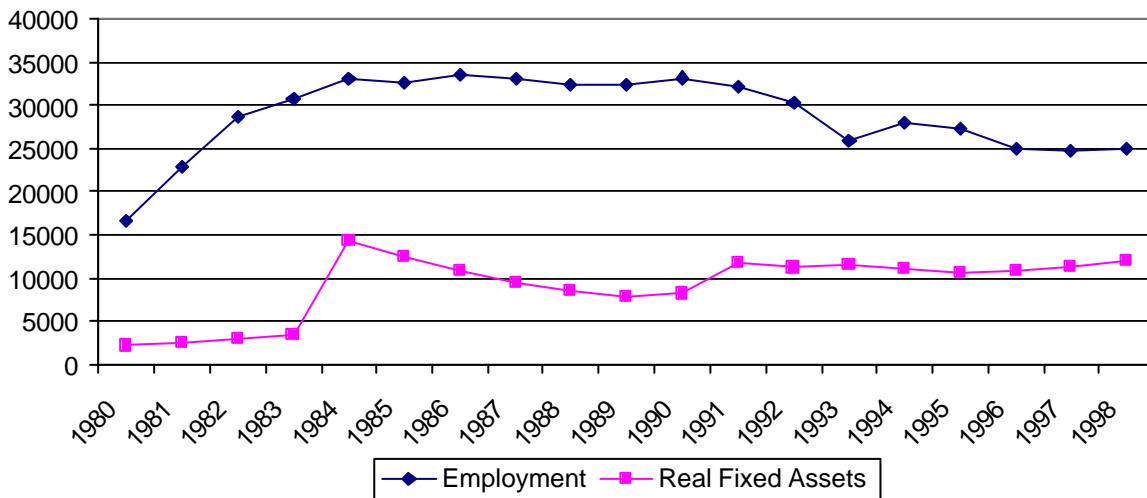
Figure 1.10: Productivity Indices for South African Manufacturing 1984-95



Source: WEFA Industry Trends (1984-1995), SA Statistics Manufacturing Statistics

What is interesting about the productivity improvements in Sasol is that they have concentrated on both capital and labour. This has meant that the capital-labour ratio has increased at a pace of only 0.5% per annum. In contrast, the rest of manufacturing has seen annual increases of 1.4% , which is almost three times that of Sasol. Figure 1.11 shows the employment and real fixed asset trends in Sasol from 1980 onwards. The initial surge in the early eighties was a result of bringing both Sasol 2 and 3 up to full capacity. Since 1984, both fixed assets and employment have decreased, although employment has fallen further.

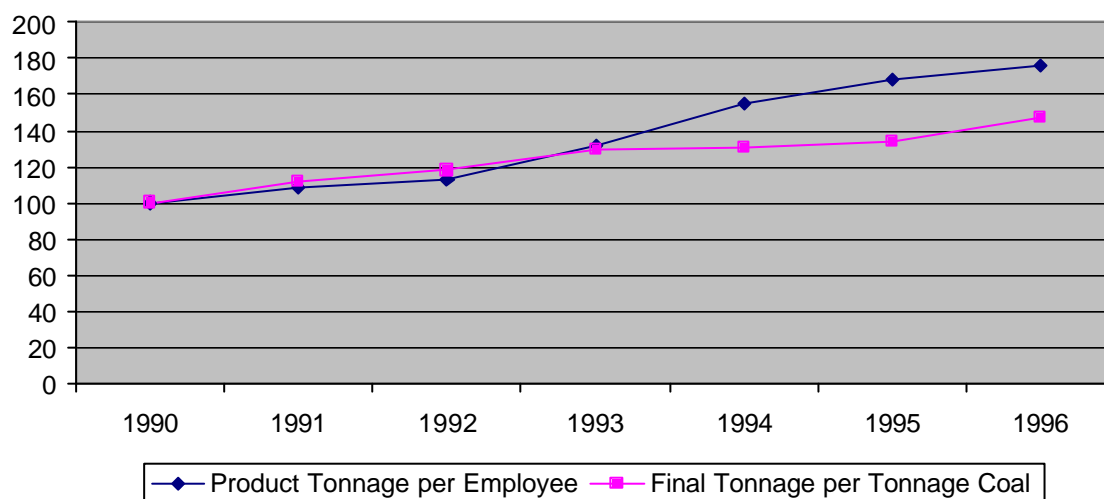
Figure 1.11: Employment and Real Fixed Assets at Sasol, 1980-1998



Source: Sasol Annual Reports 1980-1998

As mentioned previously, the use of output value for productivity measurement provides a distorted picture due to variations in output price. Sasol has kept records of physical output measures of productivity, which give a far more accurate picture of actual productivity. The measures used by Sasol are the final product tonnage per employee for labour productivity and the final product tonnage per tonnage coal for the productivity of raw material inputs. The results shown in figure 1.12 demonstrate that the use of output value has probably downplayed the incredible performance of Sasol. From 1990 to 1996, labour productivity has increased by 76% (or 8.4% per annum) and coal conversion by 47% (or 5.7% per annum).

Figure 1.11: Productivity Indices for Sasol (1990-1996)



Source: Sasol Annual Reports 1990-1998

In the following section we analyse the extent to which variations in producer service supply have been responsible for the incredible productivity and diversification success of the Sasol Group.

2. TECHNOLOGY SERVICES – ROLE, ORGANISATION, PERFORMANCE AND BROADER IMPACT

For the purposes of this paper, technology services consist of the research and development services that contribute to improvements in existing processes and the generation of new products. This is separate to engineering services and operations. In a nutshell, technology services come up with the enabling technology to produce; engineering services design and construct the new plants for production; and operations then run the plants. There is interplay between the two as engineering and operations both contribute to the research process, while research is involved in incremental improvements in operations on a continual basis³.

2.1 Role and Demand in the Sasol Production Process

2.1.1 Role in Production

The production of synthetic fuels and petrochemicals is technology-intensive and so technology services play a crucial role in driving the performance of Sasol. In fact, Sasol itself sees technology services, along with engineering capability, as the core competitive advantages of Sasol and the root of its global expansion⁴.

The reason for this perception is simple enough to explain. In synthetic fuel production, Sasol gains no competitive advantage from its raw material feedstocks or product distribution network, so the production process is the only place where significant cost reduction gains can be made. In terms of the former, it is the only company to use coal, which is a more expensive feedstock than crude oil, and it currently does not own any other sources for input, such as natural gas reserves. In terms of the latter, Sasol has been prevented from establishing a petrol distribution network as part of the deal to encourage other oil companies to purchase from Sasol for distribution at their own pumps. Therefore, growth and improvements in performance must come from cost reductions in processes and the introduction of new products to diversify into higher value products.

Technology services play a crucial role in reducing costs in processes. Radical changes in processes are one of the only sources of dramatic improvements in productivity, and these are mostly the result of research and development efforts. Even smaller incremental improvements in processes generally involve technology services in the petrochemical industry because of their technical nature.

Technology services play an instrumental role in bringing new products online. This is especially true for Sasol where off-the-shelf technology is often not available because of the unique feedstocks that emerge from coal gasification and subsequent FT conversion of syngas. These unique feedstocks also mean that some unique products can be produced for which new processes need to be developed. However, there are occasions when the unique processes of Sasol provide specific feedstocks below the costs of competitors

³ This section is based on discussions with Sastech management, Sastech publicity material and Sasol Annual Reports.

⁴ This is largely based on discussions with Sasol's management team behind finding new global opportunities for the Group

because they emerge as a by-product of the synfuel process and do not require any additional processing. In these cases, off-the-shelf technology can be used as the competitive advantage in the feedstock⁵.

Finally, technology is the one thing that Sasol is able to use as a bargaining chip to get entry into a number of joint ventures internationally. As mentioned already, Sasol does not have access to any quantity of gas or crude resources, nor does it have a petroleum distribution network. Therefore, all it can bargain with is its unique technologies, which may be of interest to potential partners, such as the production of useful chemicals and diesel from natural gas reserves.

2.1.2 Technology Types

The main technologies used in the Sasol production processes are as follows:

- *Mining technology* – used in the extraction of coal;
- *Coal technology* – specifically the gasification of coal to produce synthesis gas but also further beneficiation of coal products. As the primary input into the Sasol process, understanding the properties of coal mined locally is key to improving performance in operations;
- *Catalysis technology* – catalysis is the basis for most of the processes at Sasol. Fischer-Tropsch catalysis is the basis for converting synthetic gas to liquid fuels and chemicals. Non-Fischer-Tropsch catalysis is used to refine and upgrade chemical by-products that emerge from the F-T process;
- *Separations technology* – used to separate mixtures from the coal gasification and FT processes into individual products for sale or further upgrading - a key chemical technology along with catalysis;
- *Biotechnology* – new technologies for creating saleable products from Sasol co-product streams as an alternative to the other chemical processes used;
- *Process design* – catalysts may cause the reaction that creates the product but it occurs within a broader process, which needs to be designed and optimised. Of particular importance is FT processes. This development work overlaps with the catalysis and separations work but includes process modelling and operations research;
- *Waste treatment technology* – chemical industries can have serious detrimental effects on the surrounding environment if waste is not treated properly. This involves removing harmful chemicals from the waste;
- *Crude Refining technology* – Sasol operates a standard crude oil refinery and requires technology for its operation.

2.1.3 Levels of Demand in Sasol

The demand for technology services by Sasol has varied considerably since it began 45 years ago. From the beginning, there was demand for research into the F-T processes licensed because it had failed to work as anticipated. However, while Sasol remained a small and relatively undiversified operation, there was little incentive to invest heavily in research for economies of scale reasons. That all changed with the decision to go ahead with Sasol 2 and 3.

⁵ This does not suggest that Sasol is cross-subsidising, but that part of the costs of the process are allocated to other product streams that emerge from the F-T reactors.

Research effort increased with the commissioning of Sasol 2 and 3 for two reasons. First, there was a need to optimise the processes in the larger plants and overcome any operational problems. Second, the drop in the oil price soon after the commissioning of Sasol 2 and 3 required effort at improving the yields on the gasification and F-T processes for synthetic fuel to make the process more cost-effective. This trend continued through to the mid-to late-1980s, when a further collapse of the oil price saw a change in corporate strategy towards diversification into higher value chemicals. However, a start had already been made on the more significant developments in F-T technology, including the fixed fluidised bed reactor and the slurry phase reactor.

Research responded to corporate strategy and spent more resources on new product development. This research included beneficiation of feedstocks at all stages of the production process from coal to syngas to F-T feedstocks. It also included a sizable environmental element partly in response to greater environmental concerns but also the opportunities to create value from effluent waste. The rise in resources spent directly by the in-house providers of technology and engineering services is reflected in the Sastech budget and assets in figure 2.1. Assets increase as more pilot plants and laboratory equipment is purchased.

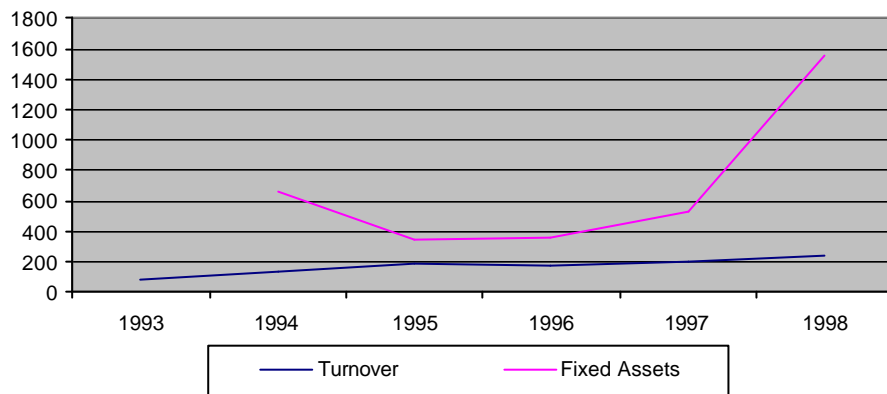


Figure 2.1: Turnover and Fixed Assets of Sastech 1993-1998 (1995 Rands)

Source: Sasol Annual Reports 1994-1998

2.2 The Technology Services Market

It is difficult to make general statements about the production characteristics of the technology services market as it may vary significantly from one application to the next. What follows is an assessment of the general trends for the main Sasol processes only. These are:

- *Human capital and knowledge intensive* – technology services are all about knowledge creation and so are naturally human capital and knowledge intensive. Much of this knowledge is obtained through formal learning and not experiential processes.
- *High asset specificity* – for the most part, technology services for Sasol require a relatively high degree of asset specificity. This is because a) they are the only synthetic fuel producer on a commercial scale in the world using coal gasifier and F-T technologies, b) even many of the higher value chemicals extracted from feedstocks need unique processes because of the unique feedstocks emerging from the F-T processes, c) there are many gains in terms of equipment optimisation and yields in the petrochemical

industry from knowing your feedstocks well. Therefore, aspects of the technology inputs are highly asset specific. However, there are still some components of production where this is not the case, such as a) coal mining technology, b) crude refining technology, c) some higher value chemical extraction.

- *High fixed costs* – petrochemical research requires a considerable amount of laboratory equipment and often the construction of pilot plants for pre-commercial experimentation. These investments are usually very large.
- *Significant externalities* – catalysis is the basis of most chemical reactions associated with Sasol, including the conversion of gas to liquid fuels and other chemicals. This common base allows for significant externalities to exist as knowledge created in one sphere is carried to another. This aspect of production also applies to an intimate knowledge of the Sasol feedstocks, from syngas to the outputs of F-T processes. These feedstocks are common inputs to numerous different processes and so knowledge of them can be used in more than one instance.
- *Economies of scale* – the high fixed costs and positive externalities mean that technology services in the case of Sasol have a certain economy of scale.
- *High returns to specialisation* – there are significant returns to specialisation due to the depth of knowledge required and the high asset specificity. The returns are realised through greater productivity in the processes being researched.

2.3 Organisation of Technology Services

It is not desirable to try and produce all technology in-house and so the organisation of technology services has always contained a mix of outsourcing and in-house production. This mix has responded to changes in the corporate strategy and changes in corporate thinking about internal and external specialisation.

From the beginning, Sasol established a technology division to try and get the licensed coal gasification and F-T technology to operate correctly. However, it specialised on these functions only. It did not attempt to provide mining technology for the coal-mining component of the operations as this was well established outside the company in South Africa due to the large mining industry that had already developed. The gradual diversification of operations did lead to a slight increase in the services provided in-house, but for the most part, technology services were outsourced and technology was licensed. For example, the construction of the Natref refinery used licensed technology.

The expansion of synfuel production with the construction of Sasol 2 and 3 meant that the economies of scale were there for a more concerted research effort into synfuel production. However, for the most part the required effort was in making the new plants operational and then optimising production. This required the specific knowledge that had been developed by the in-house technology services and was not available outside the corporation. Therefore, much of this expansion in the purchase of technology services went to expanding the in-house services.

With the collapse of the oil price once Sasol 2 and 3 were operational, corporate strategy in terms of research was threefold:

- diversify into higher value chemicals;
- optimise current production; and
- devise means to radically reduce cost of synfuel production

The broadening of the technology demand to include a range of other products meant that there needed to be some specialisation in what the in-house technology division was to produce. The choice of what to do in-house and what to outsource was based on a number of considerations.

- *F-T Processes* – this was the core of their business and they had accumulated considerable knowledge since production began in the mid 1950s. This had to remain in-house as they were the world leaders in this technology.
- *Coal gasification* – as with F-T processes, Sasol had accumulated a considerable amount of knowledge in this field which was unavailable elsewhere. It also formed part of the core processes of Sasol. However, Sasol does work in collaboration with Lurgi, the co-licenser, on this part of the process. Yet, in-house technology services concentrates much effort on understanding the coal properties in order to enhance yields and performance in the Sasol operations.
- *Value-added chemicals* – the choice of whether to license technology or not for the production of a higher-value chemical was determined in order to assess firstly whether there existed such technology and secondly, whether Sasol could produce the chemical profitably using licensed technology. In order to achieve the latter, Sasol needed a source of competitive advantage other than the process itself – such as a cheaper feedstock or unique end-product due to its unique feedstocks. In many cases, licensed technology has been used. However, the underlying process is catalysis which is a core competency in Sasol as it is a fundamental process to F-T. Therefore, there are synergies with F-T work allowing Sasol to remain specialised in more general catalysis and separations work that leads to new product development.
- *Planning for new product or venture development* – new product development usually takes the form of further beneficiation of feedstocks. As this requires an understanding of the unique feedstocks at Sasol, these processes tend to be developed in-house and are natural extensions of work already carried out to enhance performance of existing operations. Further, the in-house services have extensive pilot plants that mimic the synfuel production which can be used for testing of various techniques – an infrastructure unavailable to others.
- *Support for current operations* – one cannot ignore the cash cow and small incremental changes that improve performance which can be as important as the dramatic increases in productivity that radical changes in production methods brings about. Almost one-third of the efforts of the in-house technology services are devoted to enhancing the performance of existing operations.
- *Waste management* – there are natural synergies with existing work through the understanding of the feedstocks and processes that lead to waste production. However, it is a necessary evil and does not lead to creating a core competitive advantage. For this reason, the waste management technical services are largely provided externally but with some in-house involvement. Yet, product recovery from waste streams is a source of new product development so a core involvement in waste management and biotechnology remains.
- *Alternative technology exploratory work* – there is a need to explore alternative technologies to see if they will offer some competitive advantage to Sasol in the future. However, these are not core to the current performance and so tend to be purchased externally though in-house technology services keep up to date with developments.

Since Sasol went public, the in-house technical services have been organised as a separate operating division. One of the logical reasons for this organisation, is that in the beginning Sasol did not wholly own Sasol 3. Therefore, for accounting reasons, there was a need to separate those operations that serviced the

development of Sasol 3, like technical services. Further, there was a transfer of technology to other corporations including Mosses which was logically established in a separate division.

The purchasing of technology services within the group by the different business units is open to competition. The in-house technology services do play a central role in that it protects the intellectual property of the Group and the integrity of the technology used in the Group. Therefore, all purchasing of technology services tends to go through them, even if they are not used. The fact that expertise is often required to select a technology for purchase also means that the operating divisions tend to buy through the in-house technology services division.

The Group also makes available a budget for continued development and support activities. These activities relate to maintaining their core competencies in technology that is used in operations to enable continued support. These activities cannot be allocated to specific projects with the operating divisions and so are allocated through the Group budget as all benefit from the externalities created by this research.

Finally, buying research in SA is cheaper than buying research internationally because of the lower labour cost of research personnel. Estimates from the Sasol R&D department are that the costs are about one-third of the international prices. Even purchasing research from other developing countries is not as cheap because they tend to price international sales at the going international rate. Therefore, there is an incentive for the operating divisions to choose the in-house or local SA provider first. However, if the economies of scale are not there then the research will not be under-priced. It also needs to be sufficiently specialised to realise the benefits.

2.4 Performance of Technology Services

Technology services are one of the key core competencies and source of competitive advantage in Sasol. Sasol is different to other petrochemical companies in that it has no crude extraction rights and no distribution network. Therefore, while others gain a competitive advantage from exploration services or distribution channels, Sasol must compete through its processing, which is technology intensive.

Not only has technology services been the source of most of the productivity improvements in Sasol for the last 20 years, but it is also the source of Sasol's global expansion. Sasol does not have crude or gas resources globally and has only a fledgling exploration division that has only recently been established. In order to go global, Sasol has used its technology to gain a position in joint ventures around the development of gas fields.

The incentive to perform well has come from the fact that the Group has put large resources into the development of in-house technology as a means of becoming more competitive because other avenues were closed to it. It was also dealing with a unique technology, which was unavailable in the marketplace. Finally, it was penalised by the drop in crude prices when its product prices fell to reflect the lower input costs of other producers. Sasol did not experience that input decline so needed to improve efficiency to stay profitable. This incentive was strong even when hiring outside service providers, e.g. in mining.

The performance of the in-house technology services can be documented as a series of achievements in different parts of the production process. These are detailed in table 2.1.

Table 2.1: Major achievements by Sasol research division

Production process	Performance	Developer
Coal Extraction	Coal extraction at Sasol mines had cost increases below inflation rate every year for last 20 years. This has allowed the Sigma mine to be the lowest cost producer in SA.	Outside technology service providers
Coal Gasification	Development of Mark V Lurgi gasifier in 1980-85 which reduced capital and operating costs significantly.	Lurgi and Sastech
	Continued research on coal characteristics and operating stability to make incremental improvements in efficiency	Sastech
Fischer-Tropsch	Development of slurry phase distillate F-T reactor, commissioned in 1993 which allows longer runs and higher production rates lowering capital and operating costs. Also allows production of environmentally friendly diesel and unique waxes.	Sastech
	Development of cobalt-catalyst for slurry phase process which further increases online production times and allows a more compact design.	Sastech
	Development of Sasol Advanced Synthol F-T reactor, commissioned first in 1989 and a larger version in 1995 – lowering capital and operating costs significantly.	Sastech
	Development of iron catalyst for high temperature process	Sastech
Product Recovery	Development of a hexene-1 and pentene-1 separation and purification process	Sastech
	Development of a process to extract acetic acid and propionic acid from F-T reaction water	Sastech
	Development of a process to produce o-cresol 10	Sastech
	Development of a process to remove nitrogen bases from tar acids	Sastech

	Development of processes to produce high purity n-propanol, n-butanol and ethanol	Sastech
	Development of processes for anode, needle and electrode coke	Sastech
	Development of processes for fertiliser and explosives	Outside technology services

Source: Sasol Annual Reports 1980-1998

2.5 Broader Impact of Technology Services Tied to Sasol

Technology is a core competitive advantage for Sasol and so they have been reluctant to licence the technology to any other firms. However, they have concluded one licence agreement with Mosgas in South Africa and have interacted in a variety of ways with other firms through joint ventures and supplier creation.

2.5.1 Technical Consulting

As the only commercial synthetic fuel producer, Sasol has often been approached to consult on coal gasification or synthetic fuel projects around the world. This has generally occurred at times when the crude oil price escalates and there is heightened interest in finding alternatives. However, once the oil price falls, interest in these projects mostly disappears. This consulting has taken two forms; firstly as a licensor of technology and secondly as an expert called in to assist on experimental projects. The work has been organised under a division linked to research and engineering services called the Technology Transfer Division.

The consulting Sasol Technology Services, as licensor, has mostly been limited to the coal gasification process. Sasol initially licensed the process from a German company, Lurgi, yet has worked with the company in making such significant improvements on the process that it is now joint licensor. Most of the consulting occurred in the early 1980s after the 1979 oil shock. These included the following:

- Consultant and co-licensor for Sasol-Lurgi coal gasification in a North Dakota plant led by American Natural Resources from 1981 to 1984
- Consulting during tests to modify the Sasol-Lurgi gasifier to handle baking coal for American clients in 1981
- Feasibility studies for a possible coal gasification plant in the Netherlands in 1981
- Consultant to Phillips Coal for the production of gas from brown coal in 1982.

In the early 1980s, Sasol was involved in 60% of the \$100m put aside for synfuel projects by the US Energy department. However, interest in coal gasification waned as the oil price declined and most of Sasol's consulting came to an end in 1983. It has seemingly never generated much interest again because a glut of natural gas reserves was discovered making coal gasification a less economically attractive process.

Sasol has avoided licensing the core Fischer-Tropsch technologies as these form the basis for Sasol's competitiveness in synfuel and chemicals production. The only significant incident of licensing was to Mossgas in 1988. Mossgas was formed after the discovery of natural gas reserves off the coast of Mossel Bay. In the heart of the sanctions era, the government decided to go ahead with establishing an oil-from-gas operation to deepen the local supply of oil in case of an oil embargo. In 1987, Mossgas undertook some tests of various possible gas-to-oil technologies and made the decision to go ahead with the Sasol processes. An

agreement was reached with Sasol and work on the project began in 1988. Consulting on the Mosgas project was extensive and lasted a number of years. It included plant design, technology transfer, personnel training and plant commissioning. However, engineering services played a greater role than research in this process.

A final area of technical consulting by Sasol Technology Services is in coal beneficiation. Sasol has not been involved in mining technology but has taken great interest in coal properties as it affects their gasification process. This intimate knowledge of coal properties in SA has put them in a position to consult other major coal users in altering coal or equipment properties to achieve certain improvements in equipment performance. In particular, Sasol has consulted with Eskom locally, other local mining houses wishing to beneficiate fine coal, and a number of firms internationally wishing to undertake coal gasification with different coal types.

2.5.2 Joint Ventures

More recently, Sasol has not undertaken consulting work but rather has used its technology as a leverage to enter joint ventures (JVs). Sasol has technology to make useful applications with natural gas which is currently in abundance with few useful applications beyond liquid natural gas (LNG). Sasol does not have gas or crude fields but does have the technology. In these cases, there is limited transfer of technology to the plant established but no license to produce beyond the JV.

There are also a number of research JVs which aim to jointly produce a new application or technology based on differing competencies that firms bring to the table. For instance, Sasol is involved with Statoil of Norway in producing an offshore production facility for synfuel or diesel production using F-T processes. Statoil brings the offshore production expertise, Sasol the F-T expertise. Sasol is also involved with six other firms in an alliance to research oxygen transmission membrane technology. This is collaboration amongst the research departments - each bringing unique knowledge to the table.

2.5.3 Supplier Creation and Spillover

Sasol has been involved with providing support for the universities in South Africa for some time. The primary goal of this exercise is mostly to keep a steady flow of highly skilled and specialised labour to Sasol. From the launch of Sasol 2 and 3, the company has faced the problem of insufficient supply of local skills and so has had a human resource development programme in place ever since.

The program has extended beyond mere bursaries for students, and has included support for research institutes in fields of interest to Sasol - including catalysis research and biotechnology. The advantage to Sasol is that these research departments are a means of providing highly specialised skills to postgraduate students who are sponsored by Sasol at a very low price. Also some fundamental research is undertaken at a very low cost, which allows Sasol to keep in touch with international developments even if it is not contributing directly to Sasol's profitability.

Sasol, along with other industries, provides strong support for the catalysis unit at UCT and the establishment of a biotechnology laboratory at Bloemfontein University. Sasol also has limited involvements with WITS University, PE Technikon, University of Natal, University of PE and Stellenbosch University.

Collaborative work is conducted with the Materials Technology division (Matek) of the CSIR, although this is ad hoc and usually small.

Sasol does not support any private research institutions in South Africa. They feel that the chemicals industry in SA is too small to support a research institution. Even the university units use a wide variety of funding sources and cannot make do on the work of one or two firms alone. As a result, Sasol makes use of numerous firms and universities internationally which are linked to the international petrochemical businesses. Some relationships are established through the purchase of technology for the purpose of production, while others are more exploratory research that Sasol has an interest in. In all, Sastech estimates that it works with 50 different institutions. These are most often near centres for the petrochemical sector, such as the countries involved in the North Sea crude extraction and the USA. In recent years, Sasol has forged good links with Dutch universities.

2.5.4 Internalisation of Externalities

Many of the spin-offs from Sasol technological services demand and development have in fact been internalised through expansion of operations globally and through the extension of new products to the Group. This is partly because they are unique as synfuel producers, but also because they see technology as a core competency and so want to keep it close to their chest. The addition of products and global expansion have been discussed in section 1.1, under the history of the Sasol Group.

2.6 Impact of Liberalisation in early 1990s

It appears that Sasol has been dealing with a relatively liberal regime of technology service trade since the beginning. The recognition of the importance of technology service imports for sustainment of such a programme by the government meant that such technology imports were rarely subject to trade blocking. In fact, Sastech feels that the opening up of South Africa and the trade liberalisation of goods that followed in 1994 has had little effect on them. The only area where they feel a difference is in the ability to import services from foreign universities which, prior to 1990, was not easy in light of the sanctions against South Africa (unlike foreign businesses which were more open to breaking sanctions).

What seems to have driven the extent of trade in services instead has been Sasol's own demand for such services. Rapid product diversification in the late 1980s saw an expansion and diversification of research demand, which could not be satisfied entirely in-house, or through limited local capacity and so Sasol had to go international. It has however, suffered some difficulty recently with a determination by the DTI to monitor and approve technology purchases internationally. This represents a form of trade intervention and has raised some of the transactions costs for Sasol but with no major detrimental effects so far.

3. ENGINEERING SERVICES

3.1 Role in the Production Process⁶

3.1.1 Role in Production

Engineering services play an important part in the production process through their involvement in all capital projects. The principal roles are:

- design and construct the new plants for production;
- upgrade existing plants to improve performance; and
- maintain existing plants to prevent deterioration.

Considering the size of capital investment in the petrochemicals industry, these functions have a significant impact on the profitability of operations by impacting on the following:

- the start-up capital costs - influenced by design and project management;
- the variable capital maintenance costs - influenced by design and maintenance plan; and
- the operating costs - influenced by the suitability of the design.

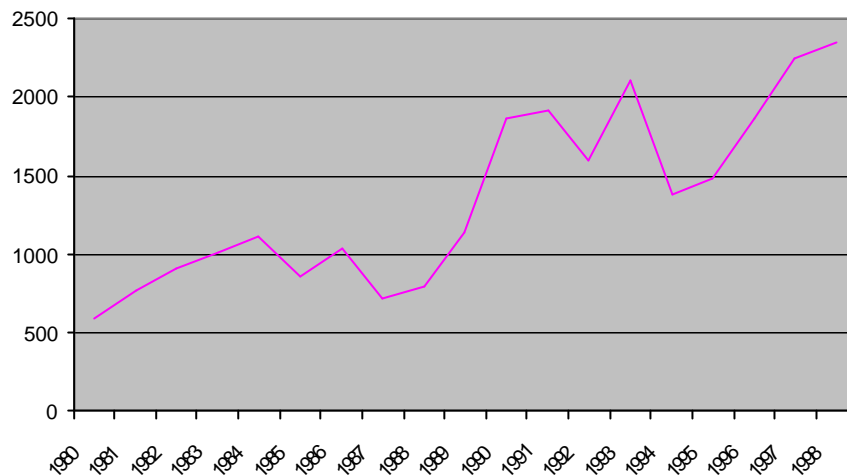
3.1.2 Levels of Demand in Sasol

The level of demand for engineering services is linked to the capital investment programme of a firm and is therefore often subject to dramatic fluctuation. We can trace two periods in Sasol's history of the last 20 years where demand has peaked at dramatically high levels. This is the building of Sasol 2 and 3, and the more recent capital expansion phase designed to diversify production and install new synfuel reactors.

The design and construction of Sasol 2 and 3 was a R34 billion project (1998 rands) spread over 6 years, or roughly R5.5 billion per annum. The recent capital investment programme is slightly smaller at around R3 billion per annum for 6 years until the year 2000. In the intervening years there was some new capital projects but most of it was spent upgrading existing facilities to enhance performance. This is clearly visible in figure 3.1, where there is a varying, but steady level of capital investment for the 1980s, which changes sharply with the new strategy in the early 1990s.

However, it is also important to note that the variety of demand placed on engineering services also changed dramatically in the 1990s as a broad range of new products using new processes were brought online. This placed demand on a variety of specialist skills.

⁶ The primary information sources for this chapter come from Sastech management, Sastech publicity material and Sasol Annual Reports

Figure 3.1: Annual Real fixed investment by Sasol 1980-1998 (1995 rands)

Source: Sasol Annual Reports 1980-1998

3.2 The Engineering Services Market

We can simplify the engineering market to see it as consisting of a number of processes involved in the design and construction of a capital project – however big or small. The first part of the process can be termed the conceptual design phase. This includes the following components:

- Idea generation and development,
- Pre-feasibility study,
- Feasibility study, and
- Basic engineering phase.

Once these have been completed, one has the scope for the project with all dimensions of conceptual design complete. In terms of an analogy to building a house, at this point one knows what the house should look like including the number of rooms, size of rooms, shape and layout on plot. What is left is for someone to put together the detailed construction plans and then manage the building of the house. This next phase is exactly that and includes the following components:

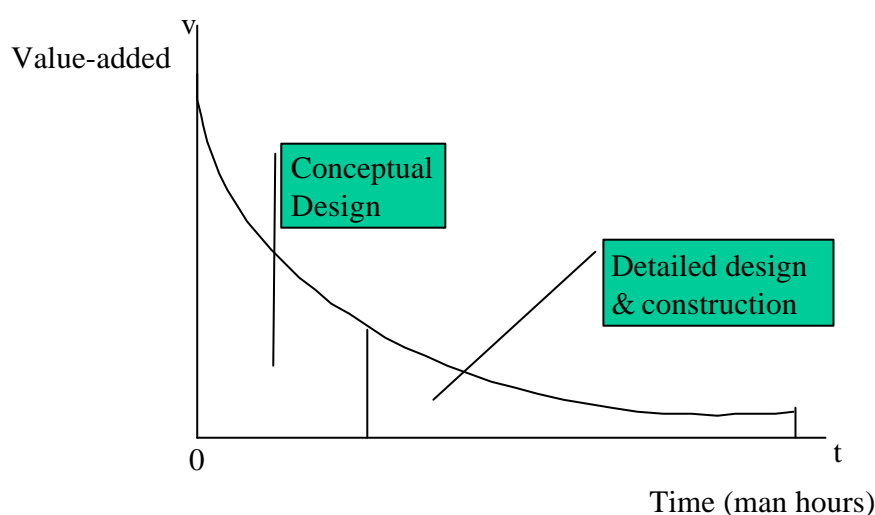
- Detailed engineering,
- Construction, and
- Commissioning (moving to full operation).

There are a number of differences between these two broad phases of the engineering process. One useful means of summarising a number of these differences is presented in a time/value-added graph as presented in figure 3.2. The figure shows that the conceptual design phase is short on time (or man-hours) but high in value-added for the firm. In contrast, the detailed design and construction phase is lengthy in time but low on value-added.

The reason that the conceptual design phase is high on value-added, is that most of the significant cost reductions and performance improvements resulting from engineering services will stem from a good design. It is in this component that the majority of the intellectual input occurs to improve design. The conceptual design phase is also the stage where the most asset-specific knowledge is required. Processes must be designed to be efficient under the conditions present at the firm itself – including the nature of the feedstock, operating temperatures, catalyst type, etc. In addition, sometimes a unique process is being developed based on specifications from R&D, which requires innovative thought based on experience and firm knowledge.

In contrast, the detailed design and construction phase requires far less innovative intellectual work. The design has been defined and it is now a process of translating that into detailed plans and constructing to specifications. This requires skills, but not innovation. For instance, the layout of a chemical plant has numerous conventions for the purposes of safety which need to be understood and applied. This stage is also more management-intensive than conceptual design. There are far more man-hours involved and co-ordination of both a workforce and materials in order to complete construction on time and within budget.

Figure 3.2: Value-added by Engineering Phase



3.3 Organisation of Engineering Services

The nature of engineering services is that its demand by any one firm is often subject to large fluctuations as capital investments are often bulky and not even over time. For this reason alone, it is unusual for a firm to undertake all its engineering needs, as it will find it difficult to fluctuate its own labour resources in line with the engineering work. Contractors are able to get a more even spread of work by spreading over a number of firms whose demand is not synchronous. Therefore, from the beginning Sasol was forced to make use of outside contracting as a means of delivery. The decision on what to outsource and what to retain in-

house, then hinged on the amount of fluctuation, the extent of asset specificity, the returns to specialisation, and the available market for engineering services in SA.

When Sasol started up in the 1950s, the amount of engineering hours required to build Sasol was too large to do in-house. Further, there were no South African companies capable of performing either the conceptual design, detailed design or construction phases for a such a complex chemical facility. However, there were international engineering companies operating in SA which were capable of undertaking the detailed design and construction phases. Therefore, Sastech was formed to undertake the conceptual design (unique as it was a commercial synfuel plant) with assistance from the technology licensors. The existence of engineering manpower inside Sasol meant that occasionally they also undertook the process of detailed design and construction for a number of smaller projects to even out demand for in-house services.

When the decision came to build Sasol 2 and 3, again the scale of the project forced the Sasol Group to look outside the corporation. An American engineering firm - the Fluor Corporation - was the principal contractor used but local firms were drawn into the project in order to create some domestic capacity. Although the Fluor corporation was an international engineering firm, it has offices in South Africa employing local engineers in order to undertake this project.

However, the company policy was that the operating divisions could buy from Sastech or from the open market. The advantage of buying from Sastech was the intimate knowledge of the Sasol production processes that it gained over time. This enabled them to add more value by designing processes that were more efficient because they were more suited to the Sasol conditions. A second advantage is that the cost of purchase from a SA firm is lower than an international one for large projects. However, some of the other engineering firms operating in SA, including international firms such as Fluor, Krupp and Parsons, established long-term relationships with Sasol through repeatedly doing work for Sasol. This enabled them to build-up their own intimate knowledge of the Sasol processes and add more value.

However, there were a couple of operating divisions where Sastech knowledge was not a specific advantage and in fact outside contractors in SA were more specialised and knowledgeable. In particular:

- Sasol Mining Division – SA has a long history of underground mining of coal and gold which meant that at the time that Sasol coal mines were being developed, there was already a large technologically advanced mining engineering services sector in SA. It was more prudent to make use of this expertise than make out with a second best in-house solution.
- Natref Refinery – the Natref refinery was established in partnership with Total and so a lot of the technology and engineering came straight from American and French partners.
- Oil and Gas exploration – a recent addition to Sasol and one in which they have no prior experience. In this case, they immediately made use of international engineering firms who had already gained the knowledge and experience.

In the early 1990s Sastech, along with the entire Sasol, underwent a process of self-examination to look at how to improve efficiency and outsource what it could. It was decided that Sastech was world-class in providing conceptual design phase engineering services but was poor at doing the little bits of detailed design and construction that it was involved in. The latter also took up considerable management resources due to the large amount of man-hours involved and so reduced the overall efficiency of the unit. At this point it was decided to cut loose all operations beyond conceptual design and specialise in this component. Sasol helped create 8 new companies from the 200 employees involved in these stages of production. They were given Sasol work to help them get established, but were required to diversify their customer base to survive. They have done so and survived.

Currently, Sastech employs around 500 engineers and handles about 90% of Sasol capital project work in the conceptual design phase only. In terms of the operating divisions, they handle 100% of SSF work, 95% of SCI work, most of the major capital projects for Natref refinery now, none of Sasol Mining, and are beginning to provide some of the services for Sasol exploration work. The shift to using Sastech by Natref and exploration in an open market demonstrates their competitiveness in the SA and international market.

Sasol has taken an interesting approach to the process of outsourcing engineering services. Sasol has decided to develop and maintain a long-term relationship with a number of locally based engineering service providers over the years. These relationships are not formal agreements, but rather an informal policy of Sasol to nurture and maintain suppliers geographically close to the Group's operations. There are a number of logical reasons for this approach:

- Sasol recognises that South Africa is geographically far from the centre of the petrochemicals industry and that there exist time delays in communicating over this distance. This is no longer a major factor, but was historically when Sasol started up in the 1950s.
- There is a small petrochemicals industry in the Southern African region which limits the number of regional engineering firms that have the necessary experience to work on chemical plants. It is important that these firms retain their expertise.
- The dependence on foreign providers exposes Sasol to foreign exchange risk and usually higher costs due to higher foreign wages. The assumption here is that only engineering firms in more developed countries can provide the level of service Sasol requires.
- There are significant returns to having your suppliers knowledgeable of the Sasol processes and value-chain. This enables them to produce more efficient and innovative designs that add value.
- There will be a continual flow of business which lowers the return to a strategy that concentrates on lowering the cost of one project only. This may occur when another country is in recession and their engineering services are then under-priced to pick up work.

Sasol has adopted a number of means of developing this relationship. These include:

- *Providing experience* – Sasol has occasionally bought in inexperienced SA firms onto non-critical projects in order to provide them with experience. In these cases, the firm works with a team from the operating division and Sastech in order to transfer knowledge to the service provider.
- *Paying for training* – sometimes Sasol has contributed to the skills development in a service provider in order that they are able to service Sasol from then on. This is often the case when Sasol is unable to even find the service internationally and so adopts a "local and closer is better" attitude. If Sasol feels that the service firm is likely to make large gains from the knowledge, then they do not pay. A particular case where this was necessary was in the construction of Sasol 2 and 3 where the mere scale of the project meant that tens of thousands of new workers needed to be trained. This was predominately paid for by Sasol as the engineering firms would not necessarily gain any future return on such an investment.
- *Providing recession work* – Sasol has occasionally kept some service providers afloat during lengthy recessions by offering them preference in contract tendering. This has meant that Sasol retained the skills of firms intimate with Sasol in the country and available for future work.

In each case, Sasol had no guarantees that these firms would reinforce this competitive knowledge and grow further, or that they would not take their knowledge overseas, as some have. There are also no guarantees for the firms that Sasol will continue to use them unless they perform to a satisfactory level.

However, Sasol is now in a position in the 1990s where it has sufficient skilled engineering firms around it to undertake the huge capital investment programme.

3.4 Performance of Engineering Services

The engineering division of Sastech decided to benchmark itself against other firms in the international oil and petrochemical industry in the mid-1990s. The benchmarking exercise was done by outside consultants and included the top 11 oil companies and 70 top chemical companies. Sasol ranked highest in terms of application of value-improving practices, new technology and innovative practices. For a few other parameters, Sasol ranked in the top 5, and in many others Sasol was in the top 20. Sasol met industry averages in the important measures of project cost, schedule and start-up time.

This performance allows Sasol to lower the capital cost of new projects and bring them into profitable production sooner. Both of these have an important impact on the profitability of new ventures for Sasol.

3.5 Broader Impact of Engineering Services Tied to Sasol

The level of demand placed on the engineering services by Sasol and the extent of outsourcing they have done, means that they have had a significant impact on the broader engineering services firms and the customers of these firms. It has already been mentioned that Sasol has purposefully developed skills in chemical plant engineering amongst a few South African based firms. These firms have in turn offered such services to the rest of the SA chemical industry, albeit a small one. This includes the Moss gas complex, the oil companies (BP, Engen, Caltex, Shell) and the few chemical product companies (AECI and Sentrachem).

3.6 Impact of Liberalisation in early 1990s

Sasol had always made use of a number of international engineering firms in its operations. In fact, when Sasol was established in the 1950s, it was foreign engineering firms that did much of the initial engineering work. More recently, it was the American Fluor Corporation that had the project management contract for Sasol 2 and 3. Other important foreign engineering firms were Krupp, Foster Wheeler and Parsons. These companies had always had a SA base as they were extensively involved with Sasol on a continuous basis. In fact, Fluor has a group in the company of 100 engineers who are dedicated purely to Sasol work.

It is important to remember that a number of factors tend to limit cross-border importation of engineering services, even in the event of free trade. First, labour costs are cheaper in developing countries and so the price of services provided locally, or provided by FDI using local engineers, is going to be preferred to foreign providers if they can match quality. Second, the search costs are high for finding an international alternative and so there tends to be a momentum in using local providers who are sufficiently qualified. Third, often the local market is too small to justify an international company setting up a SA office and so they cannot lower the service price by establishing a SA office. Fourth, SA is geographically located far from the major petrochemical producing areas which makes ad hoc cross-border business travel and support much more difficult. Therefore, there is a tendency to stick with the firm that can support you locally. Finally, sustained use of foreign providers opens the firm to exchange rate risk by committing to long-term involvement with a foreign supplier and not building up local alternatives.

These limitations on the desire to trade cross-border meant that the opening up of the economy did not have an enormous impact on Sasol's imports of services. More importantly, it seems that the impact of liberalisation was more to tempt some of the contractors into having a permanent SA office. This was hindered in the past through sanctions. This affected a company through a public relations issue of having an office in SA. But maybe more importantly, it prevented companies using SA as a springboard into the broader region, which maybe offered the scale economies to justify an office in the region. Some companies came in, but many ended up closing the SA office as too little work prevented them from being sustainable.

Where Sasol feels that there has been more activity since the opening up of the SA economy, is in the export of South African engineering services abroad. The problem for the local firm is that the local chemicals market is limited, thus in order to grow substantially, they needed to establish branches or look for work internationally. This has happened probably more than foreign entry into the local market. They were able to make that leap due to the competitive knowledge they established while working for a number of international companies and Sasol in SA. Sasol feels that many of the local firms are internationally competitive and so can enter the international market. The problem they face is to be spotted and trusted, so involvement with a more internationally recognised company like Sasol helps. However, the big international engineering firms like Fluor, Linde and Lurgi employ up to 4000 engineers and so it is difficult to compete with them.

4. INFORMATION SERVICES

Information services can be roughly defined as the provision of information that is useful in the operation of a business. Improvements in information services should lead to an improved operation of the business as better or more timely information leads to better business decisions. In the last 20 years or so, the automation of information services through information technology (IT) has meant that the term 'information services' has become analogous to 'information technology services'. The latter is, however, only a subset of information services as it concentrates only on the application of IT to automate and improve the flow and analysis of information to the business. However, it may not be responsible for generating much of the content, which may lie in the hands of other organisations or processes. For instance, an independent analyst will provide market intelligence information and IT may be used to improve the speed to which it is made available to business and integrated in their decision models. For the purposes of this paper, we are going to take the narrow definition of information technology services. This means we are going to concentrate on improvements in information services due to improvements in information technology systems and not content providers⁷.

4.1 Role and Demand in the Sasol Production Process

4.1.1 Role in Production

Information services have a role in all parts of the production process from coal mining to product recovery, from administration to research. Each part of the production process uses information to make decision and this information can be automated and improved using information technology. It is a generic technology that is molded to a specific need. An aggregate list of the possible uses of IT is as follows:

- *Administrative services* – payroll, human resources, financial bookkeeping
- *Production* – process control (continuous collection of data concerning an active process) to control and adjust an active process, analysis of past process data for purpose of improving process efficiency, production planning and scheduling, customer ordering and service, inventory control and distribution.
- *Research* – collection and storage of data on variables of interest for research, analysis of such data, process modeling in order to undergo simulated tests.
- *Engineering* – process modeling and design, cost analysis and project management
- *Strategic Management* – market intelligence, forecasting, business modeling for strategic decision-making and communication

The application of IT to these processes affects their performance in a number of ways:

⁷ This chapter is based extensively on interviews with Sasol GID management and Sasol Annual Reports.

- *Productivity improvements in production of information services themselves* – the automation of the collection, processing and transmission of information improves the productivity of labour associated with these processes. For instance, a financial system may replace many bookkeepers.
- *Productivity or quality improvements in the users of information* – the increased speed of information collection and processing has meant that relevant information is available more timely to affect decisions and that more information is collected that can improve decisions. It also allows greater precision in the information services provided, enabling better decisions. These improvements in information processing can lead to improvements in either the quality or productivity of final users.

4.1.2 Levels of Demand in Sasol

Although the potential role of information services in production is defined by the processes undertaken, the level, quality and range of demands for information services of the Sasol Group have altered over time.

During the eighties, Sasol was a relatively undiversified, though vertically integrated, company. At the same time, the information technology industry was less sophisticated. The result was that the demands placed on information services were relatively small and standard. There was a concentration on automation of individual processes at a pace that reflected a range of priorities and cost/benefit analysis.

Diversification into a range of higher chemicals in the early 1990s brought about a number of changes in the demands for information services. There has been an increase in the level of demand. The addition of new plants and turnaround of existing plants to new products was rapid and raised the overall demand for information services in the group. In addition, the new products were aimed at the export market and so information services for international marketing and distribution had to be established. These changes also brought about an increase in the variety of information system services demanded. For instance, there was a need for international communication of information within the Sasol Group and with international customers and suppliers. This has placed a need for IT systems to enhance collaboration through quick and easy transfer of information and documents.

The mid-1990s saw yet another change in the information service needs of the Sasol Group. The diversification that had been occurring was in developing high value chemicals from existing feedstocks emerging from the Natref refinery and the Synfuels plant. This means that the processes are highly integrated with chemicals emerging from one process being fed directly into another owned by another division. Therefore, once the new plants were established and their information needs catered to, there was a growing need to integrate them in an overall production planning and scheduling system for the Sasol Group. Integration offers many potential gains for the Group. In the event of the prices of various end-products changing, Sasol can divert feedstock from one product to another in order to increase overall profitability.

The internationalisation of Sasol through diversification also brought on increased competitive pressure. This has led to a shift in thinking in Sasol from seeing IT as being an enabler of business to one of IT being a competitive tool that can offer the Group a number of advantages. This change in thinking has meant that they place more stringent cost and performance requirements on IT when applied to processes that are seen to be critical for cutting costs.

The final source of increased levels and variety of demand has come from changes in the technology itself. Improvements in IT products have opened up opportunities for new application areas and vast improvements in old systems to offer new improvements in productivity. The most obvious change has been the emergence of the Internet. This has enabled dramatic changes in the way business is done. Changes have led to a new demand to alter existing business and information models.

4.2 The Information Services Market

If we take the information technology perspective of information services, then the production of information services can be cut in two different ways. In terms of the type of service provided, one can split IT services into new systems development and systems maintenance. For new systems development there are a number of distinct phases that one goes through that can be seen as the service provision process. These are:

- *Identification of business need* - this is a function of defining information needs within the business
- *conceptual design* - this has an information and technical component. The technical component will include identifying technical requirements, identifying technological options and defining a broad design. The information side requires defining in more detail the requirements for the system including performance requirements.
- *detailed design* - a more detailed analysis of system requirements from an information side, a technical side and an integration side.
- *development* - this may include custom software development or finding and customising of existing software packages. It would also include setting up the technical architecture.
- *implementation* - final component of testing and installing the system to make it operational.

On the maintenance side, there is technical maintenance and software maintenance. There is a need to ensure that PCs are operational, they are installed properly, the network is operational, software glitches are debugged, etc. This is an ongoing process. Maintenance also includes incremental improvements in the system due to small changes in demand from the business users and technological/software opportunities for improved functionality or performance in the system itself.

The second way to cut information services is by the inputs into production – namely technical design function and business design function. Each system has a business purpose and incorporates business processes and rules of operation. These need to be defined and form the basis of the system. However, this functionality operates on a specific technical platform that must be designed. Technical design must achieve the maximum cost efficiency while taking account of other requirements such as common standards, ability to interact with other systems, flexibility, etc. The input to the business process definition is an understanding of the firm's requirements, while the input into the technical design is the array of technical options available in the marketplace.

We are able to define different characteristics for different outputs (new systems vs. maintenance) and to different inputs (technical vs. business). Our concern is the scale economies, asset specificity of knowledge, economies of scope, gains from specialisation, factor intensity and rate of technical change. These factors will determine how the market for these services develops and which organisational form dominates.

In terms of the technical design aspects of information services, probably the most important characteristics are:

- *knowledge-intensive* – information technology services are very knowledge-intensive, especially the early design phases for new system development. Once design has been finalised, the knowledge input is lowered for the more mechanical tasks of programming and testing. The more complex the system, the more knowledge-intensive each phase of development becomes.
- *high degree of tacit knowledge* – much learning is done through experience. Experience is carried from one project to another as similar technical and design problems will re-occur. This creates externalities in

production as learning in one project leads to improved performance and greater productivity in the next.

- *rapid technological change* – rapid changes in technology mean that there needs to be significant investments in human capital to enable them to understand and design for new technology. The rate of technological change has increased during the 1990s relative to the 1980s. The rapid technological pace means that there is a high cost associated with stagnation in learning. If a service provider falls behind with the rate of change, their product is likely to offer less benefits than those that have remained apace.
- *returns to specialisation* – the knowledge-intensity, rapid pace of technological change and the high degree of tacit knowledge mean that there are high returns to specialisation in aspects of the technology (returns refer to improvements in quality and productivity of service provider). As the investments in learning are so great, these often outweigh the investments in firm-specific knowledge (asset specificity) and so will affect organisational form. What matters for returns to specialisation is the size of the overall market for information services.
- *low asset specificity* – there is some learning of specific technical architecture used in a firm but investments in this knowledge are minimal in comparison to investments required in technical knowledge.
- *low economies of scale* – with the provision of information services, one is able to separate the service from the provision of hardware. For the service, therefore, the only significant investments are in human capital. However, because the human capital is flexible between different projects, there are few economies of scale in production of the service. It should be stressed that although there are returns to a larger market through increasing specialisation, this is however different to economies of scale. The latter assumes scale in one organisation is important while the former focuses on scale in the overall market. They only become comparable if the firm organises a service internally and so the internal market is in effect the overall size of the market from the perspective of the firm's users.
- *labour turnover* – as a service with few capital expenditures, the investment is in human capital. Some of this human capital exists in the organisation but most exists in individuals. This means that through hiring personnel, a service provider is easily and quickly able to acquire expertise so the learning period for a single organisation may be small. However, the organisation is also vulnerable to labour turnover which can deplete its knowledge-base.

The business design function component has some similarities to the technical design component. It too is knowledge intensive and much of the knowledge is gained through experience. However, the pace of change in business models is less rapid and requires lower investments in learning. This means that there is not such a high cost to remaining behind developments. The asset specificity is much higher in the case of business design function and so it is common that members of the firm are involved in defining these even when outsourcing is the chosen organisation.

Within this generalised model, there are also crucial differences in the characteristics of production of new systems vs. maintenance work. Maintenance services are concerned with maintaining existing systems on established technology. It is these features which make it behave in a slightly different manner to new systems development. In particular, there is a higher degree of asset specificity in maintenance work even on the technical side as in-depth knowledge of systems is required. The stable environment means that there are lower costs to a stagnation in learning. Maintenance is concerned with gradual tacit learning of a system and because the technology remains stagnant, the productivity and quality costs of the service provider will not deteriorate significantly if much learning does not take place. However, it should be remembered that systems remain in place for only a limited period before being changed through either an upgrade in

technology or a revamp of the system. Therefore, although learning can stagnate for a period, it will need to be updated periodically. Further, personnel may be rotated from maintenance to new systems development for their asset specific knowledge so there may be a requirement for upgrading knowledge periodically.

4.3 Organisation of Information Services

The organisation of information service provision in the Sasol Group has undergone numerous changes in the last 20 years in response to changing needs and a changing service market in SA in general. To summarise, there have been essentially four phases of organisational changes with respect to information technology services provision to the Sasol Group. These are:

1. Single group service provider (until late 1980s)
2. Business Unit service providers (early 1990s)
3. Resurgence of group provider in decentralised model (late 1990s)
4. Introduction of substantial Outsourcing (future)

These organisational changes to IT services are common in most organisations. What follows is a discussion of the rationale for each organisational form and the reasons for transforming it to another organisational form.

4.3.1 *The Rationale for a Single Group Service Provider*

In the eighties, information technology services were delivered in-house by a single department located at a Group level. It was called GID, standing for Group Information Development. This department, like personnel or marketing, provided services to the group as a whole – from systems development to maintenance. This form of organisation was common in most corporations at the time.

The form of organisation was a response to the environment at the time. In terms of the technology, there was not the rapid change in technology that has occurred in the 1990s with the advent of the graphical user interface (GUI) and extensive data communication. Not only was the technology changing less rapidly, but the demands on systems development were lower. Systems were built usually as stand-alone and only certain key parts of the production were automated. They were usually of a standard batch type running off a mainframe. Information systems were not considered as competitive tools, but rather as automation of certain tasks for improvements in productivity and precision. Under this reasoning, systems were also built to last for a long period and so system maintenance became a large portion of the work.

The operating environment in Sasol reinforced this low and stable demand for information systems. Sasol remained largely undiversified in the 1980s with the exception of the foray into the fertiliser and explosives business. This meant that there was little additional demand for new systems from new business applications.

The result for information systems providers was that investments in firm-specific knowledge were greater than the investments in technical knowledge. They also faced a more stable environment, which meant that the costs of slow response to changing technology or business needs would not result in significantly lower levels of performance. Therefore, the corporate service provider was a common model and one that Sasol itself followed.

If Sasol chose not to follow this approach, its options in the local market were relatively limited. The South African IT developers market was relatively small and the largest independent developer was no bigger than the in-house department at Sasol. Independent service providers also did not undertake maintenance work as the demand from corporations was not there. In effect, the internal organisation approach adopted by corporations limited the independent market and so limited the entrants and their range of services.

4.3.2 *Transition from Single Group to Business Unit Providers*

In the early 1990s, the Sasol Group underwent rapid diversification as new high-value chemicals were brought on-stream. In terms of group organisation, each of these new products was the responsibility of a separate business unit. These business units were autonomous and had to be profitable in their own right. The business model at the time stressed decentralisation and cost centres.

At the same time, there was a change in the role of information systems in businesses. The advent of the PC in the eighties meant that by the early 1990s there was a growing demand for management information systems which were smaller, more flexible and drew on databases generated by the larger production-based batch programmes. There was also a move to real-time processing as the power of smaller machines rapidly increased and long batch runs on the mainframe were needed less and less.

The effect of both of these trends was to boost demand for information systems. More business units meant more separate systems and the spread from the IT department to the desks of managers and

production supervisors meant more systems in all environments – new and old. The effect on information services was that the central organisation model began to break up and the individual components began to follow their business units. GID started to split up as mining wanted its own IT department, Sasol Oil wanted its own IT dept, etc. The rise in demand for management systems also meant that there was sufficient internal demand in each business unit to support a small IT department. The diversification also meant that the synergies at the group level became weaker, making it less obvious that a centralised approach was optimal. Individual business unit departments would be more responsive (in terms of design and timing) to the needs of their respective business units.

What did not change was that almost all information services were provided in-house – the individual units became more responsive to business unit needs but they remained internal monopolies. The market for independent service providers had grown in South Africa as the pressure for more new systems development occurred across corporate SA. However, individual providers were still of a small size and generally no bigger than the combined IT department of a large corporation such as Sasol.

4.3.3 Transition to Group Technical Co-ordination

By the mid 1990s, there was a change in thinking in Sasol as to the role of the Group relative to the business units that had a particular impact on information services. It was felt that in the move to autonomous business units, a number of large synergies within the Group were being ignored and opportunities lost. In particular, the following were considered important:

Common branding - with Sasol starting to globalise through its chemicals products and technology by seeking markets and partners, there was a need to provide a united front. They found that they needed to brand their name and have each business unit show itself as part of the group because most potential buyers or partners preferred working with a large company.

Shared services - in moving to international markets, there were many services that the business units could share and these synergies meant it was costly for each to provide their own. Strong examples were sales/marketing and distribution.

Integration of physical processes - the processes of the business units were closely inter-linked with each other as different products shared common feedstocks or outputs from one unit fed directly into another. This meant that information sharing amongst business units was critical to the performance of each. In addition, there were Group-wide opportunities offered by the integration of processes. The Group was able to maximise profits by adjusting the common flow of feedstocks to the products that offered the best return at any point in time.

Integration of information systems to more effectively share information is predominately a technical function whereby data must be in a form that can be shared and systems must be in a language that can talk to other systems. Recognising this, the demands for exploiting greater synergies at the Group level resulted in a reorganisation of the IT services that sought to keep business units in charge of establishing information requirements and business functions while GID was to keep all control over the technical supply of solutions.

The feeling was that technical services had low asset specificity which was present at the Group and not at the business unit level. As such, it could always be separated from the business unit – effectively this meant outsourcing even though it was to another internal service provider in the group. However, the leveraging of information for business purposes had to remain in the business units which require the information. What they also wanted to avoid was that the technical limitations of each business unit would dominate information systems development work and result in inferior systems. The lower technical

expertise results from an inability to develop specialist skills and keep up with technical developments due to its small size. In this model, business units concentrate on the management of information as a strategic asset that could be leveraged for competitive means. All 16 business units subsequently established an information manager for this role.

However, in order for the information managers to be thinking about possibilities for group synergies in satisfying business requirements too, each were given a certain function line in group responsibilities. These did relate to IT such as networking, security, communications, etc. nor to direct business issues. However, their purpose was to vocalise demands from the business units and not the provision of the service.

The logic behind centralising technical supply within the group was that a) integrating of different business unit systems along the process flow was made easier, b) learning effects were concentrated and applied to new demands from other business units, and c) they were better able to isolate group problems and optimise to overcome them.

Supply of information solutions was moved to a central service provider in the group. However, the intent was that they would operate like an independent provider and so be more accountable to the business units. Establishing this type of arms-length relationship creates a pseudo-market for information services. This very quickly resulted in a tension in the Group as separation led to a natural comparison of how the group provider performed relative to independent providers. The next logical step in this process was therefore seen to be a move to outsourcing.

4.3.4 Transition to Outsourcing

The momentum now in the Sasol Group is to move to the outsourcing of information services – from new systems development to systems maintenance. This move is the result of a number of internal and external forces.

The main internal force is the rapid growth in internal demand for a growing variety of information systems. This is due to three forces:

Diversification and globalisation - rapid diversification that started in the early 1990s and continues to date has started to filter through to information services demand more rapidly. This is combined with the demands of establishing global operations and competing on a global stage. The latter has placed a greater strain on the performance of individual units within the group including the contribution of information systems;

Technological change – the combination of information and communication technologies has brought about an era of both rapid technical change and also dramatic changes to how the role of information technologies in the business is viewed. Information systems are no longer an internal affair but are key to relating to suppliers and customers alike. Information systems have taken centre-stage in many businesses and are seen to offer potential competitive advantages to a firm.

These two forces have effectively resulted in a leap in demand for new information systems and in the quality and value-adding performance of information systems. There is also a growing pressure on information providers to keep pace of technical changes and deliver on higher quality demands. In the case of Sasol, this has placed enormous strains on the resources in GID and questions of whether an internal monopoly will provide the best services at a time of enormous change. It seems that the concern is not so much over service cost (on which GID has performed well) but the ability to respond quickly to demands and deliver a quality product. There currently exists substantially pent-up demands.

At the same time, there have been changes in the market for independent service providers in South Africa that made the move to outsourcing more attractive. The opening of the local economy to international competition and political favour has seen a number of foreign service providers establish themselves in the market. This broadened the market and forced local providers to respond to the growing competition. The response has been a period of consolidation of local firms into fewer, larger companies that are able to offer complete solutions to large corporate clients. They have also become more competitive in the scramble for market share (Hodge and Miller 1997). This improvement in quality and variety has allowed for more outsourcing to occur.

The imminent move to outsourcing would not see all components of the information service product being delivered by independent producers. The identification of business needs will remain within the business units. The feeling is that conceptual design will also remain in the group, and will be performed by GID. This component of the process contains much of the asset-specific knowledge of firm needs and ensures greater degrees of group synergies. Sasol sees this as holding much of the value-added part of the process.

The components outsourced will include detailed design, development and implementation on the systems development side, as well as systems maintenance. The expectation is that in the move to outsourcing, the providers awarded contracts will take on existing staff which are in the location and who have the industry knowledge and some unique skills.

It is not yet clear what type of contracts will emerge from this process. It does appear though, that longer-term contracts will be necessary for maintenance services but new systems development could take place on a spot basis. The reason for the spot option is that most of the asset-specific knowledge required in the process would remain in the Sasol side of any joint development work and would not need to be required in providers.

4.4 Performance of Information Services

With outsourcing being limited in the case of Sasol, one can only really assess the performance of the internal provider (GID). Performance can be measured by a range of internal quality indicators or by the impact that it has had on the performance of those business units it serves.

Sasol's GID was not incompetent and in fact had an excellent track record in a number of areas.

Cost – Sasol's GID was considered a low cost provider and in fact lowering cost was not important when considering outsourcing. The Group head of IT identified that one of the core competencies of a highly capital intensive company such as theirs was putting together capital projects at low cost, within budget and on time. IT projects were treated like any other capital project and were scrutinised carefully with the Board acting conservatively.

IT Spend - Sasol's total IT spend was also 1% of turnover. This compares to 5% spent by Du Pont, a US petrochemicals company. However, high IT spending does not mean high effectiveness. Du Pont aims to reduce its IT spending to around 1.5% of turnover. Therefore, although Sasol was not the highest IT spender, it was a more effective spender.

Technical design - One area of particular skill identified in the IT group is the technical architecture design using cutting edge technologies - i.e. the conceptual design phase of the IT development process. The group has always allocated R&D funds for researching new technologies and designing world-class systems for the group. It is apparent that the internal demand from Sasol is sufficient to make these exercises profitable. The critical mass of internal demand is demonstrated by the fact that the staff complement is the same as

large IT firms locally. Hence, these functions will remain in the outsourcing model. Sasol had remained at the leading edge with their IT systems, with a client-server setup throughout and SAP installation for certain functions. The head of the group IT division estimates that around 20% of the skills are unique.

Business knowledge - Sasol IT providers also had an intimate knowledge of the businesses which was an advantage.

Retention of skills/knowledge - one of the main problems facing internal IT departments in South Africa in recent years is the difficulty of keeping skilled personnel in an environment where there is considerable demand and a shortage of supply of skills. Sasol has maintained a very low turnover of staff for a number of reasons. First, Sasol pays market-related salaries. Second, Sasol offers challenging work which helps keep IT professionals as it enhances their skills and marketability. Third, with the plants located outside of a major city (Secunda is about a 2 hour drive and Sasolburg is about a 1 hour drive from Johannesburg), people are locked in locationally in a place where there are few other potential outlets for their level of IT skills. Often, the spouse works at Sasol too which further confines them to that location. Locations effectively become company towns, long-servers become Sasol people first and foremost and loyalty is frequent.

However, despite these internal strengths, Sasol GID has a number of weaknesses that are making it take the outsourcing route. These can be broadly summarised as a difficulty in the implementation phase of new systems development due to a high level of diverse demands from the business units. Difficulties were being experienced with the diversity of requirements coming out of the diversity of businesses that were emerging. According to the GID, when there is an undiversified demand, then even though the rate of technological change in IT is high, the demands placed on the IT department are still low in terms of change. With pent-up demand and a high speed of change, they are unable to respond as quickly due to limited resources. Internal change to cope with this is too slow because the provider is a virtual monopoly that behaves differently from a competitive firm. The main things which the firm is looking for achieving by outsourcing is service quality and speed of delivery.

4.5 Broader Impact of Information Services Tied to Sasol

It is difficult to argue that Sasol's demand for information services has had any significant spillover effects into the broader market. First, the scale of demand relative to the overall market is small. Using a number of IT professionals as a measure of the market, Sasol employed up to 300 professionals relative to a total number of around 25 000 professionals in South Africa in the mid 1990s. This is roughly 1.2% of total SA demand (Hodge and Miller 1997).

Secondly, Sasol has provided most of its information services in-house limiting the spillovers through sub-contracting. The alternative mechanism for spillover – through the turnover of labour – was also limited as labour turnover has been well below industry averages (see previous paragraph).

Finally, the nature of Sasol's demand has not been completely unique as common technical tools were used even if a unique business application was undertaken.

In the South African context, it seems that financial services and internal trade have been the main drivers of the IT industry. They have maintained a high level of demand since the early eighties and began significant outsourcing early on. They now outsource a high proportion of their needs, and they have remained world-class users ensuring that there was demand for new technologies and techniques locally on a scale that would ensure local providers responded (Hodge and Miller 1997).

4.6 Impact of Liberalisation in early 1990s

South Africa, like many developing countries has been relatively liberal in allowing access to foreign providers of professionals services relating to manufacturing. Therefore, there have always been a number of foreign information technology developer firms operating in South Africa. However, the limited size of local demand for independent contractors, controls on the repatriation of profits and the difficult politics of apartheid meant that the number of firms remained limited.

It should also be pointed out that foreign presence does not entail a total use of foreign employees when it comes to firms of professionals. Foreign nationals used in the set-up of the operation will often hold key executive positions and experts will sometimes be called in for parts of particular projects. However, the salary demands of foreign professionals from an industrial country are too high in the currency of a developing country, which ensures that the majority of the firm's employees will be local residents. What the foreign provider brings, is access to an international network of experience and good international training in both the technology and approaches to service provision.

In 1994, there was a political change and a commitment to growing liberalisation of goods trade. The political change brought on changes similar to liberalisation as many firms felt able to establish a presence in the country. This was the case with information technology services and in the mid-1990s, South Africa saw an influx of a number of international operators. It also saw established foreign operators increasing their presence.

The entry of these firms had a number of effects on the local market. First, there has been a period of consolidation amongst local firms into fewer, larger companies that are able to offer complete solutions to large corporate clients and so compete with the foreign entrants. For instance, a merger between Persetel and Q-Data (PQ) created a massive organisation that was able to compete with the world giants. Second, the shake-up resulted in quick improvements in quality and cost of information services to meet the growing international competition.

However, local competitors did respond well to the incoming competition and survived. One of the reasons for this was that foreign providers wishing to establish a presence had to hire local professionals to staff their offices. Limits on the local supply meant these new entrants needed to offer salary premiums to attract staff from existing firms – an unsustainable policy in light of growing competitive pressure. The fact that the more established local firms had staff and were able to undertake large contracts gave them some leverage in the marketplace.

Third, in the process of consolidation, many local firms listed on the stock exchange to raise capital for take-overs and growth. Flush with cash, these firms started to go global themselves in order to deliver the kind of growth the market had expected. However, the route to globalisation was through the buyout of existing operations rather than establishing a subsidiary office in the target country. A prime example is another of the significant local players - Dimension Data - which has gone through a period of acquisition that has left it with foreign holdings of close to \$3.5 billion (Business Day 23/11/99).

Finally, there are high returns to specialisation in the information services industry and with low scale economies, there are numerous small firms in operation. These firms do not compete for primary contracts from large corporates but rather aim for niche services or for sub-contracted roles from the primary contractors – the large IT firms. Foreign entry is geared to the large corporates and not the smaller niche markets, and so this aspect of the market remained relatively unscathed by the entry of foreign providers. In fact, they may well have expanded the market through enabling outsourcing to take place on a larger scale.

CONCLUDING REMARKS

The Sasol Group has had a remarkable history. From its beginnings as a small producer of synthetic fuel using a seemingly uneconomical technology, it has grown into a large and diversified petrochemicals group that has now become a global player. A large part of this success has been due to producer services, in particular technology and engineering services. The Group recognises this by describing itself as a petrochemical company that has "...high quality research and development capacities, the ability to commercialise new technologies, proven skills in operating large and complex production facilities and cost-effective project management" (Sasol Annual Report 1998).

The focus on developing these particular producer services was largely a product of the environment that Sasol found itself in. Not only was it the only commercial synfuel producer in the world, but it did not have the same access to upstream reservoirs of crude oil or a downstream distribution network of petrol stations such as other international companies in the sector. This forced Sasol to develop its competitive advantage in the production stages of the value chain and drive the technology to the point where synfuel production was a profitable venture, albeit with some protection.

In the history of Sasol's development, it has also changed the manner in which it has sourced producer services. In most cases, the Group has shifted demand away from internal providers to make greater use of external providers - both locally and internationally. Internal providers focus on strategic services with high asset-specificity and high value-added, while external providers are bought in for all else. This has been a response not only to changes in the Group itself, but also to changes in the broader South African economy in which it operates. As the Group has grown along with the broader economy, this has created sufficient demand for specialised independent local providers to emerge. Sasol has encouraged local providers due to its distance from major petrochemical-producing countries and due to the relative isolation of South Africa. Sasol often entered long-term relationships with these companies to ensure their survival in a region with weak demand for petrochemical expertise.

Sasol's readiness to outsource services has helped create a core of engineering and IT companies in the South African economy. This has created some spill-over of knowledge and lower operating costs for service providers which has benefited the other companies making use of their services. The competitiveness of these firms is apparent from the number that are now entering the global stage in their own right. However, the main beneficiary has been Sasol. As the dominant petrochemicals firm in SA, many of the industry-specific knowledge spillovers have been internalised to ensure that Sasol diversifies and grows at a very rapid rate.

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