THE SOUTH AFRICAN COMMODITY PLASTICS *FILIèRE*
History and Future Strategy Options

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ABSTRACT

The world chemical industry is one of the most basic and important manufacturing businesses globally. Petrochemicals have played a pivotal role in industrial modernisation.

In the 1970s and 1980s South Africa developed an unusually large chemical industry as Import Substitution Industrialisation was conveniently extended into military/strategic apartheid policy. These policies steered the industry away from conventional crude oil and natural gas based feedstocks into a uniquely coal based chemical industry. The shift from oil to coal based petrochemicals also narrowed the slate of petrochemicals available.

Pricing is critical in the commodity plastics *filière*. Coal based production contributed to a higher cost structure than crude oil based producers and a 'missing link' in the production chain, the petrochemical intermediate naphtha. This facilitated the introduction of a pricing mechanism which concentrated the benefits amongst upstream producers at the expense of downstream plastic converters, stunting growth in this higher value added and more labour intensive sector. Ironically a 'sunk costs' approach and recent developments allow SASOL's to produce coal based petrochemicals at low cost.

In a significant change the traditional pillars of the local chemical industry, agricultural and mining chemicals, were supplanted by plastic raw materials as the major sector of the industry during the 1980s despite its coal base. Trade patterns also reflect these developments. A significant shift in employment from blacks to whites in Industrial Chemicals and Refineries accompanied this reordering of the major sectors.

Providing mass housing, electrification and other basic wage goods will require industrial policies, embracing the entire *filière*, which are significantly different from previous policies. Such policies should facilitate the development of higher value added and more labour intensive sectors within a broadly conceived framework of redistribution of political and economic opportunity. This will require lowering chemical intermediate input costs as

well as a range of nurturing and facilitative policies for the *filière*. These will help to reduce the current anti-export bias. The process of implementing such policies is as important as the direction itself. To facilitate national reconciliation and empowerment of previously disadvantaged groups transparent tripartite policy making institutions are recommended.

TABLE OF CONTENTS

PREFACE

The first thoughts of embarking upon a study such as this were prompted by a perusal of the Report by the Working Group for the Promotion of the Chemical Industry in September 1990. This Report represented the collective efforts of the Department of Trade and Industry together with the three major chemical companies and some larger plastic converting companies, who in this document called for public comment. I was involved in drafting a response to this document in my capacity as General Secretary of the Chemical Workers Industrial Union. We pointed out that whilst the Report contained elements of a lucid overview of the industry it also contained several basic errors, not the least of which was to underestimate the size of the local chemical industry by about 50%. In subsequent meetings with AECI economists they acknowledged the errors we had identified. These errors and the notion of leaving very important economic policy issues in such hands alone elicited a sense of profound unease.

In the process of preparing comments on the Working Group's document the paucity of publicly available information on the local chemical industry became evident. This was partly due to government policy which shrouded the workings of the oil and liquid fuels industry in secrecy. For example at that time another group known as the 'Sander Committee' (after AECI Managing Director, Mr Mike Sander) worked in parallel with the Working Group. It investigated the liquid fuels - petrochemical interface with a view to future possible sources of petrochemical feedstocks. Its findings have never been made public.

Another criticism made of the Working Group's document was that it lacked any analysis of the chemical industry's historical development. Also at this time considerable public debate was taking place about the desirability or otherwise of building a large petrochemical complex adjacent to the strategic Mossgas refinery. Capital costs of the order of (US) $6 billion were mentioned. It was public knowledge that the economics of the Mossgas project were suspect and these fears spilled over into perceptions of the proposed petrochemical project.

These were among the factors which made a serious study of the local chemical industry a necessity for those groupings which opposed apartheid and a tantalising prospect for an interested individual. An opportunity to address these needs and interests arose when a research post focusing on the chemical industry with the Industrial Strategy Project team became available. I am grateful to the Chemical Workers Industrial Union for releasing me from my commitments to them so enabling me to take up that post. It was during the course of work for this Project, between January 1992 and April 1993, that much of the research for this study was carried out.

This thesis was first submitted as a Masters thesis in December 1993. Both of the examiners were of the opinion that it could be upgraded to a PhD thesis with relatively little additional work. Their suggestions and additional requirements have been incorporated into this version. It has also been substantially reorganised and an attempt made to make the prose more accessible to those who do not have special knowledge of this industry. Furthermore certain additional material relating to recent developments in the industry such as the advent of Polifin has been included. Taking these into account necessitated certain changes to the conclusions and policy options.

As it turns out the rapid pace of political change in South Africa has presented unforseen difficulties. What was secret and forbidden knowledge, carrying serious penalties, during the period of research has suddenly been revealed to the public. Looking back upon the more or less successful April 1994 elections and the 'honeymoon' period immediately thereafter, it is easy to forget the fear, secrecy and uncertainty which prevailed before those elections, particularly in respect of matters such as the liquid fuels industry.

In the process of gathering the resources necessary for this study and in the process of writing it up many people have assisted. This study would not have been possible without the material provided by Jim Catterson at the International Federation of Chemical, Energy and General Workers' Unions (ICEF) research and information department. Among many others who assisted in the collection of resource material were; Seeraj Mohamed, Jerry Thibedi and Bill Govender. Judith Shier was relentless in her pursuit of library material. Statistical data was generously provided by the Industrial Development Corporation and the Central Economic Advisory Services. Thanks are also due to many other individuals and organisations which responded to requests for information or data.

An international study trip during the course of the research undertaken for this study was made possible by Friedrich Ebert Stiftung funding and the help of Fred Higgs of the Transport & General Workers' Union (UK), Annie Rice of the ICEF, Yves Legrange of the Federation Unifiee des Industries Chimiques (France) and Petra Krijnen of the Industriebond FNV (Netherlands). I am also grateful to Reinhard Reibsch and the IG Chemie-Papier-Keramik for hosting me in Germany.

Charles Meth helped me grapple with statistics and warned against technicist inclinations. Most helpful comments on parts of earlier drafts were received from Colin Cook of the CSIR, Dave Walwyn of the ANC Science and Technology Committee, Philip Lloydu of Industrial and Petrochemical Consultants (PTY) LTD and in particular my supervisor Professor Bill Freund. I am also grateful for several challenging discussions with Woody Naicker and Alan McIver of Sentrachem's Strategic Raw Materials Project. David Wield, Director of the Centre for Technology Strategy at The Open University (UK) and Professor Raphie Kaplinsky of the Institute of Development Studies at the University of Sussex both made many valuable comments for which I am most grateful.

All of the members of the Industrial Strategy Project collaborated, commented or assisted in some way with parts of this study. Zav Rustomjee was especially helpful in getting me started. Particular thanks are due to the Industrial Strategy Project Directors; Dave Kaplan, Raphie Kaplinsky, Dave Lewis and Avril Joffe for their encouragement, guidance and deadlines.

I am grateful to Professor Mike Morris and other members of the Centre for Social and Development Studies at the University of Natal, Durban, for affording me office facilities (and encouragement) for a few months during 1994 whilst I worked part-time to upgrade this thesis. A small grant from the ISP made this financially possible.

Jenny, my wife, gave incomparable support and also did her best to correct my attempts at written English. Tom and Sally, our children, provided the distractions and the sanity.

I hereby formally declare that the contents of this thesis, unless otherwise acknowledged, is my own original work.

ABBREVIATIONS AND ACRONYMS

ABS	Acrylonitrile-butadiene styrene, an engineering plastic
AECI	African Explosives and Chemical Industries Ltd.
bpd	Barrels per day (crude oil)
BTU	British thermal unit, a measure of heat energy.
C&EN	Chemical & Engineering News
CAD	Computer aided design
CDV	Current domestic value
CEAS	Central Economic Advisory Service
CEF	Central Energy Fund
DME	Developed market economy
DMEA	Department of Mineral and Energy Affairs
DTI	Department of Trade and Industry (South Africa)
ECN	European Chemical News
ERP	Effective Rate of Protection
FM	Financial Mail
FW	Finance Week
GDP	Gross Domestic Product
GEIS	General Export Incentive Scheme
HDPE	High density polyethylene, a commodity plastic
IBLC	In Bond Landed Cost (of petrol)
ICEF	International Federation of Chemical, Energy and General Workers' Unions
ICI	Imperial Chemical Industries
IDC	Industrial Development Corporation (South Africa)
ISI	Import Substitution Industrialisation
ISIC	International Standard Industrial Classification

LDC	Less developed country
LDPE	Low density polyethylene, a commodity plastic
LLDPE	Linear low density polyethylene, a commodity plastic
LPG	Liquified petroleum gas
MITI	Japanese Ministry of International Trade and Industry
MNC	Multinational corporation
NEC	Not elsewhere classified
NEF	National Economic Forum
NIC	Newly industrialising country
NPV	Net Present Value
NWE	North West Europe
O&GJ	Oil & Gas Journal
PE	Polyethylene, generic name for some commodity plastics
PET	Polyethylene terepthalate (a polyester used in 2 litre Coca Cola bottles and in synthetic fibres)
PP	Polypropylene, a commodity plastic
PS	Polystyrene, a commodity plastic
PVC	Polyvinyl chloride, a commodity plastic
R&D	Research and development
SA	South Africa
SABS	South African Bureau of Standards
SAN	Styrene-acrylo-nitrile, an engineering plastic
SBR	Styrene-butadiene rubber, a synthetic rubber made from petrochemicals
SIC	Standard Industrial Classification (South Africa)
SFF	Strategic Fuel Fund
tpa	Tonnes (metric) per annum

UK	United Kingdom
US	United States of America

GLOSSARY

Associated gas	Hydrocarbon gasses produced as a by product along with crude oil from oil wells. This gas was flared off until it was harnessed (at very low cost ie the cost of flaring) as feedstock for petrochemical manufacture.
Commodity Polymers	These are, LDPE, LLDPE, HDPE, PVC, PP and PS.
Cracker/ing	See steam cracking
Cryogenic	Requiring to be cooled to very low temperatures in order to make transport feasible, usually a gas to liquid. The volume of liquid methane for example is 600 times less than an equal weight of gas.
Naphtha	A product of crude oil refineries. A light distillate feedstock for gas or petrochemical manufacture. The boiling range is generally about 40-150 ^{0}C. (Sharp 1990).
Olefins	A group of petrochemicals. Alkenes (olefins) are a group of unsaturated hydrocarbon compounds characterised by one or more double carbon-carbon bond, for example ethylene and propylene which are the precursors to commodity plastics, polyethylene and polypropylene.
Petrochemicals	Substances (e.g. plastics, fertilizers, synthetic fibres, etc) that have been manufactured by chemical means using petroleum compounds, gas or coal as raw materials.
Steam cracking	Thermal cracking of petroleum products (usually naphtha) in the presence of steam and at very low furnace residence times. A process used in the manufacture of olefins.
Thermal Cracking	See steam cracking
Thermoplastics	Plastic material that can be repeatedly softened when heated and become firm when cooled.
Thermosets	Plastics which undergo a chemical reaction during processing that results in a thermally stable molecular network.

INDEX OF FIGURES

Figure | Page No.

INDEX OF TABLES

Table No. Page No.

Chapter One

Chapter Two

Chapter Four

Chapter Five

Chapter Six

Table No. Page No.

Chapter Eight

Chapter Nine

Table No. Page No.

INDEX OF MAPS

Map No. Page

INTRODUCTION

In recent years a public debate has developed concerning the most desirable economic growth path for a future South Africa. Following several academic contributions and a spate of local and international conferences, the media have come to refer to this debate as the 'great economic debate'.

Briefly, this debate turns around what is wrong with the South African economy and how to go about fixing it. Almost all the participants in this debate agree that there is a need for some form of economic restructuring. Exactly what, where and how are central issues in the debate.

In pursuance of their positions in this debate the chief protagonists have taken a growing interest in the restructuring and reorganisation of South Africa's manufacturing sector in preparation for what many hope will be a period of post-apartheid growth and development. However a closer look at the ideas being exchanged shows that they have very few detailed industry studies of the major industries at their disposal.[1]

Nevertheless there is a broad consensus that some form of economic strategy is required in order to lift the economy out of its stagnant (or in 1992 negative) growth curve. To this end a negotiating platform, the National Economic Forum, comprising organised labour, capital and the state has come into being and is expected to commence its work in 1993. The private sector too has begun to see the need for industrial strategy. For example the Nedcor and Old Mutual sponsored Professional Economic Panel in February 1993, argued inter alia, that: "the country needs a coordinated or unified industrial vision or strategy - something it sorely lacks at present." (Financial Mail, 19-2-93:95) This report also argued in favour of the need for long term industrial policy and for the targeting of important industries for development. Adequate historical and contemporary research of various industries could greatly facilitate the difficult decisions which will no doubt face those entrusted with the task of determining industrial policy.

This study attempts to redress the lack of detailed information available on industrial sectors by analysing the historical development of one area of manufacturing, a section of the chemical industry and in that way it hopes to make a small contribution to the 'great economic debate'. It has as its central focus the historical development of a large part of the South African chemical industry, the petrochemical to plastics production chain. This chain

1. Kaplan's (1990) study of the telecommunications industry is a notable exception.

traverses petrochemicals, synthetic resins and plastic raw materials, and the plastics converting and fabrication industries.

This *filière*'s upstream segments fall within the petrochemical industry. The lower reaches of the *filière* comprise the plastic products or plastic converting industry, which produces final products and intermediate inputs, to a wide range of industries. The Plastic Products Industry is used as an example of this lower link in the chain in this study.

In so far as the petrochemical, plastic raw materials and plastic converting industries are concerned, a number of proposals for restructuring these links in the chain, or parts of it, have been published in recent years. They are critiqued in the course of this study in so far as they bear upon the scope of this study. Their principal weaknesses are their lack of historical analysis and their failure to embrace the full length of the plastics production chain.

The chemical industry is usually considered a core or strategic industry in national industrial development programmes. Its selection as a core industry by many developing countries is bound up with its interpenetration of so many industrial activities. An indication of the strategic importance attached to the chemical industry, particularly in developing countries, is found in the prolific use of state ownership to launch, control and steer the industry. Internationally chemical business activity is approaching that of automobiles and electronics as a major economic indicator in terms of turnover, capital investment and research and development.

In South Africa there is little consolidated information publicly available for would-be policy makers to gauge where South Africa's chemical and plastic industries stand in relation to the shifting global configurations and trends. This study is concerned with such issues and with the developing political economy which has given rise to the present structure of the South African industry.

By way of backdrop and introduction it attempts to provide a multi-dimensional global 'map' of recent developments in the qualitative and spatial aspects of the international chemical industry, locating and emphasising the principal concern in this study, the plastics production chain. Recent developments in South Africa's chemical and plastic industries are placed in an international perspective by contrasting them with other economies.

South Africa's chemical industry constitutes a comparatively large share of manufacturing, and includes some large and well established businesses. AECI is the world's largest producer of commercial explosives. Mining chemicals (explosives) and agricultural chemicals (fertilizers), as may be expected, have traditionally dominated the local chemical industry, unlike in many developed countries.

The pivotal role played by petrochemicals in industrial modernisation has been stressed by World Bank officials.[2] The size of the petrochemical sector relative to other branches of the chemical industry is apparent in Figure 1. It is the single largest sector of the chemical industry accounting for 36.5% of world output valued at $414bn in 1989 (Chemical Industries Association, 1990:22). This excludes other major sectors of the industry such as Fertilizers, Artificial Fibres,[3] Soaps and Detergents and Other Chemicals all of which utilize intermediate inputs from the petrochemicals sector.

Petrochemicals have the following three characteristics:

a) They are derived from crude oil or natural gas (and in South Africa from coal).

b) They are mostly, although not all, commodity chemicals.

c) Most petrochemicals are used as raw materials in the manufacture of other synthetic materials rather than as final products.

In developed economies the post World War 2 economic success story was petrochemicals based on oil and natural gas. Petrochemicals provide the raw materials used in the manufacture of plastics, detergents, paints and rubbers and a host of other products. Such 'synthetic' products have been substituted for traditional materials such as glass, wood, cement, paper, natural fibres and aluminium and steel etc. Currently, increasing potential is seen for new types of plastics in new and composite materials, This has been seen as the commencement of a 'second round' of substitution (Thorpe, 1987).

In the context of rapid international development of petrochemicals and their derivative materials an intriguing question arises: how has the small South African economy lacking in crude oil and with limited natural gas resources coped in globalised industries like petrochemicals whilst pursuing apartheid policies?[4] None of sparse published material attempts an answer to this question.

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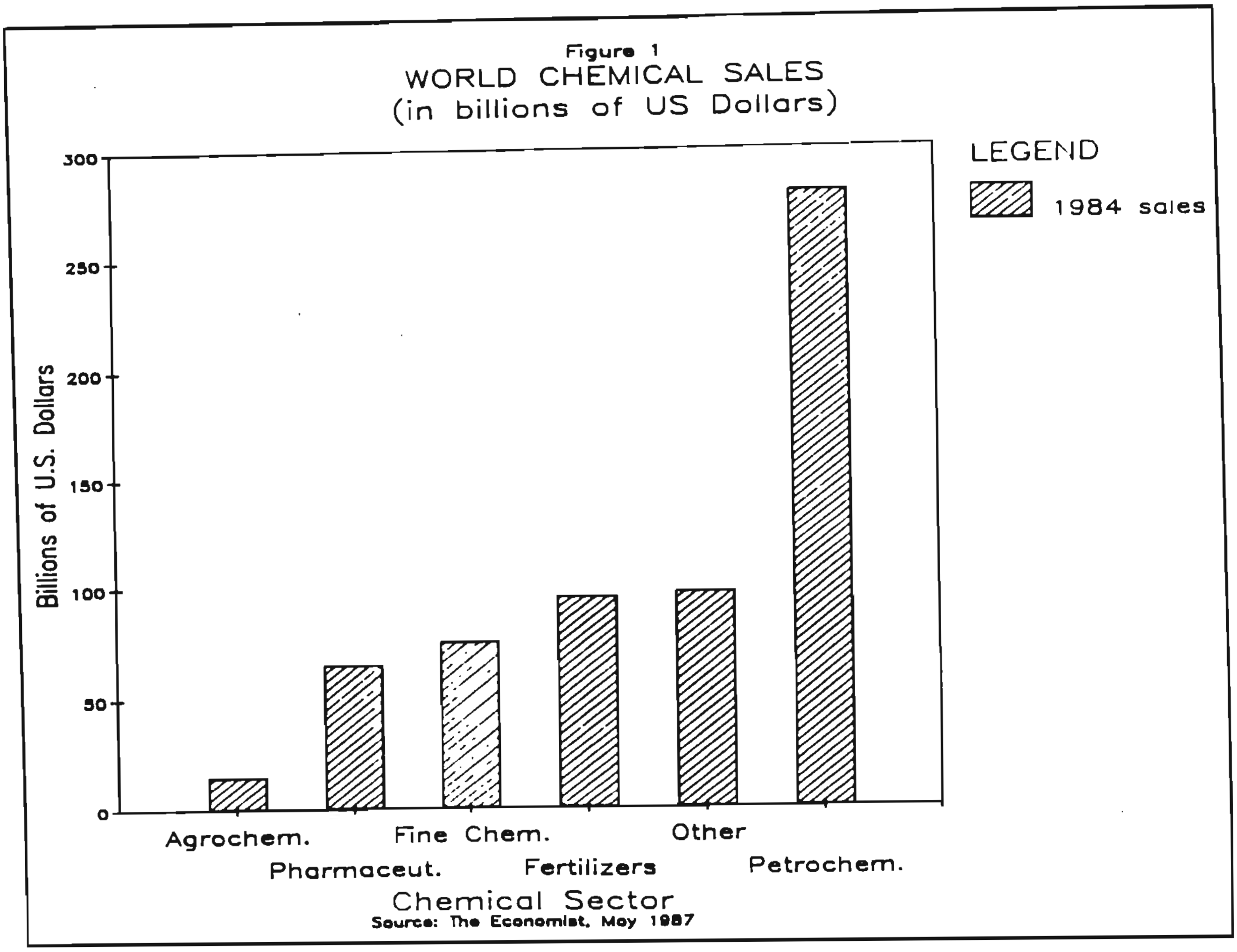
2. See for example Walter Vergara, senior chemical engineer for the World Bank's Asia technical department, cited in Haggin, 1992:12 and Vergara and Babylon, 1990.

3. The Standard Industrial Classification term is 'Man-made' fibres but since such sexist terminology is unacceptable, the term 'artificial' will be substituted in this study.

4. South Africa lacks any proven oil resources but is not entirely lacking in natural gas. A gas deposit off-shore of Mossel Bay, of uncertain size, provides feedstock for the small Mossref synfuel refinery at Mossel Bay which commenced production in 1993.



Source: Vergara & Brown, 1988.

In this study the development and heritage of this uniquely coal-based endeavour is tracked and analyzed together with the implications for the plastics industry. Finally shorter term options are identified for a future strategy to maximise the development of the commodity plastics production chain with a more democratic and egalitarian post apartheid dispensation in mind.

Chapter Summary

Chapter One provides an introduction to the chemical industry from three points of view. It begins with a 'snapshot' outline of the wider international chemical industry, providing a sense of proportion to the different sectors which make up the chemical industry. Secondly it traces the industry's historical development from its earliest beginnings up to the 1980s. Finally it provides some basic insights into and dimensions of the modern petrochemical and plastic industries.

Chapter Two provides an international backdrop to the South African focus in four parts. It examines recent trends in the global chemical and petrochemical industry. The chemical process industries are capital intensive and like many similar industries, economies of scale play an important in determining the competitiveness of plants. Part One explores the historical trajectory of this aspect of the chemical industry as well as the role of research and development in technological change and innovation. The South African chemical industry is contrasted and compared with international developments in these areas.

Part Two examines concentration, oligopolies and cartel behaviour in the international industry. Part Three explores the complex processes of globalisation and their inextricable interlinkages with the corporate strategies of the leading multinational chemical corporations as well as technological developments.

Environment is increasingly a 'buzz word' in the chemical industry. The reasons for this are explored. The more important dimensions of the relationship between the industry and the environment are examined before turning to the industry's responses to social pressures which have emerged.

Chapter Three provides the final element of the international backdrop to the South African commodity plastics *filière*. It narrows the focus to petrochemical industries in developing countries and the roles the state has played in shaping the petrochemical industry in these countries. In particular it highlights the way in which conflicting public policy objectives can come to rest upon the pricing structure of key petrochemicals. This provides useful platform of international experience against which the South African experience can be compared in later chapters.

Chapter Four narrows the focus still further. It provides an historical introduction to the South African chemical and petrochemical industry.

Chapter Five describes the South Africa commodity plastics *filière* and analyses the historical development of the pricing and production structure of the first link in the chain, the petrochemical sector and in the process identifies a 'missing link'.

Chapter Six moves one step further down the South African production chain to the plastic raw materials or polymer industry. Certain structural problems in the industry and growing international competition, or the threat of it, induced a significant restructuring of the ownership of the petrochemical industry in 1994. Chapter Seven evaluates the ingenious solution which the two largest companies developed to meet these threats.

Chapter Eight proceeds further down the chain to the last link, the plastic converting industry. The changing relationship between the different links in the *filière* and the changing demand patterns are identified and discussed.

Chapter Nine examines the South Africa's trade performance in chemicals and plastics, identifying strengths and weaknesses in production and the trade regime. Some possible improvements are proposed.

Petrochemical complexes have large economies of scale. They represent large investments and place large tranches of material on the market. A decision on South Africa's next petrochemical complex is thus an important one. Chapter Ten looks forward to future options for the South African petrochemical industry. It provides a research framework to address the strategically important question: where will South Africa source future tranches of petrochemicals?

Finally Chapter Eleven draws upon the preceding chapters to shape conclusions and industrial policy options for the commodity plastics *filière*.

The country classifications used are set out in Annexure E and the principal towns and cities discussed in Map 1.

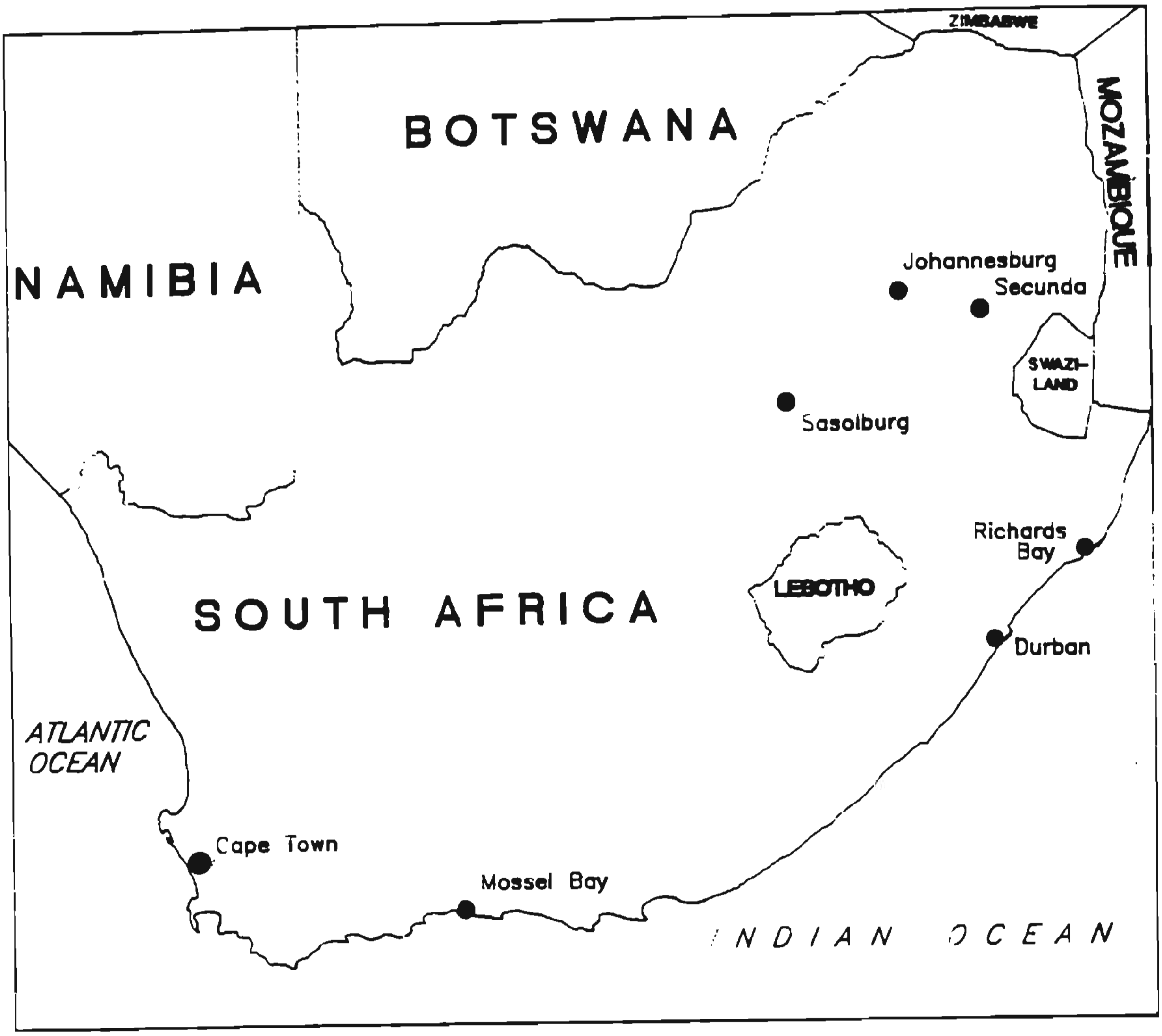
It may be helpful to point out what this study is not. It is not a detailed analysis of SASOL and its role in the (secret) liquid fuel supply arrangements which have operated in South Africa since the 1970s. SASOL features repeatedly in this study because it is virtually the only manufacturer of petrochemicals in the country, however it is primarily a synfuels producer. Only one quarter of SASOL's turnover is derived from chemical sales. This study is concerned primarily with only two of its chemicals, ethylene and propylene, which together account for 9% of SASOL's turnover (Tison, 1992).

Source Material

A brief comment on source material for a study of this nature is appropriate. The chemical industry bibliography is a short one. As far as could be ascertained during the course of this study the most accurate, detailed and useful information is to be found in three types of publications. The first and more easily available are the industry journals such as Chemical Week, European Chemical News, Oil & Gas Journal, Hydrocarbon Processing and Chemical & Engineering News. Even these are not readily available in South African libraries. Other journals of wider scope also carry useful information from time to time such as The Economist, Forbes and Fortune Magazine.

In depth studies are prepared by the Economist Intelligence Unit and the Stanford

Map 1.



Research Institute (SRI) from time to time. These are expensive publications not often to be found in South Africa. For example the latest Economist Intelligence Unit publication on the chemical industry was not to be found in a single public or private company library in South Africa.

More inaccessible still are the third category of sources. These are the by-subscription-only type of industry news briefings such as 'Chemical Matters' and Stuart Wamsley's 'Focus on Chemicals' and others. They too are expensive and rarely held in South Africa and then only by private companies. Beyond these there are the works of the international private research organisations which are also for subscribers only, almost only the large companies in the industry. A single volume costs several thousand Rands or more.

The privatisation of knowledge in the chemical and petrochemical industry makes research on the chemical industry a very expensive undertaking. This may account for social scientists comparative neglect of this industry. The need for publicly available research is an argument implicit in the chapters which deal with South Africa. Some suggestions as to how this objective might be achieved are made in the concluding Chapter.

The 'Great Economic Debate'

This study is concerned with past economic development strategies and options available for future ones. It is appropriate then to situate it within the current debate in South Africa over how economic development should be pursued.

The plethora of views aired in this debate may be collapsed into three broad tendencies for current purposes. It goes almost without saying that some of the complexity, variation within tendencies and nuances in the debate will be lost in the summaries which follow.

Big business have advanced the view commonly referred to as 'redistribution through growth'. The opposing view put forward by organised labour, chiefly COSATU and its associated Economic Trends Group has been described as 'growth through redistribution'. This approach rests upon their analysis of the economic 'crisis' spelt out in Gelb (1991). A variant of the former, lying somewhere between these two positions has been described as 'growth and redistribution' and has been attributed to the African National Congress (ANC) (Finance Week, 20-26 February, 1992:18). The need for economic growth[5] is common cause among the three tendencies identified. It is the speed and manner in which redistribution is to be achieved which largely separates the three views.

The 'redistribution through growth' thesis, put simply, advocates creating the 'right' climate for business and then allowing business to get on with the business of business. The resulting economic growth would then 'trickle down' to the historically disadvantaged in the economy. The task given to the state in this model is to fashion policies resulting in suitable input prices of capital and labour. A part of the state's role in creating the 'right' environment is the correct package of incentives such as tax allowances and incentives for exporters which are seen as the mechanism to expand markets. SACOB in its study finds that:

> "The competitive analysis reveals the following four areas are significant and these are the areas which need to be tackled first. They are :
>
> 1. Cost of capital

5. "Growth" rather than "development" is the term most frequently used. The notion of environmentally sustainable economic *development*, as opposed to more economic growth of a similar kind, has not yet surfaced as an issue among the main protagonists in the "great economic debate".

2. Productivity of capital
3. Productivity of labour
4. Cost of intermediate inputs." (SACOB, 1991:62)

Thereafter the path of development can be left to market forces which will deliver the desired economic transformation. This type of thinking also permeates the economic strategy document of the State President's Economic Advisory Council (see Economic Advisory Council of the State President, 1991).

Gelb (1991) in his criticism of what he calls 'neo-liberal export orientated growth' argues that the aim of this growth path is a continuation of the capital and raw material intensive economic trajectory pursued in the past accompanied by a continuation of the unemployment crisis. The benefits of reinvestment and rising productivity would accrue to large corporations and to some extent urban manufacturing workers. Social inequalities are unlikely to be resolved through the trajectory of this growth path. Instead the gap between those in formal employment and those left out, presumably relegated to the informal sector, is likely to increase. Although this growth path would make some effort to facilitate the 'trickle down' of limited funds, for example by including representatives of the disadvantaged on social funds, redistribution would become an activity separate from the workings of the formal economy. The likely consequence is that the disadvantaged communities remain marginalised.

The 'growth and redistribution' tendency is less clearly formulated than the other two positions and it is perhaps unfair to describe this as an ANC view. The ANC's discussion document on economic policy of 1990 refers to 'satisfying basic needs by growth through redistribution.' (African National Congress, 1990) However its position in this document is far less clearly developed and could be considered as an attempt to straddle the other two positions. For example it calls for a programme of "Growth through Redistribution in which redistribution acts as a spur to growth and in which the fruits of growth are redistributed to satisfy basic needs." (Ibid:5). A more careful argument for 'growth and redistribution' has been developed by McGrath and van der Berg (1991). It improves upon the 'redistribution through growth' position principally in its acknowledgement of "the close interaction between economic growth and redistribution" and the need for "some redistribution (social justice)" to provide the stability for further growth. (McGrath and van der Berg, 1991:21)

The 'growth through redistribution' position takes as its starting point the need for South Africa's extreme racial inequalities to be redressed and the consequent necessity to fundamentally reorganise the economy. It is underpinned by the notion of an emerging structural (economic) crisis which has its origins in the early 1970s. Gelb (1990) refers to this pattern of production, distribution and consumption or growth model followed at that time as 'racial Fordism'. He argues that a combination of racial domination and mineral wealth steered South Africa down a capital intensive growth path of production of previously imported sophisticated consumer goods. Capital labour ratios are more than double those of developing countries at comparable levels of per capita income (Levy 1992:3). The chemical industry has made a major contribution to the unusually high capital intensity of manufacturing. This is principally as a result of a strong apartheid state whose policy objectives were focused on strategic self sufficiency, import substitution and at the expense of developing (black) human resources amongst others. The apartheid state had a direct and heavy involvement in manufacturing. The reliance upon imported capital goods and the increasing failure to absorb labour into employment have grown to become the chief problems for 'racial Fordism'.

These problems were compounded by external shocks to the system. Energy prices soared with the first oil shock in 1973. At the same time labour costs began to rise, particularly for black workers as they increasingly took action and became organised from the early 1970s onwards. The effect of these changes was to raise production costs in manufacturing and mining. Further destabilisation arose from the collapse of the Bretton Woods system of fixed exchange rates.

The longer term underlying trends in the economy together with the external shocks have given rise to destabilisation of previously stable relations of production. As a result economic growth has declined, indeed stagnated, whilst productivity and investment have fallen. This analysis identifies the 'racial Fordism' crisis as a supply side crisis having its origins in the processes of production.

Consequently the proposal to end the crisis and place the economy on a more equitable growth path commences at the supply side and calls for "not the redistribution of consumption, but the redistribution of *investment*." (original emphasis) (Gelb, 1990:35) It proposes to draw investment out of financial institutions and to loosen the concentrated grip of the conglomerates on the economy. Investment is to be directed at targeted sectors with labour intensive growth potential and at human resource development. In this model, state intervention is unavoidable. However it would be :

"targeted and selective, based upon sectoral planning, rather than overarching and based on general principles as in a central planning system. At the same time, where it was undertaken, intervention would be pervasive and far-reaching in shaping the activities of economic agents, in contrast to the neo-liberal reliance on autonomous responses." (Gelb, 1991:31)

This role for the state rests upon an understanding of markets as being less than optimal mechanisms for the achievement of identified socio-economic goals. Instead the relationship between economic agents acting within institutional environments, as they develop over time, is the focus of attention in order to achieve a dynamic rather than a static efficiency.

The ultimate test for state economic policy is its ability to meet socio-economic objectives. Racial-Fordism did manage to sustain apartheid for several decades but in the process its internal contradictions undermined its sustainability. There are good reasons for a future state to take on a new and very different transformative role, one that facilitates economic development through redistribution, not just of wealth, but also of power. Industrial democracy offers opportunities for including the previously excluded and addressing racial inequalities. The particular character of concentrated industry which developed under apartheid will also have to be addressed. This too requires a redistribution of power in the process of economic policy formation. It also offers the (not unproblematic) prospect of unlocking the constraints of stultifying labour markets and bringing the energy of new stakeholders in society to bear upon the national effort. It is within this broad analysis that the strategy options set out in the final Chapter are located.

The facilitative role accorded to the state in this approach finds a resonance in aspects of recent writings on the nature of capitalist competition, what Best (1990) labels 'the new competition'.

The New Competition

Another fundamental economic debate provides theoretical underpinnings for this study. This debate revolves around the nature of capitalist competition and what it is that drives economic development. Adam Smith argued for the market whereas John Maynard Keynes theorised demand management. Schumpeter broke with these views which placed market and price at the centre of economic analysis and instead argued for the centrality of the firm as the driving force in economic development. Best (1990) has taken this argument further. His conceptual categories provide a number of very useful vantage points from which to view the behaviour of firms and the social and state infrastructure or environment necessary to secure competitive advantage and economic development.

For Best 'entrepreneurial' firms in the 'New Competition' operate 'strategically' in that they shape markets and choose the markets within which to operate rather than taking the existence of markets as a given. Entrepreneurial firms seek competitive advantage through continuous improvement and innovation in process and product. In this sense innovation is not so much about 'blockbuster breakthroughs' as it is about the Japanese concept of Kaizen or a social process of continuous incremental improvement. Success for the entrepreneurial firm requires perpetual problem solving which in turn requires a culture of learning and the creation of new knowledge within the firm as a result of problems solved.

The 'New Competition' also focuses upon the relations between firms up and down the production chain. Best argues that 'consultative-cooperation' amongst mutually interdependent firms is an important element in securing competitive advantage. This focus upon the relations between the succeeding links of a production chain is a most useful perspective from which to analyze the production chain which is the focus of this study.

Institutional environments within which firms operate also help to determine the basis upon which they compete with each other. He argues that paradoxically, it is to their mutual advantage to cooperate in certain areas such as labour training, marketing and research institutions whilst they develop their competitive advantage in other areas. This paradox between cooperation and competition in an industrial sector is, in Best's analysis, not necessarily inimical to competitive advantage. For example price cooperation among producers in high fixed costs industries in times of depressed prices may allow accumulation for future investment in internationally competitive facilities. The ability of firms to voluntarily seize the advantages of the paradox between competition and cooperation and/or the state's ability to encourage and engender such inter firm relations is a useful measure of an industrial sectors' competitive advantage and its ability to contribute to a country's economic development.

Attention has been drawn to the role of state industrial policy in successful East Asian economies by Amsden (1989), Wade (1991) and Best (1990) among others. To varying degrees they have emphasised that state intervention in countries such as Japan, Korea and Taiwan has not been about the imposition of a command economy type plan. Rather it has been to administer the paradox of competition and cooperation. They have shown that cooperation between firms (state engendered where necessary) has been instrumental in the long term development of industrial sectors whilst at the same time inter firm competition has acted to promote responsive and innovative firms able to survive and exploit new challenges and opportunities. State industrial policy has often been associated in the UK and the US with rescuing embattled industries. However the recent analyses of East Asian economies referred to above have shown that industrial policy is capable of promoting international competitiveness and industrial development. A state's ability to generate industrial policy in a way which breaks with the market/plan dichotomy provides another useful vantage point from which to view the historical development of an industrial sector.

The conceptual tools offered by Best, Wade and others are helpful but only up to a point beyond which the specifics of military/strategic apartheid strategy render them less powerful.

CHAPTER 1

AN OVERVIEW OF THE INTERNATIONAL CHEMICAL INDUSTRY

Introduction

This Chapter provides an introduction to the international chemical industry and an international backdrop for the examination of the South African chemical industry which follows in subsequent chapters. It proceeds by way of identifying those activities generally regarded as constituting the chemical industry, and locates within these the sectors which are the focus of this study. It identifies some of the major changes which have occurred in the course of the chemical industry's development and which help in understanding the industry's historical development in South Africa. Factors contributing to the changing geographical distribution of the industry are highlighted. In the conclusion to this chapter the more important issues for South Africa and this study and some of their implications are summarised.

The petrochemical to plastics production chain is schematically introduced and certain critical factors such as feedstock type and costs are highlighted. As important is the interrelatedness and interdependence of feedstock type, processing technology and resultant chemical building blocks.

During the course of this and subsequent chapters some of the everyday language of the industry and its chemical composition is encountered. An effort has been made to simplify this as much as is practicable. To assist readers who may be unfamiliar with some of the terminology, a glossary and an explanatory list of abbreviations and acronyms are provided. This, together with Annexure D, a clear and simple guide to the main organic and inorganic production chains, are intended to ease the reader's task.

An Outline of the Global Chemical Industry

There are over nine million known chemicals and this number is increasing by approximately one thousand per year. Although the number of chemicals normally used in commercial production is far fewer, some thirty to forty thousand, there nevertheless remains a bewildering complexity for those wishing to analyze the industry in any detail. This will not be attempted here.

The chemical industry is one of the most complicated of all manufacturing industries involving thousands of different chemical reactions, products and processes (UNIDO, 1990:174). It interweaves itself in a web-like way into many aspects of economic activity, typically selling a half to three quarters of its turnover to other manufacturing operations rather than directly to the consumer. It is also characterised by high capital and R&D intensity. For these reasons the chemical industry is usually considered to be a core industry in national industrial development programmes. Its importance has been further reinforced by the fact that internationally chemical industry growth rates have been higher than GDP growth rates and this is expected to continue to the year 2000 (ECN, 2-1-90).

The size of the industry is comparable to that of other large manufacturing industries such as steel, automotive and mechanical engineering. Global chemical sales in 1990 amounted to (US) $ 1230 billion, produced by a workforce of approximately 37 million people, of whom about 6.5 million belonged to independent trade unions. The chemical industry is also regarded as a core technology sector along with electronics, machinery, mechanical engineering and scientific instruments (OECD, 1992:90).

In the 1970s the organic chemical industry began to be regarded as a maturing industry. Typical maturity in an industry would include minimal technological advance but this was not the case. Within the industry, change has been endemic. The slow-down in the 1970s was a reflection of overcapacity and lower demand growth in comparison with earlier periods (Wittcoff, 1992). Technological advance continues to be a driving force in the competitive relations between firms, although in recent years the basis of this competition has shifted away from the discovery of new chemical entities towards process design and catalyst development for the production of known chemical entities. For example 'advanced materials' have aroused much interest in recent years. Engineering polymers which fall within this category are typical of the current emphasis on 'stretching' the capabilities of known chemical products.

Biotechnology has also attracted considerable interest, particularly in the early 1980s as a potential entry point for a new round of growth in the chemical industry. Pharmaceuticals and agrochemicals were expected to be the main beneficiaries of this new growth. Although it has not lived up to those expectations, considerable R&D investment in this area continues. New chemical entity R&D is almost wholly restricted to pharmaceuticals and agrochemicals which are comparatively small sectors of the wider chemical industry.

Despite less spectacular rewards from its R&D efforts in recent years, the chemical industry remains characterised by high levels of R&D spending. The largest three companies spent between 4.4% and 6.6% of sales on R&D in 1990. Spending on R&D in pharmaceuticals is higher, about 10-12% of turnover (UNIDO, 1992:7).

Historically the industry has been concentrated in three areas of the world, Western Europe, North America and Japan (the Triad). Together they accounted for 66.8% of demand in 1989 but only 15.8% of world population (see Table 1.1).

Table 1.1 World Chemical Demand and Population (Percent)

	Demand 1989	Population 1987
Western Europe	27.4	7.8
North America	23.1	5.5
Japan	16.3	2.5
Eastern Europe	15.2	8.1
Central South America	4.7	8.6
Other Asia Pacific a\	4.2	7.6
Indian sub continent	2.3	22.4
Africa	1.8	14.5 b\
Rest of world	5.0	23.0 c\
	100.0	100.0

Sources: Demand: European Chemical News, 22-1-90.
Population: UNIDO, 1989:31.

Notes:
a\ Excludes China. Chemical demand in China estimated at $30bn in 1988.
b\ Includes Western Asia.
c\ Includes China (21.9%).

Although the chemical industry is regarded as maturing, it is evident from Table 1.1 that it has large potential for expansion of its current range of products outside the Triad, should economic growth rates there permit. China and India are potentially large consumers of chemicals. As economic progress is made in those countries, particularly China, chemical markets are expanding. The scale of these emerging markets is influencing the strategic view of some global players in the industry. In turn this is contributing to changes in the structure of the industry as it moves closer to expanding markets and away from regions with stricter environmental regulations.

Historically world chemical production has been concentrated in the Triad, even more so than demand. The European Community remains the largest producer area with an annual turnover of around $350 billion in 1989. The second largest producer region is the USA with turnover of $258 billion (1989). Japan, the third largest producer at $188 billion is still a long way ahead of South Africa with turnover of a mere $10 billion (both 1989) (ICEF, 1992, and CSS, 1990).

The traditional dominance of chemical production by the Triad countries is being challenged by changes in feedstock availability and price, differential rates of economic growth and environmental pressures. Instrumental in the changing structure of the global chemical industry has been the growing participation of developing countries and regions such as Saudi Arabia and other Gulf states, South East Asia, Nigeria, Trinidad, Thailand, Brazil, Venezuela, and Indonesia. This process is eroding the traditional dominance of the Triad. The favourable balance of chemical trade which the Triad regions traditionally enjoyed is expected to continue to decline in future. Indeed Japan is already feeling the effects of the changing global geography of the chemical industry and is, according to Wittcoff, "no longer a factor in world (chemical) trade" (Wittcoff, 1992:1-1).

As the industry has grown from its early beginnings it has diversified into a wide range of activities, from straightforward bulk chemicals such as sulphuric acid to highly specialised 'designer' drugs which may involve up to thirty different manufacturing steps. This diversity is apparent in the Standard Industrial Classification (SIC) of the chemical industry (see Table 1.2). The focus of this study is commodity plastics. Their raw materials originate within SIC 35119, Basic Industrial Chemicals. These raw materials supply SIC 3513, Synthetic Resins and Plastic Raw Materials, Man-made Fibres (hereinafter referred to as plastic raw materials) which in turn supply raw materials to SIC 356, Plastic Products not elsewhere classified (nec).

From each point in the production chain, or sub-sector of industry identified above, there is a more elaborate branching of the chemical intermediate inputs into other parts of the chemical industry and indeed many other industries in a complex diverse way.

NB The relative proportions of production by sectors of the industry and the markets served by the industry may be observed in Table 1.3. Consumer goods comprise less than one third of end use markets. Table 1.3 also underlines the importance of the industry as a supplier of intermediate inputs to other important sectors and industries.

The chemical industry, like much of social science, is illusive of neat categorisation. Petrochemicals are a case in point. In Table 1.3 petrochemicals permeate a number of output sectors; plastics, inorganics, fertilizers, detergents, paints, fibres and dyes. What is evident is that upstream basic chemicals, organics and plastics in primary form, which fall within the scope of this study, together comprise 32% of output, a substantial share of the industry.

The pre-eminence of the organic and plastic industries within the chemical industry is a relatively recent phenomenon and is described below.

Table 1.2. Chemical Industry Sectors

SIC Number	Major group	Group	Sub-group
351	Industrial Chemicals		
3511		Basic industrial chemicals	
35110			Tanning Extract
35119			Other Basic Industrial Chemicals
3512		Fertilizers & agrochemicals	
35120			Fertilizers
35121			Pesticides, Insecticides, Fungicides, Herbicides
3513		Synthetic resins & plastic raw materials, man-made fibres	
352	Other Chemical Products		
3521		Paints varnishes lacquers	
3522		Medicinal pharmaceutical	
3523		Soaps cosmetics cleaning preparations	
35230			Soap other cleaning compounds and candles
35231			Perfumes, cosmetics, & other toilet preparations
3529		Chemical products NEC	
35290		Polishes waxes dressings	
35291		Inks	
35292		Matches	
35293		Explosives	
35294		Adhesives, glues sizes and cements	
35299		Other chemical products NEC	
356	Plastic Products (nec)		

Source: Central Statistical Services, 1988.

Table 1.3 EC Chemical Industry Output and End Use Markets

OUTPUT	%	END USE MARKET	%
Organics	19	Consumer Goods	27.4
Pharmaceutical	15	Services	19.2
Plastics (primary)	13	Agriculture	10.3
Inorganics	8	Textile/clothing	6.6
Fertilizers	7	Metal industry	6.5
Perfumes & Cosmetics	5	Construction	5.7
Detergents	4	Paper & Printing	3.9
Paints	4	Electrical/Electronic industries	3.8
Fibres	4	Auto industry	3.6
Dyes	2	Food industry	3.1
Others	19	Mechanical engineering	2.4
		Others	7.5
	100		100.0

Source: European Chemical Industry Association quoted in Chemical Survey, Financial Times, 13-7-91.

Historical Overview of the Global Chemical Industry

Scholarship has not been able to trace the emergence of the use of chemicals by humankind back to its origins. From the time of written records there is evidence of the use of chemicals as tools to improve lifestyle. Chaucer's vibrant but succinct account of the state of the chemical industry in his time reminds us of the ancient origins of this art which has become a science.

Oure fourneys eek of calcinacioun,
And of watres albificacioun;
Unslekked lym, chalk, and gleyre of an ey,
Poudres diverse, asshes, donge, pisse, and cley,
Cered pokkets, sal peter, vitriole,
And diverse fires maad of wode and cole:
Sal tartre, alkaly, and sal preparat,
And combust materes and coagulat;
Cley maad with hors or mannes heer, and oile
Of tartre, alum glas, berme, wort, and argoille,
Resalgar, and oure materes enbibyng
And eek of oure materes encorporyng,
And of oure silver citrinacioun,
Oure cementyng and fermentacioun,

Oure ygnottes, testes, and many mo.

The Canon's Yeoman's Tale
Geoffrey Chaucer

Although the chemical industry is often seen as an industry of science there remain nevertheless, in my experience, a good many chemical engineers who still maintain that the operation of their plants is an acquired art rather than a science! Chemical reactions which are known are carried out although they are not always fully understood.

Much early chemical use appears to have grown up around the working of metals such as gold, silver, tin, iron, lead and mercury. Also in use from the time of the earliest records were chemicals such as salt, soda, potash and others. Organic chemicals when they came into use were largely extracted from 'natural' organic substances such as vegetable dyes, sugar, products of alcohol and acetic fermentation, oils, fats and waxes. The early origins of organic chemistry in these 'natural' products account for the references to materials based upon oil and gas as 'synthetic' today. This is despite the fact that (organic) crude oil and natural gas are just as 'natural' as plants and animals.

Advances in chemistry tended to be the pursuit of isolated individuals until 1660 when the Royal Society was founded in London. This provided a forum for the exchange of ideas among scientists at a time when the rate of change in forms of production and consumption began to accelerate in Western Europe.

The advent of the Industrial Revolution from about 1760 onwards and the rapid expansion in the textile industry that accompanied it, made new demands upon the chemical industry in particular for bleaching and washing agents. Demand for soap grew.[1]

The chlor-alkali nexus provided products which radiated out into a variety of industries. Chlorine, a mainstay in bleaching processes to this day, was discovered. Soda was a much sought after chemical for its role in the paper, glass, textile and soap industries. The struggle for dominance among two competing technologies in the production of this important basic product, the Leblanc (1700s) and Solvay (1863) processes, and the chemical conglomerates which hitched their fortunes to these processes ultimately led to a merger of companies in 1926 to form what is today known as Imperial Chemical Industries (ICI)

1. Historically soap had been known since Sumerian times, when it was made from animal fats and oils. The emergence of a new crude oil based chemistry has resulted in these traditional raw materials being challenged by oil based chemicals. The trend to "Green" values in recent years in some consumer markets has led to an interesting struggle between the 'more natural' plant and animal oils and the 'synthetic' crude oil based products.

(Williams, 1972). Currently ICI is the largest manufacturing concern in the UK.

The importance of the chlor-alkali industry has not diminished with time. Just as it was at the heart of corporate restructuring in the UK in the 1920s, so is it at the heart of the corporate restructuring which occurred in South Africa in mid 1993 (discussed more fully in later chapters). ICI holds 38% of AECI which is the largest chemical company in South Africa and an important producer of chlor-alkali products. One of the by-products from AECI's chlor-alkali complex, chlorine, is a major raw material in the manufacture of polyvinyl chloride commonly known as PVC. (PVC is one of the commodity plastics which are the focus of this study.)

At the time Solvay recognised the advantage of his process and set about constructing a global manufacturing and marketing cartel, a practice many have attempted to follow through the history of the chemical industry.

Dyes were important to the textile industry and consequently to the chemical industry as well. Although dyeing cloth was an ancient art, long known dyes like indigo (woad) were challenged by organic chemical dyes in the latter half of the 1800s. During this period up until World War One, Germany excelled at this new dyestuff chemistry. The companies established at this time were the antecedents of what are today the world's three largest chemical companies, BASF, Hoechst and Bayer.

A trend apparent even in this brief account thus far, is the manner in which demands from other industries closer to consumers, helped to shape the chemical industry into a supplier of intermediate inputs. This characteristic is, as has been pointed out, still largely true today.

Another constantly recurring theme in the history of the chemical industry's evolution is the use of by-products. Chemical reactions tend to result not only in the desired product but also in one or more by-products. The costs of disposing of these by-products, or the opportunities to make something useful out of them, today called 'co-products', can often make the difference between success or failure in chemical project economics.

An example of the effective use of by-products is the discovery of carbolic acid (called phenol today) in 1865. The new and growing town gas industry produced coal tar as a by-product from which phenols were extracted. The use of carbolic acid initially as a disinfectant gave way to a host of other uses. Today phenol is used in dyes, explosives, pharmaceuticals, and perfumes. Phenol is also the basis for an early plastic known as 'Bakelite' developed in the 1920s. Just as coal based town gas producers found a valuable by-product in phenol, so too today does the coal based SASOL produce phenols from its by-products. Today phenols are precursors to phenolic and epoxy resins, caprolactum (in turn a precursor to nylon 66) and bisphenol A.

Another important influence in stimulating the development of the chemical industry has been the role of wars. This has had a number of general effects upon the industry. From the public's point of view perhaps the most emotive and shocking has been the development of new and terrible poisons as weapons of war. From the point of view of science, the demands of war have driven the industry to new heights of discovery. Economists on the other hand have drawn attention to the effect wars have had on the subsequent ownership structure of industry. A few examples illustrate this point.

Alfred Nobel isolated nitroglycerine in the early 1900's, but the favoured explosive for military purposes in 1914 was trinitrotoluene (TNT).[2] Such was the demand for toluene that an entire refinery was removed from neutral Holland and rebuilt in the UK shortly before World War I (WW1). The war also made Germany acutely aware of its vulnerability in relying upon Chilean saltpetre (potassium nitrate) as a source of gun powder. Fritz Haber, on a grant from BASF, had fixed nitrogen as ammonia in 1909 but it was left to a young engineer, Bosch, to commercialise the process, which he did by 1913. The difficulties in combining hydrogen and nitrogen to form ammonia (NH_4) were only overcome with the use of unprecedentedly high pressures and temperatures. This has become known as the legendary Haber-Bosch process. Of great importance was the fact that this process broke the link between nitrates (for fertilizer and explosives) and coke oven feedstocks and allowed the harnessing of alternative feedstocks. This allowed nitrogen based fertilizers and explosives to grow beyond the limited supplies of coke oven ammonia supply. It provided the basis for producing nitrates (for explosives) which Bosch's plant did in large volumes during the course of WW1.[3] (Today about 80% of ammonia is used to manufacture fertilizers.)

Another area of the chemical industry to benefit from WW1 was gas. It was Haber himself, at Ypres in Belgium, who released the first chlorine gas which blew over Allied troops in the trenches (Borkin, 1977:17). In the US, early attempts by Union Carbide to produce ethylene (the most important organic chemical building block today) were associated with a mustard gas project during WW1.

Germany's lack of natural rubber also drove the development of synthetic rubber

2. Toluene is one of the seven basic building blocks in the organic chemical industry (see Annexure D).

3. BASF's Haber-Bosch synthetic nitrate plant at Oppau also has its place in history as a source of death and destruction by different means. In 1921 it was ripped apart by a massive explosion, killing 600 workers and injuring a further 2 000, the largest industrial accident in history at the time (Borkin, 1977).

during the War. Although a hard rubber was produced by BASF and Bayer, the breakthrough to rubber soft enough for motor car tyres had to wait for a second world war when gas manufacture also took a new turn.

In the wake of WW1 ownership in the industry became more concentrated in response to the chemical progress which had been made during the war. This concentration in turn helped to provide a chemical industry base for the next World War just over two decades later. In Germany various companies, including Bayer, BASF and Hoechst merged into IG Farben-Industrie which played such an important role in the German war effort during World War Two (WW2).

Other chemical conglomerates emerged in the wake of WW1 which remain household names to this day, for example ICI in the UK and Du Pont in the USA. In all "The war of 1914-18 completely revolutionised the chemical industry and marked the end of an epoch." (Williams, 1972:87).

During the inter-war years the lessons of shortages and the need for self sufficiency were put into practice. For example in 1933 the British government guaranteed preference for the domestic production of petrol from coal which led in 1935 to a 150 000 tpa plant being opened at Billingham. Twenty years later this same lesson was again put into practice, in South Africa this time, when SASOL 1 began to produce petrol from coal.

The inter war years were also the heyday of the global cartels, agreed 'spheres of interest' and 'co-operation' between companies in the chemical industry. Such anti-competitive behaviour was pervasive business practice (Spitz, 1988). The cartel system "suited an industry that frowned upon unseemly competitive behaviour." (Ibid:225).

There is a certain logic to the formation of cartels which is inherent in the nature of many basic chemical products. Capital intensity and economies of scale dictate that there will be a limited number of producers of a particular commodity product. This was especially so in the depressed economic conditions of the 1930s. Markets too were much smaller then and consequently producers were also fewer. An intermediate commodity input such as soda ash for glass manufacture is required in certain volumes (has inelastic demand) depending upon the demand for glass.[4] Competition among soda ash suppliers may only result in a limited drop in the glass price, with limited effect upon the demand for soda ash or glass. Lower soda ash prices may instead be simply absorbed by glass producers as additional profit. The net result for soda ash producers would be lower revenues for similar volumes of soda ash.

4. The characteristics of commodity production are considered in more detail in a later section dealing with commodity and speciality chemicals.

The rise of giant multinational chemical companies is inextricably linked to the cartelization of certain chemical markets. For example in 1925 several German chemical companies formed IG Farben, the world's largest chemical cartel at that time. Shortly thereafter in 1926 four companies came together to form a defensive cartel in the UK under the name ICI, to defend their export markets. Discussions between ICI, Du Pont in the US and IG Farben quickly followed in what ICI's first President, Sir Harry McGowan, described as "only the first step in a comprehensive scheme...to rationalise the chemical manufacture of the world" (Financial Times, 31-7-92). ICI developed a reputation as a company which preferred to avoid competition. In 1935 ICI and IG Farben reached agreement on a division of the global nitrogen market (an important input for fertilizer). Later McGowan wrote that he did not accept "the theory.. that competition is essential to efficiency." (Ibid).

In the late 1930s the Roosevelt administration began attacking price fixing and market sharing agreements in the US. The Sherman and Clayton Acts (in the USA) and article 85 of the Treaty of Rome (in the European Common Market) were the principal anti-cartel measures. After the Second World War US anti-trust actions legally ended hundreds of agreements concerning competition (or the lack of it) between Du Pont and ICI. This together with the increasing number of competitors in the post World War 2 (WW2) economic growth phase made cartels more difficult to manage. Despite this anti-competitive behaviour cartels continue to occur in the chemical industry and are discussed in Chapter Two.

The chemical industry was also dramatically changed by WW2. It was remarkable in that it ushered in a wide ranging revolution in the industry, principally the petrochemicals era, which remains a dominant sector of the industry to this day. What brought about the introduction of petrochemical production? There is no simple explanation. Spitz concludes:

> "in the final analysis ....conditions were ripe for a change in the technology and feedstocks for the production of organic intermediates." (Spitz, 1988:63).

In the period before WW2 a number of developments had occurred which served to set the stage for the chemical industry's reorientation during and after the war. Catalytic crackers came into use which were far more sophisticated than the thermal crackers which had been in use since the 1920s. Importantly catalytic crackers provided much larger volumes of olefins which would become important during WW2.

The development of new products which found a large market in war materials is another example. In 1939 IG Farben (BASF) the inventor of nylon 6 and Du Pont the inventor of nylon 66 entered into a cross licensing agreement. This made both of the chemical routes to synthetic (nylon) parachutes and stockings available on both sides of the Atlantic.

As WW2 commenced, the USA was particularly well placed to develop petrochemicals. It was not involved in the War at that time, it had local feedstocks (oil and gas), and a developed manufacturing base with its attendant research and development capacity. The single largest boost to the petrochemical industry was the war time need to produce synthetic rubber and high octane gasoline for aircraft engines. These stimuli were particularly important in both in the USA and Germany. Germany was cut off from supplies of natural rubber. In response IG Farben developed the famous Buna-S synthetic rubber (a mixture of styrene and butadiene) from acetylene feedstocks.[5] The chemical industry played an important role in providing the German War effort with synthetic fuel and synthetic rubber from coal. Also manufactured in its factories was the infamous Zyklon B gas used in the gas ovens at Auschwitz to exterminate Jews (Borkin, 1977). Several of IG Farben's directors were subsequently convicted at the Nuremburg trials.

During WW2 the USA government had required large chemical firms to build large plants in order to meet war needs and after the war they were handed over to these companies thus providing the production base for the period of rapid growth that followed. During and after the War the US petrochemical industry received a further boost. This took the form of a great infusion of German chemical knowledge. This knowledge came from two sources: the nationalisation of German plants in the US and several US C.I.O. teams which investigated the German chemical industry immediately after the war and returned to the USA with a large collection of documentary information on advances made by the German chemical industry during the war. The US chemical industry was fortunate to have all the requirements for growth in place: pent up demand, new knowledge, large cheap plants, competition subdued (Germany), and local feedstocks. It is not surprising that the US petrochemical industry surged ahead in the post war period.

The engine of this growth was commodity plastics. Between 1940 and 1950 US thermoplastic production volumes increased 25 times and thermoset plastics 2.9 times (Spitz, 1988:229). Plastics which had been developed during the war found new markets in a wide range of peace time applications after the war. The plastics industry grew faster than any other industry in the immediate post WW2 period.

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5. An attempt was made, for similar reasons, to give a much improved version of this type of technology (ultimately coal based) a new lease of life in SA at Sentrachem's Newcastle polyisoprene plant in the late 1980s. It proved unprofitable and was closed.

Historical Background to Plastics

To place the plastic industry in some historical and developmental perspective it is necessary to go back some 300 years to the 1700s. Some of the breakthroughs in the early development of plastics are listed in Table 1.4. Plastics at this time were made largely from natural materials. This first phase of plastics relied upon cellulose. In the early 1900s synthetic plastics began to overtake their predecessors. These synthetic thermoset (see glossary) plastics constitute a second stage of plastics development. Output remained relatively small until the end of WW2.

Table 1.4 Breakthroughs in the Early History of (cellulosic) Plastics

DATE	DISCOVERY
1700s	Shellac
1839	Charles Goodyear adds sulphur to rubber, to make stronger rubber.
1846	Nitrocellulose discovered by Alexander Parkes
1851	Nelson Goodyear adds more sulphur to rubber to make ebonite.
1868	Celluloid discovered
1892	Rayon
1889	Acetate silk (Bayer)
1914	Cellophane
post WW1	Celanese (for cellulose + ease of care)

Both the early natural (cellulosic) and synthetic plastics were thermosets. Synthetic thermosets began with Dr Bakeland's discovery of Bakelite, a phenol formaldehyde resin in 1905. Up until the 1920's the feedstock for formaldehyde was the destructive distillation of wood to methanol. Later coke and natural gas reforming replaced methanol. In 1928 the famous 'Beetle' (amino formaldehyde) resins were commercialised in the UK.[6] In the US American Cyanamid later produced 'Formica' a similar hard resin.

The limitations of the hard and inflexible thermoset plastics were overcome with the development of thermoplastics and it was to this rising star that the post WW2 petrochemicals expansion was firmly hitched. This third phase in plastics development, thermoplastics, is still the dominant phase. One of the oldest thermoplastics is PVC. It is another example of a

6. Beetle resins are still produced by British Industrial Plastics in Pinetown SA.

chemical product which has its origins in a surplus 'by-product'. The advent of electric power led to the demise of acetylene lamps in the UK. This change in energy sources gave rise to an excess of acetylene. The availability of acetylene feedstock led to the development by 1909 of vinyl chloride monomer (VCM) the precursor to PVC. Similar developments were occurring elsewhere.

In the US, Union Carbide had produced ethylene di-chloride (EDC) as a waste by product (very cheap) which was 'cracked' to VCM in the late 1920s. In Germany at the same time the manufacture of acetylene based buna rubber led to surplus acetylene capacity which was exploited to make PVC.[7] PVC use was limited to rigid applications until the 1930s when plasticisers were developed enabling more flexible PVC to be made. Rubber shortages during WW2 created the space for PVC products to demonstrate their superiority in certain applications.

Another early commodity plastic to be developed was polystyrene. It is made from styrene which had been first isolated in 1831. But it was not until 1925 that the first polystyrene (PS) plant was built. It was not a great success. However the key determinant in the development of PS, was the need for synthetic rubber. Manufacture of synthetic rubber created a demand for styrene capacity (a precursor to synthetic rubber) which could then also be used in other applications. In the 1930s both IG Farben (in Germany) and Dow (in the US) built PS plants. PS demand during the war created a large capacity which at war-end needed a market.

During the early 1930s, Du Pont in the US, searching for a substitute for silk, discovered the first polyamide or nylon 66. Only a few months later German researchers discovered nylon 6 via a different chemical route. Also at this time ICI in the UK discovered 'Perspex' (polymethyl methacrylate) and produced it commercially in 1934. Its shatterproof qualities were soon in vast demand, which was further boosted a few years later by the need for aircraft canopies.

Polyethylene has been the engine of growth in the petrochemical and plastic industries. Low density polyethylene (LDPE) was discovered by ICI in the 1933 when an autoclave of ethylene under pressure exploded. The material remaining in the autoclave was polyethylene. This is just one of several chemical breakthroughs in the history of the chemical industry which occurred by accident. Manufacture of LDPE was only commercialised in 1945 and then took several years to break through from specialised military-type applications to

7. In the late 1970s AECI built an acetylene based PVC plant in Sasolburg SA which is still the major source of SA's PVC.

consumer applications. It is a continuation of the high pressure chemistry tradition requiring pressures of between 1 000 and 3 000 atmospheres and temperatures in the 100-200^{0}C range. In 1958 high density polyethylene (HDPE) was commercialised using processes at ambient temperature and atmospheric pressure following Dr Karl Ziegler's breakthrough in catalyst technology. Ziegler's breakthrough had an important application in soaps and detergents which allowed synthetic alcohols to challenge the place of natural products such as coconut kernels and tallow. An Italian scientist, Natte, working for Montecatini recognised the potential of Ziegler's discovery. By applying it to propylene he was able to produce polypropylene (PP), which was first commercialised in 1957. Montecatini (through the state owned ENI) remains a world leader in PP development and the largest producer. The last of the major thermoplastics to be added to the list was linear low density polyethylene (LLDPE) in 1977 by Union Carbide using the 'Unipol' low pressure process. This was intended as a low pressure process substitute to the high pressure LDPE.

These six thermoplastics LDPE, LLDPE, HDPE, PP, PVC and PS (referred to hereinafter as the commodity plastics) were the foundations upon which the substitution of wood, glass, paper and metal products grew apace in the post WW2 period and is still proceeding to this day. These commodity plastics are the major focus of this study.

The substitution of plastics for other materials was facilitated by certain factors such as the available plant machinery and equipment, a drop in the price of ethylene and existing chlor-alkali complexes producing soda ash with cheap chlorine by-products (for PVC). The Korean war gave a further boost to the chemical industry and by 1979 the volume of all plastics materials exceeded the production of iron and steel (Spitz, 1988).

From Coal to Oil

At the end of WW2 the petrochemical industry was largely an American industry. In the post war period the chemical industry underwent another round of restructuring. The size of the industry attracted some large oil companies which forward integrated into petrochemicals. Some chemical companies expanded in the opposite direction and back integrated into oil. However the major restructuring arose from a change in feedstocks which occurred on a wide scale in Europe and Japan.

The history of the West European and Japanese chemical industries over the 1945-60 period is dominated by the switch from coal based to oil and gas based petrochemical production. This took longer than in the US as neither location had a ready supply of feedstocks. One of the factors driving the change, along with costs, was the lack of local supplies of natural fibres. This facilitated the switch to synthetic fibres which in turn encouraged the development of other petrochemicals.

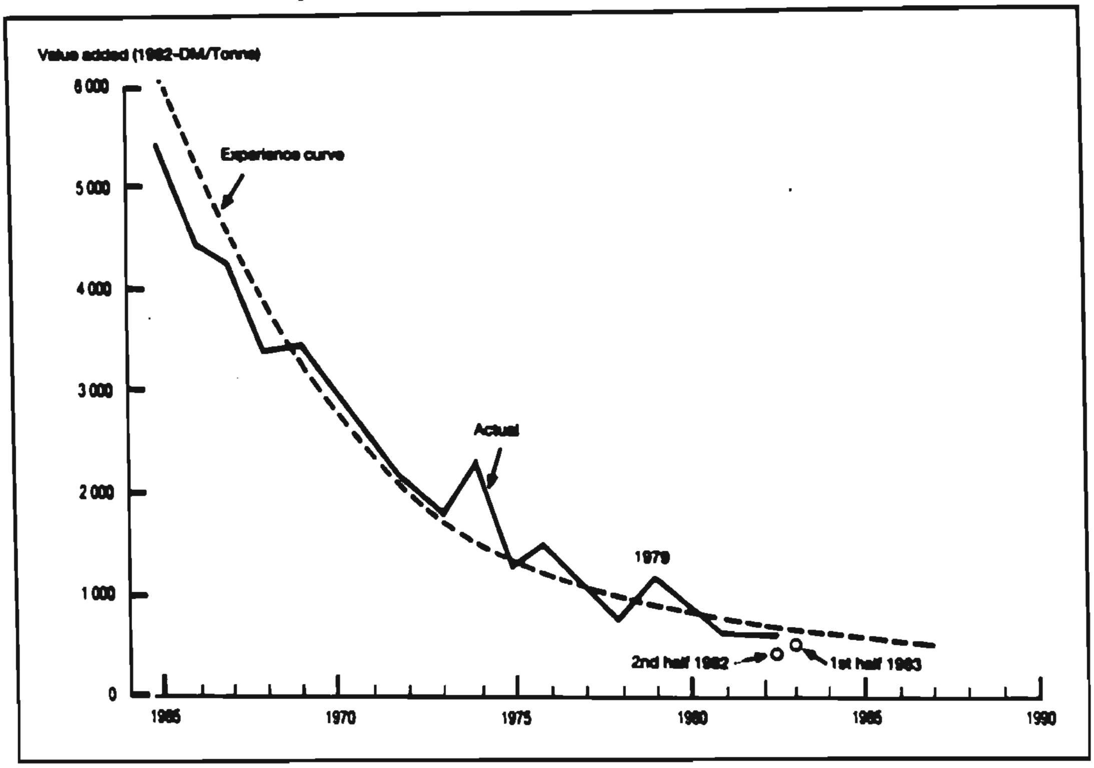
By 1960 Germany was only 40% dependent upon petroleum for organic chemicals (with 60% from coal) whilst the US was 80% dependent upon petroleum. In the UK the switch was faster. From being two thirds dependent upon coal in 1954, only half of chemicals were coal based by 1959.

The feedstock switch in Europe was speeded up by the entry of US firms into Europe from the late 1950s to the early 1970s. They had been more profitable than their European competitors during the 1960s and had gained a lead in the industry. Japanese chemical output had been more than halved by the end of the war, but following a MITI study in the late 1950s three large petrochemical complexes were started based upon imported naphtha. Other late starters into the petrochemical business were the East European countries in the 1960s and the oil-rich Gulf states in the 1970s and 1980s. (Recent trends in globalisation are dealt with more fully in Chapter Two.)

Maturity?

The strong and steady growth in the petrochemical industry in the developed economies eventually began to run into difficulties in the early 1970s. A number of factors accounted for this. Something of a ceiling was reached in the economies of scale arising from what had been ever increasing plant capacities. Rates of growth and profitability were declining and new discoveries were tailing off (Oman, 1989). Value added was declining (see Figure 2). The social costs of toxic emissions into the environment and health and safety issues among the workforce began to catch up with the industry. This together with the effect of napalm bombing in Vietnam, removed the lustre from the eyes of the public and some investors. Simultaneously the industry had been globalising and there had been particularly strong growth in Western Europe, to the point where certain US companies withdrew as a result of the fierce competition there. Rates of growth in the industry also began to decline as markets matured.

Figure 2 Western Europe, Integrated Ethylene/LDPE Trend in Value Added per Tonne of LDPE.



Source: David R. Clair, Essochem Europe Inc., in Oman, 1989:135

The single most important factor was the 1973 oil price shock which was in part an attempt by OPEC producers to protect real oil prices which had been falling since the 1950s. This raised feedstock and energy costs, reduced demand and compounded the tendency which had begun in the late 1960s for profitability to fall. Accompanying these developments were increased discoveries of oil and gas, for example in Mexico, and the entry of developing country producers into the world markets. In 1978 a second oil price shock occurred when the Shah of Iran was forced to flee. The two oil shocks brought a latent crisis to a head. Profitability in the petrochemical industry declined during the 1970s and the 1980s.

All of these factors in the 1970s contributed to the petrochemical industry's transition from orderly and steady growth to an industry characterised by uncertainty and change with large fluctuations in profitability. The latter were evident when, against the longer term trend, 1974 and 1979 were the best years the industry had enjoyed for a considerable time. By the early 1980s it was seen by some as an industry in advanced maturity or even decline (Spitz, 1988:504).

The different feedstock basis of European and Japanese petrochemical industries compared with the US industry resulted in the oil shocks impacting differently. Europe and Japan were predominantly dependent upon naphtha as a feedstock whereas the US had its own natural gas (ethane) resources. This led to substantial differences in the competitive positions of the European, Japanese and US industries. The two oil shocks weakened the European and Japanese industries before they were threatened by competition from low cost associated gas producers in Saudi Arabia. A European and Japanese recovery was facilitated by deregulation in the US oil industry and a rise in the US dollar exchange rate.

The global recession of 1981-82 brought some of the uncertainties of the 1970s to an end. But changes continued. The recession caused restructuring on a global scale. In certain countries in Europe and in Japan it occurred with state assistance. This restructuring led to large closures of capacity and concentrations of ownership in product sectors. It also contributed to a developing shift in the geographic location of the petrochemical industry. Perhaps the most dramatic example of this is the shift in synthetic fibres capacity from the Triad to newly industrialising countries (discussed below).

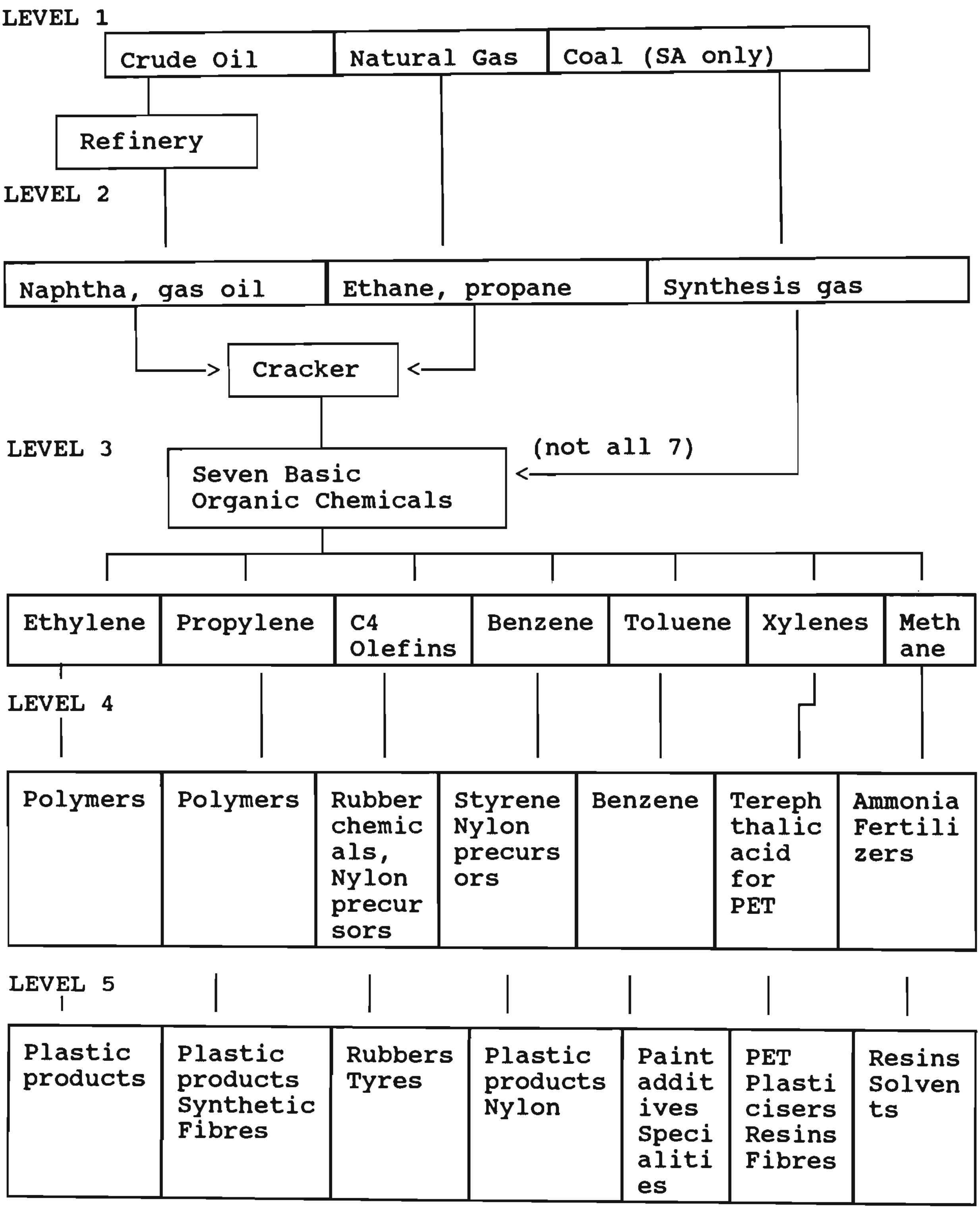
What forces or phenomena had driven the industry to the point it had reached by the early 1980s that such wide ranging restructuring was necessary? There are of course no simple answers. The answers are bound up with such issues as technology transfer, technological developments, growing capacity in newly industrialising countries, lower barriers to entry and changing patterns in feedstock supplies and costs. The role of independent engineering firms (ie non petrochemical producers) which have as their business objective the erection of new capacity without the responsibility of selling the output from such facilities contributed to overcapacity which threatened profitability. Mistaken corporate strategies in dealing with issues such as diversification also played a role. In the final analysis Spitz pins his answer on "extreme, sometimes irrational competition, the root cause of low profitability." (Spitz, 1988:538). Other industry analysts such as Wamsley concur (Interview, Wamsley). Whilst there appears to be an element of truth in this explanation Wittcoff (1992) tempers such analyses with the view that imperfect knowledge of the market may also have played a role.

The preceding discussion has charted a course through a very condensed history of the chemical industry up until the early 1980s. It is appropriate now to sketch the petrochemical and plastics production chain and to introduce, briefly, its chief constituent elements.

The Petrochemicals, Polymers and Plastics *filière*

By way of introduction this *filière* is schematically presented in Figure 3. It

Figure 3 Schematic Petrochemicals and Polymers *Filière*



emphasises the petrochemical, polymer and plastic links which are the focus of this study. A great many more products are produced, particularly at levels Four and Five than are reflected in this schematic outline. The chief characteristics of each of the levels are discussed in the sections which follow.

The petrochemical sector is the single largest sector of the chemical industry accounting for 36.5% of world output valued at $414bn in 1989 (Chemical Industries Association, 1990:22). This excludes other major sectors of the industry such as Fertilizers, Artificial Fibres,[8] Soaps and Detergents and Other Chemicals all of which utilize intermediate inputs from the petrochemicals sector. It is thus important for South Africa (and this study) to assess its standing and prospects in this large global industry.

Level 1: Hydrocarbon Sources: Crude Oil, Natural Gas and Coal

The primary petrochemical feedstocks are petroleum (60%), natural gas (39%) and coal a mere 0,2% (SRI International, 1987:300.1001c).

Level 2: Feedstocks

Feedstocks comprise ethane (from natural gas), refinery products such as naphtha and gas oil, propane, liquified petroleum gas, and synthesis gas from synfuels from coal (only in South Africa).

Level 3: The Seven Major Building Blocks

These organic chemical building blocks are the cornerstone of the modern chemical industry. They are mostly, although not all, commodity chemicals and are used as raw materials in the manufacture of other synthetic materials rather than as final products. Note that in the South African case synthesis gas yields only ethylene, propylene and methane and does not yield all seven building blocks.

Level 4: Derivatives

At this level the building blocks are further processed. For example ethylene and

8. The Standard Industrial Classification term is "Man-made" fibres but since this is unacceptable the term "artificial" will be substituted.

propylene are polymerised to polyethylenes and polypropylenes, plastic raw materials, referred to as commodity polymers in this study. These are the raw materials which are converted in the plastic converting industry to various end user products. Each of the seven basic building blocks can be processed to a variety of chemicals. For example C_4 Olefins may be processed to adipic acid, a precursor to nylon 66.

Level 5: Derivative Uses

At this level the commodity polymers are converted to sheeting, film, piping, and many other forms. Common technologies used here are injection moulding and blow moulding. In addition chemical derivatives have other uses. For example a polypropylene derivative acrylonitrile is processed to acrylic fibres.

Level 6: Finished Products

Ultimately the seven basic building blocks and their multitudinous derivatives find applications in a wide range of finished products: packaging film, crates, boxes, cartons, bottles, drums, woven bags, containers, detergents, synthetic lubricants, pipes, sheeting, automotive components, paints, inks, solvents, textile fibres, insulation materials, tyres, rubber goods, furniture, leisure goods, electronics, building materials etc etc. The recycling of post-consumer plastic waste for the manufacture of other products also occurs largely at level 6 although some recycling of 'off specification' product is possible at all manufacturing levels.

The preceding schematic *filière* is intended to provide a framework within which to locate the more detailed discussion of aspects of the various levels which follows.

Hydrocarbon Sources: History and Prospects

Hydrocarbons are the basic raw materials for the petrochemical and plastic industries. Historically they have been available from three distinct sources which have 'driven' the petrochemical industry. Their usage has of course overlapped in time.

Initially in the mid and late 1800s the availability of large volumes of coal tars and coke oven gases provided the basis for the recovery of important petrochemicals such as phenols, benzene etc. Technologies were developed to transform these chemicals into dyestuffs and pharmaceuticals.

A second phase in the historical development of petrochemical feedstocks emerged in the early 1900s with the availability of large volumes of agricultural material from which ethanol was made. Ethanol can be used as a basis for petrochemicals. This is still important in certain countries. For example Brazil's Proalcohol scheme currently provides ethanol from sugar cane to power about one third of its 12 million automobiles. It is also more environment-friendly than oil based petrol (see Homewood, 1993).[9]

A third phase in feedstock sourcing began in the 1920s with the harnessing of crude oil refinery co-products and by-products for petrochemical purposes. Initially the process used was thermal cracking but this was supplanted in the 1930s by steam cracking and this in turn, was sophisticated further by the advent of catalytic cracking in the late 1930s. The major shift occurred in the 1930s and 1940s. For the purposes of this discussion the significant swing in the 1980s to the harnessing of associated gas and natural gas for chemical purposes may be included in this current phase. The development of petrochemical process is schematised in Table 1.5.

Table 1.5 Olefin Supply History

Phase and Source		Olefins Produced	Time Period
1.	Coke-oven operations	Ethylene	18th century to World War II
2.	Ethanol dehydration	Ethylene	1910s to World War II
3.1	Thermal cracking (petroleum fractions)	Ethylene, propylene, butylenes	1920s to World War II
3.2	Steam cracking (natural gas and petroleum fractions)	Ethylene, propylene, butylenes	1930s to present
3.3	Catalytic cracking (petroleum fractions)	Ethylene, propylene, butylenes	1939 to present (propylene, butylenes)

Source: after Spitz, 1988.

The main barrier to the greater use of the vast global coal reserves for petrochemicals has been the capital costs necessary to achieve the requisite high temperatures and pressures. There is little sign that this situation will change in the foreseeable future. South Africa is the only country sourcing a significant proportion of its liquid fuels, petrochemicals and plastics from coal. Despite several severe fluctuations in the price of oil since the early 1970s the

9. A similar project proposed for Natal (SA) was recently rejected by government on grounds of poor financial viability.

petrochemical industry shows no sign of switching back to coal feedstocks.

In a high capital cost industry such as petrochemicals the expected lifespan of feedstock is an important issue. The crucial question is, how long will oil reserves last? This is a much debated and controversial issue. However what is less controversial is the amount of crude oil that is turned to petrochemical purposes. A most remarkable feature of the petrochemical industry is that this giant industry is reliant upon just 7% of crude oil processed for its feedstocks in Western Europe (British Plastics Federation, 1992). This fact, taken together with the fact that petrochemicals command higher prices than petrol, suggests that even under tight crude oil supply conditions, petrochemicals should be assured of feedstock. However, as is so often the case in the chemical industry, it is not the immediately obvious which eventually prevails. In this case the converse may be true because, from a refiner's point of view, it is more worthwhile to produce petrol than naphtha (the feedstock for petrochemicals).

The extent of remaining oil reserves is a controversial question. Projections on the future availability of crude oil, assuming a 3% p.a. increase in global consumption, point to sufficient reserves for several decades to come (van der Pas, 1990). World proven oil reserves amount to 991 011 million barrels. Present output is about 59 million barrels per day, which at a growth rate of 3% p.a. may be projected to last a further 29.3 years.[10] Exall (1992) estimates 40 years.

Natural gas deposits are another source of fuel or petrochemicals. They are being exploited at an increasing rate and the extraction technology is also developing rapidly. World proven gas reserves amount to the energy equivalent of 785 000 million barrels of crude oil. Assuming gas is substituted for crude oil and crude oil demand grows at 3% p.a., then the proven gas reserves may be projected to last a further 24.99 years. Assuming current consumption patterns continue, Exall (1992) estimates approximately 60 years of reserves. The Economist estimated 43.4 years from 1990 (The Economist, 31-8-91:6). Taken together, crude oil and natural gas reserves could meet current demand, growing at 3 % p.a. for a total of a further 54.34 years.[11]

There are several factors overlooked in this rough calculation such as the cost,

10. Data used in these calculations are drawn from United Nations, 1992, Figure V.2., Table V.2, and page 107. It is not clear whether or not these estimates take into account the anticipated oil bonanza expected after further exploration of Russia.

11. Calculated from United Nations (1992) Figure V.2., Table V.2, and page 107.

difficulties of transport and extraction which will influence the final result. Further discoveries are likely to increase the potential lifespan of oil and gas reserves. Projections of global oil and gas reserves are notoriously controversial fields of study and there will doubtless be those that contest the figures used here. Suffice to say that the size of oil and gas reserves is unlikely to be the factor which deters potential investors in large petrochemical projects. If announced petrochemical projects are taken into account in the context of significant world overcapacity then the availability of oil and gas resources fades into insignificance relative to other problems which the industry is likely to encounter (Interview Wamsley).

However in the longer term, the growing pressure of the environmental lobby on hydrocarbon industries is a factor which should not be overlooked. Disasters such as the Exxon Valdez oil spill and public knowledge about the extent of environmental damage associated with oilfields previously part of the USSR, have provoked a new round of pressure (and costs to the industry) for safer and cleaner processes to be used. Quite what the final result of environmental pressure on the hydrocarbon industries will be is uncertain. Nevertheless it seems reasonable to assume that there will be an impact of some type.

Feedstocks, Processes, Building Blocks and Prospects

This section examines feedstocks, building blocks and the processes for extracting building blocks from feedstocks together because in reality they are inextricably interlinked. In the process some key concepts and technical terms are introduced.

Feedstocks

Choice of feedstocks is critically important as they have accounted for up to 70% of total costs (APPE, 1986:9). Steam crackers, the major source of olefins, and limited aromatics, can be designed to use several different feedstocks: ethane, propane, butane, LPG, naphtha or gas oil. These different feedstocks do not give the same yield. Different feedstocks give rise to different proportions of co-product (see Table 1.6) and this can have important implications for the petrochemical industry as we shall see. In brief, selection of feedstock type must take into account the costs and benefits from the co-products that will be generated.

Table 1.6 Typical Cracking Patterns Using Different Feedstocks (in percentage of output)

	Feedstock			
Product	Naphtha	Ethane	Propane	Butane
Hydrogen	3	5	2	4
Methane	13	7	23	20
Ethylene	27	79	43	29
Propylene	14	2	20	16
Propane	2	-	-	2
Butadiene	4	2	3	2
Butenes	6	1	3	13
Raw Gasoline	24	2	4	10
Fuel Oil	5	-	-	2
Losses	2	2	2	2
	100	100	100	100

Source: ICI quoted in Oman, 1989:117.

As is evident from this table naphtha and propane give a spread of desired products whereas ethane (drawn say from natural gas) yields largely ethylene. Propane and butane have the disadvantage of yielding significant proportions of low value methane. Naphtha, by contrast also yields raw gasoline, the source of BTX chemicals, thus providing a full slate of seven building blocks at optimal costs, making it the preferred feedstock in Western Europe and Japan. Naphtha is a crude oil refinery by-product. This returns the discussion to the feedstock driven nature of the industry and the importance of co-products and by-products of other processes.

In the current (third) phase of the petrochemicals feedstock history, it is the growth in demand for automobiles and the accompanying expansion of petrol refining capacity which is providing feedstocks for the petrochemical industry. Crude oil refineries typically produce a range of products. The petrochemical industry must be concerned with the relationship between the prices of the products in this range of products as this effects the availability of feedstock from refineries. Typical relationships are given in Table 1.7. It may be observed in this table that naphtha, the basis of gasoline and also a major source of petrochemicals is not the most valuable product to the refiner and accordingly the refiner must weigh up the costs of further processing it to gasoline against the costs of extracting it and selling it on the merchant market to the petrochemical industry. Refineries do yield small amounts of olefin gases (from which plastic raw materials can be made) which can be extracted where the scale of operations makes this viable. This additional supply source makes a significant difference to the proportions of the seven building blocks available in the USA.

Table 1.7 Refinery Product Price Relationships

Product/crude price ratio per tonne of crude oil	Product
1.4 to 1.5	Motor gasoline
1.3 to 1.4	Jet Kerosene
1.2 to 1.3	Naphtha
1.1 to 1.4	Liquified petroleum gas(LPG)
1.15 to 1.3	Gas oils
0.95 to 0.7	Residual fuels

Source: Wittcoff, 1992:2.4b.

North America differs from Western Europe in the scale of its crude oil refining industry. It alone accounts for about 30% of the world's refinery output (UNIDO, 1990, Table IV.114). Consequently the volume of olefin gas by-products is larger and this is an important source of building blocks for the petrochemical industry.

The availability of natural gas in North America has also altered the output of building blocks. Typically a mixture of ethane and propane gas have been cracked in North America. Thus in North America the availability of feedstocks from crude oil refineries (two sources: naphtha and olefins direct), and natural gas has influenced the composition of the building block slate and its cost structure. These factors together with the United States' large share of world production capacity, caused it, at the end of the 1980s, to be considered the price setter in the industry (Vergara & Babylon, 1990:9).

Building Blocks

In contemporary times the first fundamental step down the petrochemical production chain is the extraction of the seven basic building blocks. These seven basic building blocks account for an extraordinary 90% of the number of organic chemicals! Extraction is by way of three processes, steam cracking (the most important) fluid catalytic cracking (FCC) and catalytic reforming (see Table 1.8). The latter two (fluid catalytic cracking and catalytic reforming) are typically intra-refinery processes.

These seven building blocks are usually separated into two groups, olefins, (ethylene, propylene and C4 olefins) and aromatics (benzene, toluene and xylenes or BTX). Olefins are commonly sourced from crackers outside refineries whilst aromatics are typically refinery products.

Table 1.8 Seven Basic Raw Materials and Sources

Source	Chemical	Source	Generic term
Steam cracking	1) Ethylene		Olefins
	2) Propylene	Fluid Catalytic cracking	
	3) C4 Olefins butadiene		
	isobutene		
Catalytic reforming	4) Benzene	Pyrolysis gasoline	Aromatics
	5) Toluene		
	6) Xylenes		
Natural gas	7) Methane		

The importance of these seven building blocks emerges from the fact that just three (ethylene, propylene, benzene) account for about 75% of all organic chemicals produced. Just one chemical, ethylene, accounts for 10% by volume of all chemicals produced and "That is an important and impressive figure". (Wittcoff, 1992:1.3).

Ethylene's major derivatives, the polyethylenes and polyvinyl chloride (PVC), are the older plastics. They account for 35% and 23% respectively of global plastics production (excluding fibres and elastomers) (Wittcoff, 1992:3.22). The newer and faster growing propylene based polypropylene accounts for 13%. Polystyrene (from benzene and ethylene) accounts for 12%. The remaining 17% of global plastic production is divided among various thermoset plastics (eg polyurethanes) and thermoplastics.

Having outlined the importance of olefins to the commodity plastics industry, the discussion now proceeds to the crucial issues of the inter linkages between feedstocks, building blocks and production processes by way of a recent historical example.

Interlinkages between Feedstocks, Building blocks and Production Processes

In the early 1980s the feedstock cost basis of the industry began to change. Although not as radical as the shift from coal to oil, the new developments nevertheless impacted upon the cost structure of petrochemicals. These changes arose as Saudi Arabian and Canadian producers harnessed associated gas at the (extremely low) equivalent cost of flaring. Associated gas is an 'unwanted' by-product of crude oil recovery. It yields cheap ethylene but no propylene co-product, a point we shall return to shortly. As a consequence of harnessing this very low cost associated gas, low cost ethylene based products entered the world market in 1984-85. This contributed to the closure of considerable capacity in Western Europe as a result of its higher cost, largely naphtha based feedstock. This was significant, because as has been shown, naphtha cracking also yields propylene as a co-product, whereas associated gas does not yield propylene, a point we shall return to shortly. The global building block supply slate had been restructured as a result of a change in feedstocks in some part of the world.

The world economy was recovering at the time and the global supply/demand balance for petrochemical products was tightening, aided by the fact that lower oil prices enabled plastic prices to undercut the prices of rival materials. The result was that during 1987-89, the global petrochemical industry posted record profits. In Europe this profit rebound was aided by tight propylene supplies.

The tight propylene supply arose because as ethylene capacity was closed a proportionate volume of propylene supply was also closed (propylene is a co-product of ethylene from naphtha cracking). But, and here lies the rub, the new (associated gas based) ethylene producers were not producing propylene. As may be expected, it was simply a matter of time before a propylene shortage occurred. Indeed some have suggested that more European ethylene capacity was closed than was necessary, precisely to bring about a propylene shortage in an attempt to recover profits lost on ethylene. None will of course admit to this.

Propylene has traditionally been cheaper than ethylene as it is a naphtha cracking by-product. The European propylene shortage caused propylene prices to exceed ethylene prices in 1991 for the first time, except for a brief period in 1986. Higher propylene prices attracted additional investment in propylene producing capacity which, accompanied by the global recession from 1990, turned the propylene shortage to an oversupply and depressed prices.

Despite these cyclical developments, the long term trend is towards lighter feedstocks such as natural gas (Vergara & Babylon, 1990). But this trend has been slowed by certain factors. The oil price crash in 1986 has lowered naphtha prices. Also the projected polypropylene growth rate is higher than any other commodity plastic. (Parpinelli Tecnon, 1991:1.1) This hope tends to keep naphtha cracker operators from closing marginal plants.

These examples illustrate the complex and apparently contradictory interlinkages operating within the industry as well as the swings in fortune which can occur. In short the cyclical petrochemical business is not for faint-hearted investors. Strategic planning in the global petrochemicals industry, even for a relatively small economy like South Africa, is a complex matter and requires considerable skill and a certain degree of courage and determination.

The long term trend to lighter feedstocks was accompanied by lower world ethylene prices to which the industry has responded in a number of ways. The limited feedstock range for crackers has been widened, (marginally) and product selectivity improved. Flexibility in the capacity to process different feedstocks offers the benefit of being able to take advantage of the shifting relative prices of feedstocks. Technological developments in these areas are likely to be continuing sources of competitive advantage. Vertical integration, and complete co-product integration, for which there is an objective basis in the nature of the products, has allowed intra-company transfer pricing and improved flexibility of product choice. This applies to both refiners who have vertically integrated forward into petrochemicals and plastics manufacture and to cracker operators similarly forward integrated.

For many olefin producers the ideal is to have an intra-firm or captive demand for all petrochemical products so as to avoid having to compete on the less certain merchant market. All the Korean producers for example are now in this situation following a reversal of government policy on this question. Such measures reinforced by the global nature of many of the industry's participants have enabled producers in the Triad to defend their local markets against imports. Western Europe and Japan have been less successful in defending petrochemical export markets.

Petrochemical Capacity and Demand

The inability of the global petrochemical market to balance supply and demand has given rise to recurrent periods of overcapacity. For example the global restructuring in the industry which took place in the early 1980s, led to the closure of approximately 25% of world capacity at that time (Vergara & Brown, 1988).

It is in the course of such restructuring that an important geographical shift in petrochemical capacity has occurred and appears set to continue. Much of the new capacity built during the 1980s has been in the NICs, particularly Asia, the Middle East and South

America. Within a relatively short period of time a much more important shift in the geographic location of production is taking place in petrochemicals than is taking place in most other industrial sectors (Oman 1987).

The period of restructuring in the early 1980s established a foundation for a much tighter demand supply relationship over the 1987 to 1989 period when profits soared before the effects of the current economic downturn began to be felt by the industry in the latter part of 1989. The period of improved profitability induced another round of capacity expansion. Wamsley expects 1995 capacity to exceed 1989 capacity by 47% in polyethylene and 94% in polypropylene (Interview, Wamsley).

In summary the world petrochemical industry that South African producers face in the early 1990s is one of general overcapacity and determined exporters in the Gulf and South East Asia.

Demand for petrochemicals is largely from the plastics and fibres industries, to a lesser extent from the fertiliser, paint, soap and detergents industries and several others. According to Wittcoff (1992) global ethylene demand growth is expected to average 3.45% p.a. between 1986 and 1995 growing slowest in Western Europe at 1.2% p.a. and fastest outside the Triad at 5.25% p.a.. High capacity utilisation rates, generally over 80%, are needed in capital intensive petrochemicals plants for profitability. Current forecasts predict declining capacity utilisation to 1995. (Interview, Wamsley) SRI International expects capacity utilisation rates to fall from 96% in 1988 to 83% in 1992 and to remain in the low 80% percentile up to 1997. (Elsberg 1990) A repetition, although possibly less dramatic than the early 1980s restructuring, appears inevitable, during which low capacity, high cost plants will be closed (Interview, Wamsley). Lower capacity utilisation rates have led to lower profits in the chemical industry in the early 1990s.

The next link in the production chain involves the manufacture of polymer and plastic raw materials from petrochemicals and it is to this that the discussion turns next.

<u>Derivatives: Polymers and Plastics</u>

At this level the building block gases are further processed or polymerised into 'plastic raw materials' or 'polymers' (also referred to as 'resins' in some journals).

Plastics are conventionally grouped into two categories, thermoplastics and thermosets. Thermoplastics can be repeatedly softened by heating and hardened by cooling. Thermosets are infusible and insoluble in their final shape. The latter tend to be the older plastics and constitute a small share, less than 15%, of the plastics market. Several are experiencing limited growth as more advanced thermoplastics are developed and capture their market share. Such trends are evident in the US market (see Table 1.9). These are among the reasons why this study focuses upon the commodity thermoplastics which commanded over 85% of the US plastics market in 1989. In South Africa commodity plastics accounted for about 82% of the plastics market in 1990 (see Table 6.10). The polymer industry is the single largest industrial sector within the organic chemical industry representing about 32% by volume in the US in 1990 (calculated from C&EN June 29, 1992:36-38).[12] The comparable figure for South Africa is probably larger as South Africa does not produce as wide a range of organic chemicals as the US.

Table 1.9 US Polymers Output and Growth

	Billion lb 1989	%	Average annual Growth1979-89 (%)
Thermosetting Resins	**6.39**	**14.1**	**2.8**
Phenols	2.86	6.3	4.9
Urea resins	1.47	3.3	0.7
Polyesters (unsaturated)	1.32	2.9	1.4
Epoxies (unmodified)	0.51	1.1	3.5
Melamine resins	0.23	0.5	1.4
Thermoplastic resins	**38.77**	**85.9**	**3.8**
LDPE	9.73	21.5	2.2
PVC	8.49	18.8	3.3
HDPE	8.1	17.9	4.9
PS	5.1	11.3	2.5
PP	7.35	16.3	6.7
TOTAL	**45.16**	**100.0**	**3.6**

Source: adapted from Reisch, 1990a:15.

Plastics have a very wide range of applications and end uses. Packaging is a major end use, but ultimately the demand pattern in each country is shaped by the nature of the economy and to some extent the ability of the plastic marketing firms. In Table 1.10 plastic end uses for South Africa and the UK are compared. This reveals the South African market to have comparatively weaker engineering and construction demand but stronger agricultural demand.

Thus far plastics have been considered in two categories, thermoplastics and thermosets. There is however a further group of plastics, commonly called engineering plastics which is not easily categorised into one category or the other.

12. Regrettably similar data for South Africa are not available.

Table 1.10 Plastic End Uses (percent)	SA	UK
Packaging	43	36
Engineering/Mining/Construction	16	25
Household/Domestic	14	13
Electrical	8	10
Agriculture	7	2
Transport/Automotive	7	6
Other	5	8
	100	100

Sources: Plastics Federation of South Africa
The British Plastics Federation

Engineering Plastics, Speciality Plastics and Advanced Materials

An extract from a recent issue of Scientific American captures a new relationship between human endeavour and materials within which engineering plastics may be located.

"A fundamental reversal in the relationship between human beings and materials is taking place. Its economic consequences are likely to be profound...it is only recently that advances in the theoretical understanding of the structure of physical and biological matter, in experimental technique and in processing technology have made it possible to start with a need and then develop a material to meet it, atom by atom."

Freeman (1990) has argued that a change in techno-economic paradigm is leading to a major change in the type of materials used in developed economies, particularly in machinery, vehicles and micro-electronic industries. This in turn, he argues, means a shift away from commodity type material products to speciality type materials of varying mixes originating from production facilities which are flexible or capable of varying the type of product they produce. This view is taken further by writers such as Kaounides (1991), who has claimed that a 'materials revolution' has occurred and that the changes new materials are bringing to industrial production are 'revolutionary'. This 'revolutionary' view has been challenged by, for example, Turner et al (1992) who, whilst conceding the strong economic impact of new materials, nevertheless point to the uneven spread and rates diffusion of these new materials across the economy. They conclude that:

"The evidence indicates that the development and diffusion of materials technology, viewed in terms of transforming the economy, have been too little and too uneven to be labelled revolutionary." (Turner et al, 1992:16)

It is not the intention here to enter this debate but simply to flag its existence in order to draw attention to the significance of the advent of new materials in modern industrial production. In this study engineering plastics and speciality plastics are of particular interest among the group of advanced materials. It is the impact such advanced plastic materials have and may be expected to have, on future industrial development in South Africa which is of concern here.

Engineering plastics are not easily defined. They include both thermoplastics and thermosets. Generally they are characterised by their special properties such as: superior strength, impact resistance, heat and abrasion resistance and retention of mechanical and electrical properties. Increasingly they are designed with particular applications in mind.

Some of the more common engineering plastics such as ABS (acrylonitrile-butadiene-styrene) and SAN (styrene acrylonitrile) are used in the appliance and auto industries. They are considered by some to be low end performance polymers, falling just short of engineering plastics status. In South Africa they tend to be regarded as engineering plastics and this will be accepted for simplicity's sake. Nevertheless their increasing usage means that they are in danger of losing their 'engineering' status and becoming commodity plastics.

Other plastics more firmly within the 'engineering' group are; polyacetyls, polyamides (nylons), polyethylene oxides, polyethylene terephthalate (or PET, the material used to manufacture 2 litre Coke bottles), polybutylene terephthalate and polycarbonates (for compact discs and lenses).

Beyond engineering plastics exists a still more exotic group of plastics commonly referred to as 'speciality plastics'. These include polysulphones, polyacylate, polyether sulfone, liquid crystal polymers, polyether ketones and many others. Most are designed with a specific purpose in mind. For example General Electric's Noryl plastics have special flame resistant abilities whilst their Lexan plastic allows a tenfold reduction in plastic bottle weight, an advantage for bottles being transported by air. Such engineering and speciality plastics are considered to be one of the categories of a new breed of materials termed 'advanced materials' (UNIDO, 1989).

Discerning the trends and developments within the specialised area of engineering plastics is not easy. At one general level this sector represents the leading edge of a second round of chemically based substitutes for traditional materials. Despite the widespread interest in their properties, they tend to be considerably more expensive than the commodity polymers and remain at this stage small volume plastics. They accounted for only about 3% of world polymer volumes in 1988 (UNIDO, 1991:341). Growth rates for engineering thermoplastics, although predicted to remain above average, are expected to fall from the 10%-12% p.a. in the 1970s and 1980s, to 6%-7% p.a. in the 1990s (Baker, 1992a:23). Growth rates for engineering thermosets are expected to be lower, for the period 1988 to 1995, at 4.9% p.a..

The global production and consumption of engineering plastics is concentrated in the Triad countries which account for 91% and 86% respectively. However some major firms in this sector are beginning to invest in NICs such as Taiwan, Korea, Brazil and Singapore. It is expected that "the North South production imbalance in these high technology materials will *begin* to correct itself ... towards the year 2000" (my emphasis) (UNIDO, 1990:281).

The top five producers of engineering plastics, BASF, Bayer, Hoechst, Du Pont and General Electric account for 60% of the global market. Among the next nine largest firms are five Japanese firms which is indicative of the direction the Japanese chemical industry is taking (Wittcoff, 1992). This move to higher value added materials is understandable in the light of Japan's heavy reliance upon imported feedstocks. It also has synergies with their electronics and auto industries. The concentration of engineering plastics production in the developed economies is attributable to a number of factors. These include the attempt to move away from cyclical commodity products to speciality type products and the greater R&D capacity necessary to stay ahead of the competition.

Since engineering plastics do not involve the development of new chemicals but rather new applications for combinations of known chemicals and plastics they are, once patented, subject to price pressure from 'me too' imitations which are not prohibitively difficult to make. The state of chemical knowledge is such that once it is known that a particular product can be made it is not too long before others find a way of producing the same or a very similar product. Product life cycles are short and R&D costs are high, factors which tend to shift competitive advantage into areas such as quality and marketing.

The growing costs of R&D and market support have contributed to limited returns on engineering plastics and this is one of the factors acting as a brake upon their expansion. Another factor limiting the volumes of such plastics is their properties, or rather their lack of specific properties at a competitive price. For example in the automobile industry, (the largest end-use sector for engineering plastics) their penetration is limited by their lack of stiffness (or 'buckle') and shear strength. If this obstacle can be overcome at a competitive price, demand is likely to increase considerably (see Amendola, 1990). Overall the trend is to cheaper materials and fewer of them (Baker, 1992a).

Environmental considerations have also retarded applications in the auto industry. The increasing number of different types of plastics in automobiles presents problems for recycling. Ideally auto producers would like one type of plastic which could meet all of their needs. Developments directed at meeting these needs are taking place. For example the commercialisation of a new 'super polyethylene' has been announced by Exxon/Mitsui using their jointly developed metallocene single site catalysts. The target market in this case is film packaging and cable applications. However the important feature of this development, as a pointer towards future developments, is the ability to tailor-make the molecular structure of different grades of the same plastic, using the same equipment, and accordingly offer a polyethylene which can have the properties of all the commodity polyethylenes and some of the more newly developed ones (Wood, 1992). Among the commodity plastics, polypropylene (PP) has been the chief beneficiary of the trend towards fewer materials in auto manufacture. This development has implications for South Africa and SASOL in particular, given its relative polypropylene advantage. These are considered in a subsequent chapter.

As a part of the process of mapping the global petrochemical and plastics industries we have in the foregoing section journeyed to one of the frontiers of this industry. The course of the discussion should now end this recent detour and return to other, more 'mainstream' areas. The next industry to be considered in the logical progression this discussion has been making down the production chain would be the plastic converting industry. However this discussion will be kept in abeyance for a later chapter.

Instead the discussion returns to a discussion left incomplete earlier, that is mapping some of the more recent contours and world trends in the diverse global chemical industry, recommencing with the artificial fibre industry, a portion of the chemical industry which branches off into the textile and garment production chain.

Artificial Fibres

Artificial fibres constitute the chemical industry's attempt to replace natural materials such as cotton, wool and silk with artificial materials. As in many such substitutions of traditional commodities, price was and is a telling factor. Polyester (a synthetic) prices for example dropped steadily from the 1950s to equal cotton prices in the early 1970s. From that time until the late 1980s polyester prices were generally below cotton prices. Acrylic (another synthetic) prices dropped below wool prices in the early 1960s and since the early 1970s have remained substantially cheaper than wool. By 1980 something of a stand-off in market share had occurred between natural and synthetic fibres with natural fibres holding the edge with 53%-54% of the world fibre market. A market split of this order prevailed through the 1980s (The Economist Intelligence Unit, 1991:30).

Artificial fibres comprise two groups: cellulosics and synthetics. Cellulosics (acetates and rayons) are made from dissolving wood pulp. Synthetic fibres such as polyamide (nylons), polyesters (Dacron, Trevira), acrylics (Orlon, Acrilan), Spandex (Lycra), polyethylenes and polypropylene are petrochemical based. Within synthetic fibres, only the latter two have experienced output growth through the 1980s, whilst the others have declined or remained static.

Cellulosic fibres have steadily lost market share to synthetics over the last two decades to the point where synthetics commanded 82% of the artificial fibre market by 1988 (see Table 1.11). In the US synthetics accounted for 94.5% of the market by 1989 (Reisch, 1990a) whereas cellulosic production has been static since 1963 and is facing increasing environmental pressure.

Table 1.11 Artificial Fibre Production, Global share

Type	1970	1975	1980	1985	1988
Cellulosic	43	30	25	20	18
Synthetic	57	70	75	80	82
	100	100	100	100	100

Source: adapted from Akzo quoted in UNIDO, 1989:239.

Overall synthetic fibres have followed a similar growth trajectory to petrochemicals and plastics, with very rapid growth from 1950 to 1970, then slowing to 1980 and slowing further still to 1990.

Within the synthetic fibres group some significant changes in market share have occurred during the 1980s. Nylon and acrylics are losing share to polyester and polypropylene (see Table 1.12). The rapid growth in polypropylene (PP) has been mirrored in South Africa and has important implications for this study, a point which will be pursued later.

Not only have market shares been changing through the 1980s but a rapid restructuring of the sector also occurred over this period. Average growth rates in the output of synthetic fibres over the period 1970 to 1987 in the Triad averaged less than 5% p.a. with Japan achieving only 1.7% p.a.. The highest rates of annual average growth rates over this period have been in China (30%), and other Asian nations (22%) (SRI International, 1989:541.1000 S).

Table 1.12 Western European Market Shares for Synthetic Fibres (percent by weight)

Fibre type	1982	1986	1988	1989
Polyester	36.5	37.0	39.7	41.0
Nylon	26.5	23.8	24.0	23.6
Acrylic	26.2	24.5	18.4	17.4
Other (mostly PP)	10.8	14.7	18.0	18.0
Total	100.0	100.0	100.0	100.0

Source: Wittcoff, 1992:9-18.

In the Triad overcapacity problems which emerged in the 1970s were compounded by the recession in the early 1980s. Simultaneously an expansion of capacity in the NICs was made possible as these countries gained access to technology which became available through the expiry of patents. The result of these changes was a dramatic and wide ranging restructuring of the global artificial fibres industry. In the US, cellulosic capacity plummeted by 54% over the 1979-89 period and Western Europe was particularly hard hit.

In response most governments in the Triad counties intervened in efforts to ameliorate the crisis. In Japan MITI introduced a law prohibiting capacity expansions which was lifted only in 1988. State involvement was most pronounced in Western Europe where the EC competition authorities approved a 'crisis cartel' agreement for the period 1978 to 1982 wherein producers agreed to reduce capacity by 15%. A second agreement ran for the period 1982 to 1985 in which a further reduction of 18% took place. Not all countries were equally affected. The UK was worst affected; 51% of capacity was closed and 76% of jobs lost. Outside of the Triad other governments also stepped in to assist their industries in countries such as Taiwan and Korea. In contrast the US left capacity closure largely to individual firms.

As a result of this restructuring, global capacity utilization improved from about 80% to 85%, with the exception of Taiwan and Korea which maintained an average of about 90%. However the major outcome of the crisis was a massive shift of synthetic fibre production capacity to developing countries. In 1970 the Triad accounted for 79% of world capacity and developing countries a mere 7%. By 1991 the Triad share had shrunk to 43% and the developing countries had risen to about 32.5% (Walker, 1992:34).

The results of this global restructuring are evident in countries like Taiwan. It more than doubled its production between 1980 and 1990 to become the second largest producer of synthetic fibres after the US. Japan is the third largest. Excluding the Triad, the rest of the world's share of production of artificial fibres has increased from 24% in 1970 to 53% in

1990 (Wittcoff, 1992:9-18). In polyester fibres this shift has been even more dramatic; the non-Triad share grew from 13% in 1970 to 64% in 1990.

These shifts in global production have tended to change the markets targeted by West European and Japanese producers. Increasingly they are turning away from commodity type textile products and towards higher value added applications in the industrial and technical markets where the opportunities for product differentiation are greater.

In concluding this discussion of artificial fibres, it is interesting to note the rapid progress Taiwan has made in expanding primary petrochemical capacity for previously imported synthetic fibres (ethylene glycol, terephthalic acid, acrylonitrile). This import substitution was initially in response to demand from the textile industry. It represents an expansion of production capacity in the upstream in response to downstream demand from the textile sector. This is an example of an economic strategy moving from labour intensive production (based on imported intermediate inputs) upstream to capital intensive sectors of production. Initially import substitution in nature, this upstream petrochemical development subsequently grew to compete internationally in its own right. This example is of interest as restructuring appears unavoidable for South Africa's highly protected synthetic fibre industry.[13]

Conclusions

Organic chemicals and petrochemicals are the largest sectors of the diverse international chemical industry. A large proportion of the output of these sectors feeds the plastic industry and within the plastic industry the commodity plastics account for over 80% of the plastics market.

The recession in the early 1980s contributed to a marked surge in the redistribution of global capacity away from the Triad countries to developing countries particularly in synthetic fibres.

The switch from coal to oil in the 1950s had major implications for the industry. This is worth noting because it is a change which still lies ahead of the South African industry. The ceaseless search for the lowest cost point in the terrain of feedstock options is a crucial factor in determining international competitiveness. From a cost of production point of view, (low) feedstock costs and security of supply are prerequisites. Despite uneven progress the

13. Nominal import duties for staple synthetic yarn are 173% (Levy 1992, Table 3.8).

international trend is towards lighter, often gas based, feedstocks.

Critical too in the cost structure and development of the industry has been the existence of by-products and co-products from one process which have met needs for other processes. This means that evaluating petrochemical projects is a necessarily complex undertaking requiring considerable skills and resources. Weakly resourced governments attempting to maintain sovereignty over their industrial strategies for petrochemicals may find this difficult in the face of large and powerful firms.

Other themes are apparent in the historical development of the chemical industry: the manner in which chemical demand has been driven by other industries closer to the customer. In a later chapter the industry's attempts to break through this barrier and get closer to customers so as to meet their specific needs more easily is discussed. The history of the industry reveals the deep historical roots that exist for cartels and other anti-competitive behaviour. This theme too will recur in later chapters.

Finally and perhaps for the South African industry the most significant historical factor to emerge in the historical overview, is the role wars and strategic considerations have played in shaping the nature of the industry and boosting its development. Such considerations have loud echoes in the historical trajectory of the South African petrochemical industry in the 1970s and 1980s as will emerge in subsequent chapters.

The organic chemical industry can be characterised as a maturing industry with ongoing incremental change rather than major breakthroughs. This together with fluctuations in feedstock prices and the commodity nature of the business make it prone to cyclical swings in product prices. The end of the phase of rapid development and healthy profits in petrochemicals in the 1970s brought forth defensive strategies. The major ones include co-product integration, forward and backward integration and attempts to widen the range of feedstocks that can be used in key processes. In addition increased attention has been paid to the development of more specialised engineering plastics and other advanced materials.

The international developments sketched in this chapter provide touchstones against which developments in the South African industry can be contrasted in succeeding chapters. Such developments can also begin to inform analysts of the steps which may be necessary to direct the local industry down a path towards international competitiveness.

In the artificial fibre industry the key trend is away from cellulosics to synthetics. Within synthetics there is a particular world trend that is of importance to the South African commodity polymer industry and that is the recent rapid growth in polypropylene textile applications. This point is taken up in subsequent chapters.

There has been a tendency for the developed economies to move further down the value added chain in petrochemicals to engineering plastics and advanced materials as their traditional dominance has been threatened and/or eroded by producers in developing countries. Japan in particular has followed this route partly because of its higher cost structure arising from its dependence upon imported feedstocks. South Africa could in future become similarly reliant upon imported feedstocks making this a strategy worth noting for future consideration.

CHAPTER 2

THE SOUTH AFRICAN CHEMICAL INDUSTRY IN THE CONTEXT OF RECENT GLOBAL TRENDS IN THE INTERNATIONAL CHEMICAL INDUSTRY

Introduction

This chapter examines some of the major trends apparent in the recent history of the international chemical industry. These trends and forces are not dealt with in great detail. Rather the objective is to sketch the international environment in which the South African chemical industry has operated and to assess the impact on South Africa in relevant instances. South Africa's capabilities and performance are contrasted with international developments in an attempt to locate the domestic industry among its international competitors.

For convenience this chapter is divided into four parts. Part One considers economies of scale and technological change. International developments in economies of scale, technology and R&D effort are reviewed and contrasted with local developments in which South African firms are found wanting but nevertheless with some potential to move closer to international competitiveness.

Part Two analyses concentration, oligopolies, cartels and the role of government in dealing with such issues. The anti-competitive behaviour of the leading multinational chemical corporations is scrutinised.

Part Three is concerned with globalisation in the chemical industry which is periodised in three phases. The discussion attempts to illustrate how the process of globalisation is inextricably interwoven with technological developments and the corporate strategies of leading chemical multinationals.

Trade is an important indicator of an industry's global impact and international competitiveness. In this regard South Africa's chemical industry is shown to have lagged behind world trends. The international growth and motives of merger and acquisition are explored. Although South Africa was for the most part excluded from this process it is argued that MNCs nevertheless had access to a share of the local market.

Other objectives important in determining international corporate strategies during the 1980s are also identified. Evidence is offered to suggest that South African firms are being ineluctably drawn to follow the direction of the world's leading firms towards speciality chemicals and 'core business'. Some expected changes in the composition of local chemical conglomerates and the industry in general are identified.

'Environment' has become the watchword in the chemical and plastics industries and Part Four is devoted to this and related issues.

The analysis is drawn together in a conclusion at the end of each of the four parts in this chapter.

PART ONE

ECONOMIES OF SCALE AND TECHNOLOGICAL CHANGE

In this section the focus is on selected aspects of international technological change which are deemed to be more important for the South African industry. The local industry's performance in keeping pace with these technological trends and in R&D are assessed.

Economies of scale are of central concern in the design of capital intensive manufacturing processes. The rapid expansion of economies of scale in the chemical industry was most prevalent in the 1960s and 1970s. One reason for this was that it was possible to increase the scale of petrochemical plants using a six-tenths 'rule', that is, a plant size could be doubled for only 60% of the initial cost, provided that the configuration was restricted to one 'train' (production line) (Spitz, 1988:424). Where more than one 'train' was built the cost of equipment duplication changed the economics and the 'rule' was no longer applicable.

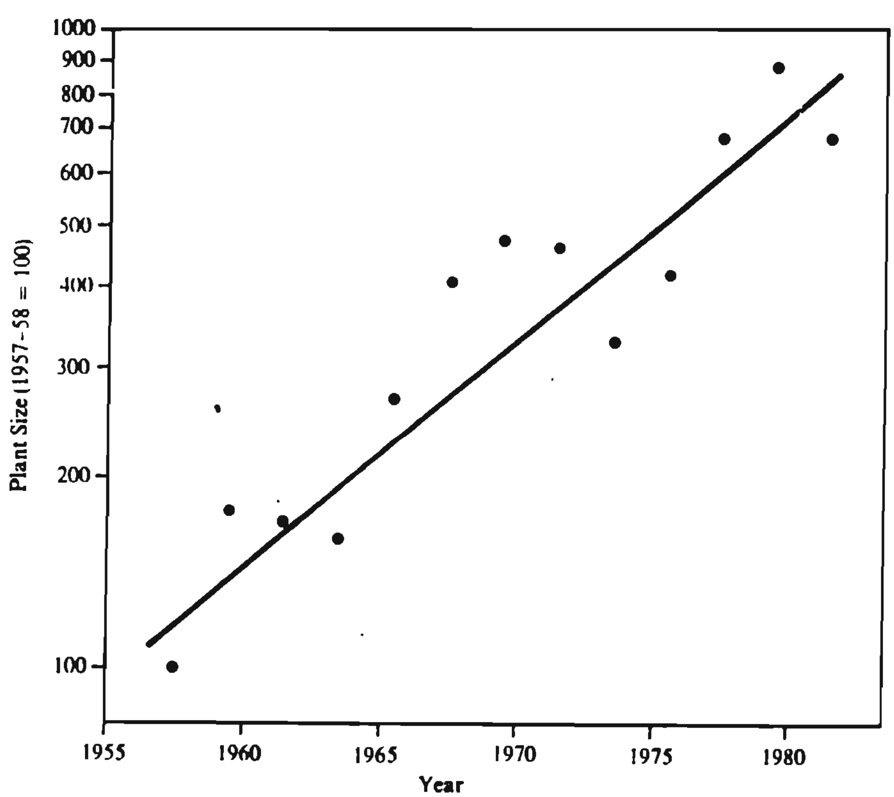
Lieberman (1987) carried out a study of plant sizes for the manufacture of 22 chemical products over a 25 year period. He found that the size of chemical plants had increased five fold over the period from the late 1950s through to the early 1980s (see Figure 4). He found no correlation between market concentration and the rate of increase in plant scale, but some evidence that oil companies tended to build larger plants. (A large number entered the industry during the 1960s.) He found no relationship between plant size and company R&D intensity which may appear unusual. Part of the answer to this apparent anomaly lies in the rapid expansion in the number of engineering contractors active in the industry at this time. Scientific Design and other such contracting companies developed the conceptual designs for large plants and were able to market them around the world.

The relationship between production costs and economies of scale in the petrochemical industry is, fortunately for small economies like South Africa, not an infinitely linear one. It begins to level off at about 400 000 tpa to 500 000 tpa in large volume chemicals like ethylene (see Figure 5). In 1990 South Africa's apparent consumption of ethylene was

264 000 tpa (see Table 5.4) warranting an approximately half world scale plant.

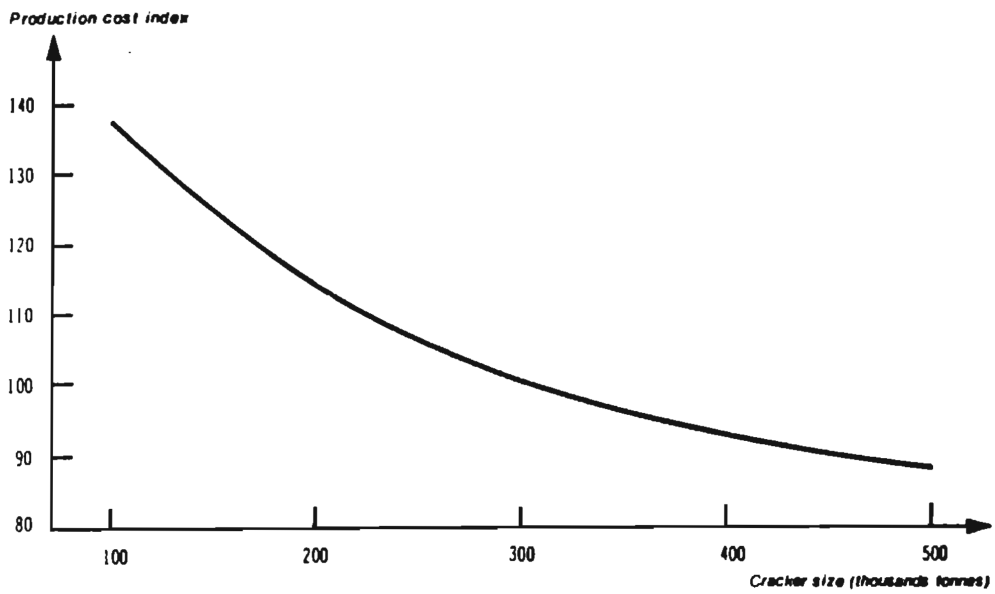
Many plants in South Africa were built in pursuit of import substitution policies directed at the limited local market and are consequently sub world scale. The capital cost per unit of output in such plants is larger than its international competitors. As a result much of the industry is not viable without tariff protection (CSIR, 1990:23). Plants built to serve the local market suffer in another respect too. Since economies of scale are large there is a considerable time interval between one plant and another. In the interim the technology and economies of scale of international competitors can advance rapidly. Because of the time interval between plants the initial plant has to operate for a considerable period utilising, older, smaller and less competitive technology, further contributing to the need for protection. Customers downstream from sub world scale plants also have to shoulder the burden of higher unit costs, which in turn are passed on to consumers by the more differentiated downstream sectors. This is the situation in the local commodity polymers industry.

Figure 4 <u>Average Size of New Chemical Plants, 1957-82</u>[1]



Note: 1 Based on coefficients of dummy variables for each two year period from 1957 to 1982.
Source: Lieberman, 1987:186

Figure 5 Economies of Scale in Ethylene Cracking



Source: OECD, 1985:145

Has the advent of post-Fordism and flexible specialisation in manufacturing perhaps limited the scale of operations in the chemical process industries? Is this not a source of some hope for the South African chemical industry? In recent years there have been efforts to move away from large plants to smaller scale plants.

Not unexpectedly, these efforts have focused upon two of the most important chemicals, ethylene and ammonia. Small scale ethylene manufacturing processes have as far as could be determined not been commercialised as yet. However ICI has developed a small scale 'Leading Concept Ammonia' (LCA) process. Such plants have moved from world scale of about 1 000 to 1 500 tons per day down to 500 tons per day (Short, 1989). But only three small-scale ammonia plants have been built over the past 10 years and licensing of this technology has not progressed as quickly as ICI had hoped. There is also uncertainty about how cost effective the LCA process is (Chynoweth, 1991). Whilst there may be some hope in the future for South African producers wishing to serve only the local market, it would appear that in petrochemicals at least, there is no escape for South Africa from the constraints of low cost producers utilizing large, world scale plants.

This has important implications for the South African chemical industry which will be taken up in later chapters. One obvious implication is that if the industry is to move away from the high cost intermediate inputs of a heavily protected chemical industry, any new plants must be of world scale and capable of competing internationally. The latter is a prerequisite since world scale output in many chemicals will be larger than the domestic market and will require a significant proportion of output to be exported. However should a more integrated regional economy emerge in Southern Africa the production base might be more geographically diversified and the target market expanded.

In the international chemical industry economies of scale do not apply only to production but also to other aspects of the business, marketing and the extent of market penetration, research and development capability, and finance. Such considerations for example underlie much of the merger and acquisition activity (dealt with below) during the 1980s.

Accompanying the expansion in 'world scale' plant size has been ongoing catalyst development. Such ongoing developments have prevented the industry from becoming static and 'mature' in the full sense. Consider polypropylene (PP) for example. Over the past 25 years there have been three distinct generations of catalyst, each an improvement upon its predecessor. These improvements were: a reduction in the number of process steps, improvements to the stereo regularity (isotacticity) and reductions in the residues of catalyst in the end-product polymer (see Figure 6 and Table 2.1).

Such developments in catalysis are the result of large R&D expenditures and considerable experience. How has South Africa fared in this regard? Significant advances in catalyst development are known to have been made in the production of synfuels (liquid fuels from coal). This capacity was demonstrated when the decision was made to use SASOL technology at Mossgas, a natural gas based fuel refinery. A suitable catalyst had to be rapidly developed. This was successfully accomplished with the assistance of the CSIR. SASOL also has several co-operation agreements in the area of catalytic research with local and overseas universities and research institutes (SASOL Annual Report, 1991:20).

R&D capacity and ability is an important determinant of success in the global chemical industry and it is thus necessary to locate the leading South African firms in this context. The most successful chemical firms in the world have been those capable of making both radical new innovations and incremental process innovations and applications (Freeman 1990).

Figure 6. The Performance of Polypropylene Catalyst

Number of process steps	1	2	3	4
4	Polymeri-sation			
3	Catalyst wash out	Polymeri-sation		
2	Atactic wash out	Atactic wash out	Polymeri-sation	
1	Pelleti-sation	Pelleti-sation	Pelleti-sation	Polymeri-sation
	PP product	PP product	PP product	PP product

Generation of PP-catalyst

Source: Scott, 1991:35.

Table 2.1 Catalyst Improvements (Polypropylene)

Catalyst type	Weight of catalyst to produce 1kg of PP	Isotacticity of PP produced
Generation 1	10g	75-85%
2	1g	85-90%
3	0.1-0.15g	96-98%
4	0.07-0.06g	98% +

Source: Scott, 1991:32.

In so far as the search for radical innovations is concerned three areas have been identified by major chemical firms as most likely to yield such developments. These are, biotechnology, advanced materials and surface treatments. They are characterised by an increasing multidisciplinary interdependence.

Biotechnology involves transfers from the science branches of chemistry, physics, biology and material sciences. Biotechnology's main impact is expected to be in pharmaceuticals, crop protection and agriculture, particularly seeds and foods. AECI has a large exposure to agricultural markets (mainly fertilizers) and animal feeds and has embarked upon some biotechnology research as a result of which a lysine (for animal feeds) plant is planned. But AECI is not involved in pharmaceuticals or crop protection and will not benefit from synergies in these quarters. Sentrachem holds 90% of the South African agrochemicals market (via a joint venture, Sanachem) and also has significant business in food additives. It has just one bioherbicide on the market and expects its bio-control work to break even in two to three years (Chataway, 1992:17).

Advanced materials have interdisciplinary interconnections with chemistry and material sciences. The main markets for advanced materials are the automobile, aerospace, and electronics industries, all weak sectors in South African manufacturing. South Africa is not producing even the more standard engineering plastics, let alone more sophisticated speciality plastics which could be classified as advanced materials. Internationally, of all R&D in advanced materials, 42% was spent on polymers, 23% on information technology materials and 22% on ceramics (ICEF, 1992:36).

Surface treatments draw upon three science branches, chemistry, physics and materials science. Surface treatments find application in the same industries as advanced materials: automobile manufacture, aerospace, electronics and mechanical engineering, which are weak sectors in the local economy. However South Africa may have potential in at least one area, water treatment chemicals. The developing water shortage in South Africa, together with rapid urbanisation and the industrial pollution of waterways is likely to provide a growing market for water treatment chemicals. In this area South Africa may be able to develop technologies marketable in other third world countries.

By the 1970s the chemical industry had reached a certain degree of technological maturity and this contributed to firms concentrating upon maximising existing investments. This reduced the emphasis on radical innovations and place increased emphasis upon incremental innovations. It is in this kind of competence that South African firms have better prospects.

What importance have South African companies given to R&D in comparison with their international counterparts? R&D spending is one measure of this. It is partly a function of scale in that R&D is usually measured as a proportion of sales or profits. The larger the sales the larger the sum represented by a similar proportion. A first crude measure then is the scale of South African companies when compared with their international rivals. A second is the proportion of sales spent on R&D. Recent figures for these two measures are reflected in Table 2.2.

Table 2.2 Sales and R&D Spending
Top 20 International Chemical Companies, Ranked by 1990 Sales Compared with 3 South African Chemical Companies.

Company	Sales US $m 1990	R&D as % of sales 1990	R&D as % of sales 1988
BASF	31 195	4.4	4.1
Hoechst	30 017	6.0	5.9
Bayer	27 863	6.6	6.1
ICI	24 909	5.3	4.8
Du Pont1,2	22 268	6.2	6.1
Dow Chemical	19 773	5.8	4.6
Rhone-Polenc	15 483	6.7	5.9
Ciba Geigy	15 459	10.4	10.2
Elf Aquitaine1,2	14 323	3.8	4.3
Enichem	13 363	2.6	4.1
Shell	12 703	2.7	2.2
Atochem	10 297	2.6	2.1
Akzo	10 229	5.2	4.9
Sandoz	9 703	9.8	9.0
Exxon	9 591	1.7	1.7
Monsanto	8 995	6.8	6.9
Mitsubishi Kasei	8 949	4.1	na
Solvay	8 265	5.0	4.3
Sumitomo Chem	7 865	6.1	4.8
Merck & Co	7 672	11.1	11.3
Average	15 446	5.6	5.2
SASOL	1 945	na	na
AECI	1 944	0.8	na
Sentrachem3	816	na	na

Notes:
1 Chemicals only
2 Excluding intersegment transfers
3 Annualized

Sources:
Chemical Insight's Company Analysis, (1991) 15th Edition.
Chemical Insight's Company Analysis (1989), 13th Edition.
Company Annual Reports

The three largest South African companies, SASOL, AECI, and Sentrachem (through its 50% share in Safripol) dominate the upstream end of petrochemicals and plastics production and also dominate the local chemical industry. These South African companies are shown to be much smaller than the top 20 international firms in Table 2.2. Where then in the international ranking order do the South African firms lie?

SASOL is the only one of these companies to have been admitted to the Fortune 500 listing where it was ranked 450 in 1992. In the Fortune 500 'Chemicals' sector it is ranked 39 out of 45 companies by sales but first by profits as a percent of sales and second by profits as percent of assets (Fortune, 27-7-92). If more properly located among the petroleum companies it would rank 52nd by sales among 54 companies. AECI is the only South African company ranked in Chemical Insight's Company Analysis (1990) of top global companies where it is ranked 88 out of 99 companies by sales. SASOL if ranked there would be 74. Sentrachem is too small to be considered in either of these rankings.

Measured by sales size then the South African companies are well outside the top 30 world chemical companies which are the firms which really dictate the pace of developments in the industry. Only SASOL and AECI are by size within 'striking distance' of being a 'world player'. Since 1990 SASOL has outstripped AECI in sales. By way of further perspective on the size of the local firms it is instructive to note that should world majors such as BASF or Neste enter the South African market as competitors, the combined size of SASOL, AECI and Sentrachem together would be less than one of these world majors.

Size alone makes possible a certain level of R&D spending but does not determine the level of that spending or guarantee the R&D performance. Pharmaceutical companies such as Merck & Co. and Ciba-Geigy traditionally spend larger shares of sales on R&D, of the order of 10%. This is evident in Table 2.2. Unfortunately the three largest South African companies generally do not publish information on R&D spending and some declined to provide it when interviewed. It is estimated that R&D spending as a proportion of sales in 1990 by the three large chemical companies was 1%.[1] This accords with the figure attributed to AECI in Table 2.2. This level of spending is similar to the Taiwanese chemical industry which also spends 1% of its turnover on R&D (Chemistry & Industry, 6-5-91:302). In Robert Wade's view this low level of spending will contribute to Taiwan's decline relative to South Korea (The Economist, 14-7-90:19). This is significant because the indications are that South Africa's chemical exports targeted at the Far East are growing in importance where they will have to compete with South Korean producers who have recently made large expansions to their petrochemical capacity. By implication then the level of spending by local chemical firms has been too low.

Evidence suggests that R&D spending by the three South African companies is likely to increase (possibly doubling) over the 1990-95 period.[2] Certainly the post 1988 attempts by SASOL to change its product mix from essentially synfuels to higher value added petrochemicals will raise its need for in-house R&D given their unique feedstock situation. Sentrachem for its part and AECI to some extent, are also changing their product mix towards more speciality type chemicals which tend to require higher R&D expenditures.

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1. Personal communication from Professor David Kaplan, University of Cape Town, based upon interviews conducted by him in the chemical industry.

2. See Baker's, 1992a, review of Enigma Marketing Research's report, The Chemicals Industry in South Africa.

AECI records in its 1992 audited results R 84 million expended on R&D, this on 'novel technologies as the foundation for new business'.[1] This is 1.56% of turnover and supports the view that R&D expenditure is being given increasing importance by AECI.

The trend in R&D spending as a share of sales in the US and Western Europe is upwards, particularly since the early 1980s. In the US this trend was downwards from 3.5% of sales in 1958 to a low of about 2.7% in 1979. But from that point onwards it rose significantly to almost 4.5% by 1985 (Bozdogan, 1989, Figure 13). In 1990 the US average was also 4.5% and in 1991 it rose again to 4.9%.[2] Western European figures show a similar trend with R&D as a percentage of turnover increasing from about 3.7% in 1980 to about 5.2% in 1989 (CEFIC, 1991:61).

The increasing costs of R&D and efforts to limit these cost increases have contributed to an increase in the number of technology alliances among multinational corporations based in the Triad countries during the 1980s. (Hagedoorn and Schakenraad, 1991, and United Nations Economic and Social Council, 1992). Such alliances usually put their combined resources together in a particular field of study or inquiry. These R&D joint ventures tend to take place among and between the leading corporations in a particular field. Such international alliances involving South African companies appear to be very limited although they have occurred domestically between local firms.

Another measure of R&D intensity is the number of persons engaged in that activity. SASOL's R&D arm employs 350 people including 120 graduates and 50 with technical diplomas (SASOL News, Vol 2, No. 3:6). This is about 4 graduates per 1 000 employees and is a long way behind the largest companies like BASF which employ about 2500 graduates alone or 18.6 graduates per 1 000 employees. It is even further behind the US industrial chemicals industry where the number of R&D scientists and engineers per 1 000 employees increased from 38 in 1977 to 53 in 1987 (National Science Foundation quoted in C&EN, 20-8-90:45). Nevertheless some consider SASOL to have sufficient 'critical mass' and a technology base, unlike AECI and Sentrachem, to be a world player. (Interview, Redlinghuys). SASOL's employment of personnel in R&D is on a par with Taiwan's chemical industry in which there are 3 persons per 1 000 employees engaged in R&D (Chemistry & Industry, 6-5-91:302).

SASOL is primarily an energy company with chemical appendages, somewhat like

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1. This is assumed to be AECI's lysine project.

2. Averages of 18 companies with sales over 1 bn US $, in C&EN, 29-6-92:44.

BASF and in this sense the basic technology issues are similar. SASOL has had to develop technology to extract from its unique feedstock high value materials such as aldehydes, ketones and acetates (Interview, Philpot). As SASOL put it:

> "The unique chemical composition of our intermediate and product streams and the lack of readily available technology for the recovery and upgrading of these compounds, has given rise to substantial in-house technology development" (SASOL Annual Report, 1990:8).

This is presumably a reference to SASOL's latest synfuels development, a commercial-scale fixed fluidised-bed reactor which began successful operation at SASOL 1 in May 1989. This is the latest in a series of developments which began with the original Kellogg design imported in 1955 which did not work well and had to be modified. The fixed bed reactors used at SASOL 1 were upgraded to circulating fluidised bed reactors for SASOL 2 and 3. The latest version reverts back to the fixed bed idea, but with the recent improvements at about half the capital cost, and increased thermal efficiency and several other savings (Oil & Gas Journal, 20-1-92:53). Such technology is expected to be commercially viable at an oil price of about $23 barrel or where suitable gas streams are available at very low cost from other production processes. There is growing interest in SASOL's technology which SASOL claims to have exported, although the licensee/s have not been made public. However with growing interest in natural gas for fuel purposes and the experience gained in the use of SASOL's technology for converting gas to fuel at Mossgas, there may be additional potential in areas such as Iran and Russia where gas is very cheap.

Although SASOL is regarded as one of the world leaders in synfuel technology it is competing against very large companies in this area. For example Shell have developed a process which has been used in the recently built Malaysian synfuels complex which is based on natural gas like Mossgas.

SASOL has also developed a process configuration for the production of alpha olefins at "significantly lower (costs) than available international technologies" (SASOL Annual Report, 1992:22). These efforts may be indicative of a higher level of R&D spending by SASOL which regards such information as confidential.

A concern may be that SASOL has pursued a 'wrong' technology in coal chemistry whilst the other major world players focused on oil and gas based technologies. While this may be true in that thus far it appears that these coal based technologies have only a very limited market, it may also be argued that having to pioneer such coal chemistry and synfuels has generated a 'problem-solving' capacity which could in future be refocused upon other challenges which may be more marketable and rewarding. This ability to create knowledge through problem solving and a culture of learning is central to Best's (1990) concept of an 'entrepreneurial' firm. Nevertheless some perspective may be gained from the fact that Exxon has spent more than SASOL has on synfuels R&D.

The same argument may be true of AECI's extensive study into coal based methanol (commonly known as methyl alcohol or wood spirit) as fuel. Such experience may stand these companies in good stead in the light of the emerging shift in R&D from the traditional product and process focus to a more problem solving approach.

In so far as the production of commodity petrochemicals and plastics is concerned, the practice by the large South African firms has been to license the necessary technology. For example AECI uses ICI technology for its polyethylene plants. Safripol uses Hoechst technology, and in the most recent polymer plant built, SASOL has licensed BASF technology for its PP plant.

Licensing technology for commodity petrochemicals is likely to be the pattern for the future. As one manager put it, "What is the point of reinventing the wheel?". This approach appears to be the one SASOL is pursuing. For example SASOL was negotiating with BP for the supply of technology for its planned acrylonitrile plant in October 1992. But since world scale plants will probably have to export, it is crucial that such licensing agreements allow for exports, otherwise South African economic development will continue to be constrained by uncompetitive, sub world scale plants aimed at the small domestic market. Consequently it is with some misgiving that one learns that the size of the plant SASOL is negotiating with BP "will depend on whether or not a proportion of the total capacity will be exported to Europe." (ECN, 5-10-92:33). Such issues have important implications for state technology licensing policy.

Even if foreign technology is licensed there is still considerable scope for local incremental innovation, assuming that local firms have a reasonably competitive technology and economies of scale to begin with. The first challenge facing new chemical plants is to get them operating at their maximum capacities as quickly as possible. Thereafter the next challenges are continuous improvements in plant operation efficiencies, 'capacity stretching' or 'debottlenecking' in the trade jargon. That is incremental modifications to plant capacity allowing higher levels of output. In the same vein more cost effective procedures and processes can be developed around the licensed 'core' technology in a plant.

The skills and capacities of the South African companies in this regard are difficult to determine. Largely as producers for the protected local market, and having had ready access to the government's ear with regard to tariff protection one might expect a less than average ability. Nevertheless SASOL has claimed that it has been able to operate its synfuels plants at 120% of their original design capacity. (Minutes of a meeting between Government and the Petrochemicals Industry Development Study Group, 10-4-89:4). Its newer polypropylene plant was also able to move output beyond nameplate capacity fairly quickly. Within 18 months of coming on-stream, output was 10% above nameplate capacity. SASOL is also under more pressure to debottleneck and cut costs as it is squeezed between its $23 per barrel (static but vulnerable) tariff protection floor price and its coal mining and operating costs, influenced by domestic inflation.

Improved process control is a continuing source of competitive advantage. 'Precision chemistry by the tanker load' is the boast of the international chemical industry. This boast has become possible with the increasing use of computerised data recording and control systems in complex multi-product plants requiring careful temperature and pressure regulation. Indeed some plants would not be possible without such systems. In this regard Safripol claim to have developed the computer software for their KO batch process which was subsequently used as a basis by Hoechst internationally (Interview, Blackburn).

In summary it appears that domestic firms have been too small to generate advanced technologies for the production of commodity chemicals and have not had comparative advantage in this area, nor may they be expected to achieve it. They will in all probability remain licensors of such technologies. However within this paradigm they evince some ability to carry out development work which could help them to international competitiveness, other things being equal. A suitable technology policy will be necessary to help and encourage these firms to develop their core competencies.

Additional potential appears to lie in their ability to exploit 'soft' technologies, that is the reorganisation of work so as to take full advantage of not just labour's physical resources but also labour's intellectual resources. Greater emphasis on training and skill formation will be central to such a process.

Japanese firms solicit suggestions from their workforces, many of which are implemented. This results in a process of shop floor incremental change, which although less glamorous perhaps than 'big science' may nevertheless be just as competitive. In this approach, which the Japanese call Kaizen, the focus is upon factory organisation, inventory sizes, batch sizes, work organisation, inter-firm linkages and quality. Now whilst it is true that in the chemical process industries, the initial choice of technology is very important in determining the reaction time or cycle time of a particular process, nevertheless Kaizen-type improvements can be made. For example Safripol (a producer of HDPE and PP) has recently introduced a version of the Crosby system[5] in an effort to empower workers and to improve problem solving abilities. Similarly attempts have been made to reduce racial discrimination, no easy thing in a town like Sasolburg, whose white local government is controlled by the (right wing and explicitly racist) Conservative Party. Training has increased including an in-house literacy course. The results include a dramatic increase in quality standards, improved interdepartmental communication, and a 25% reduction in the distribution budget (Interview, Blackburn). The coincidence in timing of the introduction of these innovations and the commencement of the firm's export drive are striking. They appear to have seen and grasped a window of opportunity.

The examples considered here suggest that the, perhaps uneven, assortment of skills and competencies available in the South African petrochemical industry do offer a basis upon which competitive producers could be established even if they lack large R&D budgets.

It is, however, worth bearing in mind that the improvements at Safripol have been achieved without any political pact or accommodation between capital and labour on the shop floor. The real fruits of Kaizen-type technology change are only likely to emerge in any real way, if some kind of accommodation is achieved. This will require overcoming some deep rooted hostilities. Management have grudgingly recognised trade unions but retain a deep hostility towards them. Black workers' experience of the shop floor has been politicised by apartheid laws. Both management and labour apply racist stereotypes to each other. These difficult challenges may be eased following political settlement at the national level. Even so, it seems likely a great deal of mistrust will remain which will require innovative solutions.

Conclusions

Much of South Africa's chemical industry developed within the framework of import substitution industrialisation policies. Such policies allowed the development of plants with limited economies of scale and they have, partly for this reason, been high cost producers. The cost of import substitution industrialisation policies has been a declining share of world chemical trade.

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5. A variation of a total quality management process, founded on one devised by American quality management specialist, Philip Crosby.

Plants in the chemical process industries typically have large economies of scale. Attempts to develop technologies permitting small scale plants have not progressed very far and consequently this route does not appear to offer a solution for South Africa. Consequently local plants will need to expand their capacity towards 'world scale' if they seek to be internationally competitive producers.

Economies of scale are important not only at the plant level but also at the firm level in the international chemical industry. To be able to compete internationally South African firms will need to consider how they might expand in size. There are potential benefits for South Africa in adopting industrial policy which promotes the development a local company to become a 'world player' (SASOL is the only obvious candidate). Such a development would lead to a high level of concentration in the local market and the disadvantages of this would need to be carefully weighed up. It would seem that a necessary condition for such a development would be a state sufficiently powerful to influence the domestic market and capable of preventing unreasonable pricing and private control.

In so far as South Africa's contribution to the three new fields of chemical R&D: biotechnology, advanced materials and surface treatments, is concerned, the potential appears stronger in biotechnology and surface treatments than in advanced materials. Further development will be a function of the local firms willingness to increase their level of R&D spending to bring them in line with leading companies and then to continue to follow the world trend towards proportionately higher levels of R&D spending.

Shortcomings in R&D however need not necessarily preclude the internationally competitive operation of large chemical plants which is something of a feat in itself. This endeavour will be aided by increased training and education and an improved dispensation for shop floor politics and relationships.

South Africa is unlikely to become a leading player in the world of 'big science' technology development although no doubt suffficient expertise exists to make a small contribution. Consequently South Africa is likely to remain an importer and licensor of chemical process technologies. The implication for public policy of this view is that policy will need to be directed towards securing technology on the best possible terms and with the least restrictions, for local producers.

Indications are that the pursuit of greater efficiency and productivity may, in the short term, be better directed towards the adoption of 'soft' technologies along with efforts designed to improve shop floor relations between workers and management.

PART TWO

CONCENTRATION, OLIGOPOLIES AND CARTELS

Introduction

The chemical process industries are capital intensive and are characterised by large economies of scale. Concentration and the extent of competition in this industry is an important and difficult area for policy makers especially in comparatively small developing economies.

This section attempts to provide a global overview of the extent of concentration in the international chemical industry and in certain of its sub sectors and at different levels within those sub sectors. The picture which emerges is one of high levels of concentration in certain sectors. Some of the imperatives which drive firms into this kind of behaviour were encountered in Part One in the form of economies of scale in areas such as plant and equipment or R&D.

Part Two is intended to provide a backdrop and a yardstick against which to evaluate, in a later chapter, levels of concentration in SA. There are difficult policy choices to be made by a post apartheid South Africa in the tension between protecting local industry with the objective of developing locally based 'world players' and the price consumers might have to pay to achieve this.

Also identified in this section are some of the international barriers to entry which have developed in certain chemical sectors; petrochemicals, agrochemicals, and pharmaceuticals. These provide something of an historical map which may help producers identify entry points, or 'no-entry' points, in international markets.

Concentration, Oligopolies and Cartels

The ranks of the leading multinational chemical corporations have been dominated by a relatively small number of firms whose presence in and relative position among, other leading firms has been fairly stable over a number of years. The largest six firms in 1990 were also the largest six firms in 1988 and in the same rank order (see Table 2.3). The same six firms were also the largest six firms in 1979, only in a slightly different order.

Table 2.3 Largest 20 Chemical Companies by 1990 and 1988 Sales

Top Companies 1990	Rank	1990 Sales $ bn	1988 Sales $ bn	Top Companies 1988
BASF	1	31.2	24.7	BASF
Hoechst	2	30.0	23.1	Hoechst
Bayer	3	27.9	22.8	Bayer
ICI	4	24.9	21.1	ICI
Du Pont	5	22.3	19.6	Du Pont
Dow Chemical	6	19.8	16.7	Dow Chemical
Ciba-Geigy	7	15.5	11.8	Shell
Rhone-Polenc	8	15.5	11.7	Ciba-Geigy
Elf Aquitane	9	14.4	10.8	Montedison
Enichem *	10	13.4	10.8	Rhone Polenc
Shell	11	12.7	8.8	Exxon
Atochem *	12	10.3	8.3	Union Carbide
Akzo	13	10.2	8.3	Monsanto
Sandoz	14	9.7	8.3	Akzo
Exxon	15	9.6	8.1	Elf Aquitaine
Monsanto	16	9.0	7.2	Sumitomo
Mitsubishi Kasei *	17	9.0	6.8	Solvay
Solvay	18	8.2	6.8	Sandoz
Sumitomo	19	7.9	6.4	Eastman Kodak
Merck & Co	20	7.7	5.9	Merck & Co
Top 10 sales as % of top 76		42.1	64.8	
Top 5 sales as % of top 76		20.6	32.4	

Note: * = new entrants to the top 20 after 1988.

Sources: Chemical Insight's Company Analysis, 15th Edition, 1991
Chemical Insight's Company Analysis, 13th Edition, 1989

Between 1988 and 1990 there were only three new entrants to the ranks of the top 20 firms. EniChem moved up from 24th in 1988 to 10th in 1990. Atochem moved up from 32nd in 1988 to 12th in 1990 and Mitsubishi Kasei up from 28th in 1988 to 17th in 1990.

These examples are indicative of the stability which has prevailed among the world's leading chemical MNCs. Leading firms have retained dominant positions within the industry for extended periods of time although their relative position may change somewhat from year to year. Significant changes to the group of leading firms are far more likely to result from mergers and acquisitions than from penetration of these ranks by new entrants. Some consider that only about 30 firms make up the 'world players' (Interview, Marriot).

Considerable market power lies in the largest ten firms which have commanded about half of the combined sales of the 76 leading world chemical firms in 1988 and 1990 (Table 2.3).

The majority of the 1990 top 20 firms are based in Western Europe, only four are based in the USA, Du Pont, Dow Chemical, Monsanto and Merck & Co. Japan is represented by only 2 firms in the top twenty whilst no firms based outside the Triad are represented.

In general the pattern that emerges is much as would be expected: the leading firms are located in the Triad and particularly in Western Europe. This is of course a highly aggregated view. If a less aggregated view is adopted and the various industries which make up the chemical industry are separated out, a different picture begins to emerge and much higher levels of concentration tend to occur. Let us consider some examples.

The petrochemical industry includes among its leading participants oil conglomerates which have a history in the legendary 'Seven Sisters'. In addition to this petrochemicals is regarded as a strategic sector in many countries. Such factors induce an expectation that, notwithstanding the size of this giant industry, there will be high levels of concentration. Indeed this was the case in 1987, when just 25 producers of primary petrochemicals accounted for more than half of the world capacity whilst the ten largest owned over 30% (see Table 2.4). Of these ten largest firms, six were US based corporations and five of these were oil rather than chemical corporations.

Table 2.4 Largest 25 Primary Petrochemical Producers (1987)

Rank	Parent Company/Ownership	Capacity million metric tons	Percent of Global capacity
1	USSR government	10.66	6.78
2	Exxon Corp. (US)	7.52	4.79
3	Dow Chemical (US)	5.33	3.39
4	Shell Chemical Co. (US)	4.74	3.02
5	Amoco Inc. (US)	4.21	2.68
6	Atlantic Richfield Co. (US)	3.93	2.50
7	Mexican government (Pemex)	3.47	2.21
8	Union Carbide Corp. (US)	3.39	2.16
9	People's Republic of China, government	3.09	1.97
10	BP Oil Corp (UK)	2.29	1.46
11	Du Pont (US)	2.90	1.85
12	Royal Dutch/Shell (UK/Netherlands)	2.87	1.83
13	German Democratic Republic, government	2.55	1.62
14	Enichem (Italy) a/	2.51	1.60
15	Rumanian government	2.47	1.57
16	Taiwan government (Chinese Petroleum Corp.)	2.37	1.51
17	VEBA AG (Germany)	2.23	1.42
18	Alberta Gas Chemical (Canada)	2.21	1.41
19	Czechoslovakian government	2.13	1.36
20	Brazilian government (Petroquisa)	2.10	1.34
21	Mobil Oil Corp. (US)	2.07	1.32
22	Texaco Inc. (US)	2.02	1.29
23	Petrofinia (Belgium)	2.01	1.28
24	Bulgarian government	1.84	1.17
25	Yugoslavian government	1.74	1.11
	Total	83.28	53.00

Notes: a/ 51% Italian government owned.
Source: adapted from SRI International, 1987:300.1000D.

The largest group, about half (13) among the 25 largest, were state owned. The second largest group are the giant privately owned oil companies which accounted for nine places in the list. Significantly firms from three NICs feature within the leading 25 producers, Taiwan, Mexico and Brazil. This is unlike almost all similar tables of the largest 20 producers in the other sectors of the chemical industry and is indicative of the importance these NICs have attached to the petrochemical industry. It is against such formidable competitors as this that South African producers must compete.

This level of concentration is also evident in other sectors. The agrochemicals industry for example is even more highly concentrated. The 14 largest firms account for about 75% of world sales. Between four and six firms account for about 35% to 60% of the sales in each of the three sectors which make up agrochemicals (see Table 2.5).

Table 2.5 Agrochemicals, Market Shares, Percent of Global Sales

	Herbicides	Insecticides	Fungicides
BASF	7		5
Bayer	7	14	18
Ciba-Geigy	13		14
Du Pont			8
FMC		5	
Hoechst		5	
Monsanto	9		
Rhone-Poulenc		10	10
Sandoz			5
	36	34	60
Number of firms	4	4	6

Source: Data from UNIDO (1989).

The highly profitable pharmaceutical industry appears to be an anomaly in so far as the level of concentration is concerned. It appears to be one of the most competitive and least concentrated of all the chemical sectors, by comparable measures, despite the continuing tendency to concentration. The sales of the top 15 companies accounted for only 20% of world sales, far less than in petrochemicals and agrochemicals.[1] No one company holds more than a few percent in any one country's market (see Table 2.6).

1. Calculated from UNIDO 1991:201 and 202

Table 2.6 Pharmaceutical Companies: Top Ten Market Share in Selected Countries

USA		Latin America		Italy		India		Indonesia	
Company	%	Company	%	Company	%	Company	%	Company	%
Merck	4.5	Roche	4.2	Menarini	3.7	Glaxo	7.3	Kalbe	4.9
Smithkline	3.6	Abbott	2.6	CibaGeigy	3.0	Pfizer	5.0	CibaGeigy	3.4
Pfizer	3.2	Merck	2.3	Hoechst	2.9	Hoechst	3.0	Bristol	3.3
Ayerst	2.5	Schering	2.2	Glaxo	2.7	Wellcome	2.5	Rhone-P	3.3
Upjohn	2.5	Lepetit	2.1	SigmaTau	2.3	Boots	2.3	Interbat	3.1
Veyth	2.4	Veyth	2.1	Bayer	2.3	Sandoz	2.0	Warner-L	3.1
Ortho	2.3	Sandoz	2.0	Erbamont	2.0	ParkDavis	1.9	Merck	3.1
Roche	2.2	Boer.Ing	1.9	Fidia	1.8	Veyth	1.8	Medifarma	2.8
Squibb	2.2	Hoeschst	1.8	Beechams	1.8	Smithkline	1.7	Hoechst	2.8
Eli Lilly	2.1	Pfizer	1.8	Boer.Ing	1.7	Warner L	1.7	Squibb	2.7
Total	27.5		23.0		24.2		29.2		32.5

Source: ICEF, 1989:22

However this belies the truth. If one proceeds to a lower level of aggregation, such as the treatments for particular illnesses, the picture that emerges is one of very high levels of concentration. For example two anti-ulcer drugs, Tagamet, made by SmithKline and Zantag made by Glaxo, together held over 80% of the world market in 1984. Squibb's Capoten drug held 73% of the ACE inhibitor market in 1985. Pfizer's Feldene together with Syntex's Naprosyn accounted for over 45% of the world arthritic alleviators and there are many more such examples (ICEF 1989:25).

This phenomenon is not restricted to the speciality type chemicals found in the pharmaceutical sector, it is also true, although to a somewhat lesser extent, in commodity plastic markets as well. At the level of the individual commodity plastics the levels of concentration in certain developed economies are as high as some therapeutic markets in the pharmaceutical industry (see Table 2.7). In South Africa all of the products which feature in Table 2.7 are monopolies except for PP where there are two producers. The levels of concentration in some speciality type polymers can be even higher in large markets. For example in the US polyamides film market Du Pont alone holds 90% of the market (Chemical Week, 30-1-91:16).

Such levels of concentration have undoubtedly increased the temptation for producers to enter into cartels and price fixing agreements or other forms of anti-competitive behaviour. In several instances the temptation has proved too great to resist. This was especially so in the EC during the phase of restructuring in the late 1970s and early 1980s. The officially sanctioned 'crisis cartel' in synthetic fibres at that time may have lulled certain producers into a false sense of security in regard to their business practices in other products.

Table 2.7 Capacity Concentration for Ethylene and Polymers, Certain OECD Countries, 1980, First Four Firms (%)

Country	Ethylene	PVC	LDPE	HDPE	PP	PS	ABS
USA	40	52	44	50	57	54	90
Japan	39	41	48	68	54	54	47
Germany	60	54	88	64	84	100	100
UK	95	87	71	-	100	56	74
France	82	62	83	67	43	51	100
Italy	93	56	74	60	100	54	7*
South Africa	100	100	100	100	100	na	na a\

Notes: * An apparent anomaly in the source table.
a\ First two firms.
Sources: adapted from Oman 1989:120 and own research.

The polypropylene (PP) industry was the subject of a cartel in the EC between 1977 and 1983 (Chemical Week, 18-3-92:4). In 1992 the European Court found seven major PP producers guilty of operating this cartel. These firms had increased capacity to meet a surge in demand in the late 1970s but with the slump in the early 1980s found that they had about double the capacity required. They then entered into pacts to control prices and output to cover losses over a five year period (Food and Drink Daily, 28-10-91). The MNCs implicated were among the top 20 chemical corporations. They were: ICI, Shell, Huls, Hoechst, Solvay, Chemie Linz and Montedipe (Packaging Week, 18-3-92:4). A further three, Atochem, Rhone-Poulenc and Petrofinia participated in the cartel between 1980 and 1982 (Energy Alert, 25-10-91).

Low density polyethylene (LDPE) producers also operated a cartel at about the same time, in this case from 1978 to 1984. A number of firms were convicted and had fines imposed. These included, again, leading MNCs which regularly feature among the top twenty largest firms; Atochem, BASF, Bayer, DSM, EniChem, Hoechst, ICI, Montedison, Orkem and Solvay (ECN, 9-1-89:4). Together they held 80% of the LDPE market (C&EN, 2-1-89:7). Such practices were not restricted to the phase of restructuring in the late 1970s and early 1980s.

More recent cartels in Europe have also led to convictions. In 1992 the European Court, found 14 PVC producers had colluded on target prices and quotas as well as acting in concert over price increases (Packaging Week, 22-4-92:11). The fines imposed were later overturned by a higher court on a technical point. However their conviction for operating a cartel remained (Packaging Week, 4-3-92:1). The companies implicated included the by now familiar names: Atochem, BASF, EniChem, Hoeschst, Huls, ICI, Montedison, Shell, Norsk Hydro, Solvay and Wacker. Together they held 90% of the European PVC market (C&EN, 2-1-89:7).

Thus three of the five major commodity plastics in Europe have been the subject of cartels in the past decade leading to the conviction of many of the world's leading chemical firms. Cartels however have not been the preserve of the plastics industry.

Soda ash, used mainly in the glass and detergent industries, has also been the subject of a European cartel. Solvay of Belgium, the world's largest producer of soda ash, together with ICI and Chemische Fabrik Kalk (German) a BASF subsidiary, were found guilty of operating a cartel in 1991 and fined (Performance Chemicals, March, 1991:6). Even without this cartel the level of concentration is unusually high. Solvay commanded 70% of the continental market and ICI 92% of the British and Irish markets (Strategic Intelligence Systems - Europe, January 1991:5).

It is not only in the EC that cartel type practices operate, in the US too, leading firms have been charged with similar practices. For example Allied Signal has sued Du Pont alleging that Du Pont uses anti-competitive practices in the polyamide films market by enforcing exclusive supply contracts which are preventing it gaining market share (Chemical Week, 30-1-91:16). Similar kinds of 'co-operative' agreements feature in South East Asian markets. For example 20 South Korean and Japanese producers of polystyrene and ABS plastics were reported set to meet on 8-11-91 to discuss ways to prevent 'excessive competition' in the South East Asian market (Korea Economic Daily, 31-10-91).

What this evidence appears to suggest, not surprisingly, is that the international chemical industry has scant regard for ethical and legal niceties. The propensity for anti-competitive practices appears, to a degree, inherent in the nature of commodity chemical production and the relatively inelastic demand associated with it. Is it too much to assert that something of the culture of 'cooperation' which prevailed in the 1930s has continued to pervade commodity chemical markets? If it is not, then the return to 'core businesses' in the early 1990s may strengthen the temptation to indulge in this type of business practice.

The Japanese state has permitted cartels in the chemical industry at various periods, notably in the early 1980s. However the significant difference in the Japanese case has been that they have been allowed <u>only</u> where a long term restructuring plan for the sector has been agreed by management and where they have had limited duration (Best, 1990).

Conclusions

A review of the world's leading chemical companies shows there to have been stability in the ranks of the top 10 as well as very considerable market power. New entrants are more likely to gain a foothold among these giants by way of merger and acquisition than competition. Significantly it is only in the petrochemical industry that firms based in NICs have a presence among the ranks of the leading producers, underlining the importance they have attached to this industry. During the 1980s many of the leading companies were party to cartels and other forms of anti-competitive behaviour. High levels of concentration have emerged in both commodity and speciality markets across a range of chemical sectors.

The implications of the international chemical idustry's structure are significant for South Africa. If unprotected, comparatively small local firms may be more vulnerable to take-over or predatory pricing. Equally local markets, when opened to more international competition, will be more vulnerable to the strategies of the major chemical MNCs. At the level of domestic competition policy, the large economies of scale and cyclical nature of commodity plastic markets, suggest that competition policy should be synchronised with industrial policy, if the two are not to work at cross purposes. The determinants of successful competition policy in such circumstances are difficult to pin down as they include a number of interrelated factors which at times have to be traded off against each other. Clearly the proximity of product prices to 'world prices' is important. From the point of view of domestic industrial development the performance of an industry in respect of innovation and upgrading is also important.

It may be that in the preceding examples it was the application of competition policy which was inappropriate for the survival of the industry, resulting in convictions against leading firms rather than their inherent predisposition to anti-competitive behaviour. The creative approach to these issues followed by South Korea and Taiwan, (see Chapter Three) suggests that it is not the existence of a monopoly or oligopoly *per se* which is critical but rather the price levels pertaining in such markets - provided that the prices delivered are appropriate to the industrial strategy being followed, an argument may exist for a more relaxed view to be taken of oligopolistic markets.

PART THREE

GLOBALISATION

Introduction

Global dominance has been a concern among chemical producers since the early days of Solvay's introduction of his chlor-alkali process. Some companies still have names which speak to their vision of themselves, such as Imperial Chemical Industries (ICI). Part Three examines the chemical industry's leading role in the process of the globalisation of industrial activity. The ascendency of MNCs in the global political economy and their impact upon international institutions is also considered.

The globalisation of industrial activity has proceeded through three broad, overlapping phases (OECD, 1992). The first, sometimes referred to as the 'Golden Age of Trade', was characterised by a rapid expansion in trade and measured by the levels of exports and degrees of import penetration. In this discussion South Africa's lagging performance is identified. Internationally the relationship between industrial policy and trade policy is changing. The nature of these changes is briefly discussed in the light of the South African state's tendency over the last decade to regard trade policy as the only instrument of industrial policy.

The second phase, evident through the 1950s to the 1970s, shifted the emphasis to foreign direct investment as the multinational corporations played out their struggles for dominance and measured their success by the proportion of sales generated abroad. However as regional trade blocs such as Nafta and the European Union emerge, the imperatives for foreign direct investment change too.

These developments give rise to two considerations; firstly the need for an assessment of the vulnerability of South African firms to foreign take-over and secondly the importance for South African firms, wishing to become global players, to adopt a global perspective and strategy.

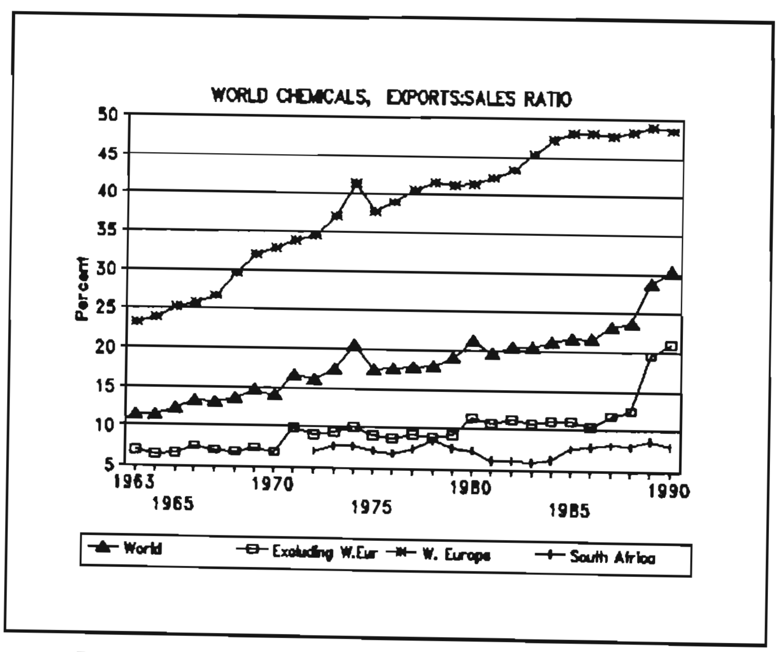
The third and current phase which emerged in the 1980s is less easily periodised. It is more complex and is characterised by complex webs of interlinkage between parts of a firm spread across the globe made possible by new technological developments. A host of mechanisms carry these linkages; new information systems, joint ventures, licensing agreements, etc. It is a period when global corporations, unlike Caesar, literally do 'bestride the world like a huge colossus'. Their corporate strategies and frames of reference are global. Finally the intermeshing of various corporate strategies with these changing approaches to global dominance are explored.

Trade

Trade was the first of the three phases in the internationalisation of industry and it as well to begin this review of trends in globalisation by identifying its global trends and to compare South Africa's performance with the observed trends. Trade is still the most widespread form of internationalisation although not necessarily the key diagnostic.

In the chemical industry an increasing share of world sales has been traded, from just over 10% in 1963 to 30% in 1990 (see Figure 7.). US and Japanese exports as a proportion of sales have hovered at about 10% and 9% respectively through the 1980s. The largest growth in exports as a share of sales has been in Western Europe. But most West European trade is intra West European trade. For example a total of 47.1% of chemical turnover was exported from EC countries in 1990 but only 13.3% of chemical turnover was exported outside the EC (CEFIC, 1991:29). Accordingly, in order to eliminate the West European influence on the statistics, West European exports:sales ratios have been reflected separately, as has the remainder of the world (that is World exports less West European exports). The result shows that the world export:sales ratio still grew, although not as fast as when West European exports were included.

Figure 7



Sources: Data from Chemical Industries Association:1991, and IDC:1992.

Comparing South Africa's historical performance with world trends shows that it has lagged behind the world trends in two ways, the proportion of chemical sales exported and the increase in proportion exported over time. Considering the export:sales ratio, South Africa in 1972 exported 7% whilst the world figure was 16%. Comparing the same ratio in 1990, South Africa had increased its exports from 7% to 8.8% of sales whereas the world figure had almost doubled from 16% to 30%.[1] A comparison of world trade, excluding Western Europe, also shows that South Africa has been under performing. In short South Africa's chemical trade performance suggests that it is increasingly being left behind in the world globalisation stakes. This is understandable in view of the ISI policies followed by the apartheid state and economic sanctions against South Africa.

Global chemical trade has been dominated by Western European producers and thereafter US and Japanese producers. Japan, reliant upon imported naphtha for 95% of its feedstock, is no longer a significant factor in world petrochemical trade (Wittcoff, 1992). The West European and US domination of world trade is being challenged by NICs and resource rich countries such as Saudi Arabia, Thailand, Canada, Malaysia, Nigeria, Trinidad, Indonesia, and Mexico. Less well endowed NICs such as Taiwan, Korea, and Brazil are also increasing their share of world trade. Western Europe's net trade in polymers is expected to move to a deficit for the first time in 1993 (Wamsley, 1992). The relative decline of the Japanese and West European petrochemical industries, experienced first in the loss of export markets is a trend predicted to continue (Wittcoff, 1992 and Wamsley, 1992). This is understandable as major growth markets are in China, India and other Asian economies which are far removed from the traditional centres of chemical production in Western Europe and the USA. The fortunate implication for South Africa is that it is closer to these markets than the EC or US producers.

Trade in large volume low added value commodity chemicals can incur high transportation and handling costs. In addition there may be tariff barriers. Consequently long distance, deep sea exports from South Africa will require producers to have a cost advantage, either capital or feedstock, if they wish to export profitably into distant markets where an established commercial chemical industry operates such as Western Europe. Since these are largely absent today in the South African chemical industry it is unlikely to become a major exporter in the short term at least. However internationally competitive production is a viable objective if suitable industrial policies are followed. An attractive alternative is to attempt to

1. South African figures calculated from IDC, 1992.

beneficiate locally the commodity chemicals which are available from sources that emerged as a result of apartheid policies, to higher value added products further down the value added chain. In this way better use could be made of existing resources if prices were such as to allow growth in the local market whilst at the same time creating employment in the more labour intensive downstream sectors. Such higher value added products could, if cheaply produced, benefit mass housing, electrification and basic wage goods. Under such conditions a considerably larger share of production might be exported since transport costs comprise a smaller proportion of the value of the product. This would make a contribution to the chemical industry's trade imbalance and the balance of payments.

The interlinkages between trade policy and industrial policy are of growing importance (OECD, 1992). Indeed the boundaries between them are becoming increasingly blurred. The symbiotic relationship between industrial policy and trade policy has long been recognised in countries such as Japan, Korea and Taiwan where trade policy has been harnessed to good effect in promoting industrial policy objectives. The analysis of the South African commodity plastics *filière* pinpoints the crucial impact of trade policy on the pricing structure in the local *filière*. Trade policy can also create an anti-export bias and this too is identifiable in the commodity plastics *filière*.

From Foreign Direct Investment to Complex Interlinkages

A second phase identified in the internationalisation of industry was characterised by foreign direct investment. This has long been a feature of the international chemical industry. During the 1980s mergers and acquisitions have been the chief form of globalisation in the international chemical industry. In this regard the chemical industry has been "one of the top three manufacturing industries out of fifty" (Elsberg, 1989:28).

The US was the country with the single largest chemical market during the 1980s and for that reason lured foreign investment. Foreign ownership of the US chemical industry increased from about 7%-8% in 1980 to nearly 30% of US assets by 1989 (Ibid). Much of this arose from West European chemical companies in search of large stable markets in order to increase profits. The imperative behind this largely West European investment drive into the USA during the 1980s has for the most part been financial rather than strategic or technological although these too have played a role. As County Natwest consultant John Knight put it "To be in the top five globally in a product, you've got to be in the US" (Layman, 1990:8). Investment in the US chemical sector in the latter part of the 1980's has far outstripped the industry average as is apparent from Table 2.8.

Table 2.8 North American Acquisition Market Trends - Foreign Buyer Activity

Percent of Total Activity

	Chemical Industry	All Industries
1985	28	3
1986	62	19
1987	62	18
1988	11	21
1989	75	23
1990	82	31

Source: Morgan Stanley, quoted in European Chemical News, 27-5-91:15.

The largest of the acquisitions and mergers have taken place in the US, several of them running into billions of dollars. Among the largest reported have been British Petroleum's (UK) acquisition of 45% of Sohio (US) for $7.6bn and the Bristol-Myers (US) acquisition of Squibb (US) for $11.5bn. Beecham (UK) merged with SmithKline (US) at a cost of $16bn.

Another explanation for the concentration of foreign investment in the US in the 1980s relates to the comparative ease with which investors could find suitable take-over targets and get access to them. By contrast Western Europe lacked publicly held small and medium sized companies "because before the (small and medium sized) companies reach that size, the bigger firms buy them up" (Layman, 1990:8). The large chemical companies on the other hand are less vulnerable to take-over because stockholdings are structured in such a way that hostile take-overs are virtually impossible. Henkel, for example, one of the bigger German firms remains a family owned business. The 15% of its shares which are traded are non voting shares.

The leading South African chemical companies are similarly structured. Relatively small proportions of their shares are actively traded. Some, like AECI, if they had not been protected by their large corporate shareholders (ICI and Anglo American) might have been the target of take-over bids. The South African companies have also been protected from international take-overs by sanctions but this may be expected to change if the lifting of sanctions is followed by the emergence of a politically stable country. Again there are implications for industrial policy arising from both of these features of the local chemical industry which are addressed in later chapters.

Notwithstanding the less accessible chemical industry in Western Europe, the flow of capital from Western Europe to the US began to reverse as the 1980s wore on. The looming political unity in the EC scheduled for 1992 and the extent of that market, uninterrupted by political barriers, made it important for many firms to have a presence in the EC.

Merger and acquisition activity in the US and Western Europe has been both inter-continental and intra-continental. Much of this activity in Western Europe in the early and mid 1980s was part of the efforts to rationalise and reduce capacity and to consolidate what were frequently fragmented businesses. Within the US firms concentrated on improving domestic market share and growth to pay back loans used for take-over purchases or used to defend themselves from hostile take-overs. During the 1980s a large number of leveraged buy outs took place in the US commodity chemicals industry which helped it to survive those difficult years. However, ruthless take-overs, asset stripping and severe management practices, with their consequent loss of jobs, were used to generate cash to meet loan repayments. The downturn at the end of the decade tipped the balance against some of these precariously financed companies and they were forced into bankruptcy.

This flurry of merger and acquisition activity in the 1980s was also bound up in firms' attempts to achieve 'critical mass' as a part of the continuing drive into specialities and other high added value materials.

Japanese companies were an apparent anomaly in this spate of merger and acquisition activity despite benefits accruing from the increasing value of the Yen through the 1980s. However they have been surprisingly small actors in international merger and acquisition activity although Japanese chemical firms are currently investing abroad at twice the rate of US companies and three times the rate of German companies. Similarly within Japanese domestic markets there was relatively little take-over activity. Shigekuni Kawamura, president of Dainippon Ink & Chemicals gives the following explanation for this:

> "Because of the strong bond of unity between the company and its employees, it is very difficult for Japanese companies to carry out a take-over in their home market. It would almost be like trafficking in the lives of human beings. This is one reason why the companies in the Japanese market are more concerned about market share than profit." (quoted in Layman, 1990:10)[2]

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2. This is in stark contrast to the attitude many South African managers came to adopt towards black labour under apartheid.

Japanese companies have also been comparatively rare investors in the West although this is changing and in the past two years they have begun to embark upon Western-style merger and acquisition activity (ECN, 27-5-91:16). They are also beginning to take part in more joint ventures. They appear to be moving slowly into downstream areas to support their auto and electronics industries in smaller joint ventures such as plastics processing.

Newer entrants to the chemical industry have been driven by their needs. South Korea and Taiwan for example have sought foreign technology through acquisitions and joint ventures. Taiwan being a small country with a small population and growing environmental problems, looked to foreign ventures beyond its shores. Saudi Arabia sought market share through joint ventures (dealt with more fully below).

The burst of merger and acquisition activity during the 1980s is slowing in the early 1990s as the 'shake out' launched by the deep recession in 1980-81 draws to a close. In the early 1990s another recession is giving rise to calls for yet another round of rationalisations.

It is often difficult to distinguish motives in corporate behaviour. Expansionary moves by one can lead to similar, but defensive moves by another. No doubt one of the imperatives to globalisation in the 1980s has been the need to improve or maintain competitive position and represents less of a proactive choice than a survival strategy.

Joint ventures are an alternative to mergers and acquisitions. They have long been a feature of the international chemical industry. Factors such as, lower and shared cost, longer time scales in developing new materials and the speed of technological change make alliances attractive, particularly in pharmaceuticals, biotechnology and agrochemicals. Joint ventures can sometimes also provide easier access to markets than exports. Such seems to be the case in South Africa. The largest chemical company, AECI, is 48% owned by ICI and Sentrachem, the second largest, has joint ventures with Hoechst.

Internationally direct investment is increasingly being targeted at rapidly growing markets. Most notable has been Asia, or countries with low feedstock costs such as in the Gulf states, Thailand, Malaysia and Indonesia. Shell and BP Chemicals for example are making huge investments in East and South East Asia.

South Africa's pariah status in the 1970s and 1980s has excluded it, to a large extent, from foreign direct investment in the globalisation of the chemical industry. However it has nevertheless managed to participate, by way of licensing foreign technology for a fee or royalties. This has had a limiting effect on exports, particularly among plastic converters, a point we shall return to. Put differently, MNCs have had access to a share of South Africa's closed market through joint ventures and licensing. As a result of changing political developments in South Africa some observers expect large MNCs to renew their interest in South Africa (Interview, Redlinghuys, and Baker, 1992b). The exact form this might take is difficult to predict. However if the wishes of leading South African chemical employers are met increasing numbers of joint ventures and alliances with MNCs are likely.[3] A key consideration for a post-apartheid state in such instances will be gaining the right to export production made with internationally licensed technologies.

Both AECI and Sentrachem have had long relationships with large foreign multinationals (AECI with ICI and Sentrachem with Hoechst). They continue to see such relationships as important because it gives them access to leading edge technology that they would otherwise not be able to generate themselves. The restraints upon exports that have in many cases accompanied such technology licensing agreements have not been regraded as unduly burdensome partly because these firms do not see themselves as emerging international players but rather as important players in the Southern African region exporting internationally where possible (ibid).

Change in Global Institutions

The current phase in the internationalisation of industry is changing the notion of comparative advantage among nations (Ibid). Traditionally comparative advantage has been measured by political nation states taking into account factors such as natural resources, labour and capital inputs. Increasingly this has shifted to the role accorded to particular countries within the global strategies pursued by large multinational companies. In some senses it is a case of the rest of industry catching up with industries like chemicals and food products which have internationalised earlier than other industries.

The ascendency of multinational corporations (MNCs) is impacting at other levels as well. Major international institutions and the global rules of economic exchange are being rearranged at their bidding, albeit indirectly. For example the United Nations Centre for Transnational Corporations was closed in 1992 apparently due to its critical stance towards the activities of multinational corporations. The Uruguay Round of the General Agreement on Tariffs and Trade (GATT) negotiations has emphasised the need for tariff barriers to be lowered and for the protection of intellectual property. Such developments will stand to improve the position for the MNCs relative to nation states and domestic firms. Indeed these

3. M. Sander, MD of AECI, and JH van der Walt, MD of Sentrachem, in addresses to the CWIU, February 20, 1991, Johannesburg.

twin thrusts, access to markets and the protection of intellectual property have were the chief concerns of the organised multinational chemical corporations in the GATT deliberations.

The chemical industry has been ahead of the general trend towards globalisation. For example in petrochemicals, competitiveness is dependent upon such factors as feedstock availability and price, scale of production, capital costs and location in relation to markets. Hence for the chemical industry globalisation has been under way throughout the last thirty years although the division of world markets among major companies was common from the 1920s.

From a chemical industry corporate strategy point of view recent globalisation has been driven by diverse motivations: attempts to achieve critical mass, maximising returns on R&D, increasing competition, attempts to achieve market dominance, survival, attempts to minimise the effects of economic downturns in one region and environmental considerations. For newer entrants such as South Korean and Taiwanese firms, technology needs and limited domestic markets have motivated merger and acquisition activity.

Corporate Strategies

The changing structure of the international chemical industry is powerfully influenced by the strategic objectives of the large corporations which dominate the industry. Accordingly no review of recent trends in the industry would be complete without some attempt to understand the corporate strategies which were at work. The following two sub-sections attempt to unpack some of these strategies.

a) Commodities, Specialities and 'Core Businesses'

The economic downturn in the early 1980s exposed structural problems in the chemical industry. In addition to immediate cost cutting measures firms began to change strategies. The bulk or commodity chemicals were particularly hard hit by the downturn of the early 1980s. In efforts to move away from the 'boom and bust' cycles of 'commodity' chemicals, firms diversified towards the production of 'speciality' chemicals such as paints, adhesives, 'performance' chemicals, pharmaceuticals, agrochemicals, engineering plastics and advanced materials.

Commodity production usually involves mass production of a standard product such as commodity plastics. The objective for commodity producers is 'low cost leadership', that is to have the lowest unit costs of production. This requires economies of scale, skill, experience, research and development (R&D) and investment. Speciality business on the other hand is aimed at 'price leadership' - that is the suppliers' ability to determine the selling price.

The relationship between commodity chemicals and specialty chemicals is schematically represented in Figure 8. In this figure commodity chemicals are represented by 'Basic Chemicals' and 'Bulk Intermediates', whilst those sectors to the extreme right of the figure are specialties.

Success in specialities requires a firm to have the flexibility to respond rapidly to customer needs. It requires investment in staff, for marketing, research and development and after sales service. Speciality production is characterised by flexibility, smaller batch processing and multi-purpose use of equipment, conducive factors for those who seek competitive advantage in terms similar to Best's (1990) 'new competition'. Such 'designer chemical systems' require a firm with an orientation quite different from a firm rooted in the production of commodities.

Speciality business requires higher R&D and marketing costs, market segmentation, globalisation, (to maximise returns on R&D and increase exposure to problems) managerial decentralisation and financial strength for the period necessary to win customer loyalty according to Diagle.[4] Diagle's (undated) study of US speciality firms found that size alone had little correlation with profitability whereas market dominance had a direct relationship with profitability.

For those international companies which succeeded in making the transition from commodities to specialities in the 1980s, profits were better than average. A good example of a firm which succeeded in changing its corporate culture away from commodity production to speciality production is Monsanto. It is also one of the more anti-union companies in the US. Some firms have struggled to adjust their corporate culture sufficiently to meet these new requirements. Others found that their location in the industry made it difficult to move. For example the three major German firms, Bayer, BASF and Hoechst each appear to have taken a different route. BASF earned 30% of 1988 revenue from specialities, Bayer 60% and Hoechst half of its income (ICEF, 1990c). An explanation offered for this is that their opportunities for manoeuvre were restricted by the parts of I G Farben that they were given when it was broken up at the end of WW2. BASF is the more commodity orientated because

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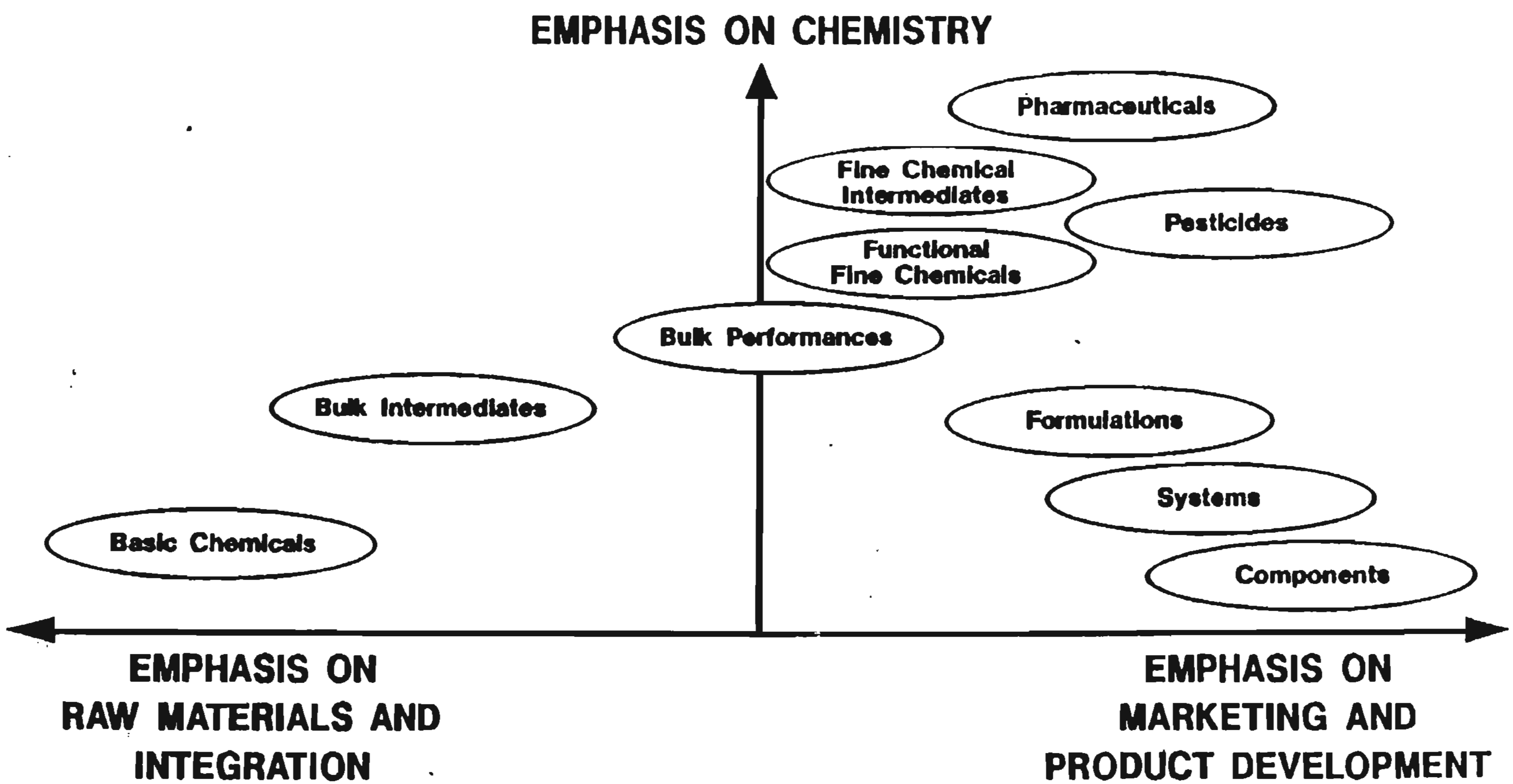
4. Diagle is Vice President of Kline & Co. which claims to be the largest business consulting firm for chemical and allied industries.

Figure 8

CONOCHEM CHART



Source: Chem Systems

it was given the Ludwigshafen site which was the site where more of the commodity production was located (Interview, Glassen and Todtner).

However the stampede into specialities and the accompanying competition reduced many specialities to pseudo-commodities. This in turn required continuous innovation of new products in order to stay ahead of competitors. The increasing costs of research and development required to do this (dealt with below) caused speciality chemical manufacture to lose some of its attractiveness. A further constraint on the trend to diversify into specialities has been the limited size of the market for such products. In addition the wide spread of speciality applications across industry, does limit them to some extent to GDP growth rates.

For these reasons some, but not all, leading firms were obliged to modify strategy once again in the late 1980s. This time re-emphasising 'core competencies' in order to maximise their competitive advantages in generating new products and staying ahead of the competition. Stern (1992) asserts:

> "In the 1990s and beyond, the multinational corporation's most reliable source of sustained competitive advantage will be its core competencies. These are the unique capabilities and collective skills and knowledge that have driven the business in the past and, if channelled, will fuel its growth in the future." (Stern, 1992:13)

A chemical industry perspective is given by ICI's chief operating officer who is quoted as saying:

> "A much greater focus on a smaller number of business areas must, I believe, replace the 1980s strategies of diversification." (Business Day, 9-12-92)

This does not suggest an abandonment of the pursuit of dominance in specialities but rather a trend by firms to home in on those areas in which they perceived they held the greatest competitive advantage. Such areas would be known core competencies capable of generating new high value added products.

SASOL by contrast, has since 1988 embarked upon an almost frantic and wide ranging phase of diversification. At the upstream end it is involved in oil and gas prospecting and is investigating exporting coal. In more specialised areas it is expanding into the manufacture of alpha olefins, synthetic fibres and a wider range of speciality waxes. Its unique position as a producer of synthetic fuels from coal and its need to increase the share of its product portfolio devoted to higher value added products account for its behaviour. SASOL's strategy may appear at first glance to be outdated diversification but it has more to do with a desperate corporate survival strategy. The end of political apartheid is likely to bring to an end SASOL's windfall profits which arise from the state regulated regime of support (subsidy) for synfuels worth approximately R1 billion p.a.. It is not unlike the diversification strategies followed by large oil companies from the mid 1970s to the 1980s, who whilst cash rich from the oil shocks feared the end of their global dominance of the industry.

Nevertheless SASOL will soon have to begin competing with those companies which have concentrated on developing their core competencies whilst it is still grappling with a very diverse range of activities.

Accompanying the shift to specialities international firms have also sought additional means to avoid the effects of economic cycles. These include joint ventures in large volume investments to better regulate the introduction of new capacity. Another strategy is sector 'swaps' between leading firms, as a means to concentrate on core business and to rationalise production. For example in 1992 ICI swapped its nylon businesses for Du Pont's acrylics businesses in the biggest swap ever made. An ICI spokesperson has said that business swaps are likely be more popular as a way of restructuring operations, not least of all because they did not incur huge costs in the way acquisitions did (Business Day, 9-12-92). The effect of the swap was to make each of the firms the largest producer in the world in their chosen product. Du Pont now has a 25% share of the world market in nylons. ICI has secured production capability in the US for methyl methacrylate (intermediate input in manufacture of acrylics) which it lacked (ECN, 27-4-92:4 and 4-5-92:8). Acrylics are used in paints, a business in which ICI is a world leader. It appears that ICI's strategy is that it only wishes to remain in those businesses in which it can compete, if not dominate, globally. It is also an attempt by ICI to change its 60:40 commodity:speciality ratio of three or four years ago by reducing its exposure to commodities (Interview, Freeman).

In a new and innovative step which has attracted the interest of industry commentators, ICI has broken up its business into two separate businesses, ICI and ZENECA. ICI will be high volume, capital intensive cyclical commodity type businesses. ZENECA will include ICI's pharmaceutical, specialities, seeds, bioscience and agrochemicals businesses. It is second in the world only to Ciba-Geigy in the latter.

At one level ICI's unbundling appears to be its novel approach to dealing with the differences between commodity and specialty production. There is an inherent conflict in all chemical conglomerates and an eternal competition for resources. The pharmaceutical and specialty businesses within ICI felt that they were supporting the flagging commodity parts of the business. Conversely the commodity type business believed that they were being starved of investment (The Economist, 1-8-92:56). A split is one way to overcome such problems.

The timing of ICI's unbundling in 1992, comes after two years of falling profits and just months after Hanson's take-over bid which ICI managed to survive. ICI's pharmaceutical business lacked a major new 'blockbuster' drug to launch and thus following Ciba-Geigy's example of investing heavily in marketing and sales did not seem warranted. On the other hand it was reluctant to follow the example of other drug companies and enter into a joint venture for fear of losing control of its business. Clearly ICI management felt bound to take some action. ICI's breakup is a precedent in portfolio management by chemical conglomerates (Chemical Week, 7-10-92:27).

It is instructive to observe the effect of a breakup in a major MNC like ICI's and the impact this has on a leading South African firm like AECI. In 1991 AECI was structured with a 62:38, commodities to specialties ratio, (although the specialities are typically lower order type speciality products) much as ICI was a decade earlier. AECI like ICI has had falling profits in recent years. In 1991 it reduced its dividend for the first time since it was listed on the stock exchange in 1966. In the same year the Johannesburg Stock Exchange dropped AECI from its chemicals and oils rating index. Its large exposure to commodity sectors such as mining and farming which were depressed industries at that time in South Africa, contributed to its flagging performance. Business day predicted that ".. AECI is due for a shake-up. The market's impression is that it is a dinosaur in a vibrant industry." (19-8-91).

Presumably in an attempt to meet these criticisms AECI split one of its main operating arms Explosives and Chemicals Ltd, into two, AECI Explosives Ltd and another company which will operate the fertilizer business. The coincidence in timing is striking, the South African split coming just months after the ICI split, although the effect was not as dramatic. Both remained wholly owned subsidiaries of AECI Ltd. and they are both commodity businesses, although the explosives business is developing speciality type applications (see below). But this was merely the harbinger of things to come.

In 1994 AECI underwent a fundamental shake up which left it a very much less significant player. AECI appeared to be caught between the scissors of, on the one hand its problematic polymers business compounded by SASOL's stranglehold over its feedstocks, and on the other ICI's reluctance to retain an interest in activities outside its core areas of interest and competence. Both of these factors also had to be seen in the context of post apartheid South Africa's increasing exposure to the chill winds on international competition. The outcome of these imperatives was that AECI lost control of its polymers business to SASOL in a joint venture called Polifin, owned 60:40 by SASOL and AECI.

On the other hand AECI lost control of its traditional core business, explosives and accessories, to ICI (a world leader in explosives) in a 51:49 joint venture. Both of these changes were effective from 1 January 1994. In the process ICI extracted itself from AECI's other (presumably less desirable) activities. This did however leave what was left of AECI, for the first time in 70 years, in control of its own destiny but at the same time more vulnerable to further take-over.

The perils of relatively small economies trying to carry out deliberate industrial policy in the chemical industry which is subject to the changing fortunes and strategies of its major international players are apparent from this example.

Higher value added speciality chemical manufacture in South Africa is limited according to Baker (1992a).[5] A part of the explanation for this is the relatively narrow spectrum of basic chemical building blocks available from our essentially coal based industry, when compared with an oil based industry. Another part of the explanation has to do with the distance between South Africa and major speciality chemical markets. Speciality chemicals typically require the producer to be close to the customer in order to understand their needs and to provide the 'systems service'. A further limiting factor is the small size of the local market and the reluctance of technology licensors to permit exports into their own markets.

The South African chemical industry is nevertheless expected to become more speciality-chemical orientated as it becomes less preoccupied with self sufficiency and mining and more consumer orientated (Interview, Laing). Potential areas of development include water treatment, and the chemical application of the treasure chest of locally available minerals such as gold, manganese, platinum, chrome and others. However this would require these minerals to be available at lower than import parity prices. This would require some form of industrial strategy. As a world leader in explosives South Africa should be able to export explosive systems (as opposed to commodity type explosives). AECI has targeted electronic detonators used in computer controlled phased explosions which they anticipate will "become an important cash generator within three years." (Business Day, 21-12-92:5) Low cost health care systems associated with primary health care delivery may also hold potential

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5. Baker, 1992a, bases his views on Enigma Marketing Research's latest report, <u>The Chemicals Industry in South Africa</u>.

if the health care system is reorientated in that direction. Low cost housing may also generate new speciality chemicals.

Whilst this might imply some hope for South African firms, Wittcoff (1992) believes that a turnover in excess of R1 350 million and a return on sales of over 20% are the levels at which 'critical mass' is achieved. By way of comparison AECI's 1991 turnover was R5 280 million derived largely from the sale of commodity chemicals. Its speciality chemicals subsidiary, Chemical Services, had a turnover of R 478 million in 1991. The smallest of South Africa's three large chemical companies, Sentrachem, has the largest share of its business in specialties. About half its business is consumer orientated. There would appear to be only a limited number of suitably sized local enterprises which could enter this competitive area of business. The changes in the policy environment that may be necessary in order to facilitate the emergence of such businesses with 'critical mass' will require further investigation.

If the shift to a more market orientated, speciality-type chemical industry materialises then the local chemical industry is likely to account for a smaller proportion of manufacturing than has been the case in the past.

b) **Other Corporate Strategies**

For a firm trying to become or remain a world leader there are a number of strategies to choose from. Different firms have selected one or more depending upon their vision and their perceived strengths and weaknesses at the time.

Marketing offers a range of possibilities. Exporting is an obvious means to increase sales although this usually requires a proximity to markets. Another is to try and become the world's largest producer as ICI and Du Pont did in their nylons and acrylics swop.

Most of the major world chemical companies are conglomerates involved in a range of chemical activities through a portfolio of companies. As with most portfolios they require managing in constantly changing circumstances. The rule of thumb appears to have been to shed losing companies, usually to other companies already strong in that business and to buy profitable companies which have synergies with stronger elements within the remaining portfolio. A variation of this is to remain with those activities that the company does best.

Vertical integration became a feature of the industry in the late 1960s and early 1970s. The advantage for an oil producer like Shell integrating forward into petrochemicals is that it allows flexibility. Through intra-firm transfer pricing profits can be extracted at different points in the production chain, depending upon the pattern of prevailing product prices. Owning several links in a production chain also usually means that the company can extract profit from downstream and higher value added activities. Vertical integration has been a crucial means to competitive advantage for the international petrochemical firms. The lack of vertical integration in South Africa's commodity plastics *filière* and the reasons for this are discussed in detail in later chapters.

Another option for companies developing new technologies is to license them around the world. This has the advantage of avoiding the risks involved in direct investment around the world. It also helps to off-set the weaknesses of the patenting system. Once a product has been patented other researchers know that it is possible and if there is sufficient incentive, it is usually just a matter of time before another route to the same product is found. As this happens more and more quickly, it places pressure on those who make the initial advance to maximise their returns in the short term. By globalising the development, the sales revenue basis is expanded, which in turn permits greater R&D investment for the next round of developments.

The capital costs involved in constructing plants across the world in a short space of time is usually prohibitive even for large chemical companies. Licensing the technology offers a way of rapidly achieving the same result without the capital expenditure, at someone else's risk, and with a guaranteed income through royalties or license fees.

Union Carbide's discovery in the 1970s of linear low density polyethylene (LLDPE) is a case in point. The manufacture of its predecessor, LDPE, requires high pressures and temperatures. LLDPE was the result of efforts to make LDPE at lower temperatures and pressures and at consequently lower costs. Union Carbide chose a strategy of marketing its new 'Unipol' technology world wide. Indeed the first recipient, in 1982, of this new gas phase low pressure technology was the AECI LLDPE plant in Sasolburg South Africa. This technology marketing approach stands in stark contrast to Union Carbide's approach to globalising its ethylene oxide (anti-freeze) breakthrough 50 years previously. At that time it chose foreign direct investment as the mechanism to globalise that business.

Control of technology is also a crucial mechanism in shaping world production. For example from the 1950s to the 1970s an oligopoly existed in petrochemicals and thermoplastics, held largely through the control of technology (see Oman, 1989). This barrier to entry has been eroded since the 1970s for several reasons: the collapse in profitability during the 1970s and initiatives by new entrants to the industry such as Saudi Arabia, to entice multinational corporations to invest and/or share their technology. Saudi Arabia used its low cost feedstock as a bargaining lever to gain entry to world markets.

International petrochemical construction firms also played a role in technology diffusion. Consequently today for many of the commodity chemicals there is a range of technology options to choose from. This is of course much less so in the more speciality type products where new technologies are more closely guarded.

Another set of strategy options pursued by the chemical majors can be categorised as 'financial management' options. In capital intensive industries the choice of timing in bringing new capacity on stream is critical. But such decisions must be weighed against the cost of finance. Dow Chemical's approach to this issue for example, has helped to give it an edge on its competitors. Simply put, they built plants when business was bad and the cost of capital was low. Thus prepared they were able to take advantage of the subsequent upswing.

Approaches to financing investment can also make a difference. Very different approaches have prevailed in the US and Japan for example. US companies tend to be more equity based, and therefore profit orientated whereas the Japanese firms are much less equity based enabling them to take a longer view and accept lower profits in the short term.

Conclusions

The globalisation of the world chemical industry has emerged and continues through a variety of complex interlinked and interdependent developments. South Africa's engagement with and participation in this process was comparatively limited during the apartheid era. However there are clear signs that this is beginning to change.

Trade figures as a measure of participation in the global economy show that South Africa has lagged behind the world trend which shows an increasing proportion of sales accruing from exports. The historically dominant share of world trade commanded by North America, Europe and Japan (particularly the latter two) has been increasingly challenged by newer producers in developing countries. Successful trade in bulk commodities requires low costs. South Africa's bulk chemical producers have for the most part lacked economies of scale and have been high cost producers. The cost of import substitution industrialisation policies has been a declining share of world chemical trade. Small scale production processes have not advanced very far. Consequently local plants will have to expand their capacity if they seek to be internationally competitive producers.

In the current phase of globalisation the instruments of this process are more complex than in earlier phases and less amenable to simple industrial policy measures. At the same time the ascendent power of MNCs makes industrial policy more important for those concerned to protect national economic sovereignty. The perils of charting industrial policy for South Africa are manifold as the AECI/ICI example demonstrates. Changes in MNC corporate strategy can have a significant impact on local ownership and the prospects for local firms.

There are signs that local producers are beginning, a decade later than their international rivals, to show more interest in speciality chemicals and the higher levels of R&D spending which must accompany such developments. This is a promising development which should be encouraged because South Africa's disadvantageous geographical location relative to major markets requires the export of higher value added products the better to withstand the burden of transport costs.

The challenges of raising the bulk of South Africa's population from the deprivation they have endured will create a market for a variety of low cost speciality type chemicals, for example in water treatment and low cost housing. This together with the chemical beneficiation of the wide range of locally available minerals, in the context of a suitable technology policy suggest that considerable potential for the local chemical industry may exist.

In sectors such as commodity petrochemicals note must be taken of the need to be a low cost producer and the advantages of vertical integration in achieving this. This issue is the subject of discussion in subsequent chapters.

The penetration of regional trade blocs in North America and Western Europe during the 1980s was primarily by means of mergers and acquisitions, often at a cost far beyond the means of South African firms. Consequently this does not appear to be an option for local firms, and instead suggests that a better strategy may be to try and dominate niche markets - this would appear to be the case in SASOL's investment in alpha olefin production.

In recent years globalisation has proceeded in part by strategic alliances among leading firms. This may be a useful route into participation in the global chemical industry for local firms. South African firms are likely to be in search of technology. In addition attempts may be made by local firms to inveigle themselves into the new and complex interlinkages that characterise the current pattern of globalisation. If this is so then industrial policy should support this by ensuring that plants in which there is foreign participation are designed to export and that measures are taken to monitor and limit the extent to which foreign companies gain influence in the domestic economy. Most importantly companies negotiating technology licenses should receive strong state support to ensure that these include the right to export.

Corporate strategies in response to changing circumstances have been complex in the 1980s but it is possible to isolate two broad approaches. One advocated vertical integration but the more popular favoured diversification into speciality chemicals. This phase is ending in the early 1990s and being replaced by a return to 'core business'. In this regard SASOL's current diversification strategy appears to be not so much out of step with world trends, as a desperate attempt to survive the looming end to its subsidies by finding more viable core competencies than synfuels.

PART FOUR

ENERGY AND ENVIRONMENT

The evil that men do lives after them, the good is oft interred with their bones.
Mark Antony

In recent years world wide attention has been increasingly focused on environmental degradation both at national and international levels. Industrialisation has exerted stresses upon the environment and the chemical industry is no exception. Indeed it is one of the main causes of this stress as is explained below. The way in which environmental issues are viewed is beginning to change. Rather than being considered in isolation they are starting to be viewed as a complex set of issues linking patterns of production, consumption, quality of life, and the potential for future economic growth or development. In this chapter the chemical industry's role and contribution to this process are considered and evaluated.

Major environmental disasters such as Chernobyl, Bhopal, the Sandoz spillage into the Rhine and others have increasingly tarnished the image of the chemical industry. They have also demonstrated, in dramatic fashion, the interdependence and global nature of industrial threats to the environment.

These major environmental disasters are among the reasons why 'Environment' has become the watchword for the chemical industry in the 1990s. This is not surprising as it is one of the most energy intensive and environmentally polluting industries (UNIDO, 1989). The most serious environmental problems arising from this industry can be categorised as follows:-

- energy use
- waste generation
- air pollution
- liquid effluents
- accident potential

Each of these aspects is discussed before turning to some of the social pressures for change faced by the chemical industry and its responses to some of these pressures. Particular emphasis is given to plastics as they are a central focus of this study and this includes some discussion of plastic recycling.

Energy Use

Chemical Industry energy consumption may be separated into two categories, feedstock (oil and gas) and energy to drive the processes of production. About 57% of the chemical industry's energy consumption is in the form of raw materials input, not process energy (United Nations, 1992:6). Process energy is however also a concern as much of it is sourced from coal fired power stations. Such power stations release large quantities of sulphur dioxides, nitrogen oxides and other pollutants, many of which are known to be environmentally damaging (see Table 2.9). In South Africa 92% of electricity is sourced

Table 2.9 Annual Effluent Production from 1 000 Megawatt Coal-fired Power Plant

Effluent	Tonnes
Airborne emissions	
Particulates	3 000
Sulphur dioxides	10 000
Nitrogen oxides	27 000
Carbon monoxide	2 000
Hydrocarbons	400
Liquid effluent	
Organic material	66.2
Sulphuric acid	82.5
Chloride	26.3
Phosphate	41.7
Boron	331.0
Suspended solids	497.0
Solid wastes	
Bottom ash and recovered fly ash	360 000
Total	403 445

Source: M J Chadwick and other eds., Environmental Impacts of Coal Mining and Utilization, Oxford, Pergammon Press, 1987, in UNIDO, 1990:99.

from coal fired power stations which in 1991 had a generating capacity of 36 000 mega watts (Eberhard & Trollip, 1992:26). If the results of Table 2.9 are applied to this capacity, South Africa's coal fired power stations have the capacity to deliver 14.5 million tonnes per annum of emissions into the environment. However not all coals contain and emit the same volumes of pollutants. For example the sulphur content of coal can vary from as low as 1% to as high as 10% for brown coal. The emission of sulphur dioxide air pollution from coal fired power stations is in direct proportion to the sulphur content of the coal burned. South African coal is generally regarded as a lower (higher emissions) quality coal. A CSIR study found that electric power generation resulted in 22 million tons of waste/pollution (CSIR, 1993/1994:35).

Data on energy consumption by industrial sector is difficult to come by but the indications are that the chemical industry consumes the largest share of energy in the manufacturing sector. The chemical and allied products industry was the largest consumer of energy among all manufacturing sectors in the US in 1985 consuming 22.7% of the total (UNIDO, 1990:100). In South Africa the chemicals sector (excluding liquid fuels) consumes 29.6% of the total energy consumption in the manufacturing and metallurgical industries.[1] One estimate places the chemical products industry at 24% of 1991 national electricity consumption.[2] This suggests that the South African chemical industry is more energy intensive than its US counterpart. This is understandable given the coal based technologies used by SASOL and AECI.

The trend in chemical industry energy consumption in the DMEs has been downwards, spurred on by the oil shocks. Consumption of process energy relative to production is declining. This is mainly due to improving operations efficiency.

Waste Generation

A disturbing feature of the local chemical industry is that its output of waste *exceeds* that of its output of product for further processing or final sale (CSIR 1993/1994:35). A similar relationship between waste and 'saleable' output exists in mining. The local mining industry generated 240 million tonnes of waste/pollution in 1989, some 20 times more than the chemical process industry at 12.3 million tonnes (ibid). However the South African chemical industry has particularly strong backward linkages into the mining sector in, for example, synfuels and petrochemicals (coal mining) and inorganic chemicals (phosphates, lime etc). The chemical industry also has strong forward linkages into post consumer waste of which plastic materials are often the most visible (see below). If these backward and forward linkages are taken into account then the overall contribution by the chemical industry to the national waste inventory is larger than that of just the chemical process industry.

A 1987 study of chemical pollution by the US Department of Commerce yielded some

1. Calculated from Eberhard and Trollip, 1992, Table 4:17.

2. Environmental Monitoring Group, based on ESKOM Sales To Selected Industries 1991.

interesting data.[3] Industrial Chemicals (ISIC 351) accounted for 54% of the volume of manufacturing releases. Industrial Chemicals was also the largest sector of manufacturing by coefficient of manufacturing value added, producing 99.7 pounds of chemical pollutants per US $ 1 000 of manufacturing value added (MVA), nearly twice as much as the next largest sector, the paper and paper products industry. In that year (1987) Industrial Chemicals contributed 4.9% of MVA, which is not an unusually large proportion in a developed market economy.[4] In the same year the South African Industrial Chemicals sector accounted for a similar proportion of MVA, 4.8%, and assuming that South Africa's environmental regulations were not more demanding than those prevailing in the US, (the opposite is more likely the case) then South Africa's Industrial Chemicals sector may also have accounted for about half of the chemical pollutants released by manufacturing. Indeed given the older technology used at SASOL and that used to make PVC in SA, it may have been substantially worse. (These technologies are considered in more detail in a later chapter). Data from a CSIR commissioned study suggest that in South Africa, chemical process industry waste accounted for 62% of the volume of manufacturing waste/pollution generated annually.[5]

In addition to Industrial Chemicals this study is concerned with the plastic converting industry, largely included in the Plastic Products (ISIC 356) category. Unlike Industrial Chemicals, its share of MVA in the US study is larger than its share of chemical pollution. This sector together with Rubber Products (ISIC 355) accounted for just 1.2% by volume of manufacturing chemical releases, whilst the combined contribution to MVA by these sectors was 3.7%. These sectors combined were the seventh largest sector (out of 20) measured by weight of pollution per US $ 1 000 of output, that is 16 times smaller than Industrial Chemicals.

If these figures are correct it may be concluded that, from an environmental impact point of view, the Plastic Products industry is preferable to the Industrial Chemicals industry. The relative size of South Africa's Plastic Products industry in 1987, was 2.1% of MVA compared with the US figure of 2.6%. If the previous assumption concerning environmental regulation is employed, then the South African Plastic Products industry released a proportionately smaller share of chemical pollutants than the Industrial Chemicals industry.

With this data in mind, and assuming the proportions to be roughly applicable world

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3. Calculations in this paragraph based on UNIDO, 1990, Table III.32 and p123, unless otherwise stated.

4. Calculated from UNIDO, 1989, statistical annex.

5. Calculated from CSIR, 1993/1994 table 25.

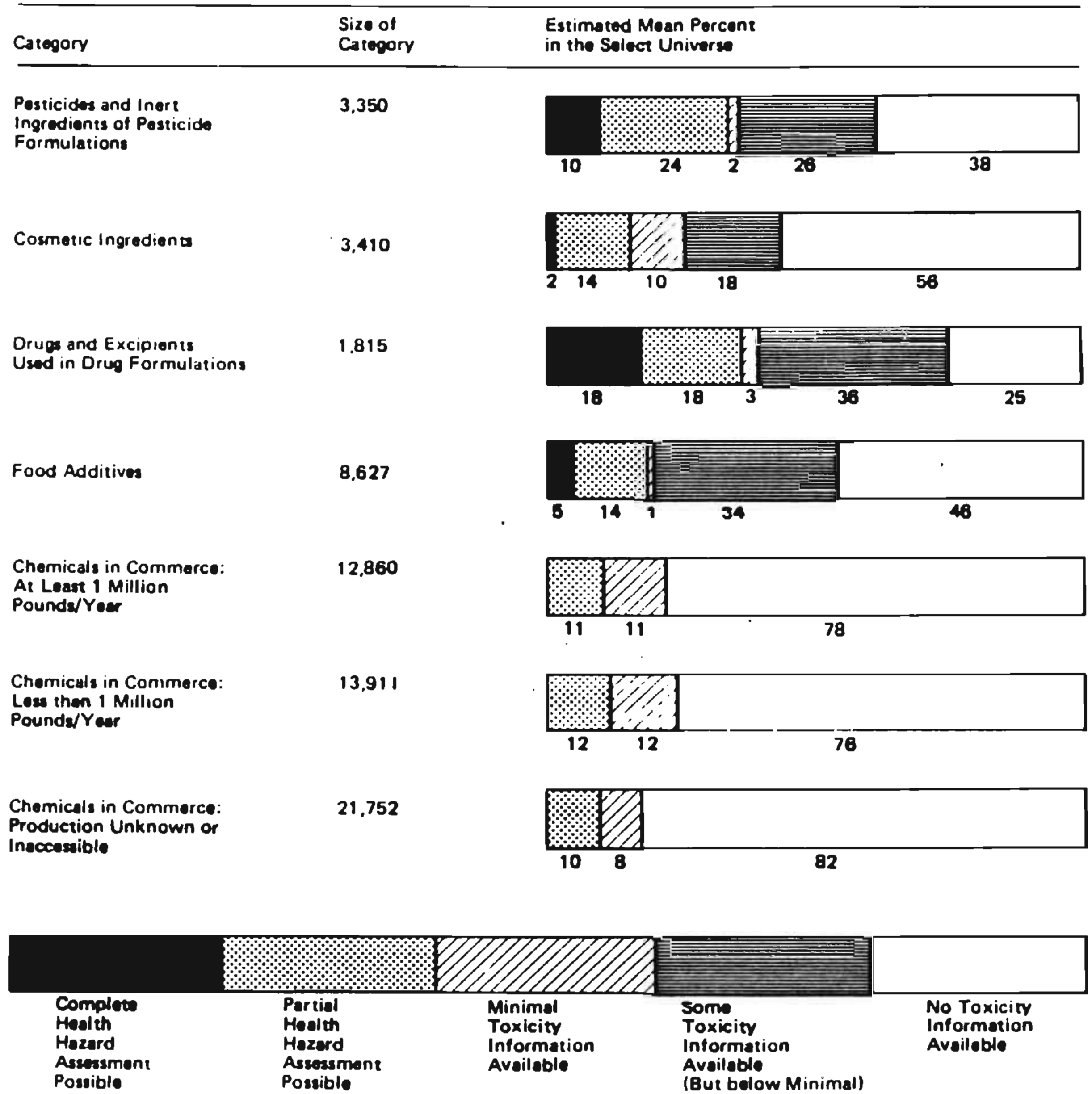
wide, it is not difficult to understand why the chemical industry has been targeted as a major environmental spoiler by those concerned about the effects of industrialisation on the environment. To compound matters further for the chemical industry, many of the chemicals being produced are not fully understood in so far as their impact upon human health is concerned, let alone the environment. A complete health hazard assessment is possible in respect of only a small percentage of known chemical substances (see Table 2.10). Worse still, many chemicals remain in some form or shape as polluting agents long after they have performed their intended task. Industrial organic chemicals are the chief offenders in so far as the environment is concerned and their global output has grown dramatically since 1945: from 7 million tonnes p.a. in 1950 to 250 million tonnes in 1985 (UNIDO, 1990:121).

Air Pollution

In so far as the chemical industries contribution to environmental pollution is concerned, this occurs in several ways; air pollution, water pollution, solid wastes, hazardous wastes and toxic chemicals. Again data on these emissions is sketchy. That which is available identifies the major contributors to air pollution as those industries producing basic industrial materials; namely chemicals, primary metals, paper etc. The European chemical industry has accounted for 20% of industrial CO_2 emissions. It is also the source of large volumes of nitrogen oxides and sulphur dioxides.

Many organic chemical emissions originate in the petrochemical industry. The chief difference between air pollution from the petrochemical industry and other sectors of manufacturing is the concentration of a variety of hydrocarbons from a single point source. Many are toxic and/or hazardous, requiring special technology to extract and control. Such equipment is costly. Emissions tend to be greater from the older plants. Newer plants tend to have more sophisticated, pollution reducing original equipment. Retrofitting older plants with pollution control equipment may not be cost effective. Since many older plants are smaller scale and therefore less competitive, the financial problems are exacerbated. In addition to these financial problems there remain serious technical problems to overcome in achieving comprehensive solutions to air emissions from the petrochemical industry.

Table 2.10 Ability to Conduct Health Hazard Assessment of Substances



Source: National Research Council. 1984. Figure 2.

Liquid Effluents

Liquid effluents from the petrochemical industry are, like its air emissions, characterised by their variety. They include ballast water, product spills, contaminated runoffs, cooling waters, and start-up and shut-down liquid effluents. The considerable technical complexity in dealing with these sources usually requires an integrated approach to a petrochemical site to determine the optimum solutions. According to the US Environmental Protection Agency, the best practicable technology for treating liquid effluents from petrochemical plants is biological treatment together with post-filtration.

In so far as water pollution is concerned a 1987 study by the US Environmental Protection Agency found that just five industries accounted for 90% of total industry releases of toxic chemicals into surface water. Among them the chemical industry alone accounted for 48% (UNIDO, 1990:131).

Accident Potential

As chemical plants have become larger the potential for catastrophic accidents has grown, and indeed materialised in some well known tragedies. Bhopal, Chernobyl and Three Mile Island are household words. The deteriorating accident rate in US oil and petrochemical facilities has been highlighted in a video documentary called 'Out of Control' produced by the Oil Chemical and Atomic Workers Union. It details the explosions and accidents which have occurred during the 1980s and draws attention to the plight of workers operating these installations.

South Africa's largest insurance claim arose from a fire at SASOL 3. Although supply interruptions are undesirable in the petrochemical business they happen regularly. It appears that insurance is cheaper than adequate health, safety and environmental standards. The environmental consequences of such accidents have gone largely unmeasured.

Minimum health and safety standards and procedures are commonly legislated. Improvements beyond those are left to the collective bargaining process. This has been the case in South Africa. However the Machinery and Occupational Safety Act enacted in the early 1980s did not officially recognise the role of trade unions in health and safety issues - indeed many trade unionists believe that it was deliberately designed to marginalise their role in health and safety. This problem has been ameliorated to some extent by the Occupational Health and Safety Act (1993) which now recognises worker representatives and gives them some rights but no duties, although it falls short of the British model, upon which it appears to be based, which recognises the right of representative trade unions to appoint health and safety representatives.

From a policy point of view there are two basic approaches; the minimum regulation plus collective bargaining approach and the 'safety case' approach. The latter approaches health and safety issues not from the regulatory point of view, but imposes a responsibility upon the employer to firstly identify the hazards and then to conduct his/her operations in a safe manner.

The regulatory model has the disadvantage that the growing complexity of the chemical industry and new technologies such as biotechnology make it difficult to draft appropriate regulations. Secondly the employer is only required to comply with the regulations, rather than provide a hazard free work environment. The 'safety case' approach has the advantage that the initial inventory of hazards provides a useful basis for an audit if an accident occurs. It also obliges the employer to think about potential hazards rather than just comply with regulations. Neither approach appears to be adequate by itself but employed in the appropriate combination, they have the potential to deliver safer workplaces.

Pressures for Change and Responses

One chemical in particular has been singled out for considerable environmental pressure, chlorine. Greenpeace, for example, have mounted an international campaign for the elimination of chlorine usage. It is usually produced in chlor-alkali plants which separate the chlorine and soda in salt. The soda is largely used in the glass and detergent industries whilst chlorine is a central building block in the chemical industry having a wide variety of applications. It is an essential component of bleaches for the paper and textile industries and in water purification chemicals. It is also a major component of PVC, (one of the commodity plastics considered in this study) and other plastics. Indeed many chlor-alkali producers are also PVC producers as PVC is a convenient 'sink' for the chlorine by-product of the soda making process. Chlorine has other uses as well, in pharmaceuticals and pesticides. PVC has been an important target of the anti-chlorine lobby because when it is burnt at low temperatures it releases dioxins, one of the more dangerous poisons, and other potentially harmful by-products created when the liberated chlorine reacts with other substances.

Another area where chlorine has received much bad publicity has been the effect of chlorofluorocarbons (CFCs) on the ozone layer. In paper bleaching and CFCs chlorine is losing market share to alternatives, even though the alternatives are less effective in some applications. However the great difficulty is that for many applications there is no alternative or suitable substitute. This example starkly illustrates one of the trade offs in modern society. The lifestyle made possible by industrial production necessarily wears down the natural systems that are the ultimate human life support mechanism. Thus far technological development has not yielded a complete solution to the chlorine problem.

Public P. Increasing public awareness in the more developed economies and some of the NICs, such as Taiwan, has resulted in pressure upon the chemical industry to 'clean up its act', along with other industries. One form this pressure has taken is political intervention through greater environmental regulation of industrial activities. This has obliged companies to devote increasing proportions of their capital investment to meeting environmental considerations. In the UK 33% of environmental protection spending in 1991 was attributed to legislative requirements and this is expected to rise to 56% by 1994 (Chemical Industries Association, 1992:5).

Financial P Other pressures on the chemical industry with environmental origins have arisen from some, perhaps unexpected, quarters such as financial institutions. Environmental considerations are also beginning to influence financial flows, such as capital markets and takeovers. Increasing numbers of merger and takeover decisions are being made only after an environmental audit has been conducted, chiefly to determine what 'hidden' environmental liabilities might lie in store for a new owner at some point in the future.

Banks too are taking an increasing interest in the environmental performance of their corporate clients in view of the risks they face as lenders. For banks a danger arises in having to foreclose on debt defaulters as a result of which the banks may become property owners. As owners they are then responsible and liable for any pollution the firm may have caused. This danger has now increased one step further, in that banks may become liable, whether they foreclose or not. This follows a US court decision which set a broad precedent making banks liable for environmental clean up costs in certain instances. The court ruled that banks must pay if they participate "in the financial management of a facility to a degree indicating a capacity to influence the corporation's treatment of hazardous wastes". (Quoted in Financial Times, 27-3-92). The legal position on this question in the EC, Japan and developing countries is less clear. But whatever the legal regulations may be, there is the ever present threat of common law liability which is likely to make banks more attentive to environmental considerations. Banks may find themselves increasingly becoming environmental enforcement agencies, irrespective of how unpalatable that may be to them.

How have the large chemical corporations responded to these public and financial forms of pressure? One response in the UK has been to increase the proportion of all new investment directed towards health, safety and environmental protection from 8% in 1982 to 17% in 1990 and to 25% in 1991. (Chemical Industries Association, 1992:5). This is in line with the trend in the OECD generally, where 20% to 30% of investment budgets of major chemical firms are devoted to environmental research and protection measures (OECD, 1992:76). Whilst this may appear large, such figures are placed in perspective when considered as a proportion of sales. As Table 2.11 shows environmental costs are a small proportion of sales.

Table 2.11 Environmental Costs as % of Sales Certain Companies, 1990.

DSM	3.0
Bayer	2.2
Rhom & Haas	1.9
BASF	1.7
Huls	1.7
Sandoz	1.7
Schering	1.6
Roche	1.5
Du Pont	1.3
Nova	1.3
Ethyl	1.0
ICI Australia	1.0
Dow Chemical	0.9
Kemira	0.9
Monsanto	0.9
Union Carbide	0.9
Hoechst	0.7
Merck & Co.	0.7
EniChem	0.7
Ciba-Geigy	0.5
Grace WR	0.5
Tosoh	0.3
Average	1.2

Source: Chemical Insight's Company Analysis, 15th Edition, 1991.

South African chemical companies do not include their environmental spending in their annual reports as some chemical MNCs do and consequently no comparison is possible.

As the large chemical corporations have begun addressing their environmental problems they have also begun to lobby for more time in which to do so. With this objective in mind, increasing sums have been spent on advertising in efforts to polish up the chemical companies' environmental images. Similarly all manner of ordinary products have suddenly become 'environmentally friendly', even those which never stood accused in the first place. South Africa is no exception in this regard. Increasing amounts are being spent on advertising designed to demonstrate how 'environmentally friendly' chemical companies or their products are.

Perhaps the most constructive response by some chemical firms has been to seize the business opportunities opened by the move towards cleaner production. Du Pont for example has been able to market the experience it gained in cleaning up its own operations. A separate division has been created for this purpose to enter the burgeoning environmental service industries. The growth in this sector has been fuelled by the increasing volumes of per capita waste that have accompanied increasing per capita incomes in the developed economies. Some perspective on the size and growth of this industry may be gained from Table 2.12. Growth and profits are both healthy in this industry, often facilitated by large state expenditures on clean up programmes in the DMEs.

Table 2.12 Growth Indicators: Waste Disposal and Recycling in Europe

	1989	1990	1993
	Production (billion ECU)		
Collection & Processing	11.0	11.8	14.8
Materials Reprocessing	14.0	14.0	16.0
	Number of Employees		
Collection & Processing	160 000	171000	225 000
Materials Reprocessing	120 000	115000	100 000
Total	280 000	286 000	325 000

Source: EC Panorama quoted in ICEF, 1992:54.

Organised chemical employers have also sought to engage environmentalists and to erect defences protecting them from environmental pressure. The thrust of the chemical employer's initiative revolves around two programmes: the 'Responsible Care' programme and the 'Business Charter for Sustainable Development', the latter being a multi industry initiative.

The Responsible Care initiative is intended to improve the image and conduct of chemical firms. It comprises a number of 'codes' such as 'Product Stewardship, Process Safety and Distribution'. One of its many weaknesses is that participation in Responsible Care is voluntary in the US and many other countries. In Canada however, implementing Responsible Care is a condition of membership of the CMA, whilst in Argentina the government has created a secretariat to tackle the implementation of Responsible Care and the petrochemicals industry will be expected to follow specific guidelines (ECN 27-1-92:29). Nevertheless in the view of a leading US trade journal, Chemical Week:

> "In terms of its effect on the chemicals industry, the Responsible Care program is as unproven as a newborn blinking its eyes in the light of day." (Chemical Week, 11-12-91:21)

The approach of the US Chemical Manufacturers Association to Responsible Care involved a public outreach initiative to establish an advisory panel of people from outside the industry to assist it in developing its codes of practice. Several large firms have reproduced the idea at company level, sometimes incorporating well known company critics. AECI in South Africa are attempting to do something similar.

Weaknesses in the Responsible Care programme occur at both levels, the national and firm level. One is the difficulty in measuring the improvements made and whether or not they are in accordance with the plan adopted. This is exacerbated by the imprecise wording in parts of the programme which allows wide interpretation. More fundamental to the legitimacy of Responsible Care is the 'player and referee' syndrome. That is, companies measure and judge their own performance. There is no provision for third party audits or evaluations.

In South Africa the local Chemical Manufacturers Association began to debate adopting Responsible Care in 1992. The chief advocate was AECI, the biggest chemical company (Chemical Week, 17-6-92:154). The unashamed intention of this initiative is spelt out by one of its supporters, Peter Hart, Sentrachem's General Manager of technical/risk control:

> "The main step is to get CMA to adopt Responsible Care, so we can go to the public as an industry with our improvement" (Quoted in Chemical Week, 17-6-92:154).

Judging by this and other company statements the main intention is to use the adoption of Responsible Care as a defence bulwark at the propaganda level. The three large chemical companies AECI, SASOL and Sentrachem claim to have begun implementing Responsible Care type programmes although they cannot call them that until the CMA adopts Responsible

Care.

The other initiative by organised business is the 'Business Charter for Sustainable Development', developed by the International Chamber of Commerce and launched in April 1991. This is even less far reaching than the Responsible Care programme. It operates on an entirely voluntary, self policing basis.

Internationally organised chemical trade unions have proposed a much more rigorous alternative:

> "A system of Environmental Accounting and Auditing needs to be devised on an internationally agreed basis which will have equivalent force to the accounting principles which companies are expected to maintain in respect to their capital wealth. Just as financial accounting is governed by strict regulation and backed by law, so too we have to develop social responsibility in the corporation in environmental matters. In the light of experience in other areas of social concern, only the incurably naive or the intentionally ingenuous would believe that this transformation could be effected without the compulsion of public accountability." (ICEF, 1990:12)

Several leading chemical MNCs are including some environmental reporting in their annual reports which may, with time, be developed in the direction organised labour envisages.

More substantial than such voluntary programmes, has been the way in which high polluting businesses have 'voted with their feet'. The phase of global industrial restructuring which gained considerable impetus from the recession during the 1980-82 period, resulted in a significant proportion of chemical capacity being closed - usually the older and less viable plants. This was true of other smokestack industries as well. These closures in the developed countries were accompanied by a shift towards more hi-tech industries (like speciality chemicals).

The fastest growing industries in the developing countries over the 1970-88 period may be classified into two groups: the light manufacturing group including shoes, textiles, leather and beverages. The second group is the capital intensive, or what in South Korea is referred to as the 'heavy and chemical industries', these include iron and steel, non-ferrous metals, basic chemicals, plastics, petroleum and coal products, metal products and paper (UNIDO, 1990:157). The latter group are resource and energy intensive and also highly polluting. There has thus been a geographical redeployment of these 'smokestack' industries from the developed to the developing economies. In many cases developing economies are competing for foreign investment and cannot afford to be too concerned about how environmentally 'clean' the technology is that comes with it.

The redistribution of 'smokestack' industries across the globe in the context of increasing environmental awareness, has impacted on international trade. Indeed environmental issues are growing in importance as an international trade issue since trade is likely to be the manner in which environmentally based differentials in international competitiveness are expressed.

Trade and Environmental Issues

Link with the SA macro economic policy. = tariff barriers 150 : 4000

Countries which have adopted stricter environmental regulations and invested considerable resources in implementing environmental clean up - largely the developed countries - have felt threatened by lower priced imports from countries which have not concerned themselves with environmental issues to the same degree.

For this reason GATT agreements have not ignored environmental questions. Article XX allows member countries to adopt measures to protect human, plant and animal life or to conserve finite natural resources. The Agreement on Technical Barriers to Trade signed under the Tokyo Round, allows signatories to deviate from international regulations and standards for health, safety and environmental considerations (United Nations, 1992:64). There are additional detailed provisions which allow the protection of national environmental standards. These would be classified as technical barriers to trade. When taken together they could be seen as a new form of non-tariff barrier. Indeed this is a concern raised, largely by developing countries wishing to export into developed countries, who fear that environmental standards will be used by developed countries as substitute for tariff protection. Whatever the case the signals are clear for those South African exporters who care to read them - higher environmental standards are and will continue to be a feature of access to markets in developed countries. Europe is an important market for South African plastic goods and in the next section changing environmental considerations in Europe are discussed.

Plastics, the Environment and Recycling

This study has as its major focus the plastics industry, an industry which has come under increasing environmental pressure. In short, the problem as often perceived by the public is that plastics do not biodegrade and have very long lifespans, remaining in the environment for many years. Indeed PVC water pipes are designed to do just that.

To begin with it is helpful to identify the sources of waste that emerge from various points in the plastics manufacturing production chain. The first step in the manufacture of plastics is usually the cracking of naphtha which falls within the category of petrochemicals that has already been discussed above. The second step involves the conversion (polymerisation) of petrochemical gases to plastic raw materials or polymers. This step employs and generates a number of toxic materials. Vinyl chloride, used in PVC manufacture for example is carcinogenic. The production of PVC also generates heavily chlorinated tars which are an environmental problem. Proper disposal such as incineration is indispensable, but expensive. Polymer manufacture also results in by-products such as reactor crusts and waste water polymer sludge, most of which can be recycled. Poor quality material and floor sweepings can also be recycled.

The next stage in plastics production involves converting the polymer into finished or semi-finished products, usually by the use of heat and/or pressure. Conversion at this stage can result in noise, odour, fumes and dust which can be environmentally damaging if they are not adequately dealt with by technical means. Much of the scrap arising in these processes, both planned (eg. when holes are punched) or unplanned (eg. 'flash' or excess material) can be recycled.

The most important source of plastic waste arises from consumer waste. Most of this finds its way to landfills, a common means of disposing of garbage. Plastic producers argue that non-biodegradable plastic in landfills stabilises them.

The call by environmental lobbies has been for biodegradable plastic. Plastic producers for the most part dismiss this pointing out that plastics which claim to be biodegradable are often not so. Instead they tend to disintegrate into tiny pieces or crumbs of plastic which still clog up the environment, although less visibly. ICI have recently announced a glucose based biologically manufactured polymer which if biodegraded or incinerated releases the same amount of CO_2 as was fixed during manufacture. This results in no nett increase in CO_2 to contribute to the greenhouse effect (PSA, February, 1991:16). It has yet to penetrate the market.

The major proposals forthcoming from plastic producers to deal with post consumer plastic waste are either to incinerate it or recycle it. Let us examine these proposals in a little more detail.

Consumer waste is the largest source of waste plastic. According to the Franklin

Institute, plastics account for 7% of the waste stream, but they have only a 1% recovery rate. The recovery rates for paper and aluminium are higher, 21% and 29% respectively. Plastic in the waste stream consists of mixed and or contaminated products and this is where the difficulties begin. Whether intended for incineration or recycling the large variety of plastics in use requires sorting which is unpleasant manual labour accompanied by several health and safety risks. Mechanical and chemical sorting is improving but lacks sufficient technological sophistication thus far to deal adequately with waste streams. From a cost point of view the collection and sorting operation is the most costly part of the exercise. In Western Europe the recovery and recycling of plastics is a marginal and often unprofitable business (United Nations, 1991:22). From an energy point of view, the savings in using recycled plastic are second only to those from using recycled aluminium. A plastic bottle requires nearly 4 BTU to produce, but to recycle it requires only 1.5 BTU (Ross & Steinmeyer, 1990).

The recycling ethic is gaining ground in some areas. For example the new 1.5 litre plastic (PET) Coca-Cola bottle can be washed and reused 15 times before being reground and the material recycled into another bottle. This will be the first time that post consumer recycled PET will be used for food-contact containers. Previously recycled PET was used in fibres and non-food contact applications.

Some of the larger companies are launching plastics recycling initiatives, but often with mixed motives. For example Dow Chemical has launched a (relatively small) US $ 1 million plastics recycling programme in the US. It is "part public relations campaign and part practical recycling mechanics." (C&EN, June 22, 1992:16) Such programmes are floundering because the market for recycled plastics is so dismal. In the US only 4.5% of plastics is recycled (Ibid).

By contrast, the Plastics Federation of South Africa (1991) claims that 14% of total plastics used are recycled, compared with 6% in the UK and only 3% in the US and Germany (Engineering Week, 1992:XI). One source interviewed disputed the Federation's figures for South Africa claiming that they include pre-consumer recycling of production waste which makes up the bulk of the local recycling. Nevertheless since domestic prices for virgin polymer in South Africa are significantly higher than world prices it is logical that a greater proportion of plastic is recycled. Given the extent of waste plastic visible in South Africa's urban areas there is considerable potential for further recycling if it can be made economically viable, and if adequate markets can be developed for recycled material, a problem not yet overcome in developed economies. Regrettably South African plastic producers have only just begun to adopt the international symbols identifying the type of plastic on their products which facilitates the sorting process.

Most EC countries and some US states have introduced regulations governing plastic usage and recycling. Several have banned non-recyclable or even non-reusable packaging and made compulsory the recycling of plastic packaging. For example in Italy 40% of packaging must be recycled by 1992 and all shopping bags must be biodegradable or pay 100 lire per bag tax. The UK requires 25% of the total to be recycled by the year 2000. Germany will soon require consumers to pay a deposit on all plastic packaging and the packaging producer will be required to take back from consumers any packaging it manufactured. This has affected South African fruit exporters who now have to ship back to South Africa all plastic fruit packaging.

South Africa has thus far not introduced any regulations governing plastic usage and recycling. This is cause for concern as there is evidence (in a later chapter) to suggest that South Africa may be one of the most plastic packaging intensive countries.

Separation of plastics from the waste stream has generally proved uneconomical. The alternative disposal solution then is incineration. Since plastics are hydrocarbons they have a good heat value. The problem area in this approach is the toxic emissions which arise when plastics are incinerated, particularly PVC.

Short of technological breakthroughs in the collection and sorting of waste plastic which would fundamentally change the cost structure of this operation, it appears that market forces are inadequate to bring about a 'closed loop' in plastics usage. The alternatives are either for the state to subsidise the plastic recycling industry or to regulate mandatory recycling. In both cases consumers will bear the burden. However in the latter case it will be restricted to those who purchase the packaging. Whilst this 'user pays' principle may appear equitable, the real issue is, will the user have a choice whether to use packaging or not? Will it not just result in a general rise in the cost of living? Will some classes in society not bear a heavier burden than others?

In South Africa producers argue that the rapid urbanisation of mostly poor and very poor people, together with the prevailing transport network and shopping pattern has resulted in a real need for strong retail carry out shopping bags. Would a tax on such packaging not discriminate against those who can least afford it? These are just some of a complex of interrelated environmental and resource management issues which are best addressed by overarching policy addressing all the issues. That is beyond the scope of this study. Nevertheless some short term solutions are offered for South Africa in the concluding chapter.

Finally what impact is the international trend towards recycling likely to have on the demand for virgin polymer? Chem Systems (a leading industry consulting firm) projects an overall decrease in virgin polymer use of 4% p.a. to 6% p.a. by the year 2000 as a result of recycling (Hydrocarbon Processing, 1991b:39). The cost of recycled polymers is fundamental in efforts to create a 'closed loop' of recycling. A substantial difference between the price of 'virgin' and recycled polymer is required. In the US only PET meets this requirement. At the other extreme polystyrene 'virgin' material is cheaper than the recycled material! (Ibid) For the majority of commodity polymers the price of recycled material lies within the price band for virgin material thus reducing the incentive to use recycled material. Until this price structure changes there is unlikely to be much change in the volumes of recycled material used.

In summary the plastics industry is not an environment friendly industry. But then neither are the alternative materials, be they wood based or metal based. In addition plastics have made so many contributions to improve lifestyle and standards of living that it seems unthinkable to try and do away with them. If the impact of the plastic industry on the environment is to be limited, it appears the most effective option in the short term will be to regulate plastic waste as many countries already have, and to induce greater R&D efforts to resolve petrochemical industry emissions.

Global Environmental Initiatives and theoretical underpinnings

The global ramifications of pollutants in the biosphere, and the biosphere's finite ability to absorb and recycle them, make issues such as the nature of industrial production, wherever it may occur, an increasingly international issue. This has resulted in an international approach on some issues.

In recent years some international agreements have been established. For example the 1987 Montreal Protocol on substances that deplete the ozone layer was signed by delegates from 27 countries. It provides for the consumption of chlorofluorocarbons to be halved by the year 2000. In 1989 the Basel Convention controlling the transboundary movement of toxic waste was signed by 34 countries.

Such issue-based agreements do not go to the heart of the complex web of interrelated issues such as access to 'clean' technologies, world debt, political power, economic comparative advantage etc. There is thus a growing need for some form of integrated global structural adjustment programme.

This need was addressed, even if only at the level of intention, at the Rio de Janeiro 'Earth Summit' in 1992. The central issue behind the issue-base agreements and the 'Earth Summit' is (environmentally) sustainable development. At the outside this implies the continued ability of human beings to inhabit planet earth, which is almost universally accepted goal. Extrapolating backwards from there to today and more problematically, what ought or ought not to be done tomorrow, is where some of the difficulties begin.

It may be helpful to identify two poles in the debate surrounding sustainable development in order to expose some of the key issues.

At one pole is conventional economic theory which has as its guiding objective 'growth'. The analytical starting point, in this view, is the circular flow of exchange value within the production consumption loop. The weakness of this conceptual approach to accounting is that it does not, automatically, take into account negative externalities or market failure in respect of the environment and this, it is held, threatens the prospects of (environmentally) sustainable development. Developments in the field of applied economics are beginning to address this shortcoming.

At another pole is an approach which considers the economics of the one-way through put of energy/matter in an economy. This approach is concerned with the scale of environmental goods (energy/matter) put through the global economic system in the context of a finite ecosystem - planet Earth. In short an attempt is made to include the negative externalities within the conceptual framework employed. It implies an optimal scale for the circular flow and limits to aggregate economic growth. Such optimal scale and limits to growth are not, in this view, quantified by measures such as the volume of production or consumption, but rather by the depletion of environmental 'capital' (rather than interest) brought about in the course the production and consumption. In this way it does imply a limit to growth in so far as 'growth' is 'more of the same' but it does not imply limits to 'development' - implying that it may be possible, through the use of better technologies for example, to improve output and consumption without increasing the level of energy/matter through put. This latter approach is not as politically popular as the limitless growth ideology. It requires a far less simplistic accounting approach to environmental resources which conventional economics is currently unable to capture.

The conceptual weakness in both of these approaches lies in the difficulty of determining the environmental opportunity cost business decisions. An emerging school of 'environmental economics' is struggling with these issues.[6] Underpinning their difficulties is the question: what discount rate, for the future, ought to be factored into their calculations?

The scope of this study does not permit further pursuit of this debate. It is however worth simply identifying certain of the conceptual and theoretical weaknesses in the foundations upon which this study is trying to build.

Conclusions

Evidence presented in this chapter suggests that the chemical industry is the largest consumer of energy among the manufacturing industries and that the South African industry is relatively more energy intensive than the US industry. In addition the local chemical process industry accounts for more than half of the volume of all manufacturing waste/pollution. The Plastic Products industry appears to be significantly less polluting than the upstream Industrial Chemicals industry.

Internationally the levels of waste arising from the chemical industry are beginning to change financial relationships. Firms' environmental liabilities or potential liabilities are beginning to influence credit as well as mergers and acquisitions. This together with environmental regulations in many developed countries are resulting in an increased proportion of chemical firms' capital spending being directed to this area in those countries. There is no evidence yet in South Africa of changing financial relationships attributable to environmental concerns. Internationally this phenomenon has contributed to a global redeployment of 'smokestack' industries to developing countries. Lower environmental standards in developing countries are improving their relative competitive advantage. In response DMEs may employ environmental standards as non tariff barriers thus leading to a fusion of trade and environmental policy issues. Factors such as this and the nature of environmental pollutants, which do not recognise international boundaries, are stimulating attempts to deal with such problems at an international level.

The response by organised employers to the tarnished image of the chemical industry and increasing regulation has been to conduct public relations exercises to try and limit damage to the industry's reputation and to belatedly develop two weak programmes (Responsible Care and the Charter for Sustainable Development) which rely upon self policing. Third party environmental auditing is likely to be more objective and credible.

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6. See for example Pearce et al (1990) and Pearce (1991).

The environmental impact of the plastics industry appears to be lower at the downstream Plastics Products industry than at the upstream end (petrochemicals and organic chemical manufacture). This is a factor to bear in mind when considering where the thrust of industrial policy should lie.

The central issue in the plastic recycling is the cost structure of post consumer recycling. Until the price difference between 'virgin' and recycled polymer is widened the proportion of polymer recycled is likely to remain limited or where recycling is mandatory, the surplus of scrap and recycled plastic is likely to remain. Consequently lower prices of 'virgin' polymer may reduce the level of recycling.

In summary the plastics industry is not an environment friendly industry. But then neither are the alternative materials, be they wood based or metal based. In addition plastics have made so many contributions to improve lifestyle and standards of living that it seems unthinkable to try and do away with them. If the impact of the plastic industry on the environment is to be limited, it appears the most effective option in the short term will be to regulate plastic waste as many countries already have, and to induce greater R&D efforts to resolve petrochemical industry emissions.

CHAPTER 3

PETROCHEMICALS AND STATE POLICY IN DEVELOPING COUNTRIES

Introduction

Many developing countries have identified the petrochemical industry as a strategic industry and have taken steps to protect it from foreign dominance. In Latin America constitutional protection has been common whereas in Taiwan and South Korea more complex measures have been employed which were not so much concerned with the protection of national 'rights' as they were with the employment of measures designed to further the objectives of economic policy and development.

As the traditional preserves of state ownership in the oil and petrochemical industries have succumbed to pressure for privatisation they have been required to grapple with sometimes conflicting policy objectives. The latter have, in important instances, turned upon the transfer price of petrochemicals from the public sector to the private sector.

This chapter reviews the manner in which certain Latin American and East Asian economies have grappled with these policy dilemmas and the results which have flowed from their efforts. In doing so major policy options are identified, thus setting the stage for an historical review of South Africa's efforts and future options.

Developing countries have moved forcefully to create and maintain their essential chemical industries. Typically in the early developing stages the government's role has been to protect the industry (South Korea and Taiwan), to control production output and to create the necessary stimuli to develop the industry. As markets have grown and the possibilities of competition with them, generally the role of government has decreased. The discussion commences with certain Latin American countries followed by a discussion of South Korea and Taiwan.

Latin America

The oil and gas industries have traditionally been state monopolies in virtually all Latin American countries due to the strategic importance attached to energy issues and to the economic possibilities their control offered. These state monopolies were extended into petrochemicals in countries such as Brazil, Mexico and Venezuela, usually via subsidiaries of the state owned oil and gas companies. In countries where the oil and/or gas resource base was historically weaker, such as Columbia and Chile, the state oil or gas companies have also been weaker and there has been more private sector involvement and less monopolistic control. The degree of state monopolisation of petrochemicals has varied. In Brazil strong state monopolistic control was entrenched in the constitution. In Mexico the state monopoly in the petrochemical industry has to a large extent been secured by regulations restricting foreign investment.

Petrochemical industry development in Latin America has tended to follow a general pattern in which the state has made the initial investments in the first one or two petrochemical complexes. In Brazil for example the first two petrochemical plants (crackers) built were government owned. The third was nominally privately owned but effectively controlled through the state's minority shareholding, its control of feedstock prices and supplies and the state's regulatory powers. Downstream derivative plants such as polymer plants in Brazil generally had a one third state ownership. Petrochemical projects were supported by state funding.

The picture that emerges of the Latin American petrochemical industry by the late 1980s is one of a highly regulated industry with monopolistic control of production resting in state owned companies often assisted by state subsidies.

As consumer markets in the region have grown in size and sophistication, the policies and strategies adopted to meet this changing demand pattern have reflected the upstream requirements of the (state) oil companies. These factors together with debt and global trade liberalisation initiatives have contributed to a dramatic policy shift in Latin America beginning in the late 1980s. This shift has been away from state monopolisation of oil and petrochemicals to privatisation of these assets and the reduction of state monopolistic control.

As this shift in policy has been implemented, developing countries have had to address the problems associated with petrochemical feedstock supply and pricing and their impact on ownership concentration and international competitive advantage.

An earlier discussion has established that feedstock prices are an important, if not critical determinant of international competitiveness. Fluctuations in feedstock prices and availability of supply create uncertainty for petrochemical producers. Internationally major producers have responded to this by integrating their operations, both backwards and forwards, upstream and downstream. Many have developed captive, higher value, derivative markets for their primary products. In this way returns are, by virtue of the differentiated markets served by derivative products, sheltered to some extent from the cyclical nature of feedstock prices.

With the move to privatisation of state oil and petrochemical industries a problem which has repeatedly emerged is: at what price should the, say primary petrochemical, cross the boundary from one ownership to another ownership? More specifically what is a fair transfer price for petrochemicals (olefins)? In many developing countries the boundary between one ownership and another in the petrochemical industry has often coincided with the boundary between public and private ownership. This bears directly upon concentration, in the sense of degree of vertical integration, and thus upon international competitiveness, for reasons which will become clear in a moment.

Before proceeding it is necessary to briefly clarify some of the practical aspects involved in petrochemical production as this is of central importance to the problematic. Olefins are often the product which cross the boundary between one ownership and the next. The thing which makes them somewhat different from many other commodities is that they are volatile gases, expensive and difficult to transport. They may be considered almost non-tradeables (in practice limited amounts are traded). Most olefins are transported by pipeline within particular economies.

It is argued later that the olefin transfer price problem is at the heart of the matter in so far as the South African plastics industry is concerned. Consequently it may be instructive to examine the experiences of other developing countries in some detail in this regard as this may serve to inform the debate, in later chapters, on the options available to the South African petrochemical industry in addressing these questions.

The limited size of developing economies requires industrial policy to pay much greater attention to the degree of monopolisation or concentration which emerges in the petrochemical sector. Petrochemical development in Brazil, Mexico and Argentina has analogies with South Africa's development in this sector in several, but sometimes differing, respects. In the inspection of the countries which follow, both the historical development of the petrochemical industry and the changing state policies adopted to deal with the issues which arise around concentration and industrial policy are considered.

Latin American state monopolies in oil and petrochemicals had advantages in that the more profitable petrochemical companies were able to generate profits which could be used to fund expansion of upstream development in oil and gas recovery and refining. The converse was unfortunately also true. For example, in Brazil when Union Carbide, a downstream polymer producer, wanted to expand production the state owned petrochemical company could not increase its ethylene supplies because it lacked the funds to make the necessary investment. This type of problem was symptomatic of the deepening economic difficulties faced by Brazilian industry partly as a result of the industrial strategies pursued prior to this.

Brazil, by way of background, has domestic oil resources but is a nett importer of oil. Crude oil is refined in state owned refineries and naphtha from these refineries is the feedstock for the three, traditionally state owned, petrochemical complexes. Historically Brazil had followed an Import Substitution Industrialisation (ISI) development path, as did South Africa. The tariff protection necessary to support this strategy led to higher prices. Consequently when tariff barriers were lowered the prices of many chemicals in Brazil were above the international market price, enabling importers to undercut them, even when import duties had to be paid (Chemical Week, 4-12-91:42). The ISI approach included state subsidies for naphtha up until 1991.

A plan adopted in the late 1980s and which replaced the ISI strategy, made provision for the privatisation of all state controlled petrochemical and fertilizer companies by 1993 (ECN, 7-12-92:4). In trying to privatise its petrochemical industry Brazil has had to grapple with three, sometimes conflicting, objectives: preventing the industry being taken over by foreign interests, preventing monopolies and trying to engender a more internationally competitive industry.

The industrial strategy for petrochemicals which was pursued by Brazil's Industrial Development Council in the late 1980s advocated greater concentration in the sector thus promoting the formation of a few large conglomerates with the necessary market power to compete on international markets and even begin to invest in R&D activity which was weak (Chemical Week, 16-11-1988:37). But in order to restrict foreign ownership the state established a ceiling of 40% foreign ownership in basic petrochemical plants (Platt's International Petrochemical Report, 12-6-92:4). And in order to prevent vertically integrated monopolies emerging it prohibited base petrochemical producers from owning more than 10% of their derivative customers' firms (Chemical Week, 8-4-92:20). This ruling cuts across one area of potential competitive advantage in petrochemical production, that is vertical integration and the transfer pricing this makes possible.

The sale of the state's 83% share in the Trufino petrochemical plant (naphtha cracker) is a case in point. As a part of the privatisation programme state subsidies of (naphtha) feedstock were withdrawn. The obvious question then arose, what price should the petrochemical plant (cracker) pay to Petrobras (the state owned oil company) for its naphtha feedstocks? This dilemma was overcome by a regulation linking domestic naphtha prices to world oil prices at a price of 1.2 times the crude oil price (Chemical Week, 8-4-92:20). This ratio is about the world average (Witcoff, 1992).

As will be seen in due course, similar kinds of problems have arisen in SA, although almost a decade earlier. It will be argued that the mechanism used in South Africa to deal with this problem was less optimal than the Brazilian mechanism.

Mexico has encountered difficulties similar to Brazil's in the privatisation of its petrochemical industry. That is, developing a policy which accommodates the sometimes conflicting demands of industrial policy, restrictions on foreign ownership and limitations on monopolies. The Mexican constitution, like Brazil's, prohibits foreign ownership of basic petrochemicals, although the definition of 'basic petrochemicals' is largely a political one. It shrank from 66 products to just 20 products in 1989 (MacDonald, 1991). Mexican industrial strategy has been driven by balance of payments considerations and has been directed towards increased production and export of petrochemicals and manufactured goods. In so far as the petrochemical industry is concerned, the strategy has been to have a positive balance of payments rather than self-sufficiency in all basic products (Chemical Week, 16-11-88:44). Local production has suffered from an inability to meet domestic demand in several important products especially in the state-controlled area of basic petrochemicals. This could be remedied by foreign investment, but this is not possible because in Mexico's efforts to find the optimum mix of foreign private and public ownership it introduced regulations restricting foreign investment.

Mexico has been more cautious than Brazil on the issue of foreign ownership. It requires 100% of primary petrochemicals to remain in the hands of Petroleos Mexicanos (Pemex) the state oil monopoly and its subsidiaries. Foreign ownership of secondary petrochemical derivatives is limited to a 49% share (MacDonald, 1991:21).

A difficulty experienced in keeping ownership and control of primary petrochemicals in Pemex's hands is that downstream customers want to backward integrate upstream in efforts to improve their international competitiveness. At the same time the constitutionally responsible monopoly, Pemex, has experienced a shortage of finance which has curtailed investment in further capacity for primary petrochemicals.

The innovative solution introduced by Pemex to this problem of conflicting policy objectives, was to offer the downstream customers, 'rent-to-buy' schemes. It proposed that the private sector build and pay for the necessary Pemex expansions and either be reimbursed in kind (product) over an agreed period of years or rent the plant back to Pemex for a fixed period of time. Ownership and the monopoly would remain in Pemex's hands, thus satisfying the constitutional requirement. These 'rent-to-buy' schemes were not popular with US firms, but the approach was supported by Mexican firms and some French and German firms took up the offer (Chemical Week, 14-11-90:30).

As in Brazil and similar to South Africa, the difficulty encountered is the price private firms ought to pay Pemex for its primary petrochemicals, a problem compounded by the fact that Pemex also competes with private producers and customers in the downstream derivatives market, much as SASOL does in South Africa. In a classic example of downstream customer pleading, the Mexican Chemical Industry Association argues:

> " What we're saying is that Pemex should treat Mexican industry as an integrated industry so that we can compete against other integrated producers worldwide, or use a fair transfer price for sale of feedstocks, rather than a spot market quotation basis." (quoted in Chemical Week, 14-11-90:32)

It would appear then that Pemex, somewhat like SASOL in South Africa, is dictating the prices of its petrochemicals to its customers, who, like SASOL's customers, have no alternative source of supply.

Argentina has been the least cautious in its privatisation of basic petrochemical complexes. It has not restricted foreign ownership and has not appeared overly concerned about private monopolies emerging. Domestic petrochemical prices were higher than world prices which attracted imports of both petrochemicals and finished goods. In response, the goal of domestic producers was to reinforce their position in the domestic market and to reduce exports (ECN, 27-1-92:29). This is similar to the position that developed in South Africa during the 1980s. Argentina is hoping that privatisation will promote vertical integration with downstream units, reducing costs and increasing international competitiveness (ECN, 27-1-92:29).

Much of the Latin American movement away from state petrochemical monopolies towards privatisation is taking place in the context of the liberalisation of trade and reductions and/or removals of state subsidies. World priced imports are placing increasing pressure on Latin American producer prices, which in turn are lowering profits and in some cases resulting in closures. Argentina's petrochemical industry for example, much like South Africa's, is saddled with small plants, high costs, lack of vertical integration, inadequate technology, and in some cases, low capacity utilization. It faces an uncertain future.

Domestic producers in some Latin American countries like Brazil and Mexico are, as a result of entrenched state monopolies, denied access to vertical integration and the competitive advantage which can flow from this. Yet they have to compete with international producers who are vertically integrated.

South East Asia: Taiwan and South Korea

Comparisons are often made between South Africa and the economies of South Korea and Taiwan. Consequently it may be useful to consider how the latter have dealt with the intersecting concerns of monopoly control, concentration and industrial strategy and national development concerns?

Both South Korea and Taiwan are renowned as examples of export led industrial growth. What is less well known is the extent of state involvement in bringing about their successes. In general they have pursued different approaches to industrialisation, underpinned by their different approaches to credit. Broadly Korea's industrialisation has hinged on the growth of several large conglomerates (Chaebol) whereas Taiwan's economic 'miracle' rests to a greater extent upon the back of 700 000 or so small and medium sized enterprises.

Taiwan's approach to industrialisation has been complex. However it has four characteristics which are germane to our discussion here. Firstly a state with a staunchly anti-big-capitalist approach. This has in general resulted in policy which has preferred not to let too many links in an industrial chain be held by the same hand. This leads to the second characteristic, a great emphasis upon the development of industrial production chains. Indeed Taiwan is generally recognised as a textbook example of a 'pipeline' economy. Thirdly policy has been constructed in such a fashion that foreign companies have been prevented from securing a large share of the domestic market. Fourthly state owned enterprises were used to assist in achieving policy objectives, for example the crude oil refining industry is dominated by the Chinese Petroleum Corporation (CPC) which has been able to influence petrochemical industry's development through its control of feedstocks.

All of the first three of these four approaches ran into difficulties in the petrochemical sector, chiefly as a result of the large economies of scale and the need for foreign technology. The state's anti-big-capitalist approach has contributed to the fact that there are few Taiwanese companies among the ranks of the world's leading companies, but interestingly, one of them, indeed the largest conglomerate in Taiwan, is a petrochemical and plastics company, Formosa Plastics. It is also vertically integrated in petrochemicals (Wandycz et al, 1989).[1] This vertical integration will increase following it being granted permission in 1989 to build a $240 million petrochemical complex which is scheduled to come on stream in the mid 1990s. The Taiwanese chemical industry is also one of the few industries in which foreign companies have commanded a large share of the domestic market.

Despite the inability of the state to have its way in the petrochemical industry it has nevertheless seen to it that foreign monopolies did not extract excessive rent and that an internationally competitive petrochemical chain was developed. In those areas outside of direct control the Taiwanese state has used a combination of indirect influence and other sometimes dubious methods to achieve these ends.

The origins of the petrochemical industry are indicative of the role the state was to play in this industry. The first plant built was a PVC plastics plant. Following research which identified the plastic industry as a suitable target industry, the government supervised the construction of a PVC plant and in 1957, handed it over in running order to Y.C. Wang (who subsequently went on to become the country's leading businessman and is currently head of Formosa Plastics). This type of initiating role and state tutelage is the hallmark of Taiwanese and South Korean state intervention. Later in 1966 when there were three more producers of PVC it emerged that all four (including Wang's) were using an inefficient technology which also required imported intermediates, whilst the Chinese Petroleum Company had excess supplies of ethylene from which an intermediate could be made at lower cost than the imported intermediate.

> "So *the government forced the four private producers of PVC to merge* in a joint venture with the Chinese Petroleum Company and another state-owned chemical company, in order to adopt a more efficient ethylene-using production method." (original emphasis) (Wade, 1991:92)

The result was a state initiated monopoly in order to serve industrial efficiency objectives.

The key to Taiwan's chemical industry is the slate of intermediate chemicals available from its refineries. These refineries are controlled by the state run Chinese Petroleum Corporation (CPC) which is also responsible for all natural gas operations and infrastructure and is the major petrochemical producer. At the upstream end then the state has traditionally monopolised the production of low profit raw materials for manufacturing. The first two

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1. For comparative purposes Formosa Plastics had sales in 1988 about 4.5 times those of SASOL's sales.

petrochemical plants (naphtha crackers) built in 1958 and 1975 were built by CPC. State monopolies control the upstream sector to this day. Currently nearly all of the feedstocks for the Taiwanese petrochemical industry come from the naphtha crackers that are associated with the CPC refineries. This traditional control over upstream operations is set to decline. Future naphtha crackers currently being planned will be operated by a variety of interests (C&EN, 10-2-92:18). However, as will be seen below this is no guarantee that there will not be state influence.

Expansion downstream from naphtha crackers into derivatives and plastic raw materials was generally by means of joint ventures with foreign firms, but under close government supervision and with much government ownership (Wade, 1991:92). However in assessing the impact of state ownership Wade (1991) believes it is misleading to consider only those companies with a 50% or more state shareholding as the measure of state power. He cites the petrochemical industry as an industry in which an element of subterfuge (for the purposes of bolstering the state's image of economic liberalisation) was involved in maintaining state power. The government may take a minority shareholding in a joint venture with a foreign company and then cajole the MNC to accept its (political) party holding company, Central Investments Holding Company (CIHC) to make up the balance of the shares. In return for this shareholding CIHC attained the right to appoint a few senior managers who act as the government's eyes and ears within the firm. This technique has been much used to keep MNCs under scrutiny.

To secure competitive prices from foreign monopolies, indirect pressure has also been used. For example in the four-monthly negotiations between the Man-Made Fibres Association and their upstream monopoly supplier over prices the state is ostensibly not present. Yet the (state) Industrial Development Board "is constantly engaged in nudging and prodding behind the scenes, but wishes the decision to emerge from the negotiators themselves" (Wade, 1991:281).

Other means used to secure competitive prices and a measure of control over foreign held monopolies involved the package of investment incentives offered. As a part of the inducements to attract foreign investors the government offered a protected domestic market to firms that would build a plant sufficiently large to meet the entire domestic demand, in that it undertook to purchase the entire output, but at a prescribed price. In this way it was able to negotiate the rent accorded to monopolies to provide the product at prices which accorded with national objectives. Should the firm not behave satisfactorily the government could remove its protection.

South Korea has followed a similar, but not identical path in the development of its petrochemical industry. It, like Taiwan, has used a variety of policy levers to deal with monopolies and oligopolies, such as credit, taxes, domestic content requirements, trade policy, and controls on direct foreign investment to influence and steer the path of industrialisation.

South Korea's first oil refinery was a joint venture between the South Korean government and Gulf Oil in 1964. A similar pattern of joint ventures was followed with the first petrochemical complex at Ulsan. All but one of the 20 petrochemical plants in this complex were built as joint ventures between state firms and established petrochemical MNCs, which were attracted by various tax and other incentives. Thus from the outset the state did not exercise an ownership monopoly. But the individual derivative producers did. In order to minimise the impact of product monopolies, South Korea, like Taiwan, attempted to spread them across as many owners as possible, and to maintain a vertical separation of ownership. This approach was reversed over time so as to enable advantage to be taken of the benefits of vertical integration which is now actively encouraged.

The key determinant of the level of concentration in South Korea is the requirement for all new petrochemical capacity to be approved by the government. This provided the means to ensure for example, participation by domestic firms or the public.

The state minimised rent extracted by virtue of monopoly positions by making import restrictions conditional upon the maintenance of prices, considered by it, to be acceptable. Feedstock prices are an important determinant of competitiveness. In South Korea naphtha feedstock prices were driven by the state policy of ensuring a certain minimum return to the refining industry. In order to achieve such returns refinery products such as naphtha feedstock prices were set higher than international prices, whilst at the same time the international petrochemical prices against which the state determined 'acceptable' prices were low. Despite a 30% tariff protection this policy approach led to heavy financial losses to the petrochemical industry until this policy was abandoned in 1986. Subsequently there have been no controls on the import or price of naphtha. Instead naphtha prices have become a function of international market prices. Because South Korean crackers are increasingly reliant on imported naphtha it is difficult for them to produce derivatives at advantageous prices.

Over the period from the 1960s to late 1980s the state withdrew from ownership of petrochemical complexes. During the 1970s it encouraged the participation of domestic conglomerates in the industry by offering credit at negative real interest rates, provision of infrastructure and government financing. These incentives have declined since the late 1970s.

By 1989 there were only two naphtha crackers in South Korea, operated by two private companies Yukong and Daelim. Downstream derivative production was in the hands of just a few groups. For example vinyl chloride manufacture, in 1991, was an oligopoly of just two producers. Permitting high levels of concentration has facilitated the emergence of plants with internationally comparable economies of scale.

In the late 1980s South Korea chose the petrochemical industry as one of the major industries for the promotion of its industrialisation (Enos et al, 1988:47). At this time the petrochemical industry was deregulated to a significant extent and petrochemical producers began to integrate downstream and to enter into competition with their downstream customers. Daelim was already back integrated into crude oil refining, an industry which was also expanding rapidly at the time. Refining capacity doubled between 1988 and 1992. At the same time downstream manufacturers began moving upstream in attempts to secure feedstocks on a competitive basis through the advantages of vertical integration. Consequently the industry is "in the process of achieving a remarkable standard of vertical integration. By 1990 no olefin producer will be in the merchant market but serving captive demands." (Vergara & Babelon, 1990:21). This process continued in the wave of investment resulting in the last of six new naphtha crackers coming on stream by mid 1993. Each cracker is owned by a different Chaebol, between whom there is fierce rivalry.

It appears that when South Korea relaxed its control on pricing in the upper reaches of the petrochemical and plastics pipeline, it did so into a sufficiently large and fiercely competitive market. This is an important consideration to bear in mind in the South Africa petrochemical market when proposals are made for its deregulation.

The pattern that emerges in the historical development of South Korea is one that commences with monopolies but as the number of competitors expands through an oligopolistic phase the extent of state regulation is relaxed and substituted by competition.

Nevertheless controls remain wherever government considers the level of concentration to be too high. Prices must be submitted to government whenever a single company controls over 50% of the market, or when three companies control over 70% of the market. Such regulation has resulted in domestic prices being kept at levels lower than international prices (Vergara & Babelon, 1990:76). This has allowed the proliferation of more labour intensive downstream industries.

Conclusions

All of the examples discussed have highlighted the difficulties state policy makers have had to deal with in the form of a matrix of, sometimes conflicting, policy objectives in the petrochemicals industry. These comprise industrial policy objectives, the extent of limitations upon private ownership and limitations upon the emergence of monopolies and/or concentration in the industry. Overlain upon these intersecting objectives lies another, striving for international competitiveness, which in the petrochemical industry, as earlier chapters have shown, requires very large firms capable of being 'world players'. If this objective is pursued by a firm (whether privately or state owned) based in a relatively small economy, it is almost axiomatic that such a firm will enjoy a domestic monopoly. The difficulty for policy makers is to arrive firstly at the optimal mix of policy objectives within the parameters of the social relations of production and then to bring to bear the appropriate policy instruments capable of realising the objectives.

In each of the countries examined, the need for vertical integration has had to be addressed (because it is one of the keys to competitive advantage) in the context of ownership and appropriate transfer pricing mechanisms. Solutions to this problem have generally attempted to establish some mechanism or other which results in internationally competitive prices.

In both the Latin American and the Asian countries the overriding commonality in the petrochemical industry has been state involvement in one form or another. State involvement in Taiwan and South Korea has been central in the development of the petrochemical industries in those countries. The full range of industrial and trade policy levers have been applied, as well as state ownership and subsidies at different points in time, depending upon the prevailing objectives. At times monopolies were promoted, at other times competition. But almost always these two countries sought to deliver internationally competitive priced intermediate inputs to the labour intensive links in the production chain in order to promote export orientated industrial policy objectives. In addition Taiwan consistently sought to limit the role of multinational companies in the domestic petrochemical industry.

South Korea provides two especially interesting lessons for South Africa. Firstly the state's use of tariffs to keep local feedstock prices down, particularly naphtha. Secondly the change in policy, from one attempting to avoid concentration arising from vertical integration, to one promoting vertical integration but only in the context of much greater domestic and international competition in the local market.

This is in contrast to the Latin American model which has placed great emphasis on state ownership. Latin American countries have entrenched state monopolies in the constitution and adopted rigid regulations about foreign ownership. This has led to all kinds of complications such as securing capital for new investment and transfer pricing which have been obstacles to development in the industry. On the other hand the two Asian NICs have chosen instead to focus upon the prices of intermediate inputs in production chains as the key issues and used flexible, but not lax, policy measures to arrange them in such a way that downstream industries could export. Where unacceptable levels of concentration or foreign ownership have occurred state regulations have been applied to limit their power and secure acceptable pricing.

All of these issues are relevant to the South African commodity plastics *filière* and are taken up at appropriate places in the following chapters.

CHAPTER 4

THE HISTORICAL DEVELOPMENT OF THE SOUTH AFRICAN CHEMICAL INDUSTRY

Introduction

Previous chapters have sought to locate the petrochemical industry within the wider international chemical industry and have highlighted its pivotal role in industrial modernisation. In this chapter the focus begins to narrow towards the chief concern of this study, the development of the South African petrochemical and commodity plastics filiere.

The importance attributed to the petrochemical industry in newly industrialising countries is evident in the industrial policies pursued by certain Latin America and Asian countries, in particular Taiwan and South Korea. The latter two have helped to promote their petrochemical firms into the exclusive ranks of the leading world companies.

In contrast, how has a relatively small South African economy lacking in crude oil reserves and with only limited natural gas resources tackled the task of developing a petrochemical industry? How has this sector come to be the dominant sector of the chemical industry? Such fundamental questions underpin this study.

The answers to these questions are inextricably bound up in a number of intertwined historical processes: the evolution of the domestic chemical industry, the emergence of the three dominant chemical firms and the apartheid state's pursuit of military/strategic policy objectives, particularly in the liquid fuels industry. For convenience these processes are reduced to a discussion of four sub-sectors of the chemical industry: fertilizers, explosives, synfuels and petrochemicals.

Historically the chemical industry originated in and was dominated by production for mining (explosives) and agricultural (fertilizer) markets. It is in these sectors that some of the dominant firms have their origins. As the historical development of these sectors is unfolded links are drawn with international developments and it is argued that the early concentration of the industry was not unrelated to similar developments in the industry internationally.

The origins of South Africa's synfuel and uniquely coal-based chemical and petrochemical industry are identified. It is argued that the rationale for this unique industry is to be found within the convenient extension of Import Substitution Industrialisation (ISI) policy into the apartheid state's military/strategic policy of liquid fuels self-sufficiency.

The launch of South Africa's petrochemical industry is described and contrasted with

South Korea's. This comparison yields helpful insights. For example the extent of South Korean state intervention in market processes appears to have been far more thorough going than South Africa's. While the South African market was regulated to a similarly high degree the state provided only feedstocks and held back from direct participation further downstream and from implementing a more full blown industrial strategy. This was partly in deference to market ideology, and it is argued, with less favourable results.

Within the parameters of this evolving South African policy mix, the history of the petrochemicals and plastics raw materials sectors was played out. The primary actors in this history were three large firms, SASOL, AECI and Sentrachem. Their origins (SASOL and Sentrachem were the result of state initiatives) and evolution are tracked. SASOL, after partial privatisation, increasingly became the dominant firm. AECI and Sentrachem adopted different strategies to deal with SASOL's expansion into 'their' traditional markets.

The interplay of state policy and the strategies of the leading chemical firms led to the industry undergoing a significant restructuring in the mid 1980s. Despite a narrower slate of locally available petrochemicals, the next link down the production chain, the plastic raw materials sector nevertheless supplanted the traditionally dominant sectors. At the same time the capital intensity of the chemical industry was significantly deepened. This was accompanied by a significant shift in the racial composition of the workforce in favour of whites at the expense of blacks. All of these developments have important implications for the future development of the petrochemical and plastic industries.

Historical Development

The origins of the South African chemical industry, like much other industrial activity, are rooted in the development of the mining industry. The first chemical plant built in 1896 was De Zuid-Afrikaansche Fabrieken Voor Ontplofbare Stoffen at what is now known as Modderfontein, just outside Johannesburg. To this day large quantities of explosives are manufactured on this site. The Modderfontein plant was followed by De Beers explosives in Somerset West (near Cape Town) in 1901 and Kynoch explosives at Umbogintwini near Durban in 1909, which like Modderfontein has also grown into a large chemical complex.

The second chemical sector to be established was the fertilizer industry in the early 1920s. First was a fertilizer plant at Umbogintwini in 1920, established by a multinational company, Nobel Explosives. This was followed by a superphosphates plant at Somerset West set up by Cape Explosives. Thus in a short space of time the fundamentals of the industry were established; three geographical anchors, Modderfontein, Umbogintwini and Somerset West were set in place and have continued to play a major role in chemical production. From an industrial point of view the explosives and fertilizer industries were the launching platform for the industry and continue to be major sectors in the industry to this day.

These industrial and geographic anchors were also the foundation for the emergence of a large company, which for many years has monopolised important parts of the chemical industry. This came about firstly through a merger between Nobel's and Kynoch subsidiaries in 1918[1]. In 1924 this merged company again merged with the Cape Explosives Works, controlled by De Beers to form African Explosives and Industries, later known as African Explosives and Chemical Industries and now as AECI. This took place in the context of the threat posed to British companies by the rise of the giant German chemical firm, IG Farbenindustrie.

Four of these threatened companies (Brunner, Mond and Company, Nobel Industries, and the British Dyestuffs Corporation) reacted by forming a defensive cartel in 1926. That was quickly followed by an agreement between Imperial Chemical Industries (ICI) and the South African company to apply monopolistic marketing principles and to divide up markets between themselves. All three of the South African firms which formed the early AECI were British and their coming together under ICI and De Beers should not be seen apart from the increasing concentration taking place in the British chemical industry at the time (Innes, 1984:125). This concentration was not without rewards for the local mining industry which benefited from lower explosives prices (Ibid). Thus production in the two main pillars of the South African chemical industry, explosives and fertilizers, came under centralised control from an early stage.

Production of these bulk or commodity type products dominated from the early days and continues to dominate the character of the industry. This may be contrasted for example with the emergence of the German chemical industry which found its early strengths in dye manufacturing, which is more of a speciality type product.

The production of commodity chemicals is typically a capital intensive activity requiring large economies of scale and for this reason, as infant industries, they are often afforded considerable protection. Such industries are conducive to high levels of concentration of ownership in small economies as indeed occurred in the South African chemical industry. This together with protected markets did allow long term investment to occur. However the

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1. The South African merger with Nobel was followed later by an international merger involving Nobel into ICI, which became one of the two large shareholders in AECI.

coincidence of concentration and protection is not necessarily conducive to an innovative and efficient style of manufacturing, indeed the opposite may be the case.

In the period leading up to World War 2, expansion of the industry was limited. However two seminal developments occurred which subsequently had a major impact on the industry. In 1932 a joint venture between Anglovaal and the British Burmah Oil Company called SA Torbanite Mining and Refining (Satmar) was set up to process torbanite oil shale for fuel. This was the forerunner of SASOL.

Also in 1932 AECI began the synthetic production of ammonia from coal for the production of nitrates used in the manufacture of explosives, a chemical route used to this day.

In these two developments lie the origins of the unique character of the South African chemical industry, its heavy reliance upon coal as a basic raw material and its pursuit of self sufficiency in fuels in the absence of oil and gas resources. Whilst coal based chemical production was also characteristic of chemical industries in other countries at that time, they began to move away from coal towards oil and gas during and after the Second World War. South Africa on the other hand has increased its reliance upon coal.

A third company which has come to dominate the chemical industry, Sentrachem, also has its origins in the 1930s. In 1935 National Maize Products began production of ethanol, methylated spirits and solvents by fermentation of maize in Germiston. This later became National Chemical Products (NCP) which joined the Sentrachem group in 1967 and is still an important company within the group. During the Second World War (1941) the government built Klipfontein Organic Products (KOP) at Chloorkop near Johannesburg to manufacture mustard gas from chlorine and in the process launched the chlor-alkali industry. After the War production was switched to insecticides and ownership passed into the private sector in the 1960s when Federale Volksbeleggings (a company with its origins in the Broederbond) took ownership. This company became a founder member of the Sentrachem group. Chloorkop remains an important site for chlor-alkali production.

The major development in the 1950s was the formation of the South African Coal, Oil and Gas Corporation, subsequently to become SASOL. The basis for the company was a licence Anglovaal had obtained from the German company Duitse Ruhrchemie for Fischer Tropsch (oil from coal) technology.[2] State capital via the Industrial Development Corporation (IDC) was added and by 1955 SASOL 1 began producing petrol from coal at Sasolburg.

2. Fischer Tropsch technology is an indirect liquefaction of coal route. First the coal is reduced to its constituent gases and then in a second stage the desired gasses are synthesised into the raw materials for liquid fuels.

SASOL 1 had a two track system in the second, or synthesis stage of the process. One of these tracks used the ARGE (Arbeitsgemeinschaft Lurgi-Ruhrchemie) fixed-bed process developed by Lurgi after the Second World War. The other track utilised a 'synthol' technology sourced from Kellogg Company Inc of the US.[3] By varying the throughput in the different tracks the yield could be changed. The Arge track produced more wax than motor fuels and although this was not in accordance with the objectives of the project, it has subsequently provided SASOL with a product which has been widely exported. The synthol track was a more efficient petrol producer and also produced methane used for industrial gas which was marketed through a SASOL subsidiary, Gascor, for the first time in 1967.

Both of these technologies were superior to those used in Germany during the Second World War, nevertheless they were still considered first generation technologies. Worst of all despite what had been a major investment, the fuel output was limited. The exact output has been a closely guarded secret but various estimates have put it between 4 000 barrels per day (bpd) and 7 000 bpd.[4] This is a paltry output compared with the Standard Oil refinery built at the same time which had a capacity of about 100 000 bpd.

In the same year, 1955, AECI commenced production of the first locally produced plastic, PVC, on the Umbogintwini site and in the process integrated other plants within the group. This was like many PVC plants, a forward integration from a chlor-alkali plant (using the chlorine from the latter). Also AECI had bought Rand Carbide in 1934 and thus had a supply of carbide within the group and a measure of vertical integration from the outset. (Carbide is used in the carbide acetylene process to PVC). Although elsewhere in the world other PVC producers were switching from coal to crude oil based PVC, (via naphtha via ethylene) AECI utilized the carbide acetylene route, which did not rely on imported crude oil. Import substitution was beginning in earnest. It did this despite the fact that Standard Oil had commenced building Durban's first oil refinery in 1954 and supplied refinery gas for the production of ammonia in a new ammonia plant built at that time.

These two developments, SASOL 1 and the Durban PVC plant are the origins of South Africa's petrochemical and plastics industry. The historical development of the petrochemical and plastics industry is elaborated further in a later section.

Phosphatic fertilizer production received a big boost in 1950 when an IDC owned company Foskor, was established to exploit phosphate deposits at Phalaborwa. This led to

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3. This process experienced technical difficulties for a few years as it had never previously been scaled up from pilot project scale.

4. See Conlon, 1984:15 and Rustomjee, 1986:141.

AECI building a superphosphate fertilizer plant at Modderfontein in 1963 using Foskor rock. Foskor also made possible two Triomf Fertilizers plants. The Potchefstroom fertilizer plant and the phosphoric acid export plant at Richards Bay came on stream in 1967.

Sentrachem was established in 1967 from four existing companies; KOP, principally owned by Federale Volksbeleggings, the Synthetic Rubber Company whose major shareholder was the IDC, NCP another public company using Distillers (UK) technology, and Karbochem a small development company with rights to SASOL's ethylene output which was another IDC and Federale Volksbeleggings joint venture. The three founding directors were Siegfried Kuschke, Chairman of the IDC, Dr Etienne Rousseau the chairman of SASOL and previously a chairman of Federale; and Jack Irvin the head of NCP at the time. The role of Federale Volksbeleggings, and the state (through the IDC) caused some to view Sentrachem as the Afrikaner's answer to the more British orientated AECI (FM Special Survey, 25-5-79).

Having brought this outline history of the chemical industry to the point where all the three major players, AECI, Sentrachem and SASOL are on stage, the approach will be changed. The development of the chemical industry is analysed from four vantage points: fertilizers, explosives, petrochemicals and synfuels. This approach yields some insights into the interrelated nature of the different parts of the industry, particularly synfuels and petrochemicals. This complex web of production streams is of course overlain by corporate ownership patterns. As the analysis unfolds insights are gained into the manner in which corporate strategies respond to these interlinked production and ownership systems.

Fertilizers

Fertilizer has been a major sector of the chemical industry. Traditionally it was dominated by AECI but in the early 1970s a new and rising firm, Triomf Fertilizer looked set to challenge AECI's dominance. AECI, in its usual fashion, preferred a takeover to competition and took a 49% interest in Triomf and merged the two firms' fertilizer marketing and production facilities.

By the early 1980s quantitative import controls and the operation of a cartel by Triomf/AECI in an agreement with Fedmis left essentially only these two producers with 90% of the market (Innes, 1984:211). A Competition Board decision ended the market-sharing agreement and other restrictive practices operated by these two producers as well as state regulation of the fertilizer price. This opening up of a long protected market was followed by a number of producers entering the market over the next few years; AECI separated from

Triomf in 1984 and re-entered the market under its old Kynoch brand name. Triomf Fertilizer, Bonus Fertilizer, Sentrachem's Fedmis Fertilizer (acquired from Federale in 1980) and Omnia were also active. Fertilizer production peaked in 1981 at 3,3 million tonnes. Price control was removed in 1982/83. A revised tariff structure introduced competition from imports. SASOL entered the market in 1984 with a plant in Secunda which exacerbated the overcapacity problems in the industry, which may be partly attributed to droughts in the early 1980s. SASOL was a major raw material supplier to the fertilizer industry and its entry into fertilizer production was its first foray into competition with its customers since its partial privatisation in 1979. Industry observers watched with interest to see what would emerge from the looming battle for the fertilizer industry.

A price war duly commenced following a 13% upswing in demand in 1986 over 1985, with prices in 1987 being lowered by as much as 40%. At the same time export markets in Brazil especially, declined. Capacity closure, mothballing and market exits were the order of the day. Bonus exited the market, and Triomf was liquidated. Omnia survived by focusing on niche markets. By the end of the 1980s demand had declined to 1985 levels. Expectations were that the three large survivors in the local market, SASOL, AECI and Sentrachem's Fedmis would have to come to some arrangement. Shortly thereafter Fedmis sold its remaining operations to an AECI/SASOL joint venture. Triomf was rescued from insolvency by a mysterious offshore firm, Indian Ocean Fertilizer (IOF), and allowed to continue operations for export purposes only. Subsequently it emerged that the IDC's Foskor (supplier of phosphate rock) and a West African government were behind IOF.

The upshot was, that from AECI's point of view, the fertilizer business had been destroyed by a semi-public company which had the unfair advantage of massive state support or subsidy through the petrol price regulatory system. This was not the last time AECI would make this complaint. These events in the fertilizer market seem akin to SASOL tearing down the door in order to get in. However since that time SASOL has proceeded in a somewhat more genteel manner as it has entered into competition with its customers. Despite the battle between AECI and SASOL on the fertilizer front they were nevertheless cooperating, (although not completely happily) in the petrochemical and plastics industry (see below).

It is interesting to note that at the time the battle in the fertilizer market was being played out (1986-88) SASOL was not expanding its supply of ethylene to feed AECI's polyethylene business which in 1988 could only operate at 76% capacity and necessitated imports of some 40 000 tonnes of polymer (BTI Report No. 2932:5). Lower polyethylene sales would of course have reduced AECI's ability to fund fertilizer losses. It is tempting to speculate about the coincidence of these developments and to what extent they were the result of deliberate corporate strategy on the part of SASOL, but since the nature of South African business conduct is that such matters are not made public, one cannot be sure.

Explosives

The explosives industry has dominated the chemical industry for many years. As a result of a long standing agreement between the Chamber of Mines and AECI, it had an unrivalled monopoly for many years. It is more than a coincidence that Anglo American is a major player in the Chamber of Mines and a 48% shareholder of AECI. This monopoly and the size of South Africa's mining economy has allowed AECI's explosives sector to become one of the few sectors of the chemical industry which is internationally competitive (CSIR, 1990:22). Despite this exports are a small proportion of output.

When the Competition Board ended AECI's monopoly in 1982, new entrants were able to enter the market. Simultaneously AECI began a decentralisation initiative, siting smaller plants away from Modderfontein, its core explosives plant. In 1982 it opened an explosives plant in Bophuthatswana, followed by another in Welkom in 1983, another in 1985 at Bethal, another in 1986 at Zomerveld in the OFS. The Modderfontein plant was modernised in 1987. National Explosives opened the way for new entrants to the industry in the early 1980s. SASOL's Secunda based SMX plant followed in 1986. This was the second industry after fertilizers in which SASOL, traditionally a raw materials supplier, moved downstream and entered into competition with private companies. The tussle between these two large players resulted, typically, in smaller producers being absorbed by them.

Corporate strategies

These fertilizer and explosives episodes demonstrate the different approaches adopted by AECI and Sentrachem to SASOL's entry into markets which had largely been their preserve. AECI has challenged SASOL head on each time SASOL has threatened its markets.

Sentrachem by contrast has opted to give way and relocate its activities and at the same time to make itself as independent as possible of SASOL's raw materials. For example it exited from the fertilizer industry and continued to move the company into speciality chemicals. In the plastics industry, by the time SASOL entered the polypropylene market it had already helped to establish a propylene importing facility and set up its own propylene source at the SAPREF in Durban. It also diversified its PP product into different markets. (More on this below.)

AECI on the other hand has its Number 4 ammonia plant at the heart of its Modderfontein explosives and fertilizer complex. Built in 1974 this coal based plant was plagued by technical problems in its early years requiring an extra boiler in 1981 at a cost of R10.4 million. Latterly this ageing plant has experienced increasing maintenance costs. AECI will require a new ammonia facility in the near future. Meanwhile SASOL has revamped the SASOL 1 plant which now includes a new and much larger ammonia plant. It is rumoured that joint venture discussions between AECI and SASOL on ammonia production, floundered as a result of AECI's efforts to place the bulk of the risks at SASOL's door.

AECI's strategy, or the lack of it, has resulted in a loss of market share to SASOL in fertilizers and explosives. Furthermore it appears likely that in future it will become increasingly dependent upon SASOL for feedstock for these products unless it takes remedial action. At the same time AECI has been tied to SASOL feedstocks for its plastic raw materials business (polyethylenes and PVC). AECI's plant is ageing. The average age of plant was almost 9 years in 1990 and has been rising since 1983 (Tison, 1991:3) largely as a result of limited investment. By contrast Sentrachem's average age of plant is just five years (Tison, 1992a).

<u>Synfuels</u>

The 1973 oil crisis triggered radical changes in the South African liquid fuels industry. Government thinking up until that time had been focused on self sufficiency type policies and in so far as oil supplies were concerned it had already built SASOL 1. The oil crisis strongly reinforced this thinking as the price of crude oil rose from $3 to $12 per barrel. Expansions were quickly carried out to increase the limited capacity at SASOL 1 whilst the government deliberated. At this time South Africa's international political position was deteriorating as a result of the apartheid policies being pursued.

The closing net of international pressure began in 1963 when the United Nations General Assembly passed a resolution condemning South Africa's 'illegal occupation of Namibia' and called upon member states to halt all oil exports to South Africa. Compliance with this resolution was however voluntary as only a Security Council resolution could effect mandatory sanctions. In 1974 a resolution went before the UN Security Council calling for mandatory sanctions against South Africa. Although the US, Britain and France rallied to defend apartheid and used their veto to block this resolution it must nevertheless have weighed heavily on the minds of apartheid state planners, confronted as they were by not only apparently rising oil prices but also dwindling supplies as well.

This international pressure combined with higher oil prices hardened government resolve to 'go it alone'. Finally on December 5, 1974 the cabinet announced that a second synfuels plant, SASOL 2, much larger than the first, would be built. This was the signal that changed a number of developments. This decision, made for military/strategic reasons, marked a major turning point in South Africa's liquid fuels history. The consequences of this decision have not in the past 18 years worked themselves out of South Africa's liquid fuels nor its petrochemical industries and seem unlikely to do so in the next 10 to 20 years. The impact of this decision is multiple and will be encountered repeatedly in this study.

Further external shocks again concentrated the attentions of the apartheid state. In 1977 the United Nations Security Council imposed a mandatory arms embargo against South Africa. The fall of the government of the Shah of Iran precipitated a second oil crisis during which oil prices leapt from $12.5 to $36 per barrel. At that time South Africa was almost wholly dependent upon Iranian oil. The combination of factors influenced the state to proceed with the construction of a third synfuel plant. The decision to build SASOL 3 (a mirror image of SASOL 2) was made in 1979.

It is worth noting that the decisions to build SASOL 2 and 3 were both made during peaks in the international oil price and at a time when oil price projections caused a flurry of investigations into alternative sources of energy. Also at the time these large investment decisions were made the state would presumably have found solace in the gold price boom as a potential source of funding for its synfuel decisions.[5] Nevertheless some measure of the state's strategic concerns may be gained from the fact that no other economy of similar size devoted as large a proportion of investment to coal based synfuels as South Africa did. These two SASOL plants cost R7 000 million or R31 500 million in 1991 Rands, a very large investment for the South African economy (Sasol Facts, Undated:13).

International opposition to apartheid continued to strengthen. Further United Nations resolutions in December 1981 (36/172 G) and December 1982 (37/69 J) culminated in a General Assembly resolution on 5th December 1983 calling for the Security Council to

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5. The US $ gold price rose at an average annual rate of 35.7% and 19.1% between 1970-75 and 1975-81 respectively (Nattrass 1990:110).

"consider urgently a mandatory embargo on the supply of petroleum and petroleum products to South Africa" (38/39 J). This was again opposed by a small number of countries including the US, UK, France and Germany.

This continuing international pressure contributed in 1987 to a decision to embark upon yet another grand synfuels scheme, Mossgas or Mossref at a final cost of about R12 billion. It was designed to produce petrol from offshore natural gas, piped 90 to 140 km to Mossel Bay. The exact size of this investment is itself a source of some controversy. Originally budgeted at R5.5 billion it was announced by Minister Pik Botha on 31 August 1994 that the total cost at December 1993 was R 11.1bn (Business Day,1-9-94:4). The output is "modest (even derisory)", (FM 13-12-91:23). Its 'nameplate' capacity is variously estimated between 25 000 bpd and 40 000 bpd (Newsletter on the Oil Embargo against South Africa, 1991, No 25:1 and FM 13-12-91:23). Most recent references to Mossgas give it a capacity of 32 000 bpd, less than 10% of local capacity (MERG, 1993:3). The magnitude of this scandalous decision is evident in the following comparisons. Oil industry calculations suggest that the cost of replacing the country's entire existing refinery capacity would be roughly the same (Financial Times 13-12-91). Democratic Party energy spokesman Roger Hulley estimated that all the houses in South Africa could have been electrified for less than half the cost of Mossgas (Newsletter on the Oil Embargo against South Africa, 1991, No 25:6). SASOL has claimed that it could have expanded capacity by an equivalent amount at a cost of only R 500 million, ie about one sixth of the cost. At the time chemical companies concerned about the waste, both of money and gas, lobbied for the gas to be used to make petrochemicals (see below).

The apartheid state's preoccupation with liquid fuels self sufficiency set in motion a train of thought in state policy circles in which military/strategic criteria were increasingly substituted for commercial criteria with the result that each episode was more outrageous than the last. Consider: SASOL 1 built in 1955 was capital intensive but of limited scale. SASOL 2 was a large capital intensive project approved in 1974. SASOL 3 doubled it, approved in 1979. Finally Mossgas, the ultimately absurd project, was approved in 1987, a tiny refinery (32 000 bpd) reliant upon an uncertain gas supply built at hugely disproportionate expense.

The increasing military dimension to these decisions is also evident in the Mossgas technology choice. It reverts back to the SASOL 1 ARGE type reactor in order to produce more diesel, because according to Bernard Smith, Mossgas Managing Director, 'the generals wanted more diesel' (at a press conference at the Wilderness in December 1991). (Tanks and other heavy military vehicles tend to be diesel powered and SASOL's synthol process had experienced problems in producing diesel.) The structure of the motor fuel market had been altering through the latter half of the 1980s and into the early 1990s - the major change being a move away from diesel to petrol (see Table 4.1). As growth in the market occurs there is relatively less demand for diesel, and assuming motor fuel producers attempt to follow the market, the generals would have been right to be concerned about the availability of diesel capacity in local refinery and synfuel plants. Of course this is not to suggest that building Mossgas was in any way an appropriate means to address this change, but merely to support Bernard Smith's point.

Table 4.1 SA Motor fuel market (%)

	Petrol	Diesel	Total
1988	59.5	40.5	100
1989	60.6	39.4	100
1990	61.8	38.2	100
1991	63.0	37.0	100
1992	64.3	35.7	100
Jan-Jun 93	64.7	35.3	100
Growth 88-92 % p.a.	2.41	-1.69	

Source: SASOL

The full extent of foregone opportunities and negative consequences of Mossgas are still to emerge. Once all the veils of secrecy covering Mossgas and its performance are lifted, its continued operation is almost certain to come under scrutiny. In the light of the foreign debt incurred by Mossgas most commentators have agreed that it will be the lesser of two evils to allow Mossgas to continue operating, rather than to close it down. One public policy issue which bedevils attempts to establish Mossgas' viability is what happens to Mossgas' product. Given its strategic nature, one might expect it to be given first preference on the local market. However because the crude oil refiners expanded capacity in the early 1990s they refused to uplift Mossgas' output at the domestic price (the IBLC - see Annexure B) and instead only pay a (lower) export parity price. The difference has in fact been made up by motorists. Part of the Equalisation Fund levy on the petrol fund has been used to pay Mossgas. The real issue is who should be required to export, Mossgas or the crude refiners? This is one of the many complex public policy issues awaiting resolution in the liquid fuels industry. Some other issues are touched on in later chapters.

Petrochemicals

The South African petrochemical industry has its origins in the small 10 000 tpa (carbide acetylene route) PVC plant built by AECI in Durban in 1955. In the same year SASOL 1 commenced production of liquid fuels from coal. (This has been discussed above.) In 1963 SASOL 1 branched out into petrochemicals. It used nitrogen, a by product from the oxygen plant, to react with hydrogen to produce ammonia, a feedstock for fertilizer, explosives and other products. Creosote and ammonium sulphates and various other synfuel by-products were also produced but SASOL did not initially venture into the production of commodity petrochemicals such as ethylene, propylene or vinyl chloride monomer (a precursor to PVC).

South Africa's real entry into petrochemical production took place in 1965 when the state, through its ownership of SASOL, built a naphtha cracker at Sasolburg. Naphtha feedstock was imported and carried inland from Durban by pipeline. This plant's original design capacity was 30 000 tpa of ethylene which was later expanded to 45 000 tpa. By the 1970s a second cracker had been added to bring the total capacity to 135 000 tpa. At this time a world scale cracker was of the order of 300 000 - 500 000 tpa. Other petrochemicals, styrene and C_4 chemicals (butadiene) were also produced in small quantities. The butadiene fed the Karbochem synthetic rubber plant and the styrene fed Kolchem's (subsequently Sentrachem's Styrochem) 4 000 tpa polystyrene plant. This was typical of the import substitution type policies being pursued by the state at the time.

Nevertheless the availability of at least half of the seven basic organic chemical building blocks was a substantial kickstart for the petrochemical industry. By the mid 1970s propylene was produced as well to feed the Safripol PP plant. A fully fledged aromatics unit was not built, a deficiency in the industry which prevails to this day. The availability of these feedstocks enabled several satellite plants to be built. A flow sheet of the plants existing by about 1975 is shown in Figure 9.

It is informative to compare South Africa's first petrochemical complex at Sasolburg with its counterpart at Ulsan in South Korea. The flow sheet for the South Korean complex is shown in Figure 10. It was built at about the same time as the Sasolburg complex (between 1967-71). The South African plants were generally bigger, for example the South African LDPE plant was 75 000 tpa compared with South Korea's 50 000 tpa plant, and South Africa's HDPE was 48 000 tpa compared to South Korea's 35 000 tpa HDPE plant. Despite being larger than the South Korean plants they were nevertheless small in world terms. The

Figure 9 Flow Sheet for SASOL 1 Petrochemical Complex (built 1965-75)

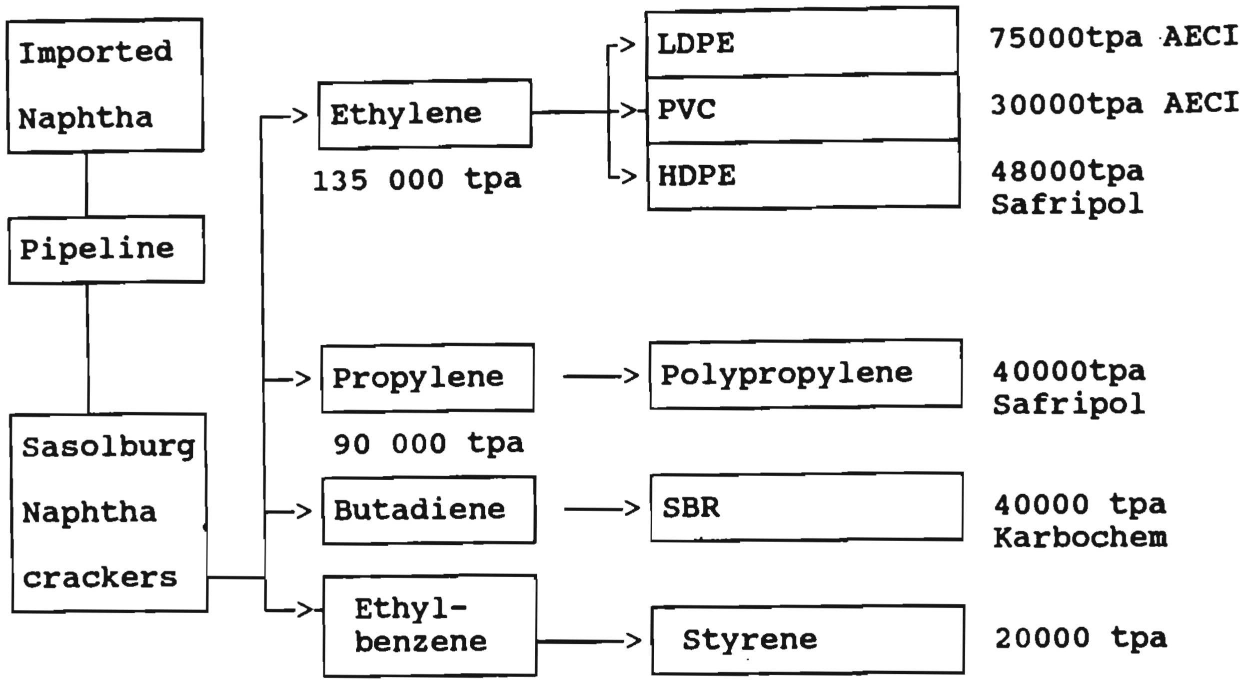
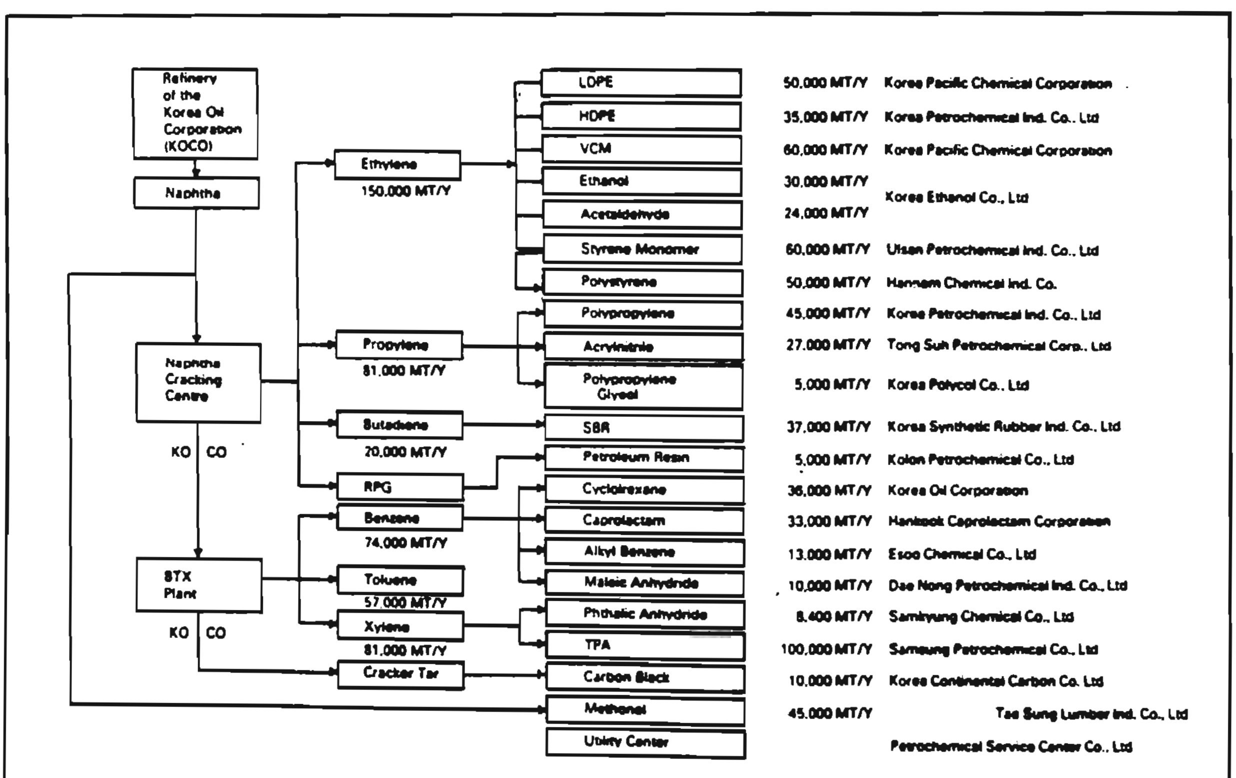


Figure 10 Flow Sheet for the South Korean Ulsan Petrochemical Complex



Source: Enos et al, 1988:49

conventional wisdom of the day was "The South African economy is too small to justify competitive plants" (FM, 11-4-74:29).

However what is striking is the wide range of petrochemicals produced by the South Korean complex. This wider range was made possible by the inclusion of an aromatics[6] unit which the Sasolburg complex lacked. Both plants followed a similar path with regard to ownership concentration, in that vertical integration was not present. However the South African complex's privately owned plants were dominated by just two companies, AECI and Sentrachem, whereas the South Korean complex had a much wider spread of ownership.

The South African PVC and LDPE plants used a high pressure technology and from the beginning AECI experienced difficulties in operations. Used to pressures of 300 atmospheres in the production of ammonia, these new plants required pressures of over 1 000 atmospheres.

The limited scale of the Sasolburg complex was soon apparent. AECI applied to the government for permission to build additional cracking capacity in 1970 but was turned down. Subsequently, in the early 1970s, discussions between Shell, BP and SASOL commenced over the erection of a larger naphtha cracker at Richards Bay (FM, 11-4-74:159). Naphtha was to be sourced from the Durban refineries, a new Trek refinery proposed for Richards Bay (never built) and imports, yielding 300 000 tpa of ethylene.

By 1974 AECI's plastics plants in Sasolburg were operating at capacity but beginning to be held back by a shortage of ethylene from SASOL's limited crackers. AECI was to have been the major ethylene customer for the Richards Bay cracker's but in 1975 AECI decided to proceed with its own coal based production inland, a chemical complex to be known as 'Coalplex'. This put paid to the proposed Richards Bay refinery and petrochemical complex. This decision followed hard on the heels of the state's decision to proceed with SASOL 2.

In 1976 AECI and Sentrachem built 'Coalplex' adjoining AECI's Midland site at Sasolburg. The decision to relocate this petrochemical complex inland was made "with Government backing for strategic reasons" (AECI/Sentrachem, Coalplex, (undated) p1). AECI deny there were any long term agreements with the state except the promise of long term protection against dumping (Interview, Fraser). AECI subsequently purchased Sentrachem's share in 1984.

The change in thinking represented by these decisions, some 18 years ago, has had a massive impact upon the South African petrochemical industry which persists to this day.

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6. Aromatics (benzene, toluene and xylene) are the other 'half' of the seven basic organic chemicals.

Firstly it indicated a major change in direction away from crude oil towards coal based liquid fuels and petrochemicals. Secondly it reinforced the Import Substitution Industrialisation policies being pursued by the state and embedded them in a manner that South Africa is now finding difficult to escape from. Thirdly it struck a long term blow at international competitiveness in that to shift Coalplex from a coastal location to an interior location also signalled higher transport costs for exports.

More than this it represented a backward step technologically speaking. AECI's first PVC plant at Sasolburg used naphtha based ethylene from the SASOL naphtha crackers. The newer and much larger Coalplex PVC plant used the older carbide/acetylene route which was being phased out in the US and other countries at just that time. Although acetylene has the advantage of a wider and more valuable product slate than ethylene, its demise as the preferred chemical building block has been largely as a result of the higher capital costs involved. Given the 20-25 year lifespan of such plants that disadvantage remains to this day.

This technology choice also has other implications. At the heart of Coalplex are two large electric arc furnaces which burn lime and anthracite at about 2 000^{0}C to produce calcium carbide. This energy intensive process consumes large amounts of electricity, about 125 mega watt, enough to supply a town with all its requirements. The calcium carbide ingots are then used to make acetylene which is reacted in turn with hydrogen chloride to make vinyl chloride monomer the precursor to PVC. On the same site salt is processed in a chlor-alkali unit to produce caustic soda and chlorine. The chlorine and hydrogen used to make hydrogen chloride are by-products of caustic soda manufacture. In short this is an integrated complex in which by-products from one process are used as inputs to other processes and products.

On the face of it this route to PVC seems eminently sensible although it is both materials and energy intensive. South Africa had cheap electric power and the major inputs are coal, lime and salt. From the point of view of adding value to relatively low grade domestic resources it appears an attractive project[7] especially from an import substitution point of view. However its cost structure is entirely different to its crude oil based competitors and consequently tariff protection is needed.

This may be elucidated if the cost structures of an oil based and coal based producer are compared. Put simply, in the case of an oil based producer, lower polymer prices can be passed upstream to the ethylene producer, beyond that to the oil refiner, and beyond that

7. PVC production in Zimbabwe utilising this same route was under consideration in 1992.

again to the oil drilling and recovery. These upstream links in the chain can respond in various ways, they can vary the volume of their throughput *without increasing their fixed costs*, or they can engage in other strategies such as varying the co-product mix. On the other hand coal based production cannot as easily pass lower PVC prices upstream as input prices are fixed by the cost of mining coal. Coal based production also has fewer options to vary the co-product mix. For example one response to a drop in polymer prices might be to increase volumes and sales whilst accepting a lower margin per sales unit. Oil based producers can do this without additional fixed costs whereas mining based producers must incur additional fixed costs.

Furthermore the price cycles of coal, lime and salt tend to follow entirely different paths to those followed by crude oil and naphtha and petrochemicals which tend to track the crude oil cycles. These cost structure problems lie at the heart of international competitiveness problems in South Africa's coal based petrochemical industry and apply equally to SASOL which is also competing with international oil based producers.

The choices in technology in petrochemicals (and plastic raw materials) and economies of scale (and the attendant cost structure) have required considerable tariff protection from inception but have provided some measure of relief to domestic customers at times when international prices were high (discussed in detail in a later chapter). Real threats against the tariff protection regime for plastic raw materials in the early 1990s and some public pressure for the deregulation of the liquid fuels industry initiated a restructuring in the *filière* in which a further concentration of ownership occurred before international competition had any effect on local prices. In 1994 AECI merged its polymer and plastic interests with SASOL's into a new company called Polifin, in which SASOL holds 60% of the interest and AECI 40%. AECI again lost considerable market power in the process. (This development is covered in more detail in a later chapter.)

The growth of the synfuels industry also had a large impact on the economy; in petrochemicals, on capital intensity, employment patterns and productivity. Indeed the synfuel investments are integral to the crisis being endured by the South African economy.

The impact of the synfuels investments:-

a) On petrochemicals

The synfuels decisions also represent turning points in South Africa's petrochemical history. SASOL 2 & 3 turned the industry back to coal based feedstocks at a time when the economics of production over the preceding two decades had been turning international producers away from coal towards oil based feedstocks. Mossgas turned the country away from natural gas based petrochemicals to make petrol instead.

Furthermore the slate of petrochemicals available from SASOL's Secunda plants was narrower than was previously the case (This is dealt with in detail in the following chapter). A narrower slate of feedstocks had a corresponding effect upon the petrochemical and polymer sectors. This is evident in a crude way in Table 4.2 which lists the number of plants in certain countries producing 10 basic petrochemicals and shows that by this measure South Africa ranks below the NICs (excluding Hong Kong and Singapore) and is roughly on a par with the more advanced second tier NICs, Thailand and Malaysia, both of which have hydrocarbon resources. Among the DMEs South Africa ranks roughly on a par with Portugal. It is ahead, as may be expected of the smaller Scandinavian countries, Switzerland, Austria, and New Zealand. Australia, which has an economy of roughly similar size, has significantly more plants, although of course it does mine oil off the North West Shelf.

The plant capacities are not reflected in this table, making it a rather crude measure. But it does demonstrate that South Africa's rather large chemical and petrochemical industry is confined to a relatively small number of plants. The core of South Africa's petrochemical industry potential lies in the SASOL facilities at Secunda.

Despite being dependent upon a narrow slate of coal based petrochemicals and being restricted to a limited number of plants, the structure of the chemical industry underwent important changes in the 1980s.

b) On the Structure of the Chemical Industry

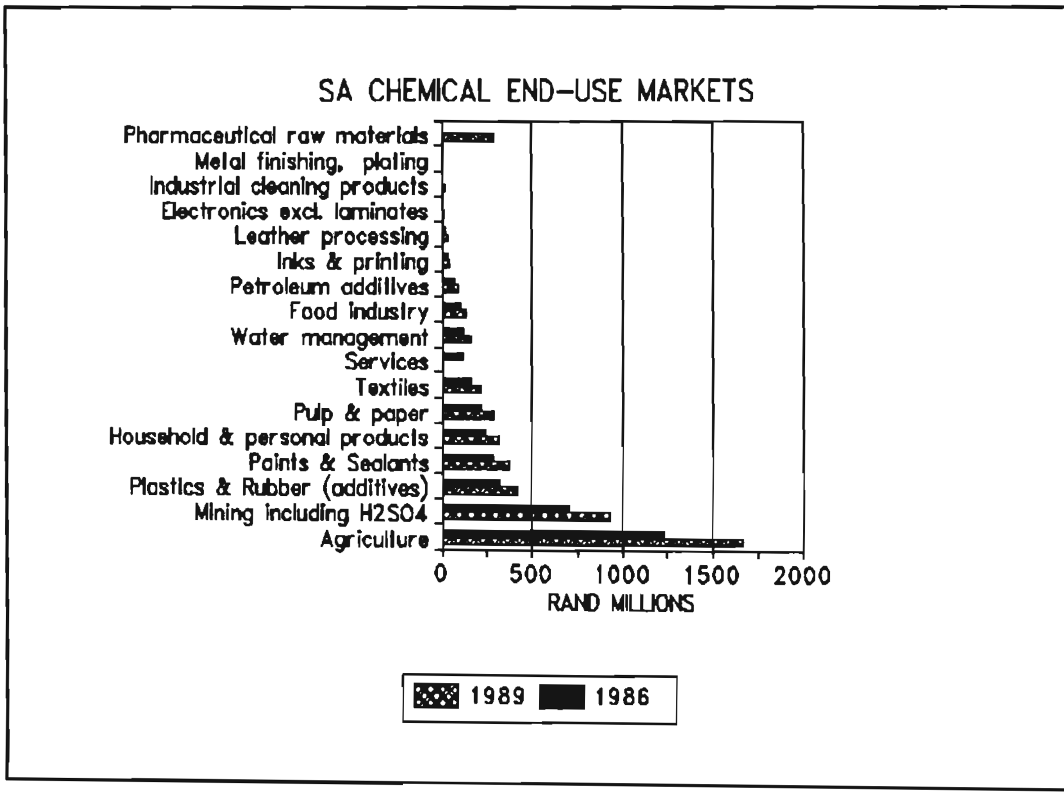
The early characteristics of South Africa's chemical industry in mining and agriculture have prevailed down the years and are still evident in the structure of South Africa's end-use markets (see Figure 11). Although it is not strictly correct to categorise sulphuric acid (H_2SO_4) as a mining chemical since a significant amount is also used in fertilizer manufacture, this does not detract from our purpose here which is to show that mining and agricultural products have dominated South African chemical markets. If South Africa's chemical markets are compared with Europe's this bias is again evident (see Figure 12). In this figure 'other' includes mining chemicals and accounts for South Africa's comparatively larger share of this category. It is also evident in this figure that South Africa's household and personal products markets are comparatively underdeveloped.

Table 4.2 Number of Petrochemical Plants, Certain Countries

COUNTRY	PETROCHEMICAL Ethylene	PE	Benzene	Styrene	PS	Propylene	PP	Methane	Ammonia	Urea	TOTAL
NICs											
HONG KONG					1						1
SINGAPORE	1	1					1				3
TAIWAN	4	4	1		3	1	2				15
ARGENTINA	6	3	2	1	1	1	1	6	5	1	27
MEXICO	6	4	3	2	3	11	3	4	6	6	48
BRAZIL	8	10	4	3	2	6	6	3	5	2	49
KOREA (SOUTH)	8	12	7	7	5	4	8	1	3	3	58
Average	5	5	3	2	2	3	3	2	3	2	29
Second Tier NICs											
TUNISIA					1						1
PERU									1	1	2
SRI LANKA									1	1	2
PHILIPPINES	1	1					1				3
COLOMBIA	3	1	2		2	1	1		1		11
THAILAND	1	3	1		3	2	2				12
MALAYSIA	3	2			1	2	2	1	1	1	13
Average	1	1	0		1	1	1	0	1	0	6
Developed Market Economies											
SWITZERLAND	1								1		2
SWEDEN	1	1			1	2					5
GREECE	1				1				2	1	5
AUSTRIA	1	1				1	1		1	1	6
NEW ZEALAND				2				3		1	6
ISRAEL	1	1	1		1		1	1	1	1	8
FINLAND	1	1	1		2	1	1		1	1	9
NORWAY	1		1			2	1	2	2		9
PORTUGAL	1	1	1			1	1	2	2	1	10
AUSTRALIA	5	4		1	1	2	4	1	3	1	22
BELGIUM	3	8	1	1	3	2	8		2	1	29
NETHERLANDS	4	4	2		2	4	3	1	7	3	30
SPAIN	3	6	4	1	3	6	4		2	2	31
UNITED KINGDOM	7	4	5	2	3	8	4	1	4		38
ITALY	11	3	4	3	2	3	4	1	8	9	48
CANADA	7	11	6		3	5	2	3	12	7	56
FRANCE	12	10	7	3	6	8	7		8	4	65
GERMANY	16	11	11	3	2	9	10	4	5	3	74
JAPAN	16	18	20	11	12	15	20	2	7	4	125
UNITED STATES	46	35	35	16	18	41	23	13	47	25	299
Average	7	6	5	2	3	6	5	2	6	3	46
SOUTH AFRICA	**2**	**2**				**1**	**2**	**3**	**2**		**12**

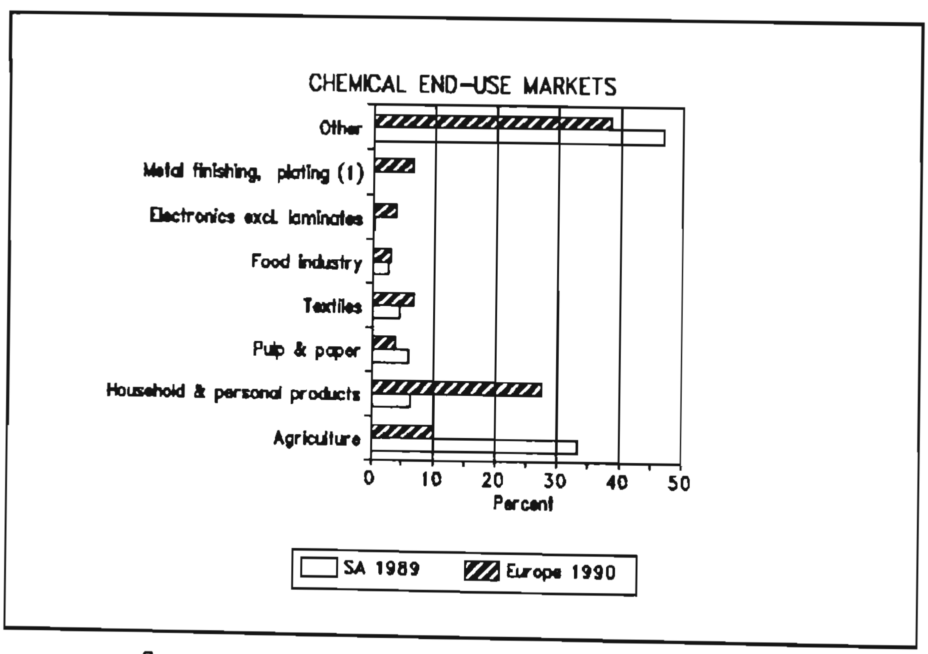
Source: SMI Chemical Database
Note: South Africa figures corrected

Figure 11



Sources: (1) Interview, Laing.
(2) Laing, 1992b.

Figure 12

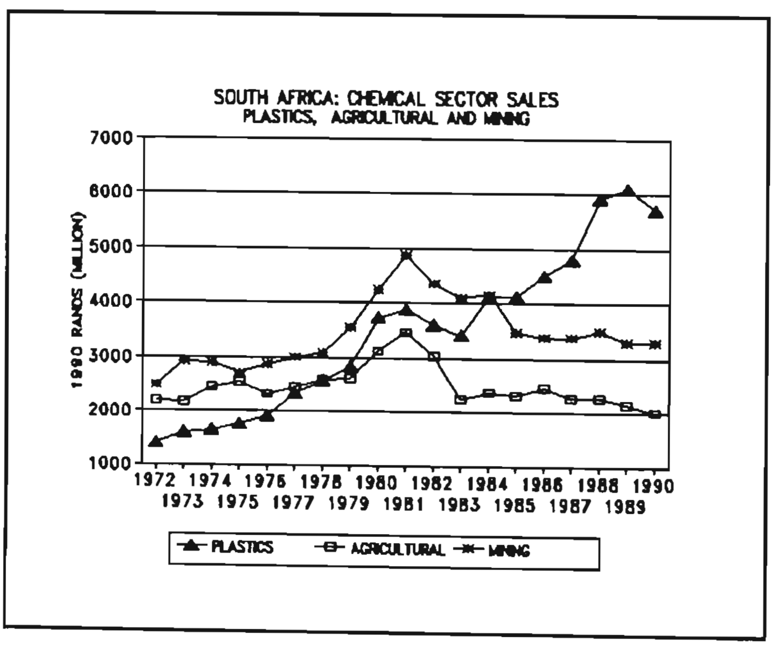


Sources: Laing, 1992b.
European Chemical Industry Association quoted in Financial Times, 13-7-91.

Note: (1) = 1986 figure.

Unfortunately consolidated market statistics are not available and the market structure in Figure 12 is distorted to the extent that it excludes the manufacture of polymers and plastic raw materials. If the demand for polymer and plastic raw materials is contrasted with the demand for agricultural inputs (fertilizers and pesticides) (see Figure 13) then a significantly different picture emerges. This shows that plastic sales overtook agricultural sales in 1978 and that whilst agricultural sales have declined from 1981, plastic sales, on the other hand, rose steadily to 1989. Growth in fertilizers and pesticides sales over the period 1972-90 averaged -0.5% p.a. in real terms whilst synthetic resins and plastic raw materials sales grew at an average of 6.7% p.a. over the same period. The longer term trend appears to be a growing plastics market and a declining agricultural market. Plastics raw materials grew faster, on average, than any other major chemical sector including pharmaceuticals, (which grew at an average of 4.2% p.a.) over the 1972-90 period. Plastics raw materials grew at about three times the rate of all manufacturing over this period. Even though plastics raw materials growth slowed to 2.5% p.a. over the 1980-90 period, this was still well above the 0.4% p.a. figure for all manufacturing.

Figure 13



Source: IDC 1992
Notes:
Plastics = Synthetic Resins and plastic raw materials (ISIC 3513)
Agricultural = Fertilizers and pesticides (ISIC 3512)
Mining = Other Chemical Products (ISIC 3529)

Figure 13 also tracks a sector referred to as 'Mining'. In fact this is Other Chemical Products (ISIC 3529) which includes and is dominated by explosives. Consequently it has been used as a proxy for mining although it also includes other smaller products such as inks, matches and glues. Plastic raw material sales overtook 'Mining' sales in 1984. The latter have followed a declining trend since then.

Petrochemicals and plastics raw materials have thus supplanted the historically dominant sectors, agricultural and mining chemicals as the main pillar of the domestic chemical industry despite the fact that the bulk of the feedstocks were coal based. The reasons for this fundamental restructuring of the leading chemical sectors arising from the growth in the value of sales of plastic raw materials are analysed in a later chapter. This new, leading chemical sector (plastic raw materials) consequently takes on added national importance as a result. Future economic policy and industrial strategy should give particular attention to this sector.

c) <u>On Output, Value Added, Capital Intensity and Employment</u>

SASOL claims that the Secunda complex has been the largest construction project in the Southern Hemisphere to date. At a capital cost of about R31 billion in 1991 Rands, this may well be true. However the resulting two refineries were not especially large. Their exact size has been a closely guarded secret but were estimated by the <u>Oil & Gas Journal</u> to be 50 000 bpd each in 1984 (Rustomjee, 1986:141). A more recent estimate gives SASOL a synfuels capacity of 150 000 bpd (crude equivalent) and an actual refined product output equivalent to 120 000 bpd. This is about two thirds of the original size of the SAPREF crude oil refinery in Durban (200 000 bpd) which was built at a fraction of the cost.[8]

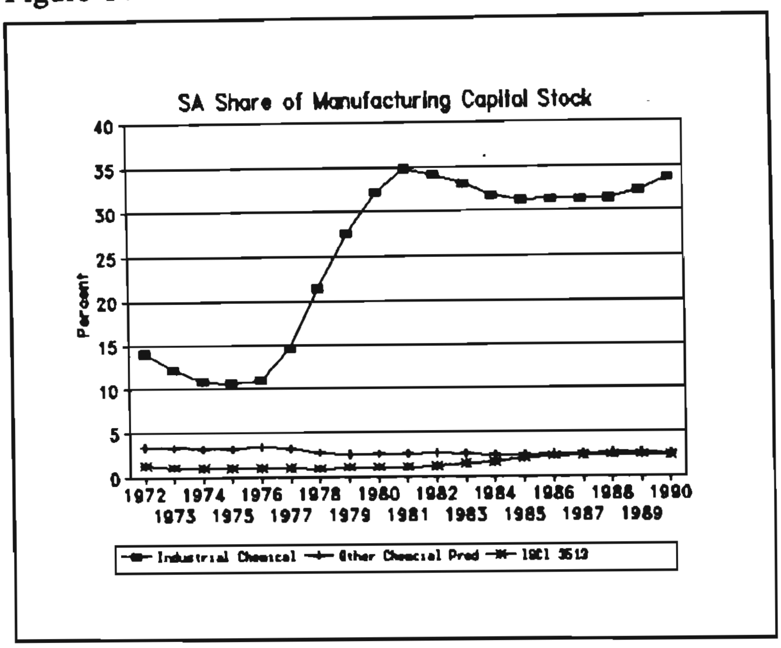
The massive impact of these plants on manufacturing capital stock is evident in Figure 14. Because of secrecy laws separate data covering oil refineries is not available. To disguise it, such data is often included with other sectors. In the data base used here refineries are included with Industrial Chemicals. (In the Central Statistical Services data, refineries are usually included with Other Chemical Products, ISIC 352).

Over the 1976-82 period when the SASOL plants were being built no major investments were made at any of the crude oil refineries as far as can be ascertained. In fact they were obliged to mothball certain equipment in order to accommodate SASOL's output. The capital stock figures for plastic raw materials (ISIC 3513) are included in Figure 14 as

8. SAPREF had to decrease its size to 120 000 bpd to accommodate SASOL's output. All other crude oil refineries had to similarly cut back. The opportunity costs of this wasted capital should be factored into any attempt to calculate SASOL's social rate of return.

this is usually a major sub sector of ISIC 351. This sub-sector's share of manufacturing capital stock increased only marginally between 1984 and 1990. Thus crude oil refineries and plastic raw materials can be dismissed as the cause of the major increase in the share of manufacturing capital stock in Industrial Chemicals over the 1976-82 period. Figure 14 also shows that Other Chemical Products' (ISIC 352) share of manufacturing capital stock did not change significantly over the 1972-90 period. It would seem reasonable to conclude that the SASOL plants account for this large increase in the share of manufacturing capital stock.

Figure 14



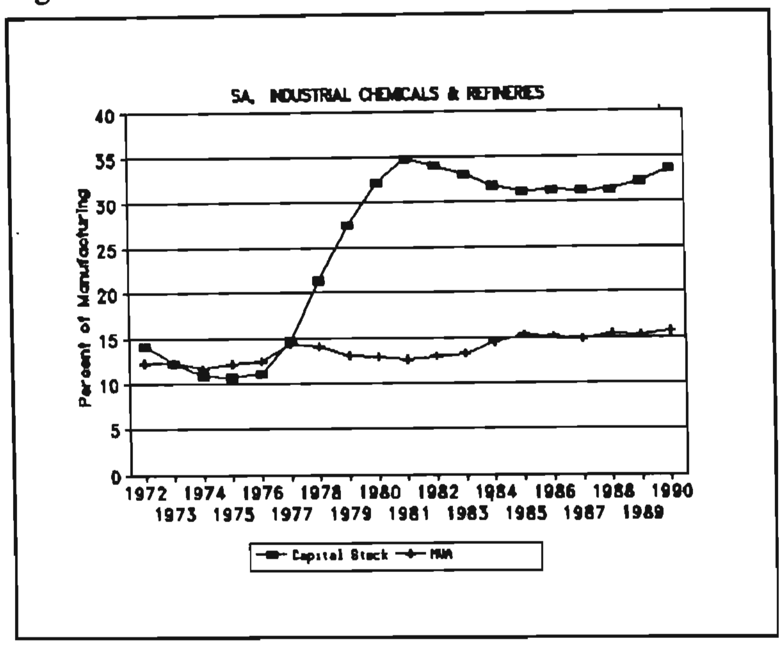
Source: IDC, 1992

Notes:
1. Industrial Chemicals includes ISIC 351 and ISIC 353 Refineries
2. Other Chemical Prod = Other Chemical Products (ISIC 352).
3. ISIC 3513 = Synthetic Resins and Plastic Raw Materials

Did this huge resource and energy intensive complex make a large contribution to manufacturing value added (MVA)? Figure 15 shows that the share of MVA contributed by Industrial Chemicals and refineries did not rise in proportion to the increase in their share of manufacturing capital stock. Such data as is available suggests that capital productivity in manufacturing has been worst in the chemical sector (see Table 4.3). The indications are that it has been declining since 1970.

The impact of the SASOL plants on capital/labour ratios is also evident (see Tables 4.4 and 4.5). It is observed in Table 4.4 that Industrial Chemicals has the highest capital labour ratios. This is to be expected given the capital intensive nature of this industry. However the ratio more than doubles between 1972 and 1980 which appears to be the impact of the Secunda complex. Note also the relationship between plastic raw materials (ISIC 3513) and Industrial Chemicals where the ratio has increased from about 1.6 in 1972 to 2.5 in 1990.

Figure 15



Source: IDC, 1992

Notes: 1. 'Industrial Chemicals & Refineries' includes ISIC 351 and ISIC 353 Refineries.

2. MVA = Manufacturing Value Added.

What is of concern is that the capital labour ratio growth rate over 1972-90 for Industrial Chemicals has been more than twice that of Manufacturing as a whole. A further indication of the extreme capital intensity of this sector is that its capital labour ratios were about two and a half times those of the typically capital intensive Iron Steel and Basic Industries in 1990 (IDC, 1992). The bias of the tax regime towards highly capital intensive sectors has contributed to lower user costs of capital in these sectors (Fallon et al, 1993:66).

Also of interest in Table 4.4 is the much lower capital labour ratios for Plastic Products (ISIC 356) and the fact that the ratio in this sector has been almost constant over the 1972-90 period. This encouraging indication, from a job creation point of view, is however somewhat muted by the negative annual average growth rates over the 1985-90 period, a sign of aging machinery and lack of reinvestment, something which was supported by evidence from interviews in the industry.

This very capital intensive development in Industrial Chemicals and Refineries, without a corresponding return in value added or capital productivity has implications for this study. These will be dealt with more fully in due course, but for the present it appears that any future development, that is concerned with the optimum utilisation of capital and labour in the petrochemical industry should attempt to redress the imbalance which has occurred as

Table 4.3 Capital Productivity in Manufacturing, 1970-88 (1985=100)

Industry	1970	1988	Lowest value (year)	Highest value (year)	Average annual % change 1970-88(a\)
Total	168,6	119,5	100,0(1985)	168,6(1970)	-2,8
Food	124,0	106,1	96,8(1984)	128,7(1979)	-1,3
Beverages	112,9	103,6	99,9(1986)	152,6(1981)	-0,5
Tobacco	126,2	135,6	97,8(1983)	189,1(1974)	-2,0*
Textiles	80,1	102,4	80,1(1970)	137,0(1981)	1,6
Clothing	50,2	110,4	50,2(1970)	127,9(1981)	5,2
Footwear	90,2	78,8	78,8(1988)	116,0(1979)	0,0*
Leather	86,3	89,7	86,3(1970)	146,9(1979)	0,5
Wood	119,5	129,8	95,4(1977)	163,2(1980)	0,4
Furniture	186,5	103,6	98,6(1987)	189,4(1980)	-3,3
Paper	158,6	121,0	90,6(1984)	181,3(1979)	-2,3
Printing	97,8	79,4	79,4(1988)	117,3(1979)	-0,3
Chemicals	**289,0**	**137,3**	**379,2(1974)**	**92,1(1983)**	**-8,0**
Rubber products	157,2	148,2	100,0(1985)	195,7(1981)	-0,6
Plastic product	125,8	92,2	88,3(1987)	125,8(1970)	-1,3
Non-met.mineral	213,9	139,8	100,0(1985)	216,6(1974)	-4,0
Basic metals	116,4	115,4	65,3(1976)	116,4(1970)	1,3*
Metal products	146,5	96,4	95,3(1987)	148,7(1973)	-2,9
Machinery	146,8	104,9	98,5(1987)	155,0(1971)	-2,1
Elec. machinery	153,3	106,2	94,0(1986)	158,9(1971)	-2,4
Trans.equipment	197,6	128,6	92,0(1986)	233,4(1981)	-3,4

Source: National Productivity Institute, 1989:49-69, in CWIU, 1991:10.
Note: (a\) Determined by linear regression analysis including each year.

Table 4.4 Capital Labour Ratios (R1000 per worker), 1990 Rands

Sector	1972	1980	1985	1990
PAINTS, VARNISHES AND LACQUERS (ISIC:3511)	15	17	21	20
OTHER PLASTIC PRODUCTS (ISIC:3560)	23	18	24	24
CLEANING COMPOUNDS AND TOILET PREPARATIONS(ISIC:3523)	28	30	36	36
MEDICINAL AND PHARMACEUTICAL PREPARATIONS (ISIC:3522)	44	40	41	42
OTHER CHEMICAL PRODUCTS (ISIC 352)	42	47	49	51
ALL MANUFACTURING	37	55	69	66
OTHER CHEMICAL PRODUCTS (ISIC:3529)	68	79	79	86
FERTILIZERS AND PESTICIDES (ISIC:3512)	85	87	106	126
SYNTHETIC RESINS AND PLASTIC MATERIALS (ISIC:3513)	93	96	172	200
INDUSTRIAL CHEMICALS (ISICs 351,353,354)	153	445	446	506

Source: IDC, 1992 data

Table 4.5 Capital Labour Ratios, (1990 Rands) Annual Average Growth Rates (%)

Sector	72-90	80-90	85-90
PAINTS, VARNISHES AND LACQUERS (ISIC:3511)	1.7	1.9	-0.4
OTHER PLASTIC PRODUCTS (ISIC:3560)	0.3	2.9	-0.3
CLEANING COMPOUNDS AND TOILET PREPARATIONS (ISIC:3523)	1.5	1.9	0.4
MEDICINAL AND PHARMACEUTICAL PREPARATIONS (ISIC:3522)	-0.3	0.4	0.4
OTHER CHEMICAL PRODUCTS (ISIC 352)	1.0	0.8	0.8
ALL MANUFACTURING	3.3	1.8	-0.9
OTHER CHEMICAL PRODUCTS (ISIC:3529)	1.3	0.8	1.8
FERTILIZERS AND PESTICIDES (ISIC:3512)	2.2	3.8	3.5
SYNTHETIC RESINS AND PLASTIC MATERIALS (ISIC:3513)	4.3	7.6	3.1
INDUSTRIAL CHEMICALS (ISICs 351,353,354)	6.9	1.3	2.6

Source: IDC, 1992 data

a result of SASOL's Secunda complex. If this is to be done then future development should be guided towards much lower capital labour ratios than have prevailed in Industrial Chemicals. In the petrochemical and plastics production chain, Other Plastics Products (ISIC 356) is the only obvious choice. Ideally activities with a higher value added per Rand invested should also be the target of future development.

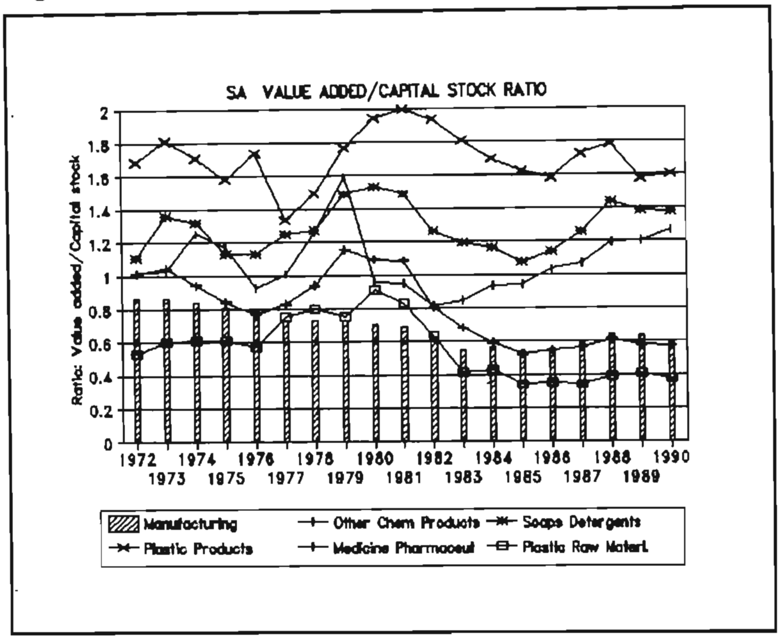
However this does not suggest that it is 'abnormal' to find poor capital productivity in the Industrial Chemicals and Refining sectors. Nor is it 'abnormal' to find that labour productivity is higher than capital productivity in such sectors (see Kaplinsky 1994). It is the choice of technology by SASOL which is at the heart of the productivity problem. "These 'inappropriate' technical choices have been so significant as to affect the overall pattern of manufacturing growth" (Kaplinsky, 1994:iii). This problem has been exacerbated by the virtual 'drying up' of investment in more labour intensive sectors.

With this in mind a search for higher value added sectors in the chemical industry was conducted. The results are set out in Figure 16 where it is apparent that Other Plastic Products (ISIC 356) has consistently, over the 1972-90 period, enjoyed a higher value added/capital stock ratio than any other chemical sector and roughly double the average for all manufacturing. Of note in this figure is Plastic Raw Materials (ISIC 3513) where the trend for this sector is below the manufacturing average except for a period between 1977 and 1982. This is cause for some concern because as has been demonstrated above this sector became the main pillar of the chemical industry from the mid 1980s.

Did the SASOL investments make a comparably large impact on employment? Clearly there was some impact. At their peak the Secunda plants employed about 6 500 black workers in 1984. Table 4.6 sets out employment figures for the chemical and plastics industries for certain years. From 1972 total employment in Industrial Chemicals rose steadily to 1985 whereafter it fell gradually to 1990. Other Chemicals followed a similar pattern although it peaked in 1988 at 48 380. The only sector in Table 4.6 which continued to grow after 1985 was Plastic Products, although slower than before 1985. The most impressive of the sectors in this table are the plastics industry sectors. Both doubled employment between 1972 and 1990, whereas employment in manufacturing as a whole only increased by 27% over the same period.

Employment in Industrial Chemicals is different from other chemical sectors in one important respect. It is the only one in which there has been a major change in the racial composition of the workforce over the 1972-90 period. In 1972 the white share of employment was 33% and the black share 57%. By 1990 the whites share was 46% and blacks 43%. This substitution of white for black labour (there is no change in the other race groups) proceeds steadily from 1972, but is accelerated between 1984 and 1986, when whites climb from 40% in 1984 to 44% in 1985 to 48% in 1986, at the expense of blacks.

Figure 16



Source: IDC, 1992

The explanation for this sudden replacement of blacks by whites appears to lie in two areas. All of the major chemical and synfuel installations fell within the ambit of the National Key Points Act, which required detailed security measures to be taken and several of the larger sites had permanent South African Defence Force units located within their perimeters. It was also a period when black workers were increasingly organising into trade unions. This was a factor which contributed to the replacement of blacks by whites (Interview, Lloyd). In such an environment it is not difficult to see how white employers could come to regard black workers who belonged to 'communist' trade unions as a security threat. For example in 1984 SASOL dismissed 6 500 workers at its Secunda site for participating in a political 'stayaway' (a political protest stay-at-home strike). It was one of the few employers to do so and may be seen as an attempt by the state to set an example for other employers on how to deal with restive black labour and trade unions. Given South Africa's strategic reliance on SASOL for its liquid fuel supplies it may also be regarded as an attempt 'teach workers a lesson'. Many of those dismissed were not re-employed. Possibly they were replaced by more docile white workers. Interestingly the timing of these dismissals coincides with the acceleration of white employment.

Table 4.6 SA Chemical Industry Employment

	Employment 1972	1980	1985	1990
Industrial Chemicals (ISIC 351, 353,354, excluding 3513)	33 100	48 140	57 130	52 350
Other Chemical Products (ISIC 352)	32 780	41 750	47 300	47 280
Plastic Raw Materials (ISIC 3513)	5 190	8 160	11 470	10 870
Plastic Products (ISIC 356)	15 900	26 700	30 200	32 900
Total	86 970	124 750	146 100	143 400
	% of Manufacturing Employment			
Industrial Chemicals (ISIC 351,353,354)	2.9	3.4	4.0	3.6
Other Chemical Products (ISIC 352)	2.9	2.9	3.3	3.3
Plastic Raw Materials (ISIC 3513)	0.5	0.6	0.8	0.7
Plastic Products (ISIC 356)	1.4	1.9	2.1	2.3
Total	7.7	8.8	10.2	9.9

Source: IDC, 1992

Another part of the explanation appears to lie in the increasing computerisation of process control which has changed the demand for skills into an area in which basic education for blacks has largely failed to equip them.

The other, smaller, chemical sector, Other Chemical Products, did not experience this trend, indeed almost the opposite. White's share of employment fell from 37% in 1972 to 29% in 1990 whereas black's share was 48% in both those years. Coloureds and asians gained at the expense of whites in this case.

In the plastics raw materials industry (ISIC 3513) white's share of employment is similar in 1972 and 1990, 31% and 32% respectively. The significant change is the decline in the coloured share from 24% to 14%, with increased shares for blacks and asians, 48% and 6% respectively in 1990.

Black's share of employment in the Plastic Products industry is one of the highest in all the chemical sectors at 55% in 1990. It is also the sector in which the shares of employment have remained very similar over the 1972-90 period, whites at about 19%, coloureds at about 22% and asians at about 4%. The only sector in which blacks account for a larger share is the cleaning compounds and toilet preparations sector (ISIC 3523) where it is 58%.

This consistency is somewhat at odds with what emerged during interviews with managers in the plastic converting industry and what was observed during factory visits. Several (white) managers quite unashamedly discussed their strategies to replace black males. The usual reason offered was the propensity of black males to participate in 'stayaways' and/or to join trade unions. One firm employed young white males as machine operators so that the plant could continue to produce during 'stayaways' and another employed coloured females for the same reason. Yet another deliberately kept a racial and gender mix in his workforce in the belief that it diluted the possibility of solidarity among the workforce. These observations suggest that blacks may have been a declining proportion of the workforce. The data however shows that the proportion of blacks has been almost constant. Unfortunately gender based data is not available.

d) On the Size of the chemical industry

The size of the chemical industry has been the subject of some recent errors and misunderstandings. In 1990 the Department of Trade and Industry published the Report of the Working Group for the Promotion of the Chemical Industry (hereinafter Working Group). This Working Group, consisting of the major companies, AECI, Sentrachem and SASOL, together with representatives of the plastic converting industry, was appointed by the state to investigate how the industry could be developed and to see what could be done about reducing the growing chemical import bill. The Working Group stated that the chemical industry :

> "..represents 10% of manufacturing industry in the USA, Western Europe and Japan - but significantly less than 5% in South Africa." (Working Group, 1990:18)

This 5% figure was used as justification for a proposal that the state provide a 'hupstoot' for the industry. It was also taken up and used by the financial press. However there is serious reason to doubt its accuracy.

If the chemical industry is taken to mean, as is commonly the case, Industrial Chemicals (ISIC 351) and Other Chemical Products (ISIC 352), then it would appear that the leading industry experts made a rather basic error as data suggests that between 1975 and 1989 it was more like double the 5% figure (see Table 4.7). If they were referring to only Industrial Chemicals (ISIC 351) then they were roughly correct for South Africa. However in neither the US, Japan nor West European countries does ISIC 351 approximate 10% of MVA (see Table 4.8). But ISIC 351 and 352 together do approximate 10%. There is also considerable difficulty in separating out petrochemicals from refineries, statistically speaking, because of the interrelated nature of their production. This is particularly so in SASOL's case. Hence if refineries are included the discrepancy between the Working Group's 5%

claim and the data is even larger.

Table 4.7 South African Chemical Industry, Contribution to Manufacturing Value Added (%)

ISIC	SECTOR	1975	1980	1985	1986	1987	1989
351	Industrial Chemicals	4.50	5.63	5.70	4.84	4.79	5.83
352	Other Chemicals	4.60	3.58	8.32	7.22	7.49	5.10
	Total	9.10	9.21	14.02	12.06	12.28	10.93
353	Petroleum Refineries	2.95	3.55	8.25	7.26	7.17	5.05
	Total	12.06	12.76	22.27	19.32	19.45	15.99

Sources: (1) UNIDO, 1988, Statistical Annex.
(2) UNIDO, 1989, Statistical Annex.
(3) UNIDO, 1991, Statistical Annex.

Table 4.8 Chemical Industry, 1987; Certain Countries Percent of Manufacturing Value Added

Country	ISIC Category 351 (A)	352 (B)	Total A+B	353 (C)	Total A+B+C
Australia	2.9	4.1	7.0	0.9	7.9
Taiwan	3.6	3.8	7.4	6.3	13.7
Turkey	4.5	3.7	8.2	14.0	22.1
Canada	3.2	5.2	8.4	2.6	11.0
South Korea	4.1	4.6	8.8	3.5	12.3
France	5.9	3.1	9.0	7.1	16.1
Japan	4.6	5.1	9.7	0.9	10.6
USA	4.9	5.1	10.1	1.4	11.5
Brazil	4.1	7.1	11.2	4.6	15.8
South Africa	**4.8**	**7.5**	**12.3**	**7.2**	**19.5**
Germany	7.4	5.2	12.6	4.3	16.9
Egypt	3.8	11.9	15.7	2.4	18.1

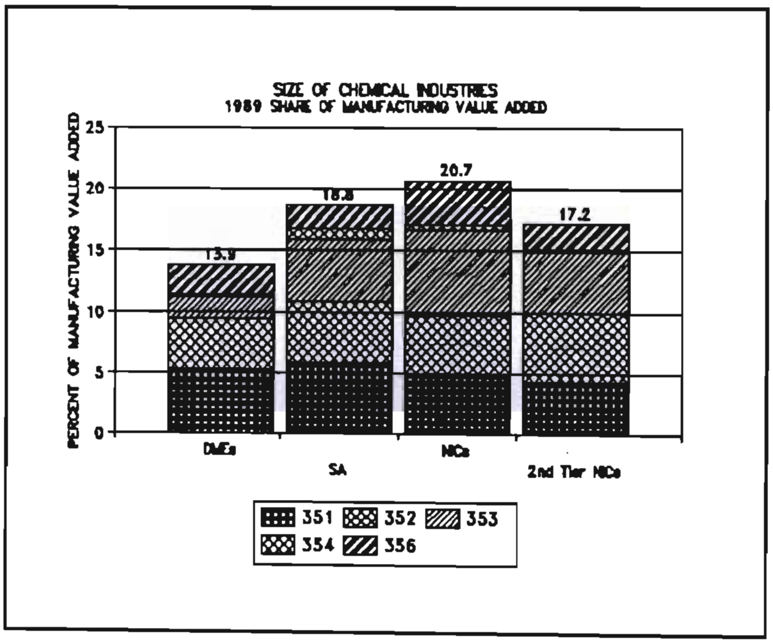
Source: UNIDO, 1989, Statistical Annex
Notes: ISIC 351 Industrial Chemicals
ISIC 352 Other Chemical Products
ISIC 353 Refineries

As a result of the massive investments in SASOL is it not the case that the chemicals industry is overdeveloped? In Figure 17 the size of the chemical industry in various sample groups of countries is compared, the evidence suggests that the local industry is not overdeveloped, falling as it does mid way between the NICs and the 2nd tier NICs. Given that the industry attracted 51% of all manufacturing investment over 1972-90[9], the industry's contribution to manufacturing value added, by the end of the 1980s was surprisingly modest (see Figure 17). This figure also shows that, at that time, the South African industry was not unusually large, given the country's stage of economic development. However the local chemical industry's share of manufacturing added was significantly larger in 1985 when just

9. Calculated from IDC, 1992.

three sectors (Basic Industrial Chemicals, Other Chemical Products and Refineries) accounted for 22.3% of MVA. This figure had reduced to 19.5% by 1987. This 'hump' in the mid 1980s is associated with both SASOL 2 and SASOL 3 reaching full production at the giant Secunda complex. It is tapering off as development in the rest of manufacturing takes place. Indeed it is partly the drying up of investment in other sectors (except basic metals) during the 1980s which exaggerates the chemical industry 'hump'.

Figure 17



NOTES:
351= Basic Industrial Chemicals
352= Other Chemical Products
353= Refineries synthesizers
354= Misc Prod of Petroleum & coal
356= Plastic Products
Source: UNIDO Industrial Statistics 1992

Conclusions

The recent history of the fertilizer and explosives industries reveal some common patterns. In both cases reduced levels of regulation and trade liberalisation was followed by a period of increased competition. This phase was in turn followed by concentration again and oligopolistic production. Such patterns of development are both shaped by and instrumental in shaping corporate strategies. The analysis reveals the differing strategies pursued. In both industries AECI had been the long term major player. It vigorously defended its markets and in both cases it survived, although weakened, particularly in explosives as a result of international developments and strategy choices by its major international partner, ICI. Sentrachem chose to give way or to seek alternative means of survival rather than to tackle the two larger companies head on. In both cases SASOL was the major interloper, gaining market share from AECI and Sentrachem.

In plastic raw materials AECI was to some extent trapped by SASOL's control over its feedstocks and its own lack or strategy to escape that trap. The net result was that AECI again lost market power to SASOL.

Looked at from a different perspective, it is possible to argue that a partially privatised parastatal (SASOL), because of its large public funding, has been able to intervene in downstream markets and crowd out some of the private companies ensconced there. Both of these perspectives have validity and may be viewed as interconnected strands in the unfolding historical fabric.

During the 1980s South Africa had a comparatively large chemical industry which reached its peak in 1985 as a result of the SASOL synfuels projects. This peak was exaggerated by the drying up of investment in other manufacturing industries. The emergence of this peak was the result of a number of interrelated factors. From the mid 1970s to the late 1980s the state intervened in two important ways. It had state companies build a series of mega-projects using local feedstocks that were unlikely to have been considered if only commercial considerations had applied. Secondly state policy, in the form of encouragement and the tax regime, influenced private companies to follow ISI/ military/strategic type investments. The result of the extension of ISI into military/strategic policies is a uniquely coal based petrochemical industry with technology and a cost structure quite different from its international competitors.

The effect of these interventions was to turn the petrochemical industry away from crude oil based feedstocks to coal and in the case of Mossgas to turn potential gas based petrochemicals into lower value petrol instead. In short they have denied the petrochemical industry the possibility of keeping up with world trends in feedstock competitiveness which is all important in petrochemicals. These major developments cannot, unfortunately be undone. However, ironically, there are certain important and internationally competitive opportunities in petrochemicals. Subsequent chapters identify opportunities to optimise these whilst at the same time promoting the development of higher value added and more labour intensive industries.

Unless such state driven investments are continued, which appears unlikely, a return to investment upon a commercial basis may be expected. This is likely to result in the chemical industry accounting for a proportionally smaller share of manufacturing.

The evidence suggests that SASOL's Secunda complex has had a major, negative impact on capital productivity and capital labour ratios in the chemical industry to the point that it has affected the overall pattern of manufacturing growth. Its contribution to MVA did not nearly match its absorption of capital.

Another important impact associated with the SASOL developments is a unique reconstituting of the racial employment profile within the Industrial Chemicals sector, in that white employment levels gained at the expense of black employment levels. It appears this change is associated with skill needs and political strategic apartheid factors.

At the other end of the production chain the plastic products industry has had low capital labour ratios that have remained relatively constant as well as consistently higher value added output per Rand of capital stock. Unlike industrial chemicals the racial composition of the workforce has been stable.

During the period of active state military/strategic intervention an important restructuring of the chemical industry took place. The traditional pillars of the industry, agricultural and mining chemicals, were supplanted by plastic raw materials as the major sector of the industry. Accompanying this reordering of the major sectors in the chemical industry during the 1980s, has been a significant shift away from the employment of blacks to whites in Industrial Chemicals and Refineries. This has important implications for the training and education of black workers as well as labour relations in a democratic state.

CHAPTER 5

PETROCHEMICALS AND THE MISSING LINK

Introduction

The establishment of a coal based synfuels and chemical industry in pursuit of apartheid's policy goals had wide ranging effects upon the commodity plastics *filière*. In analysing this *filière* through the 1980s, the approach adopted here is to begin at the upstream end of the *filière* and to work downstream to the more elaborately manufactured goods and in the case of the plastic products industry, higher value added activities, closest to consumers. The commodity plastics *filière* divides conveniently into three links:-

* petrochemicals
* plastic raw materials
* plastic converting

This chapter is concerned with the first of these links, petrochemicals. Subsequent chapters deal with each of the other links in the chain.

SASOL's synfuels capacity replaced existing liquid fuels capacity in crude oil refineries and presumably replaced crude oil refining capacity that would otherwise have been built. Refinery products such as naphtha are typical feedstocks for petrochemical manufacture. However under apartheid, refinery capacity was closed and imported naphtha ran the same risk of embargo as crude oil. How then did the petrochemical sector fare in the new synfuel era of the 1980s? And how did it make the transition from crude oil based feedstock to coal based feedstock? What were the implications of this change? These are some of the central issues dealt with in this chapter.

SASOL became a monopolistic supplier of key petrochemicals (ethylene and propylene). Its regulation of the supply of these petrochemicals and the impact of its actions on the plastic raw material industry are analyzed. It is argued that SASOL's coal based production route created a 'missing link' in the production chain which made polymer tariffs the critical lynchpin of pricing in the commodity plastics *filière*.

It is further argued that the monopolistic and more capital intensive upstream end of the *filière* benefitted at the expense of the downstream end of the *filière*, with the result that higher value added production opportunities and job opportunities were foregone. This was partly a result of the pricing mechanisms which prevailed and which allowed SASOL to enjoy the benefits of olefin prices which were some 20% to 40% above world market prices.

The inextricable interlinkages between the synfuels sector and the petrochemical sector are exposed. It is suggested that policy measures aimed at improving the pricing structure which has emerged in the commodity plastics *filière*, could benefit from a reconsideration of the complex web of regulations which govern the liquid fuels industry. That is not the focus of this study.[1] Nevertheless a crude evaluation of this complex area is made in beginning the search for appropriate future policy for the petrochemical end of the commodity plastics *filière*.

Under any given set of conditions only a certain amount of profit can be made over the length of the plastics production chain. In this sense the input price of raw materials at one end and the output price of final products at the other end, could theoretically be regarded as fixed - that is the amount of value added over the length of the chain is fixed. The consequence, for the businesses which comprise the various links in the production chain, is that there is a continual struggle to structure the chain so that as much value is added at 'their' link in the chain as possible. This is a fundamental reason why vertical integration in the plastics *filière* has emerged internationally. The reasons for the failure of vertical integration to emerge at the upstream end in South Africa prior to 1994 are rooted in the history of its development. An attempt to untangle these issues is made in this chapter.

In the latter part of the 1980s SASOL, the key player in the domestic petrochemical industry, made a very significant change in strategic direction. The principal reasons for this are explained within the context of the changing political economy within which SASOL operated.

Before proceeding to the substance of this chapter the three links in South African commodity plastics *filière* are broadly described in order to provide a background for the more detailed analysis which follows.

The Petrochemicals and Plastics *Filière*: An Overview

The plastics production chain (*filière*) accounts for about 4% of GDP and employs about 40 000 people (Spindler, 1992). The plastics *filière* may be schematised as essentially three links or 'stages':

1. In 1992 and 1993 when the bulk of the research for this study was carried out data on the liquid fuels industry was still classified secret. Subsequently a considerable amount, but not all, has become available. A thorough analysis of this industry is still required.

1. the manufacture of petrochemicals, or olefins
2. the manufacture of synthetic resins and plastic raw materials (mostly comprising polymers)
3. the manufacture of plastic products

These are set out schematically in Table 5.1.

Table 5.1 Schematic Representation of Plastics *Filière*	
1. Olefins	Ethylene Propylene Benzene/styrene
2. Poylmers	Polyethylenes (LDPE, LLDPE, HDPE) Polypropylene (PP) Poly vinyl chloride (PVC) Polystyrene (PS)
3. Plastic Converters	Various processes eg.injection moulding, extrusion, blow moulding, vacuum forming etc.

The major petrochemicals (olefins) produced in South Africa are ethylene and propylene. SASOL has a virtual monopoly on the supply of these two crucial feedstocks. It is the only ethylene producer. Some propylene is manufactured at the SAPREF (crude oil) refinery in Durban in a splitter Sentrachem had built and some is imported through Richards Bay Bulk Storage, but SASOL is by far the largest local producer. The ethylene and propylene recovery facilities at Secunda are capital intensive processes employing very few employees.

Some benzene was produced locally but SASOL ceased styrene production in 1984. (Benzene is a precursor to styrene which in turn is the precursor to polystyrene.) The largest polystyrene facility (Sentrachem's Styrochem) was closed after import tariffs were removed in 1990. Strictly speaking benzene is an aromatic and not an olefin, however it is included in Table 5.1 for completeness sake. Local manufacture of polystyrene from styrene is very limited. Most polystyrene is imported.

Butadiene, the other olefin building block (precursor to synthetic rubber) is wholly imported following the closure of the Sasolburg naphtha crackers in 1981.

These businesses, like the next link in the chain, are 'high volume, low margin' type businesses whereas the plastic converting businesses are more diversified and can operate in more segmented markets. These facts contribute to the pressures for vertical integration in the *filiére*.

Plastic Raw Materials (Polymers) (ISIC 3513)

Polymers or plastic raw materials are manufactured in Secunda and Sasolburg drawing their major raw materials from the SASOL plants in Secunda. Ethylene (gas) is piped from SASOL in Secunda to the polymer plants in Sasolburg where Safripol makes HDPE and AECI manufacturers LDPE, LLDPE and PVC. Each firm has a monopoly. Internationally, high concentration ratios and oligopolistic behaviour are not unusual. The reasons for the emergence of this concentrated ownership structure are discussed further below as are the limitations it imposes upon international competitiveness and local economic development.

SASOL has since 1990 used most of the propylene it manufactures to make polypropylene (PP) on site in Secunda. Some is also supplied to Safripol in Sasolburg. SASOL's entry into the PP market ended Safripol's long standing domestic monopoly in the manufacture of this polymer.

Large volumes of plastic raw materials and polymers are imported resulting in a persistent trade deficit in these products with increasing import penetration to 1988 (IDC, Bylae D, 1990:8). Polymers, usually in powder or granular form, are sold to the converting industry which manufactures a wide range of plastic products the chief of which is packaging.

Plastic Converting Industry

Unlike the olefin and polymer industries the converter industry is highly fragmented and competitive. Several technologies are employed in this industry including injection moulding, extrusion, blow moulding, calendering, rotational moulding, extrusion of film and sheets, thermomoulding, thermoforming, laminating, casting, film casting and foaming. The plastic products industry has also had a persistent trade deficit. There is some vertical integration among the polymer producers and the converting industry. AECI shares ownership of a joint venture called DPI which produces PVC piping and building materials. Sentrachem owns Mega Plastics which is the largest and most diversified plastics converter in South Africa which has several large plastic converting operations producing beer crates, flexible piping and auto bumpers among others. A summary of the *filière* is provided in Table 5.2.

Under any given set of conditions only a certain amount of profit can be made over the length of the plastics production chain. In this sense the input price and the output price could theoretically be regarded as fixed. Consequently for the businesses that comprise the various links in the production chain, striving for greater profitability also means accumulating as much of the profit available in the production chain at their link in the chain. This is a fundamental reason why vertical integration in the plastics *filière* has emerged internationally. The reasons for the failure of vertical integration to emerge at the upstream end in South Africa are rooted in the history of its development. An attempt to untangle these issues is made in the following section.

Table 5.2. Petrochemicals and Plastics Industry Summary (1992)

	Monomer/Polymer suppliers	Converter companies	Comments
Investment (R mil)	5 000	15 000	1991/92 replacement values
Turnover	3 000	9 000	1991
Employees	2 000	37 500	Down 11% from 42 000 in 1990
No. of firms	3	+- 1 000	53 discontinuations, 37 new entrants

Source: Spindler, 1992

In so far as the proportion of value added at each link in the production chain is concerned, Table 5.3 suggests that, at least during the 1980s there was a progression in the extent of value added per Rand invested, down the production chain from Basic Industrial Chemicals to Plastic Products, in so far as these data categories are representative of the basic petrochemicals and plastic converting industries. This progression in value added down the production chain has an inverse relationship with capital intensity which is to be expected.

Table 5.3 Value Added in the South African Commodity Plastics *Filiére*[1]

	1972	1980	1985	1990
Basic Industrial Chemicals	.75	.28	.26	.28
Synthetic Resins and Plastic Raw Materials	.53	.91	.34	.38
Plastic Products	1.69	1.95	1.63	1.60
All Manufacturing	.87	.71	.54	.60

Source: IDC 1992.
Notes: 1. Value added = Value added per Rand of capital stock, 1990 Rands.

The evidence from these two tables strongly suggests that, of the three links in the commodity plastics *filiére*, the plastic converting industry is the most labour intensive and adds more value per unit of investment.

History of petrochemical production facilities and supply problems

SASOL was partially privatised in 1979 as SASOL 2 neared completion. This changed the nature of the relationship between SASOL and the other leading companies in South Africa in a very important way. SASOL ceased to be the helping hand of the state and supplier of much needed petrochemical raw materials. Overnight it became a competitor and a supplier of raw materials. Security of raw material supply (from the state) became strategic vulnerability to a competitor (newly privatised SASOL). This caused some private firms to follow rather different strategies than would otherwise have been the case, as has been recorded in the preceding chapter. Sentrachem for example has strenuously avoided reliance upon SASOL for feedstocks and intermediate inputs.

From the petrochemical production point of view SASOL 2 initially had mixed results. The small naphtha crackers in Sasolburg were shut down and replaced by ethylene produced in Secunda. This had the advantage, initially, of lower ethylene prices, and reduced fluctuations in the ethylene price. When the Sasolburg naphtha crackers were finally closed in 1982, ethylene prices fell to their lowest level since 1979 (AECI Annual Report, 1982). However there were a number of negative results of this switch to Secunda which have, for the most part, continued to impact upon the petrochemical industry since that time.

There was no replacement in Secunda for important petrochemicals such as propylene or butadiene or styrene which had been produced by the crackers. (SASOL continued to produce some styrene until 1984.) Thus imports of lower value added naphtha were replaced by imports of higher value added propylene, styrene and butadiene to make up for the loss of the locally produced building blocks.

Closing the naphtha crackers with their wider slate of petrochemicals skewed development towards a narrower slate of coal based chemicals. Thus all propylene had to be imported for several years and required investment in a special facility to do so. A small proportion is still imported. Styrene (for polystyrene) and butadiene (for rubber chemicals) manufacture had not recommenced by 1994.

Ethylene however, was too large and costly a business to switch to imports. Since 1982 SASOL has honoured an understanding that it would not compete downstream in polyethylene unless an alternate source of supply was domestically available (Interview, Marriot). Since no alternate ethylene sources have existed the possibility of vertical integration was denied. This disadvantage became increasingly important as domestic tariff barriers were lowered. Although SASOL honoured its 'undertaking' not to compete downstream with AECI, it was eager to do so if an alternate source of ethylene became available (Interview, Brand).

Not only was the slate narrowed but the supply also suffered. The Secunda ethylene capacity in 1982 was not much larger than that of the crackers it replaced so that by 1987 a shortage of ethylene had developed. Because domestic LDPE demand exceeded ethylene supply capacity in 1987, AECI had to import 25 000 tonnes of LDPE. SASOL, commanding the only potential source of ethylene, did not expand capacity despite the apparent annual consumption of ethylene growing by 5.4% p.a. over the 1978-1985 period (see Table 5.4). Due to ethylene shortages in 1988, AECI's LDPE/LLDPE operations were only able to operate at 76% capacity necessitating imports of over 40 000 tons of polymer (BTI, Report No.2932:5).

Table 5.4 Apparent Annual Consumption of Ethylene

	Metric Tonnes ('000)			Percent change p.a.		
	1978	1985	1990	78-90	78-85	85-90
LDPE	81	112	97]			
LLDPE	na	na	50]	5.09	4.74	5.59
HDPE	47	72	105	6.93	6.18	7.99
PVC a\	7	11	12	4.75	6.77	1.98
Total	135	194	264	5.76	5.36	6.31

Notes: a\ Ethylene based PVC consumption is assumed to be 35/150 of PVC consumption and the remainder carbide based. Ethylene is assumed to be 42% of ethylene based PVC volumes.

Source: Own calculations based upon Plastics Federation of SA Annual Reports

Apparently SASOL allowed ethylene demand to develop by way of imports, until such time as another tranche could be brought on stream at satisfactory capacity utilization. However from SASOL's point of view, as the sole supplier, scarcity could have been a useful argument to keep prices up. Indeed senior officials of some companies interviewed, who wish not to be identified, claim that SASOL continually attempted to convey the impression that it could not extract any more ethylene out of its system. Then just as the market became desperate, it would suddenly find a further tranche of ethylene.

Part of the ethylene supply problem may also have been the way in which SASOL perceived its role. Up until 1988 SASOL appears to have seen itself as a synfuel producer which coincidentally produced some petrochemical by-products. This changed when, for the first time in 1988, mention is made of a new "strategy of selective and horizontal and downstream diversifications in order to enter new markets and add greater value..." (SASOL Annual Report, 1988:5).

A number of other factors may have contributed to this change in strategy. In August 1985 a group of leading businessmen, led by Gavin Relly of Anglo American, travelled to Lusaka (Zambia) for a top level meeting with the ANC in exile. This may be seen as formal recognition by business of the ANC's important, if not central, role in the future of South Africa at that time. As pressure mounted on the apartheid regime long term planners in the business sector increasingly supported international calls advocating a 'negotiated settlement' with exiled forces.

The nature of SASOL's business activities requires long term time horizons. It is reasonable to assume that a large corporation like SASOL would have monitored these developments. Whatever the case it appears to have adopted a stance which recognised the importance of the props and supports for its business provided by the apartheid state. Whilst determined to cling to these supports for as long as possible it also had to develop a business strategy which would prepare it for their possible or even probable withdrawal. This kind of strategy would have gained added weight from the collapse of the oil price in 1986 and a lower prevailing price thereafter. This effect of lower oil prices is evident in the plunge in SASOL's 1987 sales compared to 1986 (see Table 5.5). At the same time SASOL's sales in real terms were only slightly above 1982 levels between 1987 and 1989.

Table 5.5 SASOL Turnover

Year	R mil Current	R mil 1985 Rands	Index 1985 Rands
1982	1 504	2 192	100
1983	1 501	1 946	89
1984	2 217	2 578	118
1985	3 166	3 166	144
1986	3 638	3 067	140
1987	3 109	2 258	103
1988	3 478	2 238	102
1989	4 094	2 296	105
1990	5 033	2 470	113

Source: SASOL Annual Reports

Returning to the question of ethylene shortages; these finally prompted SASOL to revamp one of the old Sasolburg (naphtha) crackers into a 100 000 tpa ethane cracker and ethylene recovery facility in 1988. The Secunda ethylene capacity was expanded by 30 000 tpa in late 1989. In 1991 a R115 million 90 000 tpa ethylene facility was commissioned at SASOL 3. The current total 405 000 tpa capacity is, for the first time, considerably in excess of current demand. Annual ethylene sales to the end of June 1992 were 297 000 tpa which represents a capacity utilization of 73% (SASOL Annual Report, 1992:15). Assuming a capacity utilization of 90%, then excess capacity is about 67 500 tpa. However a further obstacle to unimpeded supply exists. About 75% of the ethylene capacity is in Secunda whereas the downstream polymer plants are in Sasolburg. The pipeline used to transport the ethylene to Sasolburg restricts the volume of ethylene that can be piped to Sasolburg[2]. This problem would need to be overcome if a rapid expansion of production in Sasolburg was considered.

In addition to the vagaries of SASOL's capacity expansion timing, ethylene users have also had to contend with interrupted supplies. During 1989 fires at SASOL cut ethylene supplies to polymer users for lengthy periods. AECI lost 25 000 tonnes potential production (AECI Annual Report, 1989). The SASOL 3 fire, which caused 12 deaths, was a result of poor maintenance. At the subsequent inquest, the Secunda Magistrate found SASOL engineers negligent and SASOL 3 criminally liable (Inquest No. 19/91, 6-3-92). In the highly corrosive conditions of coal chemistry, proper uninterrupted supply requires costly maintenance to thousands of kilometres of pipe lines. This defence, offered by SASOL, was rejected by the Magistrate.

Given the pressure to reduce costs, maintenance costs have come under scrutiny. This is cause for concern as SASOL is constantly under pressure to reduce costs, an issue taken up below.

The 'missing link' and vertical integration

A critical consideration for the plastics industry is of course the price of ethylene. The price of ethylene can be influenced by the structure of the production chain within which it is produced. South Africa's ethylene production chain is unique in the world in that it has one less link than its oil and gas based competitors. Synthol reactors put the chemical molecules from coal back together again, but in new forms. SASOL regards them as their 'treasure chest' because they produce a wide range of useful chemical compounds. Among them are ethylene and propylene. This happens in one step, the crude oil refining and subsequent naphtha cracking stages are collapsed into one. By contrast crude oil must first be partly refined to naphtha and then in a second step naphtha must be cracked to olefins. The SASOL

2. Personal communication K. Pretorius, Sasolchem Marketing.

process does not have naphtha as a link in the chain: (see Figure 3).

The importance of this is fourfold. Firstly naphtha is an internationally traded commodity. This allows a state, such as South Korea for example, to use its control over the tariffs on imported naphtha to keep petrochemical prices down. Brazil set an international 'world price' for its naphtha.The other source of petrochemicals is natural gas. Natural gas prices can also be subjected to international competition as liquified natural gas (LNG) is also a globally traded commodity, like naphtha. Such instruments are not available to the state in South Africa. There is no 'world' price for impure ethylene generated from synfuels manufacture.

Secondly if polymer prices drop, there is in the South African case, less 'flexibility' upstream to absorb lower prices because of the 'missing link'. The first three steps in the SASOL process, mining, coal preparation and gasification of coal are essentially materials handling processes in which it is difficult to suddenly lower costs by increasing throughput. By contrast (and in its simplest form) it may only require an oil well valve to be opened wider to achieve greater throughput. In addition a naphtha cracker produces a slate of products. By cross subsidising products and 'managing' price changes (to the advantage of the firm) naphtha cracker operators have more flexibility in responding to price changes. SASOL on the other hand, has to look upstream for flexibility, either to coal gasification and synthesis operations or to coal mining itself. These areas do not lend themselves to this form of flexibility - it can really only come from improved productivity, which is presumably why SASOL has put so much effort into productivity schemes.

Thirdly, the recovery of ethylene from the hydrocarbon streams generated by the synfuels process, requires comparatively little extra investment. Because SASOL's ethylene arises almost automatically as a product of the synthol process, it is not necessary to invest in a high capital cost, say R3 billion, naphtha cracker to recover ethylene. This fact, ironically, gives SASOL an unexpected international competitive cost advantage in times of low prices. At these times survival depends upon low operating costs (depreciation is ignored). Under these circumstances the SASOL process allows the chemical side-streams to be produced at a low cost by international standards. Considered over the longer term this advantage continues to prevail as, in the words of a SASOL manager, 'SASOL is not a reinvestment industry'. In other words the original capital costs of the synfuel plants are regarded as 'sunk' costs.

Fourthly in synfuels plants chemical feedstocks are produced <u>before</u> petrol and petrol is made from them, whereas in a refinery it is the other way around, in the sense that naphtha must first be produced and then cracked to petrochemicals like ethylene and propylene.

The consequences of this 'missing link' for South Africa is that it is even more difficult for normal markets to operate and there is a correspondingly stronger case for industrial policy of some kind. Yet, ironically the potential exists for very low cost feedstock for the petrochemical industry.

The ownership structure which prevailed during the operation of the crackers was perpetuated when production shifted to Secunda and along with it the lack of vertical integration.

SASOL, the sole producer of ethylene, does not produce any polyethylenes whereas in propylene SASOL is vertically integrated having recently built a polypropylene facility. Sentrachem controls the other PP facility which is vertically integrated to its propylene splitter at the SAPREF refinery in Durban for a considerable proportion of its needs.

Ethylene prices

How has this peculiar process of ethylene production impacted on prices and how have SASOL's ethylene prices compared internationally? SASOL Technology Managing Director John Marriot believes South African ethylene prices are close to North West Europe (NWE) prices (Interview, Marriot). Safripol believe that ethylene prices are 'not unreasonable' in comparison with NWE prices. However AECI, the other major consumer of ethylene, believe them to be 20-35% above NWE and US prices.

A comparison of prices in Table 5.6 establishes that South African ethylene prices were about 47% higher than US prices and 22% higher than NWE prices over 1980-91. Given that ethylene prices are typically 50% to 60% of polyethylene prices this is a severe handicap for polymer producers and their customers in turn.

Is importing ethylene an alternative? Ethylene is cryogenic (see glossary) and has seen little international trade for that reason until the last few years. It is to all intents and purposes a 'non-tradeable' and this increases the difficulty of determining an appropriate price for ethylene in a small market with a single producer. This important question arose several times in a previous discussion concerning some Latin America and South East Asian petrochemical industries. What is the appropriate transfer price of a non tradeable commodity in a small economy? Such difficult public policy issues are among the reasons for a high level of state involvement in upstream petrochemicals in so many developing countries and some developed countries.

Table 5.6		ETHYLENE PRICE COMPARISON				
Year	Quarter	SA R/tonne	US R/tonne	SA/US (%)	NWE R/tonne	SA/NWE %
1980		794	377	210	568	140
1981		869	512	170	611	142
1982		866	466	186	612	141
1983		667	497	134	607	110
1984		841	618	136	755	111
1985		908	761	119	1118	81
1986		1079	780	138	919	117
1987		1190	673	177	900	132
1988		1564	1427	110	1168	134
1989		1783	1739	103	1576	113
1990	1	1760	1396	126	1364	129
	2	1760	1292	136	1359	130
	3	1760	1265	139	1543	114
	4	1844	1556	119	2195	84
Average 1990		1781	1377	129	1615	110
1991	1	1953	1396	140	1877	104
	2	1860	1140	163	1418	131
	3	1800	1035	174	1310	137
	4	1800	1181	152	1347	134
Average 1990		1853	1188	157	1488	127
Average 1980-91 (%)				147		122
Average 1990-91 (%)				144		120

Sources: Donaldson, Lufkin & Jenrette Securities, New York.
AECI
Sasolchem

In South Africa this problem was resolved by a formula linking the ethylene price to local polyethylene prices (SASOL Annual Report, 1992:15). This has been seen as a form of wealth sharing (Interview, Blackburn). The contracts are negotiated quarterly and if agreement is not reached then a fixed percentage derived from long term US and NWE prices operates for a further quarter while continued efforts are made to reach agreement.

This is a curious form of bargaining in which the seller has no alternative ethylene buyers and the purchasers no alternative source, and all of them monopolies in their own right in a closed market. As one polymer company representative put it, 'during the 1980s a lot of money was made by all parties'.

If ethylene prices are a function of polyethylene prices, what is it then that determines local polyethylene prices? Traditionally domestic polyethylene prices have been import parity prices.[3] Tariffs were ad valorem from the mid 1960s to the early 1980s at which point a reference price was added. The effect of a reference price is to create a floor price below which it is impossible to import, no matter how low the international price of polymer falls. This has been used to good effect by the DTI in claiming to lower tariffs whilst in fact

3. Import restrictions also existed for long periods.

increasing them. For example in 1991 PP ad valorem tariffs were cut from 20% to 10% but at the same time the reference price was increased from 93c/kg to R2.30/kg.

LDPE, the first polyethylene to be produced locally, enjoyed a 20% ad valorem tariff virtually from start up in 1965. This prevailed until 1983 when a reference price was added. The tariff structure was amended again in 1987, 1989 and 1990. The pattern is similar for HDPE, PVC and LLDPE. AECI bases its call for protection upon the cost of ethylene. If it had NWE ethylene prices it would accept only a 5% tariff (BTI, Verslag No. 3037:32). The Board of Trade and Industry have been sympathetic to AECI's case because:

> "Broadly considered, it must be concluded that the South African organic chemical industry did not develop under normal market conditions and that with reference to the raw materials a cost structure arose on a higher level than would have been the case under more normal conditions." (BTI, Verslag No. 3037:7, synopsis (only) is printed in English)

In short the domestic polymer price has been a function of the degree of tariff protection, which in turn has been determined as a result of the large producers lobbying the Board of Trade and Industry, which has been sympathetic to their cause, and who have determined tariffs accordingly. These reference price tariffs have set the local price of polymer. It is this reference price which is the critical lynchpin of pricing throughout the plastics chain as it works both upstream influencing ethylene prices and downstream influencing plastic converter's polymer input prices. Moreover since it is linked to imported prices it carries with it freight, insurance and wharfage costs all the way down the production chain and raising prices at each step.

So the state has in effect set the ethylene price by setting the polymer price. But instead of doing this directly as Korea did or as Brazil did and linking it to 'world' prices, it has gone through the charade of tariff hearings and allowed the three large companies to set (by means of the tariff) the local polymer price, but at higher than 'world' prices (as will be demonstrated below) and thus 'damming up' value added at the upstream end of the production chain. The division of spoils behind this 'dam' was left to the major companies to sort out amongst themselves. As it turns out they have agreed to share the risks and benefits, how fairly is known only to those party to these secret negotiations.

How rigorous has the state been in setting the polymer floor prices? The written reports of the Board of Trade and Industry are weak. They lack any rigorous analysis and rely heavily upon the submissions of the applicants for international price developments and information on the extent of plant competitiveness. They consider only nominal protection and not effective protection.

The capacity to influence government behind the scenes must have been important to these companies. Both SASOL and Sentrachem are historically off-shoots of state initiatives and AECI has also been successful in its appeals for tariff protection in the past, even over the heads of the plastic converting industry.

SASOL does offer ethylene at lower prices to polymer producers for the purposes of manufacturing polymer for export, however the details of this are not available. This lower ethylene price allows the polymer producers to compete on world markets. Even though SASOL's (indirect) export price of ethylene is lower, larger volumes would enable SASOL to achieve better plant capacity utilization rates, ie it is sold at marginal cost. The marginal ethylene price is the fuel/gas alternate value, that is the value it has to SASOL if it were put to the next most lucrative use - petrol. At 'fuel alternate value' (petrol) prices, SASOL's ethylene price is internationally competitive, somewhere between lower cost associated gas (see glossary) based producers and US prices.

The critical question then is, did SASOL need to sell its ethylene at such high prices? Could they not have sold it at lower prices?

Transfer Prices and Ethylene Opportunity Costs

What should the transfer price of this non tradeable commodity be when sold from one monopoly (SASOL) to two other monopolies (AECI and Sentrachem)? This section poses the question: what is the lowest price at which SASOL could have sold ethylene?

Firstly SASOL's basic cost structure is examined. SASOL's feedstock costs are rooted in coal mining. Unlike international petrochemical and polymer prices, SASOL's costs are not linked to the international crude oil price. Consequently when petrochemical feedstock prices are falling SASOL's are not necessarily following suit. Indeed they are subject to domestic inflationary pressures which in periods of low international oil prices, such as the early 1990s, oblige SASOL to indulge in dramatic cost cutting exercises. For example some 2 500 employees were retrenched in mid 1992. The SASOL 1992 Annual Report is littered with comments such as "further rationalisation and restructuring in order to reduce operating costs..."(p3).

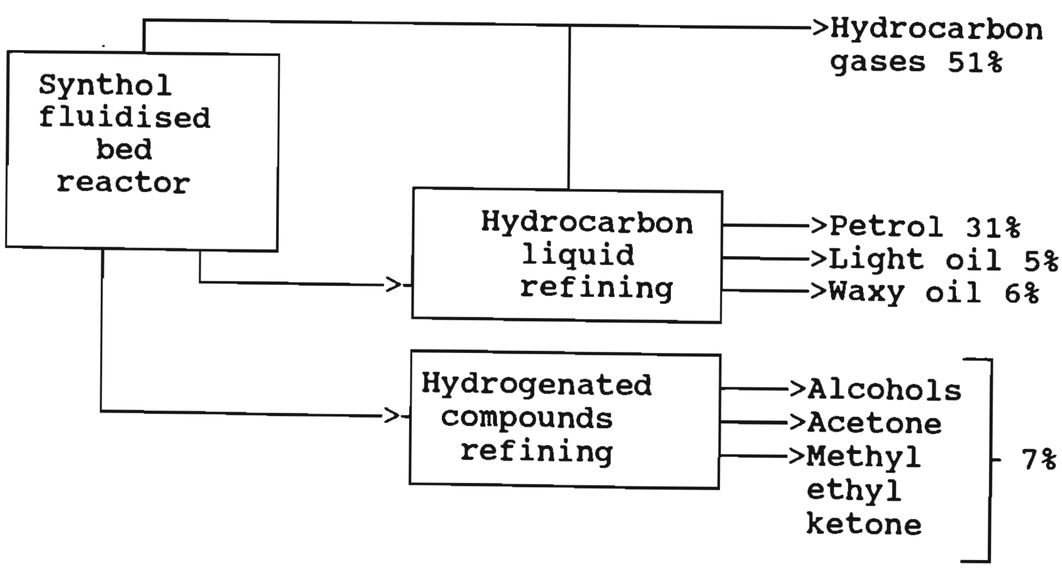
The point is that it is not easy for SASOL to arrange domestic input price fluctuations to follow the international oil price. Equally there is a limit to which cost cutting measures can proceed. The SASOL 1988 Annual Report comments:

> "Although good results were achieved in the past in keeping cost escalation below the inflation rate, *we have now reached a temporary plateau.*" (my emphasis) p1.

On the other hand it must be borne in mind that SASOL has the advantage of being vertically integrated in so far as coal feedstocks are concerned. These costs are very low and their coal mining is among the most efficient in the world. The recent commissioning of SASOL's Syferfontein strip mine will further lower coal mining costs. However as has been noted in the discussion of the Coalplex coal-based PVC plant, the price rigidities and the lack of links in the production chain are the constraint for coal based producers and SASOL is no different in this regard. From SASOL's cost structure the discussion now moves on to the nature of SASOL's process and the resultant yield.

The production flow at SASOL 2 & 3 begins with coal mining. Mined coal is washed, fed to Lurgi gasifiers and reduced to gas. The emerging mixture of hydrogen, carbon monoxide and other gases is then purified and this purified gas mixture is fed into the synthol fluidised bed reactors where the hydrogen-carbon bonding takes place. The principal products yielded by the synthol reactor are shown in Figure 18. As Figure 18 shows, the largest

Figure 18. <u>The Principal Products from SASOL Synthol Reactors</u>
(in % by weight)



Source: Owen, 1983:184.

proportion of products by weight is hydrocarbon gases. These include 4% ethane (C_2H_6) the precursor to ethylene, 4% ethylene itself (C_2H_4), propane (C_3H_8) the precursor to propylene (C_3H_6), and 12% propylene itself and other gases (Bennet, 1990:266). To produce petrol the higher value gases are downgraded to lower value petrol. For example in July 1991 the domestic ethylene price was about R 1 860 per tonne whereas the 87 octane petrol price was only about R708 per tonne. Even by comparison with the lower US ethylene price of about R1140 per tonne, ethylene is more valuable than petrol to SASOL. As the SASOL's Managing Director Mr Paul Kruger has put it:

> "These feedstocks have a higher value than petrol and therefore the profitability of the venture is reduced by converting valuable chemicals to fuel." (Minutes of the Petrochemicals Industry Study Group, 10-4-89:3)

Herein lies the clue to SASOL's poor capital productivity. In producing fuel it is not adding value but subtracting value!

The nature of SASOL's operations is such that if the hydrocarbon gases emerging from the synthol reactor were not marketed as petrochemicals they could alternately be processed to petrol or industrial gas. What then is the value of petrol to SASOL and what is the value of industrial gas to SASOL?

Three considerations apply:

i) the opportunity cost of ethylene as petrol
ii) the opportunity cost of ethane as industrial gas
iii) the conversion/recovery costs of the ethylene and ethane

Each one is dealt with in turn, after the inner workings of the SASOL process are examined.

The simple comparisons of petrol and ethylene prices are, unfortunately, in the real world of chemical engineering, not quite so straightforward. The conversion of ethylene to petrol is not a simple one to one relationship, at least not all of it. Presently about half of SASOL's ethylene/ethane stream not sold as ethylene is processed through a catalytic-polymerisation unit which is an efficient conversion to fuel, so a straightforward conversion factor of 1 is assumed. The remaining half follows a partial oxidation route with approximately a 0.45 conversion rate. Consequently if similar proportions are applied to the entire ethylene/ethane stream then the average conversion rate would be 0.75 suggesting that ethylene/ethane value as ethylene is, somewhat higher than expected, approximately 2.3 times that of petrol. This assumes zero conversion/recovery costs. The converse applies to the petrol alternate value for SASOL of its ethylene. In short SASOL could have sold ethylene a lot cheaper than it did.

A second source of ethylene is from ethane, piped from Secunda to SASOL 1 in Sasolburg, and then cracked in one of the converted old naphtha crackers. What is the opportunity cost of this unique light hydrocarbon/ethane feedstock? The alternative use for this ethane would be as industrial gas. SASOL Oil, trading as Gascor, operates an extensive industrial gas pipeline network in the PWV region supplying energy to industry. At September 1992 prices ethane's alternate value (as industrial gas) was about R917 per ton (see Annexure A), about one half the value of ethylene. Against this measure then the price of ethylene could be halved, excluding the extraction and recovery costs. One implication of these calculations is that as the market grows with economic development and if SASOL is relieved of its fuel obligations, it could become more profitable for SASOL to sell gas and petrochemicals, rather than petrol. The difficult question arising from this which requires investigation is how much synfuel would SASOL have to continue to produce in order to simultaneously produce chemicals?

Extraction and recovery costs of ethylene are very difficult to gauge without access to SASOL's internal finances. Safripol Managing Director D. Blackburn believes that despite all three of SASOL's ethylene facilities being less than half the size of a world scale (500 000 tpa) cracker they are competitive as the feedstock arises as a matter of course (Interview, Blackburn). That is once the SASOL plants were operating it was comparatively capital cost effective to extract ethylene. The authoritative Oil & Gas Journal reports that:

> "..at small additional cost, the ethylene and propylene can be extracted and purified to standard polymer-grade feedstock." (Oil & Gas Journal, 20-1-92:53)[4]

The unique feedstocks used are by-products integral to the synthol process so there is no easy international comparison to make here to judge the competitiveness of this ethylene recovery. What is known is that the recovery/conversion costs could be reduced by virtue of a market for any methane by-product through Gascor's network. Equally this feedstock stream should bear its share of the synfuel capital and operating costs. Apportioning a share is very difficult

4. Based upon a paper presented by SASOL scientists at the Achema 91 Conference, June 9-15, 1991, Frankfurt.

if not impossible.

In summary, thus far it has been established that SASOL's ethane/ethylene stream is worth more to it as ethylene than as petrol. The next question then is, if SASOL had sold its ethylene at the alternate value, petrol, how would this selling price compare with international ethylene prices? For the time being the import parity price, known as the In Bond Landed Cost (IBLC) will be accepted as the value of petrol to SASOL. This is the price the oil marketing companies pay SASOL for its petrol which they market.

A comparison of South African petrol prices and US ethylene prices in Table 5.7 shows that South African petrol is on average cheaper than US ethylene by about 80% over the 1982-90 period. Consequently if SASOL had sold ethylene at its 'fuel alternate value' it would have been providing ethylene at an extremely competitive price internationally.

Table 5.7 Comparison: RSA Petrol and International Ethylene Prices

YEAR	MTH	Ethylene US Gulf R/TONNE (A)	RSA PETROL R/TONNE (1) (B)	(A)/(B) (%)
1982		466	415	112
1983		497	381	131
1984		618	480	129
1985		761	703	108
1986		780	463	168
1987		673	399	169
1988		1427	405	353
1989		1739	568	306
1990	JAN	1368	569	240
	FEB	1368	588	233
	MAR	1368	622	220
	APR	1311	637	206
	MAY	1311	608	216
	JUN	1254	561	223
	JUL	1245	568	219
	AUG	1219	1102	111
	SEP	1330	1050	127
	OCT	1488	1039	143
	NOV	1587	827	192
	DEC	1592	779	204
	AVE	1379	746	185
1991	JAN	1499	783	191
	FEB	1373	727	189
	MAR	1315	610	215
	APR	1177	624	189
	MAY	1139	673	169
	JUN	1104	741	149
	JUL	1047	708	148
			Average 1982-90	184
			Average 1990-91	182

Notes: 1. The 'fuel alternate value' is the In Bond Landed Cost of 87 Octane petrol, the price paid to SASOL for such product.

Sources: Donaldson, Lufkin & Jenrette Securities, New York., Shell SA (Pty) Ltd.

Propylene supplies and prices

Propylene is the other major feedstock in the South African commodity plastics chain. The history of propylene supplies, or rather the lack of them, must rank as one of the more extraordinary parts of South Africa's petrochemical history. From the time the Sasolburg naphtha crackers were closed and replaced by production from Secunda in 1981, no propylene was produced by SASOL until 1990 when they commissioned a 150 000 tpa facility at Secunda. This failure by SASOL to produce propylene occurred despite a relative abundance of propylene in SASOL's system and the fact that propylene can be extracted very economically at the 'fuel alternative value', according to SASOL Polymers Managing Director Brand, (Interview, Brand).

In so far as SASOL's relatively abundant supplies of propylene are concerned, it is known that the synthol reactors yield about 12% propylene. This yield is significant in that international competitors using naphtha feedstock typically get a 2:1 ethylene/propylene yield. Yet at SASOL, if ethane is included, the ethylene/propylene yield is about 1:1.5.

The low cost of SASOL's propylene may be judged, as in ethylene, by assuming that the cost of propylene to SASOL is its 'fuel alternate value' and comparing it to an international benchmark propylene price (see Table 5.8). This evidence suggests that SASOL's propylene costs (at the 'fuel alternate value') were under 70% of US Gulf propylene costs.

Good commercial reasons also existed which ought to have enticed SASOL into propylene production. Propylene is the precursor to polypropylene (PP) which is a C_3 polymer as opposed to polyethylenes which are C_2 polymers. The additional carbon atom and the chemical structure of PP make it a more versatile and desirable polymer. It has greater tensile strength and is stiffer than high density polyethylene. Its tensile strength is sufficient to allow it to be used in textile applications.

Despite these considerations, for almost a decade SASOL produced no propylene. The reasons for this are not known but since propylene is also a constituent of petrol, it seems plausible that SASOL saw its priorities in petrol rather than chemicals. Whatever the reason, SASOL must have changed its view in about 1987 or 1988, in order to bring its propylene plant on stream by 1990. This follows immediately after a period during which propylene was more valuable than ethylene, which may have influenced the decision. At the time SASOL was not to know that ethylene would by 1989 have established its traditional price relationship to propylene. This propylene plant decision also coincides with the announcement of the new value adding strategy in the 1988 Annual Report, quoted earlier.

Table 5.8 Comparison: SASOL's 'Fuel Alternate Value' and US Gulf Propylene Prices

Year	FUEL ALTERNATE VALUE(1) R/TONNE (A)	Propylene P'mer grade US Gulf R/TONNE (B)	(A)/(B) (%)
1982	415	550	75
1983	381	466	82
1984	480	618	78
1985	703	822	86
1986	463	614	75
1987	399	731	55
1988	405	1036	39
1989	568	1196	48
1990 JAN	569	841	68
FEB	588	886	66
MAR	622	855	73
APR	637	883	72
MAY	608	886	69
JUN	561	912	62
JUL	568	959	59
AUG	1102	935	118
SEP	1050	1047	100
OCT	1039	1205	86
NOV	827	1362	61
DEC	779	1366	57
1990 AVE	746	1015	74
1991 JAN	783	1242	63
FEB	727	1230	59
MAR	610	1196	51
APR	624	1177	53
MAY	673	1139	59
JUN	741	1104	67
JUL	708	1015	70
Average 1982-90	507	783	68
Average 1990-91	727	1065	69

Note: 1. The 'fuel alternate value' is the In Bond Landed Cost of 87 Octane petrol, the price paid to SASOL for such product.

Sources: Donaldson, Lufkin & Jenrette Securities, New York.
Shell SA (Pty) Ltd.

Part of the reason for selecting propylene is probably to be found in the global restructuring of the industry which occurred following the recession in the early 1980s. At that point considerable cracker capacity was shut down. As was observed in an earlier chapter, propylene is a by-product of naphtha cracking whether desired or not, and for this reason traditionally had a lower price than ethylene. However as a result of the closure of cracker capacity and its substitution by gas based capacity (which lacked propylene co-product), a shortage of propylene occurred driving up the price of polypropylene. This period of higher priced propylene occurred at about the same time SASOL must have been considering extracting propylene.

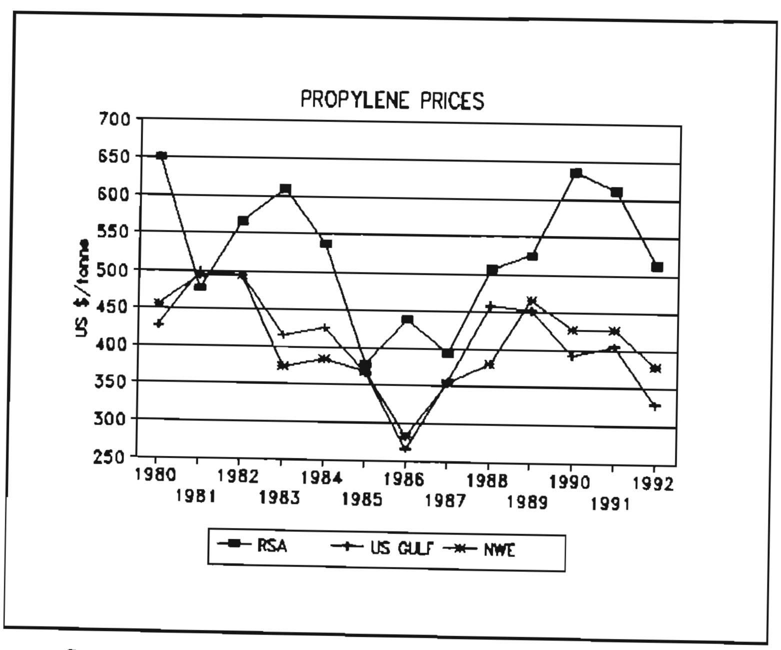
Through the mid 1980s the Sentrachem annual reports regularly refer to the local propylene supply shortage. It accordingly adopted two strategies to relieve this shortage.

The first was to import supplementary quantities through Richards Bay Bulk Storage[1]. The second was to boost local supplies. A small facility to supply refinery propylene was built by Sentrachem in 1991 at the SAPREF refinery in Durban. This facility has only 30 000 tpa capacity, but this is sufficient to supply 60% of Safripol's needs which are supplemented by imports and supplies from SASOL.

This move by Sentrachem is typical of its attempts to avoid dependence upon SASOL for feedstocks. It must also be borne in mind that SASOL had begun to compete with Safripol in the manufacture of PP. There may also be cost advantages to Sentrachem of vertical integration in so far as its propylene supplies are concerned despite the fact that these supplies have to be moved a longer distance (from Durban to Sasolburg), than if they were sourced in Secunda.

The recent propylene price history is reflected in Figure 19. It reveals that for most of the period between 1980 and 1990 domestic propylene prices exceeded the US and NWE prices for most of this period, indeed by an annual average of 29% over the 1980-92 period in both cases.

Figure 19



Source: Safripol

1. A joint venture between Sentrachem, AECI and Rennies, a local shipping and transport company.

Following the propylene drought during the 1980s the future looks comparatively rosy. Estimates of SASOL's untapped propylene supplies range between 250 000 tpa and 450 000 tpa[6]. Refineries, another potential source of further propylene, are undergoing a phase of expansions in the early 1990s which also augurs well for propylene supplies.

Petrol Prices and SASOL's Profits

Thus far this study has assumed the (fuel alternate value) IBLC petrol price to be the alternate value for SASOL's petrochemicals (olefins). This is not strictly true. The price which SASOL is paid for its synfuels is built up through the application of a complex web of regulations governing the liquid fuels industry which makes the value of petrol to SASOL higher than the coastal import parity price (IBLC). The chief of these, price inflating, elements are set out, very briefly, below. (They are explored in more detail together with some of the criticisms and rebuttals applicable in each case under the appropriate headings in Annexure B.)

Firstly the IBLC is a theoretical cost of imported petrol at the coast and acts as a form of 'tariff' protection estimated to be equivalent to about 10%. This has been criticised as being too high and indeed the National Economic Forum's Liquid Fuels Industry Task Force did negotiate a reduction in mid 1994.

Secondly the import parity principle is extended to the movement of product inland to Secunda. This means that SASOL is also entitled to an 'inland transport allowance', which is added on to the IBLC. This is the theoretical cost of piping petroleum products inland, which of course is not done for synfuel production. SASOL argue that this is their natural locational advantage. The amount of this 'inland transport allowance' is also in dispute. Petronet pipeline charges are deemed to be excessive which also acts to SASOL's advantage.

Thirdly SASOL enjoys 'tariff protection' (comprised of levies on the retail petrol price via the Equalisation Fund) which has provided SASOL with a guaranteed floor price at a crude oil equivalent of $23/barrel for its petrol output.

If it is accepted that this web of regulations inflates the value to SASOL of petrol then it follows, hypothetically at least, that if these regulations were removed the value to SASOL of petrol would drop substantially. This would increase the incentive for SASOL to produce higher value chemicals instead of liquid fuels. If regulations such as the IBLC and the inland

6. P Lloyd, petrochemical consultant and own calculations.

transport cost charges were lowered then the alternate value of olefins as fuel would drop by a corresponding amount. Consequently it is within the power of the state - as the body responsible for the liquid fuels regulatory regime - to lower the cost of major raw material inputs into the commodity plastics *filière* by adjusting downwards regulations governing the value to SASOL of its synfuels. Such a reduction would of course impact on SASOL's finances and profitability. A question which then arises is how reliant is SASOL upon its regulatory supports and could it survive deregulation of the liquid fuels industry?

According to Davie (1991c:13) these regulatory supports were worth R927 million to SASOL in 1991 which is close to its profit of R 1bn in that year. Detailed calculations by another source (hereinafter X) show SASOL's benefit was R1.9bn in 1991, almost double SASOL's after tax income in that year.[7] In this case SASOL would have been cash negative without regulatory support.

If the latter is true and .71% of GDP went to support SASOL as part of a total of R3.8bn (1.42% of GDP), in payments to the liquid fuels industry, then there is an urgent need for the veil of secrecy to be removed so that properly informed and more equitable regulations may be devised.

The somewhat alarming picture which emerges from Davie's and another calculation by X, has to be tempered by the knowledge that the year in which these calculations were made was also the year in which anticipation of the Gulf War was associated with a steep rise in oil prices. Benchmark Brent crude oil prices leapt from about $18-20 per barrel to almost $42 per barrel in the latter half of 1990 before falling back to previous levels in early 1991. This in turn would have raised the IBLC and caused SASOL's sales and profits to rocket upwards which they did. SASOL's turnover in 1991 rose 50.2% above the 1990 turnover and attributable profits rose by almost 40%! (SASOL's financial year end is mid year).

A year later, at the end of 1992, a stockbroking analyst calculated that the value to SASOL of only the 10% tariff protection was R440 million in 1992 and a similar amount in 1990 (Tison, 1992). He argues that SASOL has very good prospects "even after stripping out the subsidy" (Tison, 1992b:14). Former Minister of Mineral & Energy Affairs, George Bartlett, answering a question in parliament in March 1993, said that the total tariff protection given to SASOL in the 1991/92 financial year had been R 537.5 million against SASOL's attributable income for the year end to June 1992 of R1.1bn (Business Day, 11-3-93). In the previous year he claimed the tariff protection given to SASOL was R 222.5 million (Ibid).

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7. This source wishes to remain confidential due to the sensitive nature of the information and the secrecy legislation which prevailed at the time it was made available.

Recently another set of figures has been made available by the Department of Mineral and Energy Affairs for SASOL's 'tariff protection', just one of the three elements in SASOL's support system (see Table 5.9). It should be noted that isolating the 'tariff protection' in this way yields the most conservative estimate of SASOL's subsidy. The discrepancies between the Department of Mineral & Energy Affairs (DMEA) figures and some of the others may be partly attributable to inclusion or exclusion of other elements of SASOL's subsidy such as the 'inflated' IBLC and the locational advantage. Although the figures provided differ from source to source, all of them are substantial as is revealed by comparing the 'tariff protection' with the GDP.

Table 5.9 SASOL's Tariff Protection

Financial Year	Protection R million	Tariff Protection as % of IBLC	Protection as % of GDP a\
1989/90	479.5	21.1%	0.19%
1990/91	223.3	7.2%	0.08%
1991/92	538.7	18.7%	0.17%
1992/93	629.9	20.5%	0.19%
1993/94	1062.9	32.0%	0.28%

Sources: Department of Mineral & Energy Affairs
South African Reserve Bank, 1994:b-5.

Note: a\ GDP figures used are for the first of the two years mentioned in the first column.

Deregulation of the liquid fuels industry would clearly have a major impact on SASOL. On the other hand SASOL has been the most profitable chemical company among Fortune Magazine's 'Fortune 500' and it does have the protection of the declining interest 'safety net' clause in the SASOL 3 claw-back agreement (see Annexure B). An exact answer would require a major calculation which lies beyond the scope of this study and which is not possible on the basis of available information.

An ancillary question which arises in the light of the massive public funding supporting synfuel operations, is would it not be in the public interest to simply close them?

A rough estimate of the costs associated with a closure of SASOL is provided in Annexure B. It appears from these calculations that the costs of closing SASOL would be about 1.1% of GDP. From a balance of payments point of view the impact would have been of the order of R3 billion p.a. in 1992 Rands.

These figures outweigh the extent of public support given to synfuels. However they do not preclude a reduction of such support which would appear to be in the public interest from the point of view of liquid fuel and commodity plastic prices.

A re-regulation of the oil industry with much greater transparency would also benefit SASOL. In 1992 SASOL's share price on the Johannesburg Stock Exchange was discounted because investors were concerned about its vulnerability to deregulation (Tison, 1992). SASOL's image is also suffering because whenever it encounters competition it tends to face accusations of unfair competition and of using its fuel 'subsidy' to cross subsidise other business.[8] A prerequisite for all of the above is a complete lifting of all of the veils of secrecy that hang over SASOL and the oil industry. Thereafter, access to SASOL's inner financial workings will be necessary to determine if transfer pricing has taken place. SASOL remains a partially privatised business which means that the issue of confidentiality around information effecting its competitive position arises.

If SASOL wishes to silence its critics on the question of transfer pricing it will have to find a widely acceptable process of doing so without compromising its innermost business secrets.

The threat of deregulating the liquid fuel industry and its impact upon the petrochemical industry

There has been an increasing clamour in sections of the commercial press for the deregulation of the liquid fuel industry. The influential Automobile Association has also added its weight to the cry (see Automobile Association, 1992). The government carried out an extensive (but unpublished) study of the regulation of the oil industry in 1990 which found no reason to change (Davie, 1991b:17). Subsequently the government has begun to reconsider such issues and has commenced another investigation into deregulation of the fuel industry (Business Day, 23-9-92:7). A number of other signs make some form of deregulation a plausible option within the next few years. These include statements by oil companies and the progressive collapse of economic sanctions against South Africa. However SASOL Executive Director, Du Toit, has claimed that the National Party government has given SASOL an undertaking that 'tariff protection' will be kept in place until the end of 1995 (Business Day, 29-7-92:7) so it seems that at least that aspect will remain in place until 1996 unless the 1994 Government of National Unity can find a way of extracting itself from this undertaking

8. SASOL's attempts to break into coal exports through Richards Bay have led SA coal industry executives to accuse SASOL of using its fuel subsidies to boost exports. (Financial Times International Coal Report, quoted in Business Times 21-12-92:3). Similar accusations have been made in respect of its chemical businesses.

without compromising investor confidence.

SASOL no doubt considered these demands for deregulation. From SASOL's point of view, if the liquid fuels industry was deregulated this could lead to lower liquid fuel prices. Then, as has been argued above, the price of olefins should theoretically fall thus reducing SASOL's revenue. Is this likely? Representatives of SFF and CEF believe this to be the case (Interview, van Zyl & Roberts). Since the value of SASOL's sales would drop one might reasonably expect it to attempt to compensate for this by raising its olefin prices.

There is an opposing view which differs from the preceding orthodox view. It argues that fuel industry deregulation will not necessarily result in lower liquid fuel prices. It is possible, depending upon the nature and extent of the deregulation, that liquid fuel prices might rise because a legal cartel has operated for many years and the habit may prove difficult to break. South Africa also lacks any independent 'maverick' type refinery which could assist in keeping prices down.

As has been pointed out earlier, olefin prices have been largely a function of the import parity prices of polymer which have been fed back upstream. Import parity prices are in turn a function of the applicable tariff. At the same time polymer tariffs were under pressure from South Africa's participation in the Uruguay Round of the GATT negotiations.

Consequently two key props of SASOL's revenue were under threat; the value (to SASOL) of liquid fuels and polymer prices (under threat of tariff protection).

These two threats (liquid fuel deregulation and tariff reduction) also challenged SASOL in a third area in the early 1990s. At this time it was busy with a spate of wide ranging, large investments, most of which were being funded by cash flow. This might have forced SASOL to fund these projects from more conventional sources (debt and share capital) thus possibly making them less attractive projects. These projects were at different stages of implementation and depending upon the time at which the two threats might be realised, these projects could be severely compromised. Furthermore if these investments dried up the lack of investment might encourage the government to take a closer look at the petrochemical industry which might have limited SASOL's room to manoeuvre in some way. SASOL faced something of a vicious circle of threats.

Overriding all of these uncertainties of course was the political uncertainty; would South Africa make the transition to some form of democracy and what sort of government might this yield?

One obvious option for SASOL was to follow international precedent and forward integrate downstream into polymer production. However SASOL faced a constraint down this path, its historical undertaking to AECI not to compete with AECI until an alternative source of olefins was available. There was no apparent prospect for this on the Highveld in the early 1990s. Whatever strategy SASOL chose it seemed inextricably tied to AECI.

SASOL did find an ingenious solution to its problems which commenced in 1994. However before analysing this solution, it is helpful to proceed to an examination of the next link in the chain, the polymer manufacturing industry, and to determine what forces and imperatives were brewing there which may also have contributed to this ingenious solution. This is the subject of the next chapter.

Conclusions

State encouragement and intervention in the petrochemical industry has steered the industry away from conventional crude oil based feedstocks towards reliance upon coal based feedstocks to a very large extent. State policy has placed a priority on self sufficiency in meeting liquid fuel needs and this has taken preference over higher value added chemicals which could have been produced instead. These induced chemical shortages resulted in larger imports. (Chemical industry trade is discussed in a subsequent chapter). Similarly the slate of petrochemicals available was narrowed as a result of state intervention. Coal based production lacks the ability of oil based petrochemical production to pass lower prices upstream. Consequently SASOL is likely to remain under continued pressure to reduce operating costs. The new Syferfontein strip mine will assist in lowering coal costs but it is likely that the brunt of this pressure will continue to be targeted at increasing production productivities. This is already a wide ranging initiative and is likely to remain so. Redundancies are likely to continue especially among lower skilled production workers. Pressure to reduce operating costs cast doubts upon the extent to which spending on health, safety can be made and to which real wages can be improved.

The 'missing link' in the production chain has removed the ability of the state to regulate petrochemical prices by adjusting the tariff on imported naphtha as was done in South Korea. Because of the lack of vertical integration, and the 'missing link' in the production chain, the nature of the transfer pricing mechanism between the upper links has been crucial in determining prices for the commodity plastics production chain.

The regulation of this crucial link in the chain has been left to the private sector who have met to settle the transfer price in a rather peculiar negotiating forum where there are no alternate buyers or sellers. The results of these negotiations were buoyed up by the tariff reference price set by the state.

State self sufficiency policy objectives, a weak state apparatus responsible for fixing polymer floor prices, and powerful companies having access to government's ear, have resulted in ethylene prices above world prices. Both ethylene and propylene prices have been well above their 'fuel alternate value'.

The inability of market forces to set optimum prices has even been acknowledged by the conservative Working Group:

> "It is questionable whether market forces alone will achieve the necessary objectives, as the circumstances in the upstream end do not comply with the conditions for a perfectly competitive market. This is because there are only a few major companies involved and the mega scale of operations represents a formidable barrier to entry into the industry." (Department of Trade and Industry, 1990:31)

They go further to recommend that "a coordinated overall industrial strategy" (p47) is needed. Although this appears an eminently sensible idea in the light of the foregoing discussion, unfortunately this has not been forthcoming from the Working Group. To some extent this study attempts to redress this failure. Ideally an integrated study of the entire field of petrochemicals with its many and complex interrelationships is necessary. This unfortunately is beyond the scope of this study.

Indeed if the results are measured against apartheid's public policy objectives then the results were reasonable under the circumstances. Measured from the point of view of economic and petrochemical industry development the reverse is the case. SASOL did not give petrochemicals priority and supply suffered in the process.

In 1988 SASOL made a very significant change in strategic direction away from concentrating on synfuels provision and towards diversification and value adding strategies, which they have subsequently continued to pursue. It has been argued that the pressures for this change in direction are to be found in principally three areas: the changing political environment, threats to the regulatory regime in the liquid fuels industry and in international pressure to reduce key tariffs through South Africa's admission to the GATT.

An appropriate re-regulation of the fuel industry could have a potentially beneficial effect on the price of olefins. In one sense the regime of support for the synfuels and oil industry does provide the state with an alternative to the missing link, in that it is a policy lever which the state could exercise to bring about a reduction in olefin prices, as well as petrol prices.

CHAPTER 6

THE PLASTIC RAW MATERIALS OR POLYMER INDUSTRY BEFORE 1994

Introduction

This chapter moves one step further down the production chain to what is effectively the second stage, the production of commodity polymers, the raw materials from which plastic goods are made. It commences with an overview of developments in this sector and then proceeds to show how historical developments in the upstream link of the chain have influenced developments in this section of the chain up until the start of 1994 when a new episode in the *filière's* history commences. This more recent episode is the subject of a later chapter.

The plastic raw materials industry is analyzed from three different perspectives; production, the capabilities of firms engaged in production and the demand, both international and local, for polymer. Attempts are made to explain the changes, or lack of them, which occur over time and how these shaped the developments which occurred in 1994.

Finally the changing relationship between this link of the chain and the next, the plastic converting industry, is analyzed and international trends compared to the South African trends.

Industry overview

A striking characteristic of this sector of industry is its geographical location. All of the major production facilities are located on the Highveld, either at Sasolburg or Secunda. These facilities make PVC, LDPE, LLDPE, HDPE and PP. Some polystyrene is made in Cape Town from imported styrene for in-house purposes by Sun Packaging, and some is made by Sentrachem in Germiston near Johannesburg.

By contrast the major port and refining centre, Durban does not have a single commodity polymer facility. The reasons for this are historical. The first sources of olefins were from naphtha crackers located at Sasolburg and it made economic sense to locate the polymer plants near those crackers. Subsequently the second petrochemical complex, SASOL's Secunda complex was also located inland, immediately above its raw material source, the coal deposits of the Eastern Transvaal Highveld. In short the location of polymer manufacturing facilities has for the most part been determined by the location of the petrochemical feedstocks whose location in turn was a result of import substitution and military/strategic policies.

Outside of commodity polymers some petrochemical development has taken place at other centres. For example the AECI subsidiary South African Nylon Spinners has a nylon and polyester plant in Cape Town serving the large surrounding clothing industry. Hoechst also has a synthetic fibre plant in Cape Town. These plants rely on imported raw materials as it is cheaper to import by sea than to transport them from the Highveld to Cape Town (Lloyd 1991a).

Polymer manufacture has been highly concentrated. AECI has been the only producer of PVC, LDPE and LLDPE. Safripol has been the only producer of HDPE and was for a considerable period the only producer of PP until 1990 when SASOL also began to produce PP. Sentrachem was also the major producer of polystyrene (PS) until the removal of tariff protection in 1990 caused it to shut most of its Styrochem plant in 1991.[1]

This section of the petrochemical industry coincides with ISIC category 3513 (Synthetic resins & plastic raw materials, man-made fibres) and consequently some basic data is available to provide a general picture of developments in the industry. It is dominated by the polymer producers but there are also a few small producers of more exotic plastic raw materials. For example Solidur is a small producer of ultra high molecular weight polyethylene. These small facilities use much smaller scale and less capital intensive technologies.

In so far as capital productivity is concerned this capital intensive sector (ISIC 3513) does better than the manufacturing average over the longer term than over the shorter term. The capital productivity measure used here is the ratio of output to capital stock. This ratio declined over 1972-90 at an annual average of 1.2% p.a. which is about half the rate of decline for all manufacturing. Capital productivity (measured in this way) improves in the latter half of the 1980s but does not improve as fast as the all manufacturing average (+1.1% p.a. over the 1985-90 period, against +2% p.a.for all manufacturing[2]. In absolute terms the output/capital stock ratio is about 1.8:1, just below the manufacturing average, over the 1985-90 period.

Labour output growth has been superior to capital output growth in the plastic raw

1. There has been a peculiarity in the international polystyrene market in that on two occasions between 1983 and 1991 the price of polystyrene fell below the price of its precursor, styrene.

2. Calculated from IDC (1992) in 1990 prices.

materials industry. Output per employee increased on average by 3% p.a. over the period 1972-90, and by an average of 4% p.a. over the 1985-90 period, as against an average of 1% p.a. for all manufacturing (see Table 6.1.). Real labour costs over 1985-90 increased by the manufacturing average of 0.2% p.a. In broad terms this sector appears to have followed general trends in manufacturing in respect of the indices just considered. In summary this evidence reveals that labour productivity in the polymer industry improved faster than the all manufacturing average.

Table 6.1 Plastics industry: Output per employee
Annual Average Change (%)
(1990 Rands)

	Plastic raw materials (1)	Plastic Products (2)	All Manufacturing
Annual average change (%) 1972-90	3.1	-0.6	1.1
Annual average change (%) 1985-90	4.2	-0.5	1.1

Notes: (1) = Synthetic resins and plastic raw materials (ISIC 3513)
(2) = Other Plastic Products (ISIC 356)
Source: IDC, 1992.

With this overview in mind the discussion now moves down from the industry level to the level of the individual production facilities of each of the major commodity polymer producers in order to make an assessment of each. By way of an introductory guide the sizes of the commodity polymer plants and a proxy for their price competitiveness are summarised in Table 6.2.

In Chapter Four the history of PVC reached the point at which AECI and Sentrachem launched their Coalplex project at Sasolburg in 1967. This chapter takes up the developments from there. Table 6.3 provides an historical outline of the development of South African polymer manufacturers.

PVC Manufacture

In two adjoining sites, Midlands and Coalplex, AECI produced PVC in two plants using quite different technologies. These sites are to all intents and purposes one site. They comprise a horizontally integrated chemical complex producing not only PVC (a mixture of ethylene 42%, and chlorine) but also a variety of chemicals - caustic soda, chlorine, lime hydrate, and hydrochloric acid.

Table 6.2	Polymer Plant Comparison		
Plant[1]	Capacity (1991) tpa	'World Scale'[2] Capacity tpa	Price Competitiveness[3] USA (CDV) Price = 1 (1991)
HDPE	120 000	120 000 to 250 000	1.7
LDPE	90 000	200 000 to 500 000	1.6
LLDPE	100 000	120 000 to 250 000	1.6
PP (SASOL)	120 000	120 000 to 250 000	1.5
PP (Safripol)	52 000	120 000 to 250 000	1.5
PVC (acetylene)	125 000	n/a	1.7
PVC (ethylene)	35 000	150 000 to 500 000	1.7

Notes:

1. All of the plants are located in Sasolburg except the SASOL PP plant which is located in Secunda.
2. There is no widely held definition of 'World scale'. Capacities used here are estimates based on the views of firms interviewed and reported capacities of recently built plants and approximate to those used by Petrochemical Industry Study Group (see Chapter 10). These are somewhat higher than 'minimum world scale'(mws) estimated by Lloyd (1990a) based on a 25 percentile of 550 plants ranked by capacity. This would include some older plants which are likely to be smaller. His estimated mws for LDPE is about 130 000 tpa, for PP to be about 80 000 tpa and for PVC to be about 50 000 tpa.
3. Price Competitiveness reflects the selling prices in the US Gulf and South African markets and not the costs of production which producers regard as confidential. Prices are the average of 1991 prices.

Table 6.3 <u>History of South African Commodity Polymer Plants</u>

Date on stream	Polymer	Location	Original capacity tpa	1992 capacity tpa
1955	PVC	Durban	10 000	closed
1965	LDPE	Sasolburg	55 000	90 000
1965	PS	Germiston	4 000	closed
1966	PVC a\	Sasolburg	35 000	35 000
1967	PVC b\	Sasolburg	75 000	125 000
1972	HDPE	Sasolburg	48 000	140 000
1974	PP	Sasolburg	40 000	40 000
1982	LLDPE	Sasolburg	100 000	100 000
1990	PP	Secunda	120 000	132 000

Notes: a\ Ethylene route
b\ Carbide acetylene route

The newer and larger 125 000 tpa plant utilises 40 year old carbide-acetylene technology. This PVC technology fell into disuse in the USA in the 1960s (Spitz, 1988:407 & 412). Only two other such plants in the world continue to operate this technology. This plant was built in 1976 as a part of the Coalplex complex. Originally it had a nameplate capacity of 75 000 tpa which was expanded when it was 'de-bottlenecked' in 1988.

The acetylene based plant is also the more expensive of the two plants to operate (BTI, 1991:42). Yet AECI chose to expand their carbide/acetylene plant rather than the other lower cost ethylene based plant. There are several factors which may have contributed to this curious decision. At this time (1987/88) SASOL was unable to meet ethylene demand and AECI's polyethylene facilities were forced to operate at reduced capacity utilization. Prospects of further ethylene from SASOL may have looked poor because the premium placed on fuel production and self sufficiency had been underlined by the state's decision to go ahead with the Mossgas project in 1987. Also at this time SASOL and AECI were participating in a fertilizer price war with each other. All of these factors may have contributed to AECI's decision to expand the higher cost route. Whatever the reasons, this higher cost structure has insidiously crept into the cost structure of the petrochemical and plastics industry over the years.

Assessing the acetylene route is difficult as it operates as part of an integrated chemical complex producing caustic soda and chlorine by-products. Caustic soda consumption was growing rapidly at the start of Coalplex, more than doubling every 10 years. Indeed AECI's PVC business is 'caustic driven' (Interview, Lake). PVC manufacture is an accepted route of forward integration from chlor-alkali production (Spitz, 1988:397). To some extent caustic soda and PVC businesses are counter cyclical so they make a useful business combination. Disposing of chlorine is costly and in AECI's view PVC acts as one of the more environmentally friendly chlorine 'sinks'. The acetylene route to PVC involves physically aggressive conditions which have not been without industrial relations and other problems. Breakdowns have even caused AECI to import at times. Process difficulties, described as 'recurrent' and 'intermittent', plagued operations in 1990 and 1991 and reduced exports (AECI Annual Reports, 1990:12 & 1991:12).

Although not necessarily connected to the harsh operating conditions and plant breakdowns, some measure of the international competitiveness of this plant over the years is to be gleaned from the tariffs applicable. Virtually from start up import control existed, which amounted to a prohibition on PVC imports. This operated from 1977 until June 1990, although a proposal to remove it had been considered in 1983 (BTI, 1991:41).

Critics have claimed that South Africa's coal based PVC plants are probably three to four times more expensive than oil-based plants elsewhere in the world (Logichem Process MD, Schalk Pienaar, quoted in Business Day, 11-6-92:8). AECI claim that as far as production efficiencies in PVC manufacture are concerned they compare favourably with ICI.

South Africa liberalised its trade regime in the early 1980s but one of the last products to be affected was PVC. Import controls were replaced by ad valorem tariffs and a reference price only in 1990. Several adjustments have occurred since then. AECI consistently exported PVC virtually since start up. However for the first 13 years of Coalplex's life it exercised a monopoly in PVC in a closed market and its prices tend to reflect that. Under such circumstances it would be surprising to find a highly efficient producer at the end of that period.

AECI's other PVC plant is 10 years older and was built in 1966 using ethylene supplied by the SASOL naphtha cracker built at that time. It is a small 35 000 tpa ICI suspension polymerisation process and draws ethylene by pipeline from Secunda. It is very much smaller than world scale.

In all, seven grades of PVC are produced, 4 in one plant and three in the other. By contrast, a world scale plant would typically have half of one plant devoted to the production of a single grade and use the other half of the plant for four other grades. The disadvantage of a wide product range was off-set to some extent by a measure of vertical integration. AECI owned about half of the downstream of PVC converting capacity. Its plastic converting operations produced PVC piping, sheeting and building materials. As the only producer of PVC in a closed market its forward integration into converting was the source of some discomfort to its competitors who were denied access to PVC from other sources for many years because of trade barriers. As a result of rationalisation in the converting industry AECI has merged its interests with another firm to form a company called DPI which carries on this business.

By 1992 AECI had become concerned about the future prospects for its PVC plants and began to investigate possible investments in a new ethylene based facility.

The threat of tariff reductions nudged AECI into investigating an R800 million expansion to update to an internationally competitive technology (Finance Week, Sept. 17-32, 1992:59). Projections at that time were that exports of 100 000 tpa would be possible. This was about double the current level and about equal to domestic sales. AECI MD Mike Sander believed it would be a business "more than capable of taking on the rest of the world" (Ibid). These may be taken as signals that AECI was responding to the threat of competition from imports resulting from lower tariffs by investigating more efficient technologies. However the level of investment contemplated was somewhat out of character for AECI which was a very reluctant investor in the 1980s and 1990s. The division of ICI (one of AECI's two major shareholders) into two companies (discussed previously) and its reluctance to invest in commodity chemicals like PVC, further compounded the problem. AECI did find a way out of this difficult situation in 1994, at some cost to itself, but this is the subject of the next chapter.

AECI's interest in a new and more outward orientation may also account for its commitment to achieve ISO 9000 standards by 1993. Access to technology is always important even in mature businesses such as PVC. In this regard AECI has access to ICI technology which helps to keep R&D spending at less than 1% of turnover.

LDPE and LLDPE manufacture

LDPE is one of the older plastics, discovered by ICI in the 1930s. AECI brought South Africa's first LDPE plant on stream at the time the Sasolburg naphtha cracker first came on stream in 1965. It is still the only LDPE plant in South Africa and utilises ICI high pressure and energy intensive technology. The original 55 000 tpa capacity has been gradually expanded, notably with debottlenecking in the early 1980s to the current 90 000 tpa. Despite this it is sub world scale leading to higher unit costs of production. In the mid to late 1980s the plant began to be squeezed between two forces. On the one hand a major market, the fertilizer bag market shrunk from about 35 million bags to about 18-19 million as a result of the drop in domestic fertilizer consumption. On the other hand fixed costs were rising at about 20% p.a.. AECI has over the last five years or so tackled fixed costs across a wide front; reducing stocks, trying to improve efficiency, long term maintenance costs, working capital etc. to the point where fixed costs are now rising by only 10% p.a.

In so far as the future prospects of this plant are concerned, AECI believe that if they had 'world price' ethylene they would only need a 5-10% tariff protection. They do not believe that the plant is internationally competitive because of their ethylene cost disadvantage, low international prices and high capital costs. Consequently they did not intend investing for exports, other than for those countries accessible by road. Nevertheless the plant is about 80% depreciated thus removing a finance burden and directing attention to operating costs. Technology licence fees are no longer paid, instead there is a loose agreement with ICI. Capacity utilization has been 90-100% in the last 2 years. There are thus signs that in its remaining 10-15 year lifespan the plant could be a reasonably low cost producer if it has lower priced ethylene.

LLDPE is produced using a low pressure process developed by Union Carbide. AECI was one of the first companies to license this UNIPOL technology from Union Carbide, for their Sasolburg plant which came on stream in 1982. The technology is reputable, Union Carbide is one of the largest international LLDPE licensors. This 100 000 tpa plant is about half 'world scale' capacity but despite this it was capable of meeting twice the 1990 domestic demand. These limited economies of scale are estimated to bring a R75-R150/tonne premium to the polymer price (Interview, Baker). Intermittent production difficulties have necessitated imports at times (AECI and SASOL Annual Reports).

AECI believed, in 1992, that in terms of plant efficiency they were in the lower one third of plants in the world but hoped to move to the upper third by 1993. They anticipated improvements in labour productivity and catalyst yield. About 10-12 scientists have been researching improvements to catalysts for the LLDPE gas phase process at a cost of about R2 million p.a.. Catalysts are manufactured on site in an attempt to improve upon the catalysts commercially licensed by Union Carbide. Capacity utilization was just 70% in both 1990 and 1991, the highest yet achieved. It suggests that notwithstanding SASOL's lower 'export price' ethylene and GEIS benefits, exports were insufficiently rewarding to operate the balance of the capacity. Such a low capacity utilization level is disturbing as it must drive up unit output costs.

In summary low density polyethylene production comprises one old and one small plant (with erratic production) which have not been internationally competitive. Their prospects, in 1993, of becoming so appeared unlikely although current efforts to improve efficiencies may have made survival possible.

HDPE manufacture

Safripol commenced HDPE manufacture in 1972 at Sasolburg, drawing ethylene from SASOL's naphtha cracker there. Safripol is a Sentrachem/ Hoechst joint venture utilising Hoechst technology. Capacity gradually crept up from 48 000 tpa to 60 000 tpa by 1981 at which point new reactor technology was introduced. This brought capacity up to 80 000 tpa where it remained until 1990 when it was increased to 128 000 tpa. In 1992 it increased again to 140 000 tpa, and is scheduled to increase again to 160 000 tpa in 1994. The interval in these capacity expansions coincides with the restricted supply of ethylene available from

Secunda in the 1980s. Nevertheless Safripol experienced some difficulty in that as they expanded capacity, SASOL's ethylene production could not meet their needs. In the period prior to the 1990 expansion, Safripol could not meet domestic demand and had to import HDPE for this purpose, adversely effecting Sentrachem's finances. The 1990 capacity expansion replaced imports of about 20 000 tpa, a forex saving of about R 60 million at that time. Yet again the impact of military/strategic government policy is evident in the petrochemical based manufacturing economy.

Coordination between Safripol and SASOL in bringing new capacity on stream has improved in recent years and as SASOL has made more ethylene available, capacity has been expanded. Safripol's 140 000 tpa HDPE capacity is now one of the largest single HDPE sites in the Hoechst group. The reason for this is "The additional cost per installed ton is extremely low in world terms, making Safripol's production of HDPE very competitive" (Sentrachem Annual Report, 1989:11). Safripol's strategy is "...to grow the number of tons produced, specially because of our domestic inflation problem which leads to costs growing faster than prices, which are governed by world inflation." (Safripol MD quoted in Finance Week Survey, Sentrachem, 1992:46). This together with increased availability of ethylene from SASOL and improved product quality have allowed Safripol access to Hoechst's world export markets. This in turn is sharpening its focus on productivity and quality.

The technology used by Safripol is one of three basic types available. All are low pressure processes. Safripol use the Ziegler suspension process, named after the famous inventor of the catalysts, Carl Ziegler. It is a slow process with reactor residence times of 1.5 hours being common (Burdick & Leffler, 1990:285). It is this robust process which allows relatively cheap capacity expansions. Currently the lower cost producers use a gas phase process technology. The technology used by Safripol is licensed from Hoechst which is the world leader in HDPE. World scale R&D requires a critical mass beyond Safripol's resources, however it has access to Hoechst's extensive resources. New polymer grades developed for local conditions now account for about 15% of sales. Indeed 80% of sales is material 'fine tuned' to meet local conditions. Monthly reports to Hoechst Germany and a two way flow of key personnel assist in keeping Safripol abreast of world developments and standards.

In this way Safripol efficiencies of operation and yield rank midway in the Hoechst range of HDPE facilities although staffing levels could be considerably reduced if necessary, something Safripol is reluctant to do.

As in the case of other polymer manufacturers, Safripol efficiency is handicapped by the number of grades that it makes, in this case 8 or 9, compared with 2 or 3 in a typical German plant. This results in Safripol spending more time on set up, producing more 'twilight' (between grades) material and reduced operating capacity. For example effective capacity could be raised by 14% if production was concentrated on one simple grade. Shorter runs also dictate larger stocks. Typically one to one and a half months finished stock is held. Ultimately stock management dictates capacity. In efforts to optimise production and stock levels production is run in 'campaigns'.

In the siege economy years of the early 1980s the company attitude was to produce the extra ton at any cost, without worrying too much about quality. They saw the need to change this approach and to address quality issues so a version of the Crosby System[1] was introduced in an effort to empower workers and improve problem solving. Similarly attempts were made to reduce racial discrimination. Training has increased, including an in-house literacy course. The results include a dramatic increase in quality standards, improved interdepartmental communication, and a 25% reduction in the distribution budget.

Sentrachem is vertically integrated in HDPE through its Mega group of companies which are large HDPE users and one of the largest plastic converter groups in South Africa. This downstream integration, like AECI's, provides a 'base load' for their polymer operations, and allows some flexibility, through transfer pricing, in determining where profits will be extracted from the production chain. Plastomark, another Sentrachem/Hoechst joint venture, is responsible for marketing and offers customers extensive technical back up. This cluster of production, marketing, technical resources and vertical integration has allowed Safripol to drive HDPE to the highest commodity polymer growth rates in the local market in recent years.

Polypropylene Manufacture

Polypropylene (PP) is one of the newer polymers and understandably was one of the later additions to polymer manufacture in South Africa. Safripol also produce PP on the same Sasolburg site as their HDPE plant. Two years after the HDPE start up, one production line was converted to a 40 000 tpa PP manufacture unit (FM, SASOL Survey, 21-9-90:43). This has been expanded to 52 000 tpa which is only about half world scale size. However this disadvantage is off-set to some extent by the fact that there are advantages in operating on

1. A variation of a total quality management process, founded on one devised by American quality management specialist, Philip Crosby.

the same site as the HDPE plant, particularly in the expensive extruding step. Utilities are an important cost item for polymer plants, and in this case they can be shared to a large extent. The Hoechst technology used is both older and inferior to the BASF gas phase technology used in the newer SASOL plant. BASF is a world leader in PP technology whereas Hoechst is fourth in the world order.

Given the limited domestic propylene supply during the 1980s it is not surprising that Safripol chose to develop the HDPE business rather than the PP business. There were other considerations as well. Ultra violet (UV) light in South African sunshine is stronger than in Europe which meant the PP used in Europe for crates would need so many imported UV stabilizers that it would have been too expensive. Consequently HDPE was developed for this application instead. These factors have skewed the market share in favour of HDPE at the expense of PP as will be shown presently. This is expected to correct itself as PP growth forecasts are 8% p.a. whilst those for PE are only 4% p.a.. SASOL's entry into the PP market in 1990 is also expected to help establish a more typical balance between PP and PE market shares.

SASOL's entry into the PP market in 1990 caused Hoechst to seriously reconsider its options as SASOL was now both a supplier of feedstocks and a competitor. Sentrachem's strategy was to try and avoid direct confrontation with SASOL. In this case they addressed the strategic question of feedstocks by building a propylene splitter at SAPREF (oil refinery) in Durban, and took the medium term view that a range of feedstock options were likely to arise, particularly as a result of the capacity expansions in almost all the crude oil refineries. Larger refineries mean that a propylene off-take sufficient to meet Safripol's modest needs is a proportionally smaller share of refinery throughput. Thus they foresaw the possibility of avoiding reliance upon SASOL's propylene. From the marketing point of view, Sentrachem diversified its product range and further developed its marketing advantage in 1990 by building a R 5 million technical advice centre equipped with leading edge computer aided design facilities (Sentrachem Annual Report, 1990:16). Furthermore it is attempting to maximise its vertical integration advantage.

The most recent polymer plant to be built in South Africa is SASOL Polymers' 120 000 tpa PP plant in Secunda which also marks a turning point in the development of South Africa's commodity polymer industry. It is the first plant built where the bulk of output, some 70% in this case, was intended for export. It employs leading BASF, gas phase technology. However the curious aspect of this export plant is that it is built at Secunda some 500-600 km from Durban or Richards Bay, the nearest ports. South Africa's reputedly high overland transport costs will place it at a disadvantage. A decision like this, ought perhaps to be seen in the context of SASOL's scramble to diversify its product base. The burden such a decision may place upon the polymer industry in future underlines the need for transparency in SASOL's regulatory support and internal transfer pricing.

This plant may be considered to be world scale although at the lower end of the capacity rankings of such plants. The technology choice was influenced by SASOL's ability to manufacture catalyst on site, thus avoiding the need to import. Operating efficiencies are improving rapidly. Within 18 months of coming on stream output was 10% over nameplate capacity. Output per employee compares favourably with other leading edge plants according to SASOL Polymers. As with other polymer plants the number of grades produced is an important issue. Originally 27 grades were produced, but by 1992 this had been reduced to 18 grades, yielding a 10% improvement in efficiency. Nevertheless the larger number of grades means that 'twilight' material is budgeted at 8% whereas an internationally competitive plant would budget it at about 1%. In January 1993 the number of grades was increased again in order to penetrate new markets in packaging fresh frozen and processed foods, pharmaceuticals, cosmetics and industrial products (Business Day, 26-1-93:13). SASOL made this change "To help stimulate polypropylene beneficiation in the export field, we offer our local customers attractive commercial incentives...."(Ibid). This was presumably warranted by the low prevailing prices on export markets, and if so, suggests that low international prices can assist in driving the point of export further down the value added chain.

Continuity of operations has been a problem. As with ethylene, SASOL's propylene supply has been irregular at times, in this case for technical reasons (SASOL Annual Report, 1992:21).

In summary the larger of the two PP plants is competing internationally whilst the other is likely to struggle if tariff protection is removed. The latter may choose to expand rather than close if tariffs are lowered or reduced, in view of the effort it has made to build the South African market.

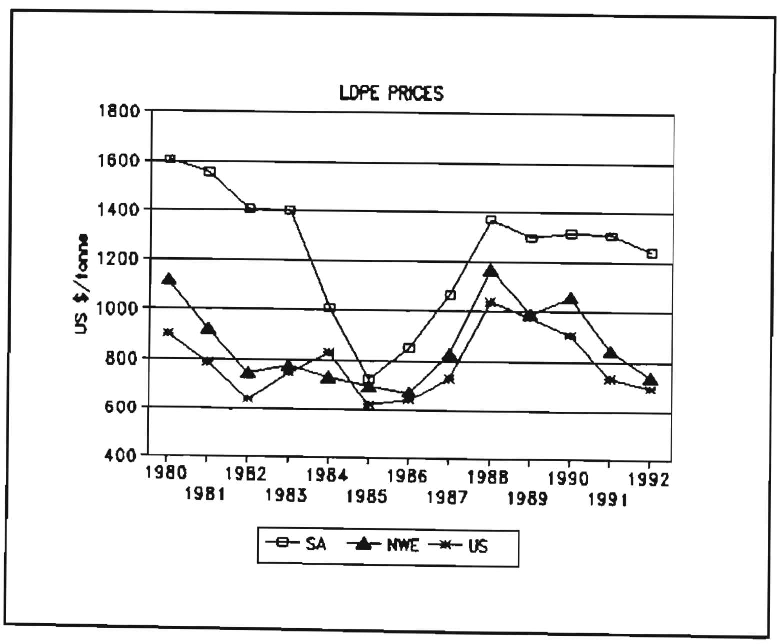
The ultimate test of competitiveness in globally traded commodities is price. How have domestic producer prices compared internationally?

Polymer Prices[1]

In this section South African domestic polymer prices are compared with US and NWE prices over the last 5-10 years. In general South African prices have been between 20% and 60% above NWE and US prices. Strictly speaking the price comparisons which follow are comparisons between markets, rather than producer costs and efficiencies.[2] In the South African case it is known that the domestic price is a function of the tariff reference price, which is ultimately a state decision consequent upon lobbying by the producers. However it may be used as an approximation for the efficiency of the local producers. In contrast the US and NWE prices arise in much less protected markets and consequently are a better indication of efficiency of production over the longer term. Each one is considered in turn.

The largest volume polymer is LDPE. It is observed in Figure 20 that over the 1980 to mid 1992 period domestic prices were always above US and NWE prices and that the difference was largest during economic downturns during the early 1980s and early 1990s. The converse also appears to be true. This may be assumed to be the working of the tariff

Figure 20



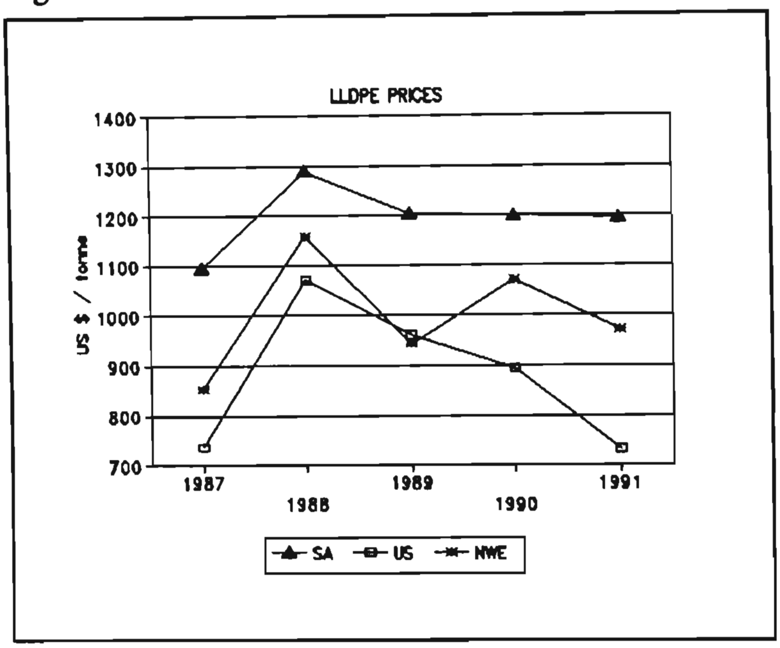
Sources: AECI
Parpinelli Tecnon, 1991.

1. All polymer prices referred to in this section are Current Domestic Value (CDV) prices and not Free on Board (FOB) prices unless so stated. FOB prices tend to be 'spot' prices which are frequently lower than CDV prices. They are often regarded as 'dumped' prices.

2. A better measure of a plants' efficiency would be its 'cash cost of production' or operating cost, that is its cost of production excluding any reward to capital. Such data is commercially sensitive and is not available.

reference price which protects the local producer when international LDPE prices fall. On average over this period the South African prices were 59% higher than US prices and 44% higher than NWE prices. This also meets the expectation that the largely gas based US prices would be lower than the imported naphtha based prices of NWE. Domestic LLDPE prices have also been in excess of US and NWE prices, by an average of 38% over US prices and an average of 20% above NWE prices over the 1987-91 period (see Figure 21).

Figure 21

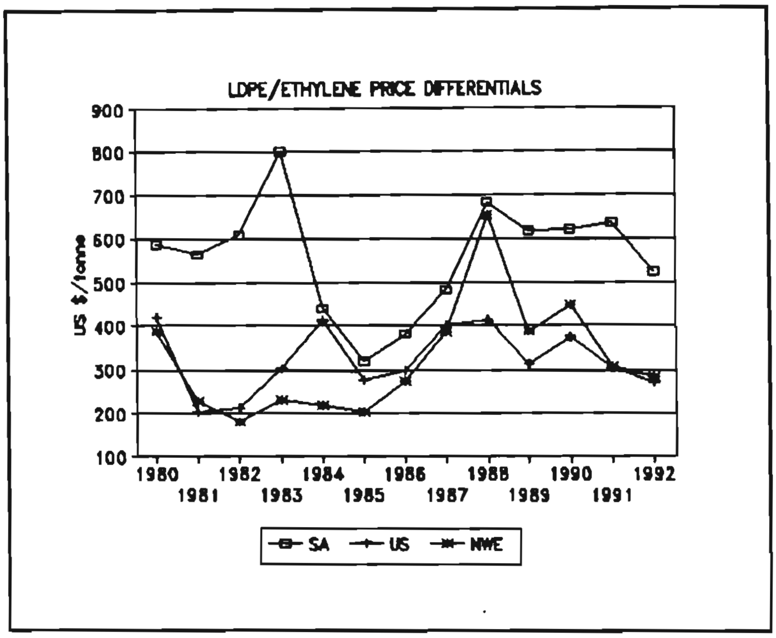


Sources: Parpinelli Tecnon
AECI

One measure of production efficiency is the difference in price between the LDPE price and the ethylene price. One would expect this difference in South Africa to be larger than in international markets and Figure 22 shows this to be the case over the 1980-92 period. Again when supply and demand are tight, as in 1987-88, the NWE figure is closer to the South African figure, but again this gap widens as international prices fall.

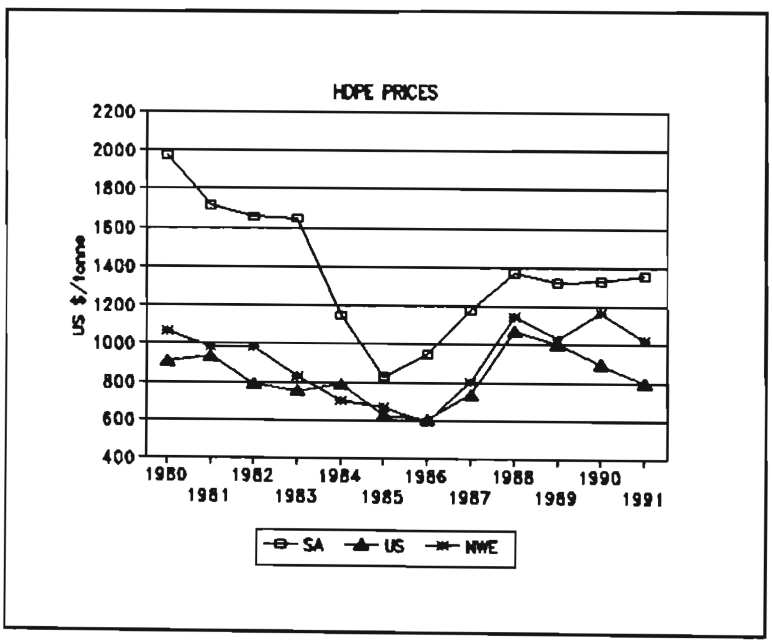
Domestic HDPE prices are also higher than international prices. Again the gap between South African and US prices is larger than the gap between South African and NWE prices, on average 67% and 51% respectively over the 1980-92 period (see Figure 23). In this figure the operation of the reference price support mechanism is also evident in the early 1980s and after the 1988 price boom. HDPE follows the LDPE trend in that South African prices (in nominal US$) have fallen over the 1980-92 period. The gap between South African and international prices is also smaller during the latter part of this period than the earlier

Figure 22



Sources: Plastomark
SASOL Chem
AECI

Figure 23

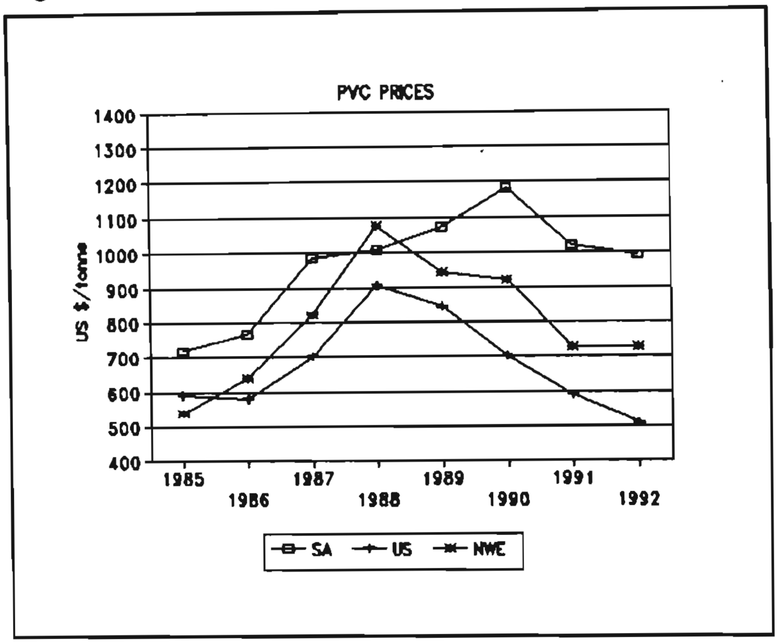


Sources: Plastomark
Parpinelli Technon.

part, which may be attributable to the capacity expansions and efforts to improve efficiency.

Domestic PVC prices follow the trends identified in the polyethylenes with one notable exception (see Figure 24). During 1988 when supply and demand were tight internationally the South African price was actually lower than the NWE price. The explanation for this apparent anomaly appears to lie in a 1988 explosion on the Coalplex chlorine plant which caused it to be shut for about 8 weeks thus necessitating the import of (cheaper) PVC to satisfy local demand.

Figure 24



Source: Plastomark
Note: To June 1992 only.

> " The reduction in output caused by the Coalplex incident together with higher local demand necessitated curtailment of export sales and the import of significant quantities of PVC as every effort was made to meet customer requirements. At a time of world shortage and hardening international prices, this proved a difficult and costly endeavour." (AECI Annual Report, 1988:11)

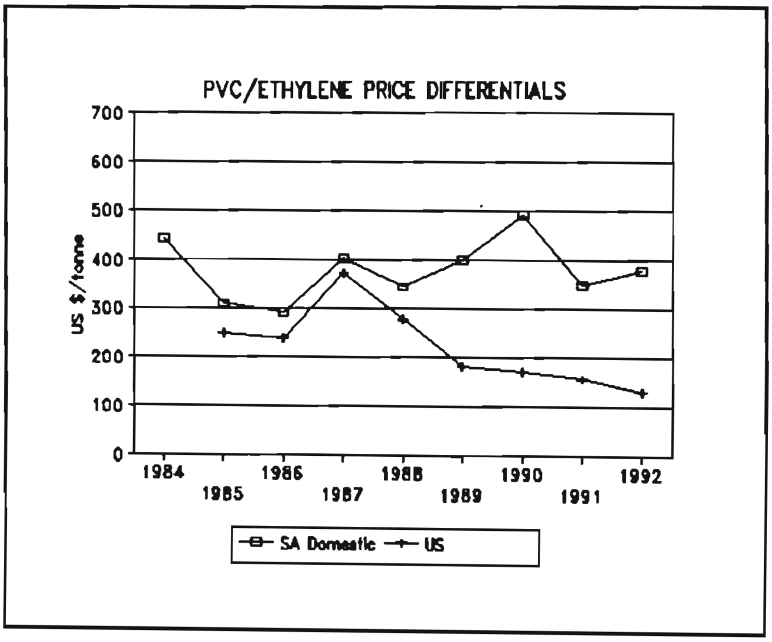
Since AECI were unable to meet domestic demand, they imported at below import parity prices, and attribute their losses to their 'long term market view' and the stance of a responsible monopoly. Over the 1985-92 period South African prices were on average 46% above US prices and 23% above NWE prices.

The PVC/ethylene price differential shows much the same pattern as the LDPE/ethylene differential, being consistently higher than the US price difference (see

Figure 25).

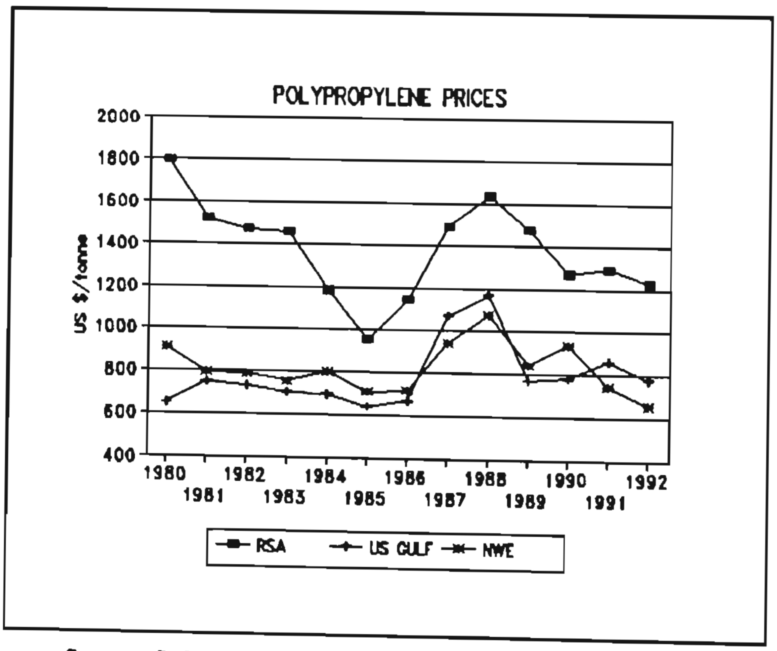
Domestic PP prices have also been above international prices and trends similar to those identified for other polymers are evident (see Figure 26). Over the 1980-92 period South African PP prices were on average 75% above US prices and 69% above NWE FOB prices. Some measure of PP manufacturing efficiency (or monopolistic rent) may be gained by comparing the differences between propylene and PP prices. The PP/propylene

Figure 25



Sources: Plastomark
AECI.

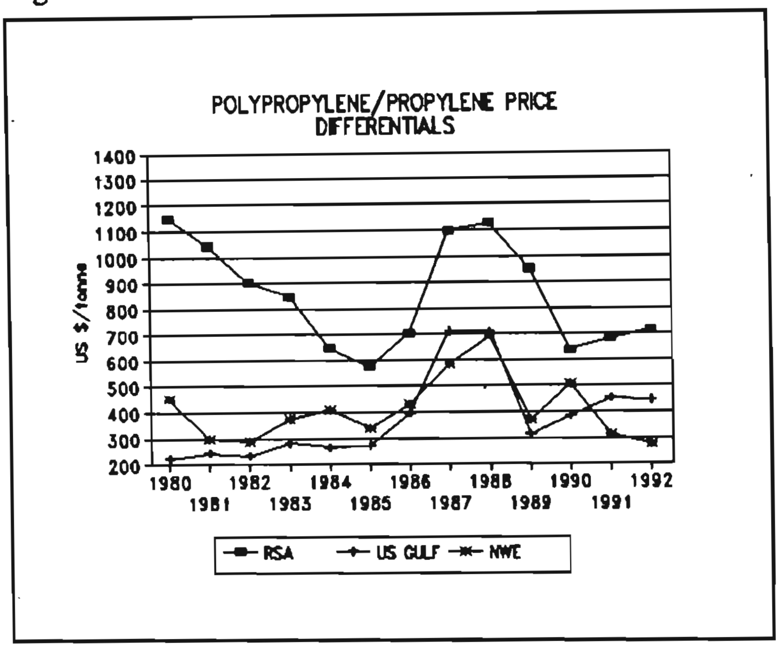
Figure 26



Source: Safripol data

differentials in Figure 27 reveal the extent of these differences, with the South African difference significantly higher than the international difference: on average over the 1980-92 period just more than double the differences in the US Gulf and NWE price differentials.

Figure 27



Source: Safripol

In general the problem for the domestic market is the inability of the local producers to follow international prices downwards in periods of low prices. This accords with the understanding of the production chain developed thus far. It has limited ability to pass lower polymer prices back up the chain. It may also be partly a function of the monopolistic practices in the petrochemical and polymer industry, but this is very difficult to prove conclusively.

Capital costs and the lack of investment

A prominent feature of South Africa's petrochemical history is the absence of private investment to create upstream petrochemical complexes. The first two crackers were built by SASOL (then state owned). The second complex intended for Richards Bay in the late 1960s and early 1970s was driven by private interests but never materialised. The various private investigations into synfuels projects during the 1980s also floundered on the rocks of government financing, or lack of it. These were the AECI mega-methanol project, the Gencor torbanite shale project and the Natal, sugar cane based ethanol project. On the other hand investment in the polymer industry has also been entirely private (if SASOL is regarded as a private company in 1990).

The local polymer manufacturers have been high cost producers and part of the explanation for this is the small scale of the plants and the correspondingly higher capital cost component of each unit of production. Although there has been 'de-bottlenecking' and capacity expansion in the commodity polymers industry since the mid 1980s there has been only one new plant built. The rest are 10 or more years old and AECI is falling behind in terms of technological competitiveness and plant reliability (Tison, 1991). This is important because AECI produces three of the five commodity polymers. In this capital intensive industry where planning horizons are 15 to 20 years, this may be an area of weakness which would need to be addressed to put the industry on a more internationally competitive footing. The most oft cited reason for this lack of investment is the cost of capital equipment and the tax burden.

These concerns prompted AECI, the largest chemical company in South Africa and which has been conspicuous by its lack of investment in recent years, to do a detailed study focusing on the fiscal environment. This study concluded that:

> "the fiscal environment makes it impossible for a South African producer to invest if he has the same cash costs as his competitors and is disciplined by the same world prices. A South African project needs to have exceptionally low cash costs if it is to be viable, especially if it is export focused." (AECI, 1991:15).

In the absence of any reduction in the tax rate the study argues for a "kick start approach......involving temporary investment incentives aimed at getting investment going in the interim." (Ibid:14). This study develops a theme explicit in the earlier 'Report by the Working Group for the Promotion of the Chemical Industry' which recommended that:

> "Government ... facilitate development of the industry by appropriate incentives of an enabling or 'hupstoot'[6] nature." (DTI, 1990:46).

At about the same time the so-called Sander Committee, named after its chairperson, AECI

6. 'Hupstoot' is Afrikaans for kickstart.

Managing Director Mike Sander, was discussing the same issue.[7] His views are captured in the Minutes:

> "The strategy must encourage open competition all the way down the chain of industry in the local market, as well as creating a competitive petrochemicals industry internationally, which is not the case at present.
>
> A further objective was to make it unnecessary for government to maintain a high level of involvement in the industry on an on-going basis therefore Mr Sander believed that there was no other way of launching the strategy other than to get Government support at primary producing plant level - this meant either a synfuels project or a cracker based on gas or naphtha. Government support at this level was essential." (Minutes, Petrochemicals Industry Development Study Group, 10-4-89:1)
>
> "Mr Sander...further explained the philosophy of a once off support for the industry right at the beginning of the chain." (Ibid:5)

In this meeting the views espoused by Mr Sander were supported by Sentrachem but opposed by SASOL. AECI's arguments are couched in terms of international competitiveness and 'GATT proof' support. But by that time AECI had spent considerable sums investigating a mega-methanol project intended to produce synfuels from coal. They had even licensed the technology from Mobil at considerable cost. Sentrachem were at that time investigating a naphtha cracker as a potential source of petrochemical feedstocks. In short both of these companies appear to have been vying for government blessing (and a 'hupstoot') for their projects.

SASOL for its part opposed the Sander philosophy. "SASOL believed that it was necessary to concentrate on the downstream activities. ...The area which really needed attention was the structure of the downstream industry where we have historically built small, uneconomic units." (Ibid:4). (Considering financial viability, a case of the pot calling the kettle black?) Mr Du Toit from SASOL:

---

7. This committee was similar to the Working Group and consisted of representatives of Government and large chemical companies. In this case representatives of the chemical industry were joined by representatives of the oil industry. Organised labour was again excluded. This committee, more properly known as the 'Petrochemicals Industry Development Study Group', sat between April and November 1989 to identify the best means of developing the petrochemicals industry.

> "disagreed with the suggestion that this could only be achieved by a Government or State subsidy to the primary producer. .. He believed that Government assistance should be in the form of capital support only for downstream plants built specifically for exports." (Ibid:5).

It appears from these remarks that SASOL was attempting to preserve its monopoly on the upstream source of strategic petrochemical feedstocks, and expand the market for them by encouraging larger downstream plants as well as securing assistance for its large PP facility which was under construction at that time. At the same time it appears to have been trying to protect its government support, as the SASOL representative goes on to point out that "A chemicals from coal industry could not be commercially viable at present." (Ibid)

Thus the picture that emerges is one of the three large chemical companies squabbling for a share of the government purse in order to secure a 'hupstoot' (kickstart) for a project in their own area of interest. Put differently, there appears to be a distinct distaste for investments which are not shored up in some way by the public sector so as to minimise risk to the private investor.

Historically the state has provided the 'hupstoots' for the upstream petrochemical industry in the form of the first (Sasolburg crackers) and second (Secunda) petrochemical complexes. These were longer term investments but over the years military/strategic concerns came to dominate economic policy. Private companies have taken less long term strategic views. Instead they have located their interests peripheral to and dependent upon state interests. This is not surprising given the nature of the strong state. Private companies investigated strategic-type projects which did not stray too far from the state's concerns in the hope of attracting the state's attention but for the most part held back from investing in the hope that if they waited long enough they would get assistance from the state.

The central state's involvement in military/strategic ventures was used successfully by private companies as argument for concessions in the form of tariff protection. A culture of symbiosis with the state and its apparatuses emerged. The state's concerns were accommodated and a cosy relationship developed. Whilst not ideal from the private firm's point of view - instead they would have preferred to dictate the strategic direction as well as making use of public funds - it was a second best option which nevertheless allowed them to accumulate capital. However it appears to have lulled them into an adversity to risk.

AECI's distaste for risk is evident in its only recent major investment, the R 1 093 million Sua Pan soda ash project in Botswana. AECI provided only 26.5% of the capital, the rest was provided by the Botswana Government, Anglo American and De Beers. The project is protected by a tax rebate from the Botswana Government until such time as the capital outlay, in real terms, has been recovered. The South African government was required to give an undertaking that it would not allow 'disruptive' imports. Within months of start up AECI called upon this undertaking in an appeal to the South African government for relief in the form of "anti dumping tariff protection" (FM, 7-8-92:82).

The state response to complaints about the cost of capital for capital intensive projects with long lead times was to introduce Section 37(e) to the Income Tax Act for export orientated investments. It allowed depreciation to commence with construction rather than production. This was later extended to other investments as well.

Since their introduction SASOL has taken the lead in the chemical industry in exploiting this incentive for a number of their investments. Sentrachem intend to do so if their proposed petrochemical complex materialises although they are not overly impressed with it as an incentive (Interview, McIver). AECI has not announced any major investments other than the investigation into the PVC expansion.

<u>Installation Factors and Timing</u>

In capital intensive industries like petrochemicals it is not only the cost of capital that is important but also the speed with which it can be translated into productive assets. The factors which determine this are referred to here as the installation factors. They include: (a) the domestic construction and engineering capability, (b) obstacles to the adoption of modern technology and construction methods (c) long construction times (d) infrastructure.

Of these four factors the weakest in South Africa is the limited construction and engineering capability, from the chemical industry point of view. It does not have any domestic firms which participate in the international market for the construction of petrochemical complexes. Consequently big South African petrochemical projects tend to be carried out by foreign companies. In the petrochemical industry, as in other industries, there are benefits to firms repeating the same or similar construction projects several times. This is present in the local mining sector, but in the chemical industry this benefit does not arise as most plants are unique to the local economy. This too encourages the use of foreign firms which have the benefits of repetition as well as better reputations than local firms.

Episodes like the Mossgas construction debacle reinforce this deprecating view of the local plant construction industry. Unlike many other big projects a large share of work was given to local contractors rather than foreign contractors. Overall the Mossgas project was characterised by gross mismanagement and huge cost overruns. In general, South Africa's fledgling plant construction industry does "...not have the experience, systems or capabilities to manage large projects efficiently" (Edge, 1990:6). This weakness is however not fatal for the industry. Indeed it may be considered an advantage in that local firms are free to utilize the best construction companies in the world.

Do the chemical companies fare any better than the local construction industry? The only large project commissioned AECI recently has been the Botswana soda ash plant on Sua Pan in central Botswana. It appears to have encountered design and/or start up problems. In 1991 an additional R31 million had to be allocated to fund a larger than expected negative cash flow in the start up period (AECI Annual Report, 1991:9). Several production problems have arisen, the development of the 'slab' necessary for the extraction of the raw material has taken longer than anticipated. An algae discoloured the product and lowered quality, particularly for the detergent industry which requires, 'whiter than white' inputs. These problems together with international competition means that "Soda Ash Botswana is now trading at a loss and shareholders are being expected to subsidise the company.." (FM, 7-8-92:82).

SASOL has a better reputation for project management and bringing large projects on stream on time. One of its recent large projects is the propylene/PP project in Secunda completed in 1990. It was built almost entirely by foreign contractors, who broke a world record in erection time but spared little expense in the process. Whilst companies like SASOL may have the necessary project management expertise, South Africa lacks the capabilities to actually carry out the projects themselves. Skilled labour is one indicator of this. In both the SASOL project just referred to and the Mossgas project, large numbers of foreign artisans were imported to carry out more sophisticated welding and other tasks. South Africa lacks the skilled human resources for this kind of work.

It may be noted that the capital installation factors considered here are distinct from the capacity to operate existing facilities and/or 'stretch' their capacity. SASOL, in particular has claimed some success at this but this kind of technical capability is difficult to quantify. It arises out of a cluster of capabilities including engineering skills, information and services planning, associated maintenance structure, quality and safety procedures. SASOL are regarded by some as the superior South African company in this regard (Tison, 1992 and Interview, Redlinghuys).

Timing the introduction of production in projects with long lead times is a vitally important skill because "Start up at the bottom of the price cycle can result in an impaired financial situation for the lifetime of the plant" (Vergara & Babelon, 1990:67). This ability to 'read the world markets' may cost SASOL dearly in its propylene/PP project. It rushed construction in order to enter world markets during 1988-89 when prices and capacity utilization were peaking. Unfortunately SASOL was somewhat late and the early years of the plant life span were being spent exporting into depressed international markets where recovery of only operating costs is the order of the day. The project was based on PP prices of $800/tonne whereas in mid 1992 they were about $600/tonne and exports, which are 70% of output, were 'not recovering full costs' (Interview, Brand). A large group like SASOL can probably endure although other expansion plans may be slowed. In fairness many other companies internationally also misjudged the length of the global recession in the early 1990s.

South Africa's major chemical companies

The capital installation and technical capabilities of the large South African companies are just one dimension of their general ability to cope with the ever changing business environment. This section examines certain financial and growth trends by comparing the three large South African companies with leading international chemical companies.

Three companies SASOL, AECI, and Sentrachem dominate the upstream end of the plastics *filière* and also dominate the local chemical industry. SASOL's operating profit and total assets are more than twice the sum of the other two combined (see Table 0.1). Engen a locally owned crude oil refining and marketing company is included for comparison purposes. The relative size of three South African chemical companies has already been compared with their international rivals in Chapter Two, Part One where they were seen to be relatively small.

The polymer operations conducted by the three South African firms are just one part of their businesses. SASOL is mainly a refining company and should more properly be compared with Engen, the only other local refining company listed on the Johannesburg Stock Exchange. This comparison starkly reveals SASOL's weakness, its comparatively poor assets to turnover ratio (Table 6.4). However, internationally, capital productivity measured by asset turns, has been low among the leading chemical firms, even during the 1987-89 boom years, emphasising the capital intensive nature of the industry (see Table 0.2). SASOL is somewhat below the top 20 firm average over this period. AECI is consistently better. This may be accounted for by AECI's conspicuous absence from investment projects in South Africa over

Table 6.4 Comparison of SA Chemical and Oil Companies				
	Sentra-chem 8/91	AECI 12/91	SASOL 6/92	Engen 8/91
Turnover (Rm)	2275.4	5280.0	7853.9	6098.4
Operating Profit (Rm)	235.0	402.0	1758.6	463.6
Total Assets (Rm)	2016.9	4028.0	12495.8	3733.1
Employees	8319	24100	30300	3693
Sales/employee (Rm)	0.27	0.22	0.26	1.65
Asset turns	1.1	1.3	0.6	1.6

Source: Company Annual Reports

Table 6.5. Capital Productivity: Asset Turns of the Top 20 International Chemical Companies Compared with 3 South African Chemical Companies (Ranked by 1990 Sales)

Asset turns (sales/total assets)					
Company	Rank	1986	1987	1988	1990
BASF	1	0.73	0.69	0.69	0.66
Hoechst	2		0.76	0.77	0.75
Bayer	3	0.70	0.65	0.66	0.61
ICI	4	0.80	0.88	0.86	0.84
Du Pont1,2	5	0.63	0.64	0.65	0.65
Dow Chemical	6	0.57	0.60	0.67	0.57
Rhone-Polenc	7	0.69	0.67	0.69	0.55
Ciba Geigy	8				
Elf Aquitaine1,2	9				0.75
Enichem	10				0.67
Shell	11	0.72	0.79	0.79	
Atochem	12	1.01	1.07	1.09	
Akzo	13	0.85	0.81	0.78	0.78
Sandoz	14				0.80
Exxon	15	0.88	0.92	1.04	0.92
Monsanto	16	0.59	0.63		0.67
Mitsubishi Kasei	17		0.53	0.34	0.55
Solvay	18	0.66	0.64	0.65	0.56
Sumitomo Chem	19	0.55	0.52	0.63	0.62
Merck & Co	20	0.65	0.72	0.78	0.77
Average		0.72	0.72	0.74	0.69
SASOL		0.63	0.56	0.60	0.70
AECI		1.39	1.41	1.44	1.56
Sentrachem3		0.53	na	0.76	1.45

Sources: Chemical Insight's Company Analysis (1987), 11th Edition
Chemical Insight's Company Analysis (1988), 12th Edition
Chemical Insight's Company Analysis (1989), 13th Edition
Chemical Insight's Company Analysis (1991), 15th Edition
Company Annual Reports

Notes: 1 Chemicals only
2 Excluding intersegment transfers
3 Annualised

the 1986-90 period and its largely depreciated assets. Sentrachem's asset turns have improved as it has divested itself of its more commodity-type (fertilizer) businesses, written off loss making synthetic rubber assets and moved towards more speciality chemical type business. There is supportive evidence of this low capital productivity in the age of plant. Between 1989 and 1992 AECI's average age of plant was between 10 and 11 years. Over the same period Sentrachem's average age of plant fell from 6 years to 5 years (Tison, 1992a).

Sales growth, or the lack of it, during the 1984-90 period is the key difference between the South African companies and the top chemical companies (see Table 6.6). The leading 20 chemical companies achieved an annual average sales growth rate of 10.2% p.a. over 1984-90, whereas SASOL only achieved a 0.5% p.a. growth rate, (both in real US $) or a decrease of 0.7% p.a. in real Rand terms. The other local companies did better although they achieved still less than half the growth rate of the leading firms.

Labour productivity among the three South African firms was lower than the average for the leading 20 international chemical firms by some indicators (see Table 6.6). For example, sales per employee, in 1990 and 1984, were less than half the top 20 average. A comparison with leading Brazilian companies also shows the South African firms to have lower sales per employee, between a half (Sentrachem) and a third (SASOL) of the Brazilian average (see Table 6.7). Measured by sales per employee Brazilian firms are much closer to the leading international companies.

However if the wage differentials between South Africa and the developed economies are factored in then it is apparent that average wages in South Africa are 4 to 5 times lower than the average for the leading firms (Table 6.6). The change in average wages over the 1984-90 period is significant. Average wages in the leading companies increased by an average of 10% p.a. whilst those for the South African companies by less than half that. This is revealing, particularly in view of SASOL's complaints about unskilled and semi-skilled wage levels, over the 1991-92 period. For example in the 1991 SASOL Annual Report the Chairman has this to say:

> "It is my view that in comparison with the newly industrialised nations, South Africa has succeeded in pricing itself out of the market in terms of its remuneration of semi-skilled and unskilled workers." (SASOL Annual Report, 1991:4)

Table 6.6 Top 20 International Chemical Companies, Ranked by 1990 Sales Compared with 3 South Africa Chemical Companies (1990 prices)

Company	1990					1984 (in 1990 US $)					Annual Average Change 1984-90 (%)				
	Sales $m	Employ-ees	Sales/ employee $	Ave. wage	Wages/ Sales $ m	Sales $m	Employ-ees	Sales/ emplo-yees	Ave. wage	Wages Sales $ m	Sales	Employ -ees	Sales/ employ -ees	Ave. wage	Wages Sales
BASF	31,195	172,890	180,433	55,964	0.24	16,131	115,816	139,279	27,735	0.20	11.6	6.9	4.4	12.4	3.3
Hoechst	30,017	171,000	175,538	50,787	0.29	15,684	177,940	88,144	24,896	0.28	11.4	-0.7	12.2	12.6	0.6
Bayer	27,863	134,647	206,934	52,378	0.32	16,884	174,755	96,615	26,551	0.27	8.7	-4.3	13.5	12.0	2.6
ICI	24,909	132,100	188,562	40,529	0.21	14,446	115,600	124,962	21,501	0.17	9.5	2.2	7.1	11.1	3.8
du Pont1,2	22,268	113,235	196,653			19,946	124,893	159,706			1.9	-1.6	3.5		
Dow Chemical	19,773	94,141	210,036	61,095	0.19	14,359	49,800	288,330	48,737	0.17	5.5	11.2	-5.1	3.8	2.1
Rhone-Polenc	15,483	91,571	169,082			6,690	79,230	84,440	21,683	0.26	15.0	2.4	12.3		
Ciba Geigy	15,459	68,900	224,369	52,298	0.32	8,452	81,423	103,804	29,065	0.28	10.6	-2.7	13.7	10.3	2.2
Elf Aquitaine1,2	14,323	62,100	230,644			6,072					15.4				
Enichem	13,363	56,924	234,752	45,488	0.17	5,162	27,700	186,364	19,939	0.11	17.2	12.8	3.9	14.7	7.7
Shell	12,703	52,685	241,112			8,694					6.5				
Atochem	10,297	52,640	195,612												
Akzo	10,229	49,000	208,755	43,063	0.29	5,844	66,100	88,410	22,969	0.26	9.8	-4.9	15.4	11.0	2.1
Sandoz	9,703	45,671	212,454	46,235	0.25	3,595	38,036	94,525	27,059	0.29	18.0	3.1	14.5	9.3	-2.2
Exxon	9,591	42,500	225,671			8,639					1.8				
Monsanto	8,995	41,081	218,958	53,163	0.24	8,414	50,754	165,787	41,849	0.25	1.1	-3.5	4.7	4.1	-0.6
Mitsubishi Kasei	8,949	39,988	223,792			3,950					14.6				
Solvay	8,265	38,791	213,065	49,023	0.27	4,464	43,527	102,565	23,695	0.23	10.8	-1.9	13.0	12.9	2.7
Sumitomo Chem	7,865	37,756	208,311	72,046	0.07	3,521					14.3				
Merck & Co	7,672	36,900	207,913	54,054	0.26	4,477	34,800	128,647	38,591	0.30	9.4	1.0	8.3	5.8	-2.4
Average	15,446	76,726	208,632	52,009	0.27	9,233	84,312	132,256	28,790	0.24	10.2	1.4	8.7	10.0	1.8
SASOL	1,945	33,200	58,583	11,023	0.19	1,889	33,200	56,901	8,386	0.15	0.5	0.0	0.5	4.7	4.2
AECI	1,944	25,600	75,946	13,722	0.18	1,719	26,800	64,136	11,574	0.18	2.1	-0.8	2.9	2.9	0.0
Sentrachem3	816	8,589	95,008	14,155	0.15	617	8,527	72,302	12,262	0.17	4.8	0.1	4.7	2.4	-2.1
	(1990 Rands)					(1990 Rands)									
	R mil		R	R		R mil		R	R						
SASOL	5,033	33,200	151,593	28,524	0.19	5,253	33,200	158,216	23,317	0.15	-0.7		-0.7	3.4	4.2
AECI	5,031	25,600	196,523	35,508	0.18	4,779	26,800	178,334	32,183	0.18	0.9		1.6	1.7	0.0
Sentrachem	2,112	8,589	245,848	36,629	0.15	1,714	8,527	201,040	34,096	0.17	3.5		3.4	1.2	-2.1

Notes: 1 Chemicals only
2 Excluding intersegment transfers
3 Annualised
4 Includes salaries and related benefits
5 Deflators from International Financial Statistics Yearbook 1991

Sources: Chemical Insight (1991) Company Analysis, 15th Edition
Chemical Insight (1985) No. 326, Late September.
Company Annual Reports

Table 6.7 Brazil's Top 20 Chemical Companies and 3 South African Companies

	1990 Sales ($ mil)	Revenue per employee ($ '000)
Petrobras *	11430	198
Rhodia	674	73
Copene *	665	352
Copesul *	615	406
Hoechst	536	106
White Martins(1)	523	na
Ciba-Geigy	469	246
Petroquimica Uniao *	445	329
Bayer	419	96
Glasurit(2)	365	145
BASF	357	128
Kodak	338	na
3M	301	82
Dow Quimica	285	276
Solvay	274	146
Petroflex	269	143
Du Pont	267	191
Poliolefinas	248	299
Tintas Coral	238	118
Salgema	229	264
Average	947	180
SASOL	1945	59
AECI	1944	76
Sentrachem(3)	816	95
Average	1568	77

Notes: 1) Union Carbide subsidiary
2) BASF Paints subsidiary
3) Annualised
* = state owned

Sources: Chemical Week 4-12-91:42
Company Reports

Although the comparison is made with newly industrialising countries, the underlying reasons for blaming wage levels may be identified in Table 6.6 which shows SASOL's average wage costs to have risen at 4.7% p.a., over the 1984-90 period, faster than its local competitors, but only at half the rate of the top 20 average (all measured in 1990 US $). The faster rise in SASOL's wages may be attributed to the fact that SASOL employees at its largest Secunda works negotiated their wages as part of a trade union for the first time in 1984 and in the ensuing years achieved a measure of success in raising minimum wages to AECI and Sentrachem levels.

It appears that the real cause of SASOL's complaint lies in unit labour costs (wage costs per US $ of output) which although considerably lower than those of the leading companies, grew at more than twice the rate of the leading companies over 1984-90. The major factor contributing to this appears to be stagnant sales, not the increase in labour costs.

In short, the top 20 firms were able to offset higher wages by growth in sales. The growth in unit labour costs at AECI and Sentrachem were among the lowest in the sample of 23 firms.

This analysis supports the view presented earlier concerning SASOL's disadvantageous cost structure and the need for it to follow a strategy of changing its product mix to increase the proportion of higher value added products. The end of apartheid and sanctions may facilitate this change for SASOL in that the pariah price South Africa has had to pay for oil is expected to fall away and fuel self sufficiency will be less of a policy priority.

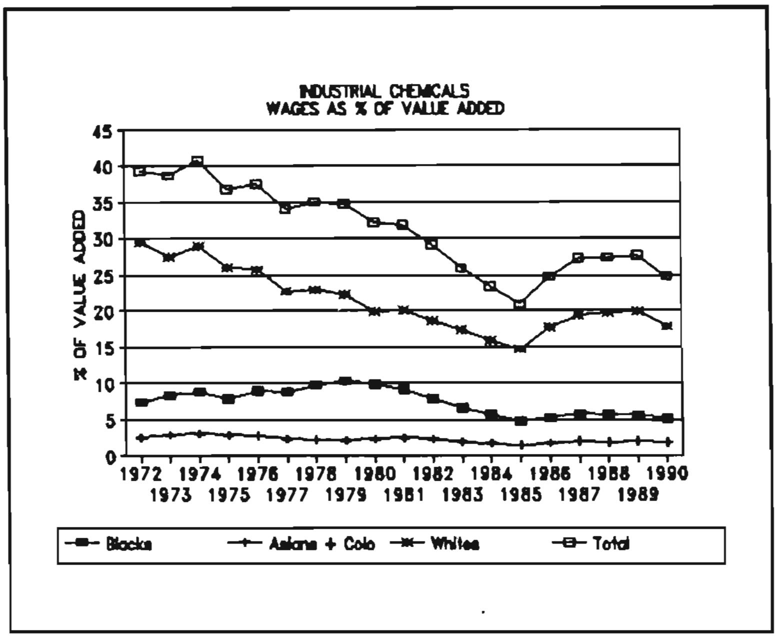
Nevertheless SASOL's perception that wages paid to lower skilled workers are too high, is fairly widely held within the business community. Whilst it is not possible to explore this perception in full here, it may be helpful to point out that wages have enjoyed a declining share of value added, in the more capital intensive parts of the chemical industry (see Figure 28). Black wages, if considered as a proxy for less skilled workers, have also declined marginally, as a share of value added over 1972-90.

Domestic and International Plastic Markets, recent growth trends

The per capita consumption of plastic is a crude indicator of the level of development in a plastics market and that market's potential. South Africa's total per capita consumption of commodity polymers in 1989 was roughly on a par with Eastern Europe, the Soviet Union and Latin America (see Table 6.8). This is only one fifth of the US per capita consumption. Overall South Africa's demand growth for plastics over the 1983-90 period has been slower than the world average and the African average (see Table 6.9). Nevertheless domestic demand for plastic raw materials and plastic products has been growing faster than South African manufacturing as a whole over the period 1972-90. The annual average growth rates over 1972-90 for manufacturing, plastic raw materials and Plastic Products were 2.5%, 3.7% and 8.2% respectively (calculated from IDC, 1992 in constant 1990 prices).

Historically the growth pattern over this period in South Africa among the different commodity polymers, was roughly in step with the world trends; PP and HDPE were the two fastest growing polymers in South Africa and globally (see Table 6.9). The only polymers in which South Africa experienced faster than world average growth was LDPE and LLDPE. This accords with the facts: ethylene was the most readily available olefin in South Africa over this period and the local market was protected. South Africa's somewhat lower PP and PS growth rates also accord with the history of supply problems in propylene and styrene

Figure 28



Source: IDC, 1992

Table 6.8 Plastic Consumption kg/capita

		LDPE+ LLDPE (1)	HDPE (2)	PP (3)	PVC (4)	PS (5)	Total (1)-(5)	All Plast-ics
USA	a\	17.7	15.2	12.6	15	9.7	70.2	
Japan	a\	13.0	7.4	14.8	15.2	9.7	60.1	
West Europe	a\	15.2	7.4	8.2	12.9	6.6	50.3	
Korea	c\	8.3	7.2	10.7	9.9	7.0	43.1	
Malaysia	d\	6.3	<	2.8	2.5	2.1	13.7	
East Europe	a\	3.7	1.6	1.7	4.3	1.8	13.1	
South Africa	**b**	**3.7**	**2.7**	**1.7**	**3.2**	**0.7**	**12.0**	**15.0**
Soviet Union	a\	4.5	<	0.6	2.0	1.5	8.6	
Latin America	a\	2.5	1.3	1.4	2.4	0.8	8.4	
Thailand	d\	1.0	1.6	1.3	0.7	0.6	5.2	
Indonesia	d\	1.4	<	1.1	0.5	na	3.0	
China	a\	0.6	0.4	0.5	0.6	0.2	2.3	
India	a\	0.1	0.1	0.1	0.3	0.1	0.7	
Taiwan	e\	na	na	na	na	na	na	16.7
World	a\	5.7	<	2.3	3.5	1.6	13.1	

Notes a\1990 figures
b\1989 figures
c\1988 figures
d\1987 figures
e\1981 figure
< included in LDPE + LLDPE

Sources: Polymer apparent consumption from Plastics Federation of SA, Annual Report 1990.
Population from Development Bank of Southern Africa, 1991.
Interview, Wamsley.
Republic of China, 1983.
Vergara & Babelon, 1990.
ICEF, 1992.

Table 6.9 Demand, Annual Average Growth 1983-90 (percent per annum)			
	WORLD	AFRICA	SOUTH AFRICA
LDPE + LLDPE	5.6	6.7	6.0
HDPE	8.7	5.7	6.8
PP	10.1	14.9	9.3
PVC	5.2	4.8	2.3
PS	6.6	9.5	5.5
ABS/SAN	5.7	17.0	0.6
Total	6.8	7.2	5.3

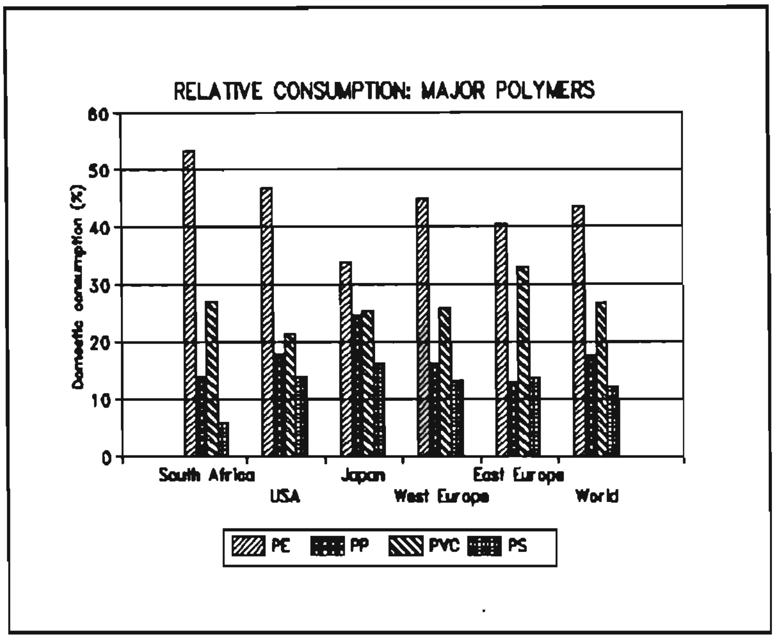
Sources: Parpinelli Tecnon, 1991:IV.112
Parpinelli Tecnon, 1991:II.11
Plastics Federation of SA Annual Reports

discussed earlier. South Africa had particularly low growth rates in engineering polymers (ABS and SAN), an issue to be discussed shortly.

The differential growth rates among the commodity polymers also accords with the demand pattern (see Figure 29 and Figure 30). These figures reveal the unusually large share of the South African market occupied by polyethylenes in 1989, higher than for all other countries and regions in the sample. They also reveal the unusually small share of the market held by PP and PS, again on account of the poor domestic supply. Now that SASOL has a large PP plant on stream it may be expected that the historical imbalance against PP will be corrected over a period of years. Tariff protection on PS manufacture has recently been removed and it may also be expected to gain in market share. But what of engineering plastics?

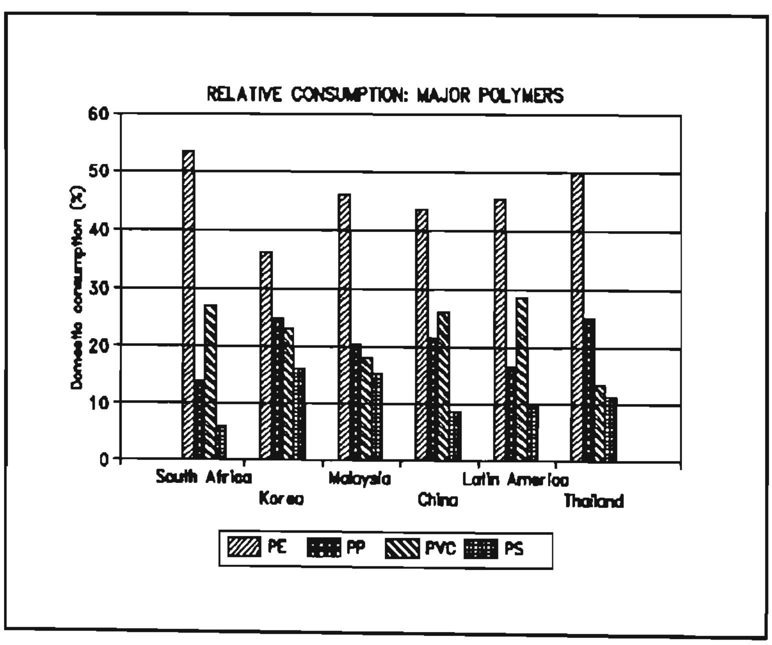
Engineering plastics do in some cases compete with commodity polymers in certain applications but in general they represent part of a new round of substitution of more conventional matarials by advanced materials. Global sales of engineering plastics have been expanding at about 8-10% p.a. against fairly slow growth for plastics as a whole (3-4% p.a.) in Europe for example (UNIDO, 1990:278). However in South Africa the opposite trend is evident. Over 1980-90 commodity polymers' share of the total polymer market grew from 77% to 82% whilst the share held by all engineering polymers shrank from 3% to 2% (see Table 6.10). But in the shorter term there is evidence of this trend reversing. Over the 1985-90 period, engineering polymer growth rates switched from -3.2% p.a. over 1980-85 to +8.2% p.a. over 1985-90. This was faster than the commodity polymer growth rates of 5.5% p.a. in the latter period. This more recent upswing in demand for engineering polymers may be associated with the switch in the South African automobile industry local content

Figure 29



Sources: Polymer apparent consumption from Plastics Federation of SA, Annual Report 1990.
Population from Development Bank of Southern Africa, 1991.
Interview, Wamsley.
Republic of China, 1983.
Vergara & Babelon, 1990.
ICEF, 1992.

Figure 30



Sources: Polymer apparent consumption from SA Plastics Federation Annual Report 1990.
Population from Development Bank of Southern Africa (1991)
S Wamsley, Focus on Chemicals
Abridgement of Development Plan for Downstream Sector of ROC Petrochemicals Industry of Free China
Vergara & Babelon (1990)
ICEF (1992)

Table 6.10 Apparent Consumption of Commodity, Engineering and Other Polymers in South Africa

	1980	1985	1990	--Annual Change %-- 80-90	80-85	85-90
	Percent					
Commodity polymers	77	80	82	0.6	0.7	0.5
Engineering polymers	3	2	2	-0.9	-4.8	3.1
All other polymers	20	18	16	-2.5	-2.3	-2.6
Total	100	100	100			
	Metric Tonnes ('000)					
Commodity polymers	320	361	471	3.9	2.4	5.5
Engineering Polymers	11	9	13	2.4	-3.2	8.2
All other polymers	85	82	91	0.8	-0.7	2.2
Total	416	451	575	3.3	1.7	5.0

Sources: Plastics Federation of South Africa, Annual Reports
Notes: 1. Commodity polymers = LDPE, LLDPE, HDPE, PP, PVC & PS
2. Engineering polymers = SAN, ABS and polyamides (nylons)

programme from mass to value based incentives in recent years. Despite this the local automotive industry's share of engineering plastics consumption is well below global percentage figures. (PSA, August, 1992:29).

These data provide an indication of the type of plastic converting industry which has existed in South Africa: one focusing on lower value added type products using the commodity polymers but beginning to change towards increasingly sophisticated applications.

Within the engineering polymer market certain trends are evident. Among engineering plastics internationally, nylons are the most important materials (Wittcoff, 1992 & UNIDO, 1990:277). In South Africa their apparent consumption grew at 6.3% p.a. over 1980-90, slightly slower than the engineering polymers as a group.[1] Domestic consumption of other engineering polymers, ABS and SAN, declined at -4.5% p.a. over 1980-90, but this negative trend was dramatically reversed to +8.9% p.a. over the 1985-90 period (Ibid).

Although the market share of 'all other polymers' continued to shrink between 1985 and 1990, there was nevertheless a turnaround in the historical pattern of declining volumes, from -0.7% p.a. over 1980-85 to +2.2% p.a. growth over 1985-90 (see Table 6.10). The declining market share is a result of the much faster volume growth in commodity and engineering polymers.

Thus it emerges that the South African market is not developing in step with the developed economies and some NICs and has only belatedly begun to experience a shift to engineering plastics which are still only 2% of the market. By comparison they accounted for

1. Calculated from Plastics Federation of SA, Annual Reports, apparent consumption data.

about 3% of world polymer volumes (a 50% difference in engineering plastic volumes) in 1988 (UNIDO, 1991:341). South Africa has followed a pattern typical of developing economies in which commodity polymers are more important. Domestic demand then suits the nature of the existing production facilities. This suggests that South Africa may more easily find markets in developing countries which are higher cost producers than South Africa.

In preparation for the future, attention needs to be given to the supply of ABS and SAN polymers as they appear to be the fastest growing. South Africa has a relative abundance of propylene, a precursor to acrylonitrile which is used in the manufacture of engineering plastics such as ABS (acrylonitrile-butadiene-styrene) and SAN (styrene-acrylonitrile). However the other petrochemicals needed such as styrene (from benzene) and butadiene are not manufactured locally as there has been no aromatics facility in South Africa. The lack of suitably priced feedstocks and the lack of an integrated approach to the petrochemical industry have probably contributed to this state of affairs.

There are signs that this may be beginning to be corrected. SASOL has announced plans to build a 75 000 tpa acrylonitrile plant scheduled to come on stream in 1995 (Business Day, 9-3-93). Most of its output is destined for its new acrylic fibres plant in Durban but some will be exported. This holds potential for local ABS production although world capacity utilization predictions, if correct, make this seem unlikely before the year 2000.

Historically the polymer manufacturers have been inwardly focused and geared to serve certain parts of the local market, or rather a wide range of local markets, in many sectors of the economy. In Table 6.11 the end-uses of domestically produced polymer are contrasted with the West European demand pattern. This reveals some significant differences.

A comparatively high proportion of domestic PP is used in fibres. In Chapter One the global growth in PP textile applications was noted. This trend has been even more noticeable in South Africa. Domestic growth in this area has been very rapid, 8.2% p.a. by volume over 1984-89.[2] The most significant feature of the local PP market is the large proportion which goes to the textile industry, some 44% in contrast to the West European figure of 27%, and the world average of 29% (Interview, Scott). PP textiles are used in heavy duty packaging applications associated with mining and agriculture, geotextiles, cement reinforcement, filter cloth, and carpet yarns. Although such products are not the most sophisticated PP products, they may represent South Africa's 'natural' comparative advantage in PP uses. Lovegrove

2. Calculated from data in De Voest, 1990:7.

(1990) sees this PP substitution and penetration as only 'the tip of the iceberg'.

Table 6.11 Polymer End Use Comparison

Western European polymer end use (1990) (percent)	LDPE	LLDPE	HDPE	PVC	PP
Film & Sheet	72	80	16	19	17
Injection moulding	6	8	26	0	47
Extrusion Coating	8	0	0	5	8
Blow moulding	3	1	42	9	2
Wire & Cable	5	1	1	9	0
Pipe and Conduit	3	3	12	30	0
Other	4	8	4	29	1
Fibres	0	0	0	0	27
	100	100	100	100	100

Source: Wittcoff 1992.

South Africa polymer end use (1991) (percent) a/	LDPE	LLDPE	HDPE b/	PVC	PP
Film & Sheet	79	63	19	22	16
Injection moulding	5	9	34	0	40
Extrusion Coating	7	0	0	0	0
Blow moulding	3	3	33	16	0
Wire & Cable	1	7	0	14	0
Pipe and Conduit	0	2	6	35	0
Other	4	17	2	12	0
Fibres	0	0	6	0	44
	100	100	100	100	100

Sources: AECI, SASOL, Plastomark.
Notes: a/ domestic production only and excluding exports
b/ 1992 figures

A second feature of Table 6.11 is the larger proportion of PVC used to make bottles (blow moulding) in South Africa, almost double the proportion used in Western Europe indicating a concentration on packaging applications. Bottle applications are exaggerated, partly a result of the fewer number of grades produced locally and partly as a result of the local development of grades of PVC suitable for bottle applications. Both PVC 'wire and cable' and 'pipe and conduit' show higher proportions of polymer used in these applications in South Africa, indicative of agricultural and infrastructural applications. South Africa lacks PVC and PP extrusion coating grades. Consequently these grades are imported for important markets such as footwear, automobile upholstery and certain types of flooring. LLDPE film and sheet usage in South Africa is below West European levels as a result of larger application in 'other'. This 'other' is typically lower value added and packaging products aimed at primary sectors of the economy. According to interviewees aware of this demand pattern, export efforts would best be directed at countries like Israel and Turkey where a demand for such products exists.

From the foregoing discussion one can begin to shape an understanding of South Africa's historically poor export performance in Plastic Products. This is not solely attributable to higher polymer prices in South Africa. Indeed a range of issues has contributed to this bias against exports. These are dealt with in later chapters. Trade patterns, historical and potential are also the subject of a separate chapter.

Growth in Commodity Polymers explained

It has been observed above that commodity polymers have outstripped engineering polymer growth rates, as is typical of developing countries. What are the end-uses and markets in South Africa which have accounted for this phenomenon?

The major markets for plastics according to the Plastics Federation of South Africa are shown in Table 6.12 (regrettably they do not have data for the early 1980s). The most striking features of this table is the large proportion (41% in 1990) of plastic devoted to packaging and the small proportion used in building and construction. In practice this figure will be somewhat larger than the 7% recorded, as much of 'Electrical' will be plastic cable sheathing, some of which is used in the building and construction industry.

Table 6.12 Major Markets for Plastics (1990)

	(%)
Packaging	41
Engineering	8
Electrical	8
Building & Construction	7
Agriculture	7
Transport/Automotive	8
Housewares	4
Toys and leisure items	4
Clothing & Footwear	4
Furniture	3
Medical	1
Other	5
	100

Source: Plastics Federation of SA, Annual Report, 1990

Packaging's share of total polymer consumption is open to question. Based on BMI (1991) figures packaging's share of total polymer consumption was 47.6% in 1990, up from 34.5% in 1980.[3] The BMI data is very detailed whereas the Plastics Federation data is

3. Calculated from BMI (1991) and Plastics Federation of SA Annual Reports, various years.

unsupported and consequently the BMI data will be used here.[4]

In order to discover the historical pattern of commodity polymer end-use, Table 6.13 compares packaging and non-packaging applications over 1980-90. Engineering and other non-commodity plastics are not material as they account for less than 1% of plastic packaging (BMI, 1991:79). The results are most illuminating. Overall growth of commodity polymer volumes averaged 3.9% p.a. which is considerably higher than GDP growth, but in packaging applications the growth rate was more than double this, 9% p.a. In contrast, consumption by non packaging applications was slightly negative, -0.1% p.a. Thus a significant shift in end use markets for commodity polymers occurred. In 1980 only 35% of commodity polymer was used in packaging. By 1990 this had increased to over 56%.

In short, all growth in domestic commodity polymer consumption between 1980 and 1990 was in packaging. The polymers with the fastest growth in packaging were HDPE and PP, which suggests that Plastomark, Safripol's marketing arm, was aggressively marketing its products in packaging applications. One packaging firm interviewed volunteered that Plastomark was a very aggressive monopoly. It did not discount PP prices for export until SASOL began PP production and offered such discounts.

Does this mean that South Africa has become a packaging intensive society? Plastics Federation Executive Director, Bill Naude, claims that "SA uses more plastic carrier bags per capita than any other country" (Business Day, 18-11-91:10).

In comparison to Australia and the UK, a larger proportion of South Africa's plastic is used for packaging (see Table 6.14). However this does not necessarily mean that South Africa is an unduly packaging intensive society. In the Federal Republic of Germany, plastics represented 14% by weight and 27% of the total value of packaging materials (UNIDO 1989:284). The figures were almost identical for South Africa in 1990; 13.5% by weight and 29.5% of the total value of packaging materials (BMI 1991:38).

The explanation for these apparently contradictory data appears to lie, not in packaging, but in the other applications for which plastic is used. South Africa uses a much smaller proportion of plastic in building and construction than either the UK or Australia (see Table 6.14). This difference accords with South Africa's lower standard of housing. If so, a mass housing programme may be expected to increase the demand for plastics.

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4. The Plastics Federation did not respond to a letter querying the discrepancy between their figures and the BMI figures.

Table 6.13 SA Commodity Polymer Growth Rates and Market Shares, Packaging and Non Packaging Applications

	Apparant Consumption (Tonnes)									Growth Rates, 1980-90 % p.a.		
	Packaging			Non Packaging			Total			Packaging	Non packaging	Total
POLYMER	1980	1985	1990	1980	1985	1990	1980	1985	1990			
LDPE + LLDPE	58,000	65,985	116,185	35,500	46,015	30,815	93,500	112,000	147,000	7.2	-1.4	4.6
HDPE	21,735	61,935	81,600	51,665	9,565	23,400	73,400	71,500	105,000	14.1	-7.6	3.6
PP	10,000	18,790	29,830	28,100	26,210	39,170	38,100	45,000	69,000	11.5	3.4	6.1
PVC	13,580	18,230	24,900	83,920	93,270	98,100	97,500	111,500	123,000	6.3	1.6	2.4
PS	8,810	11,055	12,190	9,090	9,445	14,310	17,900	20,500	26,500	3.3	4.6	4.0
Total	112,125	175,995	264,705	208,275	184,505	205,795	320,400	360,500	470,500	9.0	-0.1	3.9
Share of commodity polymer (%)	35.0	48.8	56.3	65.0	51.2	43.7						

Sources: Calculated from data in:
Plastics Federation of South Africa, Annual Reports, various years
BMI, 1991

Table 6.14 Plastic Markets, 1989
Percent of Total Market

	SA	Australia	UK
Packaging	43	32	36
Electrical/Electronic	8	8	10
Building & Construction	8	23	25
Agriculture	7	4	2
Transport/Automotive	7	6	6
Household/domestic	14	14	13
Other	13	13	8
Total	100	100	100

Source: BMI, 1991:78
British Plastics Federation

Returning to the plastic packaging market, a breakdown of the types of packaging used is also informative (see Table 6.15). South Africa's plastic packaging market is concentrated in bags and packets and thus appears relatively underdeveloped, compared to Australia, in bottle (up to 5 litre) applications.

Table 6.15 Plastic Packaging by Pack Type, 1991 (% of Total Market)

Pack Type	Australia	SA
Bottles (up to 5 litre)	32	19
Bags/packets of film	32	43
Pails/Drums/Crates	6	5
Caps/Closures/Seals	8	5
Other rigids	8	11
Other types	14	17
TOTAL	100	100

Source: BMI, 1991:82

Plastic packaging is usually categorised in one of two categories, rigid or flexible. In South Africa flexible packaging has been the larger of the two. It accounted for about 60% of the packaging market in 1980 and in 1990.[5] Within the flexible packaging market the product areas which have experienced significant gains in the proportion of polymer used are shrink and pallet wraps, monofilm bags and form/fill/seal (FFS) applications (see Table 6.16). The latter are typically used in packaging food items such as rice, beans, maize meal, etc. and also for chemicals and fertilizers. Pallet and bundle shrink wrap has grown at a spectacular annual average growth rate of over 15% p.a. between 1985-90 (BMI, 1991:58).

5. Calculated from BMI, 1991.

Retail check out bags have been an area of comparatively slow growth (2.6% p.a.) over this period. Their share of packaging plastic fell by one third between 1980 and 1990. Thus it appears that the major growth areas have been in packaging for lower value added foodstuffs and in industrial packaging applications.

Table 6.16 Flexible Plastic Packaging Consumption, SA
(Percent)

Pack Type	1980	1990	1995 est.
Heavy duty sacks	19	11	11
Woven sacks & pockets	13	15	14
Shrink & pallet wraps	22	28	29
Monofilm bags/FFS	21	26	28
Retail check-out bags	21	14	14
Other bags	4	5	5
TOTAL	100	100	100

Source: BMI, 1991:55-57

These demand patterns have implications for export prospects across a range of industries. To the extent that South African plastic prices are higher than world prices, packaged exports will be adversely affected, albeit marginally in many cases. If palletised goods are exported they are usually wrapped in some kind of plastic sheeting. Consequently if manufacturing exports increase so will the demand for plastic packaging. However there is a proviso to this which concerns final destination. The EEC has adopted strict plastic packaging regulations and alternate packaging material may replace plastic to some extent in EEC markets.

The type of food products being bagged and wrapped in plastic are unprocessed or marginally processed type products. These include trays of cool drink and food cans which are also usually wrapped in plastic. The cost of this type of packaging has implications for the cost of living for lower income groups. Equally, food exports into Africa are likely to be these kinds of products and accordingly plastic packaging costs will need to be competitive. The rapid urbanisation of lower income groups in South Africa has been accompanied by a burgeoning informal sector which in turn has added further impetus to the trend to smaller pack sizes (FM, Packaging Special Report, 21-8-92:57).

The implications for trade policy of these findings may be noted here. Over 40% of all plastic consumption is packaging which is an intermediate input to other manufacturing processes. Accordingly any export incentives for packaging users should ideally be structured in such a way that packaging manufacturers can also benefit, because there is considerable need for assistance to the plastic converting industry if it is to become more internationally competitive, as we shall see later in this Chapter.

International polymer markets and export potential

Export potential is an important consideration in inducing firms to move towards internationally competitive production. In capital intensive process industries like the polymer industry, economies of scale are critical. The limited size of the South African market, together with the state's import substitution strategy, resulted in plants lacking the economies of scale enjoyed by internationally competitive plants. Policies encouraging investors to move towards 'world scale' plant size will only be meaningful if it can be demonstrated that markets exist for the output from such 'world scale' plants (assuming other preconditions for export such as world priced feedstocks are also available).[6]

Potential markets could be of two types: for plastic raw materials or a larger domestic plastic converting industry intent upon exporting. The prospects for both of these are discussed in this section. There is evidence to suggest that international markets exist for both polymer and Plastic Products, the major concerns in this study. Data collection and processing on the structure of international demand is another of the aspects of this industry which appears to have been largely privatised. Data in the public domain are scarce. Much of the analysis of polymer markets here relies upon a commercial source, Parpinelli Tecnon, one of the leading firms in this activity, because there is very little else available. Data on the diverse markets for plastic products is even more difficult to come by. Consequently certain products had to be used as a proxy for the industry.

International Polymer Markets by polymer type

It has previously been observed that there has been growing international trade in chemicals. Plastic raw materials are a convenient point in the production chain at which to participate in trade as the materials are often in granule or powder form which make for high volumes per shipment container.

The major markets for virgin polymer, by polymer type, are evident in Table 6.17. The two leading polymers in 1990 were PVC and LDPE, however by 2005 PP is expected

6. Historical trade patterns and export markets are the subject of a later Chapter.

to replace LDPE. The three polymers which experienced the fastest growth rates over the 1983-90 period are LLDPE, PP and HDPE (see Table 6.18). The same three polymers are also projected to continue growing faster than the others, albeit at a slower rate. LDPE, one of the older polymers is expected to reach maturity over the 1990-2005 period with limited growth.

Table 6.17 World Virgin Commodity Polymer Demand by Polymer Type (million tons) Ranked by 1990 volumes

Product	1983	1990	1995 est.	2005 est.
PVC	12.5	17.8	20.5	26.5
LDPE	11.3	14.0	14.4	15.9
PP	6.4	12.6	17.1	27.7
HDPE	6.4	11.4	14.3	20.9
LLDPE	1.5	4.7	7.8	15.3

Note: (est.) = estimted
Source: Parpinelli Tecnon, 1991:11.11

Table 6.18 World Thermoplastics Product Summary

	Annual Average Growth (percent per annum) 1983-1990	1990-1995 (est.)	1995-2005 (est.)
LDPE	3.1	0.5	1.0
LLDPE	18.3	10.4	7.0
HDPE	8.7	4.6	3.9
PP	10.1	6.3	5.0
PVC	5.2	2.9	2.6
PS	6.6	3.1	3.0
ABS/SAN	5.7	5.6	3.5
Total	6.8	4.0	3.6

Note: (est.) = estimted
Source: Parpinelli Tecnon, 1991:1.1 & 11.11

These differential growth rates are giving rise to a restructuring of polymer market shares (see Table 6.19). A clear trend is evident in which the older polymers, PVC and LDPE are relinquishing market share to the newer polymers, PP, HDPE and LLDPE. The preceeding review of South Africa's production capabilities suggests that South Africa is better equipped to compete in the PP and HDPE markets than in other polymers, such as LLDPE.

Table 6.19 World Virgin Commodity Polymer Demand, Percent share, Ranked by 1990 Share

	1983	1990	1995 est.	2005 est.
PVC	33	29	28	25
LDPE	30	23	19	15
PP	17	21	23	26
HDPE	17	19	19	20
LLDPE	4	8	10	14
	100	100	100	100

Note: (est.) = estimted
Source: Parpinelli Tecnon, 199:11.11

The closest potential export markets for South African producers are other African countries. African demand for commodity polymers has grown faster than the world average over 1983-90 at an average of 7.2% p.a., despite a GDP growth rate of only 1.8% p.a. over 1981-87 (United Nations, 1992:11). Commodity polymer demand in Africa is forecast to continue to grow faster than the world averages over 1990-95 and 1995-2005 (Table 6.20).

Table 6.20 African Thermoplastics Growth

	Annual Average Growth (percent per annum)		
	1983-1990	1990-1995 (est.)	1995-2005 (est.)
LDPE + LLDPE	6.7	4.3	5.1
HDPE	5.7	5.2	5.7
PP	14.9	9.4	7.8
PVC	4.8	4.6	3.8
PS	9.5	7.9	5.8
ABS/SAN	17	7.2	3.9
Total	7.2	5.8	5.5

Note: (est.) = estimted
Source: Parpinelli Tecnon 1991:IV.112

Africa is forecast to become the main importing region by the year 2005 (Parpinelli Tecnon, 1991:ii.29). South Africa ought to be in a position to meet some of this demand as it dominates the production of thermoplastics in Africa. In 1990 South Africa commanded 87.5% of African polyethylene capacity, 83% of African polypropylene capacity, 38% of African PVC capacity and 100% of African polystyrene capacity (Parpinelli Tecnon, 1991:Iv.112).

International Polymer Markets by Region

The major regional markets for virgin polymer are closely correlated with the level and/or rate of economic development. These are Western Europe, the USA, East Asia and Japan (see Table 6.21).

Table 6.21 World Virgin Commodity Polymer Demand by Region (million tons) Ranked by 1990 volumes

Region	1983	1990	1995 est.	2005 est.
Western Europe	13.7	20.5	23.2	29.7
USA	11.8	17.9	20.6	27.0
East Asia	4.0	8.3	11.5	18.0
Japan	5.0	8.1	9.6	12.4
Eastern Europe	3.7	5.1	6.0	9.3
Latin America	2.5	3.9	5.4	8.8
South Asia/Pacific	2.0	3.8	5.8	10.5
Africa	1.1	1.7	2.3	3.9
Canada	1.1	1.6	1.8	2.4
Middle East	0.8	1.1	1.7	3.0
Totals	45.6	72.2	87.9	125.2

Notes: (est.) = estimted
Figures include PS and ABS
Source: Parpinelli Tecnon, 1991:11.11

The per capita consumption of plastics is far lower in the less developed countries (LDCs) and newly industrialising countries (NICs) than in the developed market economies (DMEs) suggesting a potential for market development (see Table 6.8). Similarly the LDC and NIC markets are predicted to experience higher growth rates, 6.6% p.a. and 5.2% p.a. respectively, compared with 2.7% p.a. for the DMEs between 1990 and 2005 (Parpinelli Tecnon, 1991:1.2).

Outside of Africa considerable demand exists in markets into which South Africa could and does export in the Asia Pacific region (Table 6.22). Africa and South Asia/Pacific are the regions which are forecast to have the largest net imports between 1995 and 2005. East Asia will also remain an important importer. South Africa's 1991 exports of polymers amounted to 145 700 tonnes (IDC), just 3.4% of the 1990 imports into Latin America, Africa, East Asia and South Asia/Pacific, and this excludes markets in North America and

Europe. Domestic exports are discussed in detail in Chapter Seven.

Table 6.22 Net Regional trade in Thermoplastics (thousand tons)

	1983	1990	1995 (est.)	2000 (est.)	2005 (est.)
Latin America	-403	-399	-407	-352	-375
Africa	-701	-763	-1004	-1327	-1919
East Asia	-1138	-1478	-854	-919	-928
South Asia/Pacific	-1029	-1654	-1444	-1674	-1745

Source: Parpinelli Tecnon, 1990:11.29
Notes: a) negative indicates imports
b) (est.) = estimted
c) Data are for six commodity thermoplastics.

If the regional markets are disaggregated further by polymer type and reduced to imports only (rather than net trade volumes) it is evident that (in 1990) the major world importing markets were Western Europe, South Asia/Pacific and East Asia (see Table 6.23). Given South Africa's geographic location, the latter two are probably the best prospects for exporters.

Table 6.23 1990 Polymer Imports (million tons)

	LDPE	PVC	PP	HDPE	Totals
Western Europe	0.7	0.5	0.1	0.4	1.2
South Asia/Pacific	0.6	0.3	0.5	0.3	0.9
East Asia	0.6	0.3	0.5	0.3	0.9
USA	0.5	0.1	0.0	0.2	0.6
Latin America	0.2	0.1	0.3	0.2	0.3
Africa	0.2	0.2	0.2	0.1	0.4
Middle East	0.1	0.1	0.1	0.1	0.2
Canada	0.1	0.2	0.1	0.1	0.2
Japan	0.1	0.1	0.1	0.0	0.2
Eastern Europe	0.1	0.1	0.0	0.0	0.2
Totals	3.0	2.0	1.9	1.6	

Source: Parpinelli Tecnon, 1991:11.30

International Markets for Plastic Products

Although raw polymer in powder or granule form is a convenient form for export purposes, the higher value added products are those which have been fabricated from plastic raw materials. Given the diverse nature of converted plastic products, data are difficult to come by. If 'Articles of Plastic NES' (SITC 893) and 'Plastic packaging, containers, lids' (SITC 8931) are used as a proxy for converted plastic goods, then it is possible to identify major trends in the world market economies. Rapid growth over the 1984-88 period is the most obvious (see Table 6.24). As may be expected Europe and the USA are the major importers. There may be potential for South African exporters in these markets. How have these markets varied over time? Table 6.25 shows that while Europe remains the major importing region, its share of imports has declined whilst imports into Asia and the USA have increased over the 1979-88 period.

Table 6.24 Trade in Plastic Products
World Market Economies
('000) US $

SITC 893 Articles of plastic NES	1984	1985	1986	1987	1988	Annual Average Growth p.a. 1984-1988
Imports	9063041	9863538	12811972	16557534	20000413	17.2%
Exports	7625714	8653585	11456458	14559042	18171380	19.0%
SITC 8931 Plastic packaging, containers, lids.						
Imports	215960	2304768	3034313	3912944	594000	22.4%
Exports	1984109	2071812	2774372	3583736	4509982	17.9%

Source: United Nations, 1990, Vol 2., pp227 & pp788.

Table 6.25 Imports of Articles of Plastic NES (SITC 893), Share of World Market Economy (%)

Region	1979	1988
Africa	2	2
Asia	9	11
Europe	69	61
USA	12	18

Source: United Nations, 1990, Vol 2:227

If these data are disaggregated further it is possible to identify those countries which experienced a rapid growth in imports of plastic produts over the 1984-88 period with several countries imports growing at over 20% p.a. These are identified in Table 6.26. Among those countries with more rapid growth in imports are several high wage European and Scandinavian countries. Countries which experienced significant growth (over 20% p.a.) in imports over the 1984-88 period and which South African firms may consider as export targets are: Japan, Hong Kong, South Korea, Yugoslavia, Turkey, Morocco, India and the Philippines. Countries such as Japan and the Asian NICs may appear unlikely targets for South African exports, however they have experienced rapidly expanding imports and there may well be niche markets where South African products may be marketed. The data exclude many of the centrally planned or previously centrally planned economies which are also potential markets for South African plastic products..

In summary there would also appear to be large and rapidly expanding international plastic product markets into which South Africa may be able to export.

Having established that international markets exist and sketched the profile of the domestic market, consideration now needs to be given to capacity utilization projections so as to gauge the extent of opportunity. There is widespread agreement in the trade journals to the effect that world polymer markets will begin to recover from the current recession in 1995/6. This is evident in the capacity utilization rates forecast for the 1990-95 period (see Table 6.27). Ironically the older and slower growing polymers such as LDPE and PVC are forecast to experience higher capacity utilization rates to 1995 which should be to the benefit of South African producers as these are the older plants in South Africa. If the capacity utilization projections are correct, and these are notoriously difficult projections to make, then overcapacity will exist in SAN and ABS polymers through the mid 1990s which bodes well for low priced imports of these engineering polymers. However the prospects of domestic SAN or ABS production beginning without some form of state assistance or protection do not look promising before the turn of the century.

Table 6.26 Imports of Articles of Plastic NES (SITC 893)
Million US $, Ranked by 1988 Values

	1984	1985	1986	1987	1988	Ann. ave. Growth % p.a. 1984-88	>20%
USA	1695	1990	2499	3099	3580	16.1	
Germany	853	884	1258	1686	2097	19.7	
France	764	832	1215	1628	2060	21.9	*
UK	684	770	1015	1325	1706	20.1	*
Netherlands	546	615	873	1141	1196	17.0	
Belgium-Luxembourg	392	416	603	792	1017	21.0	*
Italy	276	312	446	599	735	21.6	*
Switzerland	287	310	459	594	649	17.7	
Canada	504	541	597	709	613	4.0	
Sweden	244	268	348	462	606	20.0	*
Japan	143	153	219	334	535	30.2	*
Austria	180	188	269	361	482	21.9	*
Hong Kong	147	184	216	331	455	25.4	*
Norway	141	158	249	315	365	20.9	*
Australia	190	193	213	257	342	12.5	
Denmark	132	146	236	294	315	19.0	
Spain	33	42	66	90	283	53.5	*
Singapore	122	113	132	169	243	14.9	
Ireland	113	124	163	211	243	16.5	
Finland	87	97	134	186	239	22.4	*
Mexico	146	183	33	40	184	4.7	
Saudi Arabia	206	162	121	118	148	-6.4	
Korea Republic	53	50	76	87	145	22.4	*
Malaysia	83	58	36	99	122	8.1	
SA Customs Union	**47**	**34**	**66**	**55**	**91**	**14.2**	
Israel	45	45	69	90	80	12.4	
Greece	29	31	41	56	70	19.6	
Portugal	15	14	31	59	62	33.3	*
United Arab Emirat	41	50	45	58	61	8.2	
New Zealand	34	37	47	58	60	11.9	
Yugoslavia	20	19	26	34	58	24.2	*
Thailand	39	38	53	92	54	6.6	
Egypt	33	29	33	38	41	4.0	
Kuwait	38	30	35	41	38	-0.2	
Indonesia	21	17	24	18	33	9.7	
Brazil	20	15	23	30	33	10.6	
Turkey	11	14	23	27	32	24.9	*
Chile	18	15	17	20	32	12.1	
Iceland	11	13	20	30	30	22.8	*
Iraq	50	49	38	32	30	-9.7	
India	10	12	23	28	29	23.5	*
Libyan Arab Jamahi	29	18	18	26	27	-1.2	
Bahrain	12	31	30	32	26	16.9	
Morocco	9	17	18	20	26	24.2	*
Philippines	8	7	11	40	23	23.8	*
Algeria	37	35	36	21	20	-11.9	
Pakistan	16	18	15	12	19	4.2	
Nigeria	12	11	18	18	19	10.4	
Trinidad & Tobago	29	23	20	17	12	-15.8	
Oman	18	22	22	20	10	-10.4	
Total	8 668	9 434	12 283	15 899	19 376		

Source: United Nations, 1990, Vol 2., pp227
Note: * = > 20%

Table 6.27	World Capacity Utilization Rates (percent)					
	1983	1990	1993	1995 (est.)	2000 (est.)	2005 (est.)
LDPE	81	87	85	84	87	89
Flexible	73	88	72	69	79	90
HDPE	83	89	79	80	88	92
PP	84	89	77	79	86	92
PVC	75	84	82	83	89	92
PS	69	84	79	80	84	89
ABS/SAN	79	73	71	72	79	87
World Average	78	86	79	79	85	91

Note: (est.) = estimted
Source: Parpinelli Tecnon, 1991:11.5

Upstream and Downstream, the changing relationship

Increased trade in Plastic Products during the 1980s has been observed above. This provokes the question: is this part of a longer term trend, what is this trend and how does South Africa's development compare?

One approach to identifying the changes in production underlying this trade trend is to measure, over time, the relationship between the downstream sector and the upstream sector of the industry. In this case, a proxy for the downstream plastic converting industry, the Plastic Products industry (ISIC 356) has been expressed as a percentage of the upstream Industrial Chemicals (ISIC 351) sector (which includes plastic raw material production). Table 6.28 measures the value added ratio of Plastic Products to Industrial Chemicals in a sample of countries over a period of years. Data are unfortunately not available for all the sample countries listed in Annexure E. In smaller economies the establishment of a single world scale plant can have such a large impact as to cause large fluctuations in the data. For these and other reasons data for certain countries have been excluded, viz Hong Kong, Cyprus, Peru and Sri Lanka. However the data for the sample of DMEs are of better quality and the size of these economies, for the most part, is sufficient to absorb capacity additions which would cause large fluctuations in smaller economies. In these larger economies such as the USA, UK, Japan and Germany a clear trend is evident over the 1970-90 period. Plastic Products share of manufacturing value added (MVA) has increased relative to Industrial Chemicals. In the UK for example the ratio increased from 20% to 50% and in Japan from 31% to 76%. In countries which are known to have followed deliberate industrial strategies such as South Korea, Taiwan and Israel this trend is even more apparent. It is also apparent in certain of the second tier NICs, Indonesia and Uruguay. This trend represents an expansion of downstream, higher value added, type activities relative to upstream more capital intensive production. Exceptions to this trend are the Scandinavian countries where the relationship has been static or declining. A possible explanation for this may lie in the limited size of these economies and where an additional petrochemical complex would significantly affect the relationship.

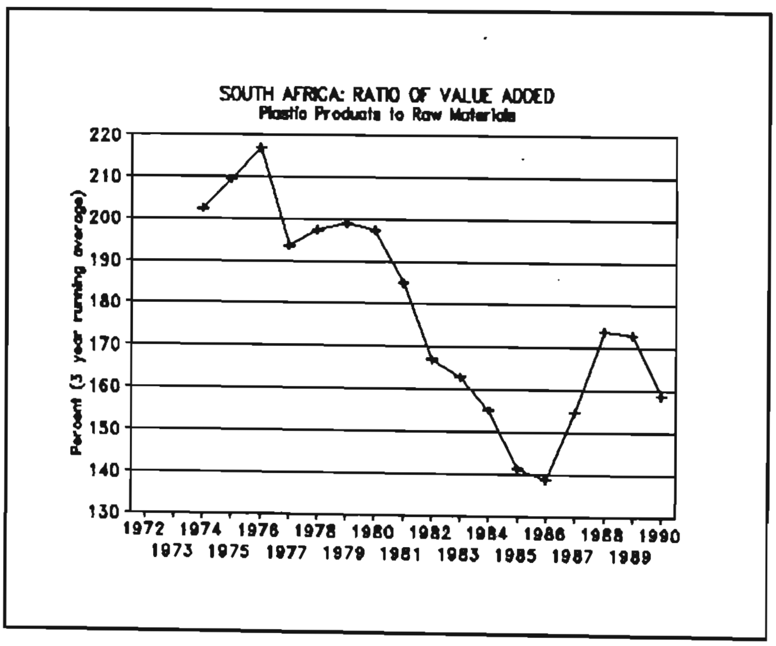
Table 6.28 Value Added Ratio: Plastic Products to Industrial Chemicals (SIC 356/SIC 351)
(percent)

Country	1965	1970	1975	1980	1985	1990
NICs						
Argentina		45.3	42.4	46.4	35.5	
Brazil	35.7	44.8	56.9	58.2	39.1	
South Korea	10.4	15.6	16.0	36.0	55.6	55.8
Mexico	30.0	25.4	33.7	25.7	24.3	
Singapore	78.2	75.0	91.1	159.6	74.0	
Taiwan	33.6	81.1	142.1	147.5	159.3	149.5
Average	37.6	47.9	63.7	78.9	64.7	102.6
2nd Tier NICs						
Columbia				46.5	41.8	46.3
Indonesia		22.1	16.0	17.1	40.8	
Jordan	0.0	0.0	135.2	115.8	91.8	
Malayasia	0.0	43.8	37.3	89.1	14.9	
Morocco				15.8	9.2	
Phillipines	15.1	20.7	54.2	28.6	31.9	
Thailand		86.3	114.9	63.2	55.2	
Tunisia	3.7	14.3	30.0	43.2	74.8	
Uruguay		67.5	38.0	116.2	94.5	81.6
Average	4.7	36.4	60.8	59.5	50.5	63.9
DMEs						
Australia	39.4	70.0	92.1	85.8	82.3	44.8
Austria	27.1	32.5	35.5	42.3	36.9	28.5
Belgium	24.3	23.4	27.3	33.9	28.4	
Canada	20.8	39.4	40.8	40.3	64.4	45.4
Denmark	71.3	57.0	52.7	48.5	59.6	58.8
Finland	25.0	40.0	22.2	29.5	29.9	25.9
France	51.2	49.2	49.0	47.7	51.7	55.4
Germany(West)	26.7	32.3	31.9	43.7	34.0	43.6
Greece	53.6	64.3	73.5	115.5	63.7	92.2
Iceland		65.3	58.4	107.2	121.7	
Israel	60.3	74.3	67.8	82.8	91.5	124.6
Italy		145.7	26.6	24.5	43.3	56.8
Japan	21.4	31.4	56.0	68.6	80.7	76.2
Netherlands	19.9	17.6	17.5	20.9	19.1	22.8
New Zealand	89.8	102.4	73.3	78.8	102.9	
Norway			45.5	37.7	34.7	29.9
Portugal	37.9	45.0	55.1	87.5	38.3	
Spain	37.5	51.3	38.4	54.7	46.9	43.8
Sweden	61.5	40.0	38.2	40.8	39.6	37.3
Switzerland	21.9	22.8	40.9			
UK		20.5	22.2	44.9	42.1	50.2
USA	18.7	27.6	29.7	37.4	57.1	49.6
Average	40.4	50.0	44.4	55.2	55.7	52.1
South Africa	**30.3**	**28.7**	**35.2**	**31.4**	**35.6**	

Source: UNIDO Industrial Statistics, 1992.

It is difficult to determine from the South African data whether this trend has been marginally present or not, as the ratio hovers between the 30% to 35% level. It is known that there are problems in many South African data bases with ISIC 351 and ISIC 352 as the secret refinery sector (ISIC 353) is usually hidden in one of these two categories. In Figure 31 another data set shows the relationship between Plastics Raw Materials (ISIC 3513) and the next link down the chain, Plastic Products (ISIC 356). In this figure Plastic Products MVA as a proportion of plastic raw materials is declining over time. The upstream sector has been growing relative to the downstream sector, quite the opposite of the trend evident in the sample averages in Table 6.28.

Figure 31



Source:	IDC, 1992		
Notes:	Plastic Products	=	ISIC 356
	Raw Materials	=	ISIC 3513

The expansion in trade of Plastic Products and the historical shift in the relationship between upstream and downstream sectors has industrial strategy implications for South Africa which are taken up in the final chapter.

Conclusions

The foregoing discussion provides a basis for the development of a general view of the plastic raw materials link in the production chain up to 1993. A slow process of restructuring was gaining momentum as plant sizes increased towards 'world scale', driven by tariff reductions or the threat of them. At the same time a more outward orientation was emerging which is likely to have a favourable impact on quality and efficiency. Newer plants have better technology, but even the older ones could be more competitive if they had access to world priced olefins.

All of the polymer plants attempt to serve the domestic market. As a result they produce a larger number of grades than their international competitors resulting in lower efficiencies and reduced quality consistency. Plant optimisation becomes a trade-off between the length of production runs and stocks. The dilemma polymer producers face is that in order to develop local markets they need to increase the number of grades, whilst plant optimisation demands the opposite. Ironically within this weakness, (a larger number of grades) lies a potential strength. This potential strength lies in the growing world tendency to produce materials that meet customers' specific needs, for example through the development of 'speciality grades'. As Ken Sinclair from the US consultancy SRI International puts it:

> "Mastering the business procedures required to deliver just the right material at competitive cost will become central to the success of future polyolefin materials companies." (Quoted in Eisberg, 22-6-92:19)

Better manufacturing practice in terms of faster changeover times between grades and less 'twilight' material production in the process may be the key to lower costs which may yield access to new markets.

South African polymer manufacturers have had some success in the modification and development of known catalyst systems, improving yield and adapting products for local conditions. In future R&D requirements are likely to continue to focus around the further development of existing catalyst and reactor systems, that is building upon known operations, rather than the more expensive and difficult exploration of entirely new areas of the unknown.

The weakest areas of commodity polymer production appear to be LDPE and LLDPE where lack of economies of scale and the absence of any announced plans for investment are cause for concern, particularly in view of the fact that together, these are the largest volume commodity plastics in the domestic market. AECI appears to have followed a strategy of entering domestic polymer markets early, and building sufficient capacity to warrant production to be monopolistic whilst sheltering behind trade barriers. Since these businesses could continue operating without major new investment nor substantial research expenses, they could, in the Boston Consulting Group terms, become 'cash cows' which were 'harvested'. In general AECI was, in the early 1980s, 'milked for dividends' when a very small proportion of earnings was retained by the company (FM, 24-1-92:25). This was despite the fact that the conglomerate shareholders, Anglo American and ICI, presented themselves as long term investors. AECI may need to be nudged into a more competitive mode by industrial policy measures. Almost inevitably some investment will be required.

In a comparison of local and international chemical companies, SASOL stands out by virtue of its poor increase in sales over the 1984-90 period and its very poor asset turnover ratios. Compared with the leading 20 international companies the three large South African chemical companies have poor labour productivity but low average wage costs. SASOL's unit labour costs grew at twice the rate of the leading international companies in the sample whereas AECI and Sentrachem had the lowest growth rates in unit labour costs in the sample.

South Africa's plastic demand pattern reflects its per capita income distribution. The great bulk of demand is for commodity polymers. Engineering polymers occupy a small (2%) but recently faster growing, market share.

International polymer demand projections show export potential in a variety of markets including those which South Africa has exported to in the past. Africa is predicted to become a large importing region in future. South Africa's geographical advantage could be strengthened if it gains political acceptability among African countries. There has been strong growth in trade in certain converted plastic products during the 1980s. This suggests that potential export markets exist for plastic converters. The major markets are in Europe and the USA in which South Africa's relatively low wages (in dollar terms) should give it some advantage. This point is pursued in a later chapter.

In the domestic market a significant shift in end use markets for commodity polymers has occurred. The proportion of commodity polymers used for packaging expanded from 35% to over 56% between 1980 and 1990. In fact all growth in domestic commodity polymer consumption between 1980 and 1990 was in packaging. South Africa's plastics market is skewed in favour of packaging applications at the expense of housing and construction applications.

Polypropylene has experienced rapid growth in textile applications. Much of this serves packaging needs for the mining and agricultural industries.

There is evidence to suggest that in a range of countries the trend has been for the share of MVA contributed by the downstream, higher value added sector, Plastic Products, to increase relative to the upstream sector. In South Africa the evidence suggests that the trend has been static or in the opposite direction. The reasons for this are several and interrelated. The dominance of military/strategic state policy has had repercussions on the industry. It led private companies to develop competing proposals designed to accommodate such policies in the hope of a 'hupstoot' from the state. Attention was thus focused at the upstream end. This together with uncompetitive polymer prices for downstream producers has led to the 'underdevelopment' of the Plastic Products industry with the consequent loss of employment opportunities. This industry is considered in more detail in a subsequent chapter.

CHAPTER 7

AN INGENIOUS SOLUTION - POLIFIN

Introduction

The South African petrochemical industry entered a new era on 1st January 1994 when a new joint venture between SASOL and AECI, Polifin, came into existence. Polifin is the product of a number of forces acting upon SASOL and AECI which have been analyzed in preceding chapters as well as some new forces which came into being in 1993. Before proceeding to identify the new forces and to analyze what Polifin means to the commodity plastics *filière* it is as well to take stock of the petrochemical industry as it was in 1993.

By 1993 the major proportion of South Africa's petrochemicals were sourced from SASOL's unique oil from coal process. Indeed SASOL straddled a 'watershed', with petrol and liquid fuels flowing in one direction and petrochemicals in the other direction, the one intimately and inextricably interconnected with the other. In both directions different state regulations propped up SASOL's sales and profits, allowing it, from 1988 onwards, to embark upon an ambitious investment spree, largely down the more profitable petrochemical path.

In Chapter Five various forces were identified which began to build up pressure upon the main players in the petrochemical and polymer industries. In the face of these pressures SASOL's strategy from 1988 was to embark upon a new strategy of diversification into higher value added chemicals. It has been suggested that the reasons for this included an assessment of the changing political circumstances evolving in South Africa in the late 1980s and SASOL's recognition of the extent to which it stood exposed and vulnerable if an unsympathetic government should come to power.

On the business front SASOL faced pressures as a result of the collapse of the oil price in 1986 and its inability to lift sales above the plateau they had reached in the late 1980s. Simultaneously SASOL was under pressure from customers to invest in more olefin extracting investments but at the same time hamstrung in its ability to vertically integrate downstream by its 'understanding' with AECI that it would not compete in polymer markets until a further source of olefins became available and there seemed little prospect of that. This 'understanding' cut right across the most obvious path (polymers) for SASOL's new strategy of diversification into higher value added chemicals. Consequently it was almost inevitable that some form of accommodation would have to be reached with AECI, its major petrochemical customer.

In addition to these pressures SASOL had, in 1990, embarked upon its own polymer business (the PP plant). This and its other chemical businesses faced a number of threats from South Africa's engagement in the GATT negotiations.[1] Its tariffs could be lowered and perhaps more seriously, it could face countervailing measures (in terms of the GATT rules) against its exports of chemicals, if it was found to be receiving a subsidy. It would be a relatively simple argument to make to suggest that motorists contributions to SASOL's income, via the Equalisation Fund, of between R 500 million and R 1 billion p.a. constituted a subsidy.

AECI's polymer businesses were also threatened by the pending GATT agreement. Through the 1980s AECI had largely declined to invest in these businesses and indeed, had been accused of 'milking them for dividends'. It has also been shown that whilst none of these businesses was internationally competitive in their own right, they were further hampered in this objective by the high cost of olefins purchased from SASOL. In the case of PVC, a material for which demand was expected to grow in the post apartheid reconstruction phase, AECI was employing a dated technology. Simultaneously with these developments, AECI's major technology partner, ICI, and one of its two major shareholders, decided, in the light of the changing international environment, to split itself into two companies and to begin a process of disengaging itself from commodity chemicals. For AECI this meant that ICI was reluctant to continue part ownership of the polymer businesses, just at the time when AECI was investigating a new PVC technology and plant which would need investment capital. Given AECI's declining share performance, shareholders did not seem to be a likely source of capital either.

These then were some of the pressures acting upon SASOL and AECI which came to a head in the early 1990s. This chapter discusses these pressures and the industrial restructuring industry which occurred as a consequence.

<u>Possible changes in the Liquid Fuels Industry Regulatory Regime</u>

The possibility of a change to the regulations governing the liquid fuels industry

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1. The general requirement for participation in the Uruguay Round of the GATT negotiations was a commitment to a 33% reduction in manufacturing tariffs over five years. There are of course many exceptions to this general requirement.

strengthened in 1993. Political developments had unfolded; a new government was in place, sanctions had been lifted and some of apartheid's most closely held secrets were coming out into the open, included among them, those concerning the liquid fuels.

In May 1993, the Department of Mineral and Energy Affairs made public considerable information about the industry and its regulation and called for public comment[2].

On 15th September 1993, the Department of Mineral and Energy Affairs implemented a 7 cents per litre (c/l) increase in the petrol price. This led to a public outcry, public demonstrations and blockades by taxi operators and a threatened strike by organised labour. As a result the National Economic Forum set up a Liquid Fuels Task Force, (LFTF) which began to negotiate a reduction in the petrol price as well as a new regulatory regime for the industry. In the LFTF SASOL has had to defend itself (and its subsidiaries) against its competitors (the crude oil refiners) and against organised labour, and against a new government searching for additional funding for its Reconstruction and Development Programme.

From the commodity plastics *filière* point of view, possible changes to the liquid fuels regulatory regime constitute an opportunity to influence the pricing structure at the upstream end and it remains to be seen whether this will materialise or not (explained below).

Polifin

A new joint venture company between SASOL and AECI, called Polifin, was agreed in principle in mid 1993 and came into formal existence at the beginning of 1994. It creates a vertically integrated petrochemical and plastics business holding the potential for internationally competitive prices for certain commodity polymers. Polifin embraces all of the first link (petrochemicals) in the production chain and most of the second link (polymer manufacture).

SASOL contributed its ethylene and propylene facilities as well as its polypropylene plant, while AECI contributed its polymer plants (PVC, LDPE and LLDPE) in Sasolburg as well as its chlor-alkali facilities there, various related plants and importantly, its downstream plastic converting subsidiaries. SASOL owns 60% of Polifin and AECI the remainder, based upon the assets each brought to Polifin. Polifin is planning to close AECI's unprofitable

2. Nothing in the information made available thus far seriously jeopardises any of the facts used in this study despite the fact that most of the period during which the research for this study was carried out, fell within the 'secret' period of the liquid fuels and petrochemical history. For example the refinery capacities mentioned earlier are for the most part correct or close to the figures now available.

carbide acetylene PVC plant and to invest, in 1996, in a new ethylene based PVC facility.

The effect of Polifin's establishment is to create a considerable measure of vertical integration in the commodity plastics *filière*. This will start from petrochemical production (ethylene and propylene) through polymer manufacture to certain important converting firms. The international trend towards this type of arrangement (because it enhances competitiveness) was identified in Chapter Two. Safripol (the HDPE and PP producer) has been left out of the new arrangement leaving it exposed and somewhat vulnerable.

The advent of Polifin will impact on developments at both the upstream and the downstream ends of the commodity plastics *filière*. At the upstream end, barriers to entry are raised and SASOL's subsidy is 'inherited' by Polifin (discussed below). At the downstream end the access of small producers to fair polymer prices is at stake. Each of these points is elaborated on below.

At the upstream end of the *filière* the pricing of petrochemicals (ethylene and propylene in South Africa) at the point of entry to the *filière* is critical as these costs cascade all the way down the *filière*. SASOL has resolved this issue by contracting to sell its appropriate hydrocarbon streams at the 'fuel alternate value'. The price comparisons made earlier show this to be very competitively priced feedstock, on average about 80% below US Gulf ethylene prices.[3]

A brief, somewhat technical digression is necessary at this point. The gas stream which SASOL will sell to Polifin is impure ethylene, largely ethane (C_2H_6). The ethane stream has to be cracked, by Polifin, to ethylene (C_2H_4), a relatively cheap process. The beauty of making the transfer of ownership from SASOL to Polifin at this stage, and not one stage later, ie ethylene, is that it is easier for SASOL to argue that the 'fuel alternate value' is the correct price to be paid for this gas stream.

This ingenious 'fuel alternate value' arrangement has a number of important implications. Firstly, competitors who contest for Polifin's markets will have to do so in the knowledge that Polifin has access to feedstock at prices low enough to sustain low polymer prices for extended periods. This in turn makes the costs, for an intruder intending to capture Polifin's markets, very high, especially in view of Polifin's vertical integration which gives it the flexibility to counter low prices in one area with higher prices in another. In short the barriers to entry in the commodity plastics *filière* have been raised considerably.

Secondly, in so far as the domestic market is concerned, Safripol (the other major

3. In practice this percentage should be reduced by the costs of cracking and purification. Nevertheless the result would be very cheap ethylene.

olefin customer) is placed at a considerable disadvantage, in that it will now have to buy its ethylene and propylene from its major competitor, Polifin. Understandably Safripol made much of this in its representations to the Competition Board and won, in return, an undertaking from Polifin, that Polifin would not discriminate in its pricing between its own subsidiaries and Safripol. The formula for setting the prices Safripol pays for ethylene and propylene will be left unaltered. Consequently Safripol's olefin prices will depend upon import parity pricing which in turn depends upon the extent of tariff protection. The advantage for Safripol is that if polymer tariffs are lowered it can pass some of the costs back upstream to Polifin.

This is something of a hollow victory for Safripol in that it is excluded from the real benefits Polifin creates for its owners. The advantage of vertical integration is that the source of profit may be switched from one point in the production chain to another, as circumstances dictate. Polifin obtains its raw materials from SASOL at about 80% below US Gulf prices, (less small processing costs) and then markets its polymer at about 50% above US prices (local prices being a function of the tariff). This difference represents considerable sums of money and is a strong argument for the removal of tariffs on Polifin's polymers. In short, if in the pre 1994 scheme the olefin price formula operated as a 'dam' of value added in SASOL's favour, now under the 1994 arrangement, this 'dam' will be shifted one stage further downstream to Polifin.

Raised barriers to entry impact upon the possible sources of South Africa's next tranche of petrochemicals. It would appear that the next petrochemical facility in South Africa, if it intends to contest the local market, will have to be decided upon in consultation with Polifin and largely with its consent. The need for Polifin's consent could be avoided in two scenarios.

Firstly if a petrochemical complex could be built primarily for export then a minority of its output could contest for the domestic market. Secondly if the domestic petrochemical and plastic market grows and a new petrochemical complex is delayed until Polfin can no longer satisfy the entire local market, then an opportunity may exist for a new entrant to compete. This is likely to be several years after the year 2000.

At face value, the advent of Polifin offers hope for downstream plastic converters:

> "The merger will place the joint venture in a position to offer world competitive prices to downstream producers for higher value added exports" (SASOL/AECI Merger, briefing document, June 1993:2)

However these hopes will only be realised if tariffs are reduced, something which Polifin expects. Representations on the need to reduce tariffs were made to the Competition Board by the Association of Plastic Processors of South Africa (APPSA) and the Chemical Workers Industrial Union. If Polifin is sheltered behind high tariffs then as the local monopoly it may be expected to charge whatever the market will bear. In the course of the preceding analysis the tariff on polymer was identified as the critical lynchpin of the pricing structure in the *filière*.

The Board's stance was that such considerations were matters of trade policy and industrial policy which were beyond its purview. The joint venture was approved without any such requirement. In consequence the patterns of the past will be perpetuated - a large(r) commodity plastics monopoly will continue to live, comfortable within its protected domestic market - unless tariffs are reviewed by the Board of Tariffs and Trade.

During that period downstream converters will continue to be held captive by Polifin's polymer pricing policies without recourse to imported polymer at world prices and so the opportunity for lower commodity polymer prices may be lost. This despite the fact that Polifin should be able to compete adequately without protection in view of its cheap hydrocarbon streams at the upstream end. It remains to be seen whether the Board of Trade and Industry will lower the polymer tariffs or not.

Equally important for plastic converters is the pricing policy Polifin will follow in respect of its own subsidiaries and their competitors. Part of the rationale for vertical integration is after all the opportunity for intra-firm transfer pricing. If Polifin gives its subsidiaries favourable polymer pricing (not prohibited by the Competition Board), which seems a reasonable expectation, then they may gradually take over their competitor's businesses and concentration will be increased. The Competition Board also rejected this argument on the basis that such conduct would first need to be proved and secondly that discriminatory pricing is acceptable in accordance with the internationally accepted principle of similar prices for similar volumes. In practice this will mean that small converters will continue to pay higher unit prices than large ones and will remain handicapped to this extent.

Whilst the solutions to such issues are not necessarily simple, these Competition Board rulings do illustrate the importance of synchronising competition policy with industrial strategy or policy.

Returning to the upstream, the advent of Polifin also raises important public policy issues related to SASOL's subsidy. SASOL's decision to sell hydrocarbon streams to Polifin at the 'fuel alternate value' has several implications. It suggests that SASOL is prepared to share with AECI some of the windfall profits that have accrued to it from the price paid for its assets at privatisation but more importantly from its regulatory support. AECI as a chemical company has been considerably reduced in stature, having lost control of a considerable proportion of its business. On the other hand it will have access to profits, from what are expected to be profitable facilities in Polifin, which may improve its market rating. SASOL will increase in stature in chemicals and also have an outlet for its excess ethylene capacity, in the planned PVC plant. It may also improve operating efficiencies and throughput at the ex-AECI polymer plants by bringing to bear its considerable skills in this area.

The structure of Polifin's raw material pricing scheme also signals SASOL's emerging corporate strategy, particularly in relation to its core synfuels business. In Polifin SASOL has separated out its petrochemical facilities into a separate company following the route of its fertilizer and explosives businesses, but going one step further, in that it intends to list Polifin on the Johannesburg Stock Exchange (JSE). It has also announced that it intends to launch its crude oil refinery (NATREF) as a separate company on the JSE. These arrangements relate to SASOL's downstream businesses. In so far as the upstream is concerned, oil companies have accused SASOL's coal mining operations of inflating the price of coal to SASOL.

Such moves to relocate profits away from synfuels operations are leaving the synfuel activities increasingly isolated and hamstrung, from a financial point of view. Hamstrung in the sense that the synfuel operation is now bound by commercial agreement to sell more valuable petrochemicals to Polifin at the 'fuel alternate value' which is less than their 'theoretical' commercial value. In short the synfuel operation will be subsidising Polifin. The significance of this is that whereas in the past only the synfuel operations were subsidised, now that subsidy has been extended to Polifin as well by virtue of the 'subsidised' 'fuel alternate value' petrochemical price.

It has been argued that SASOL's synfuel impact upon the economy is too large to allow it to be closed. If it requires a subsidy or some other form of protection (to remain operational) then a part of this subsidy/protection will in effect be passed on to Polifin. This will mean that the subsidy/protection will have to be larger than might otherwise have been the case without the contractual obligation to supply Polifin at the 'fuel alternate value'. Worse still, those who pay the subsidy/protection (motorists?) will, indirectly and unwittingly, be contributing to the profits of Polifin and the wealth of its shareholders. Given the extent of public outcry about the petrol price, those responsible for designing a new regulatory regime involving a subsidy for SASOL are likely to be unable to justify anything more than a mediocre profit for its synfuel operations. If this is so, Polifin cleverly perpetuates the subsidy and wealth transfer function but through a new mechanism at one step removed. In short the public will continue to subsidise big business, now SASOL and AECI, in Polifin. This 'public interest' issue was also considered by the Competition Board to be beyond its purview.

In addition the commercial viability of the synfuel operations will also be reduced if in fact it is paying its coal mining subsidiary inflated prices for raw materials (coal). The pattern that is beginning to emerge is one in which SASOL appears to be deliberately 'ring fencing' its synfuel operations with commercial supply agreements and prices unfavourable to the synfuels operation. Thus if an investigation into the viability of the synfuels operations and their need for some form of subsidy or protection took place, the synfuel operations would appear in a poor light, so increasing their prospects of some form of support.

But from SASOL and AECI's points of view Polifin is an ingenious solution from which both will gain something. SASOL at last has a way into the broader polymer business which it has been keen to develop (Interview Brand). AECI has a significant shareholding in a business which is likely to make money and will also benefit from the indirect subsidy passed along by SASOL. AECI's position in other chemical markets such as chlorine is also strengthened against their other competitor (Sentrachem).

The dangers for Polifin in the 'fuel alternate value' pricing mechanism is that its international competitors may accuse Polifin of benefiting from a subsidy and may also launch counter vailing measures or anti-dumping charges under the GATT rules. SASOL's reply, which is not entirely without merit, is likely to pose the question: what then is the appropriate price at which it should sell its olefins? The 'fuel alternate value' formula has the straightforward defence that, indeed if those gas streams were not used for chemicals they would be used for liquid fuels as has happened in the past. That would carry the debate onto the treacherously complex ground of the myriad regulations of the liquid fuels industry which SASOL know well but would take considerable unravelling for the uninitiated.

Nevertheless the most obvious and vulnerable point for SASOL and Polifin is the 'tariff protection' which SASOL receives from motorists via the Equalisation Fund. It may be expected that SASOL will try to have this subsidy restructured into a more acceptable form such as conventional tariff protection, in this case on crude oil imports. This will raise costs for the crude oil refiners and they may be relied upon to oppose this. Higher costs will be passed on to motorists and they too may object. Another option would be to 'ring fence' the crude oil refineries and regard them as 'off shore' for tariff purposes and to impose a tariff on refined products at the refinery gate. There are other options too but a discussion of these takes us beyond the scope of this study. Suffice it to note that the complex interrelations between the petrochemical and liquid fuels industries and their evolving ownership patterns may be expected to continue to complicate efforts at sound industrial policy.

Until the latent threat of GATT measures against Polifin are resolved they may influence its marketing strategy. Obviously such a threat only exists to the extent that it exports polymer. In a global context the scale of Polifin's polymer exports are too small to seriously disrupt large markets thus giving it a measure of protection. If there is growth in the local market SASOL may then be expected to compete more vigorously for that market. This may put it on a collision course with Safripol in PP markets and possibly HDPE markets if SASOL invests in HDPE. It may also build in a reluctance to export polymer which at first glance may seem threatening to South Africa's chemical trade imbalance, but may also hold an opportunity to relocate exports one link further down the production chain to the plastic converting industry.

Conclusion

Pricing is crucial to the future of a plastics industry. This makes it important to view the commodity plastics *filière* as an entity. Taken together the two new developments accompanying the advent of Polifin - increased vertical integration and advantageous feedstock prices - do hold new opportunities in that they begin to advance the *filière* closer to internationally competitive pricing and a more vibrant downstream industry. However for a truly dynamic *filière* to materialise, several other important issues need to be addressed if the objective is to pass the advantages which exist downstream to the more labour intensive and higher value added plastic converting industry. Polymer tariffs will be a key element among these issues.

The advent of Polifin also raises once more, unfortunately in a more complex fashion, important public policy issues relating to the nature of the SASOL enigma.

Finally the Polifin episode has demonstrated the limitation of the Competition Board as it is presently structured. If industrial policies are to be pursued then a way will need to be found for the Competition Board to synchronise its activities with industrial policy objectives.

CHAPTER 8

THE PLASTIC CONVERTING INDUSTRY

Introduction

The final link in the commodity plastics *filière* is the plastic converting activity which is spread through a number of industries, from packaging to automobile components and construction. This plastic converting industry is the subject of this chapter. The Plastic Products Industry (ISIC 356) spans the bulk of these activities and is a statistically convenient category. For these reasons it is frequently used as a proxy for the plastic converting industry. However some plastic converting also takes place in the automobile and auto components industries, the glass industry (which also makes car bumpers and attachments) and in the household chemicals and pharmaceutical industries (bottles) among others.

It has earlier been established that this link of the chain is where the most value is added and where the capital labour ratio is lowest. It has also been the link furtherest from the focus of military/strategic interventions and state concerns although it has not escaped the indirect impact of same. Other than this it has not been the subject of any particular state policy intervention, other than manufacturing wide initiatives. In this way it was nurtured and developed within the prevailing protective ISI policy framework. In latter years it has benefited, to some extent, from initiatives designed to assist exporters[1]. This lack of a specific and targeted developmental policy appears to have stunted the development of this sector in comparison with Taiwanese and South Korean initiatives which have targeted such labour intensive sectors for expansion. Indeed the ISI mind-set appears to be deeply embedded in the attitudes of many managers. This has been compounded by the structure of production costs that has prevailed historically.

Opportunities for much needed job creation exist in this sector. This chapter explores some of these and begins to identify policy areas which are dealt with more fully in the final chapter. The last chapter grapples with the difficult and complex changes to state policy necessary if the Plastic Products industry is to be energised into a flourishing and innovative industry.

If manufacturing is to be the base of economic development for the future then

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1. In 1978 the Van Huyssteen Committee's proposals were implemented with the adoption of a system of assistance Categories (A-D) to exporters. This was replaced by the General Export Incentive Scheme (GEIS) in April 1990.

fabrication industries producing more elaborately manufactured articles are likely to be instrumental in such development. The vast range of products produced by the Plastic Products industry make it imperative that this industry be advanced and efficient. Appropriate measures designed to try and bring this about will have to based upon a thorough knowledge of historical development of this sector.

At the same time this sector provides many basic wage goods, such as packaging and building materials. If in future it is intended that the primary beneficiaries of industrialisation are to be the most disadvantaged in society then such goods will have to become available at lower cost. This will require enhanced efficiency of production and the adjustment of other factors which have raised costs in the past.

In this chapter the size of the Plastic Products industry (ISIC 356) is compared with a sample of other countries to assess its past performance and the possibilities for future growth. Historical manufacturing efficiency and productivity trends are established and a comparison of labour productivity is made with countries which export into South Africa. Various other aspects of the industry such as concentration, cooperation and manufacturing practice are explained and/or discussed with a view to assessing how vibrant the plastic products industry is and what potential it may have. Obstacles to exports that have developed over time and other factors which are leading some firms to increase exports are also identified as well as areas of potential export growth.

The issues which emerge in this discussion are drawn together in the conclusion where determinants of future industrial policy for this industry are established.

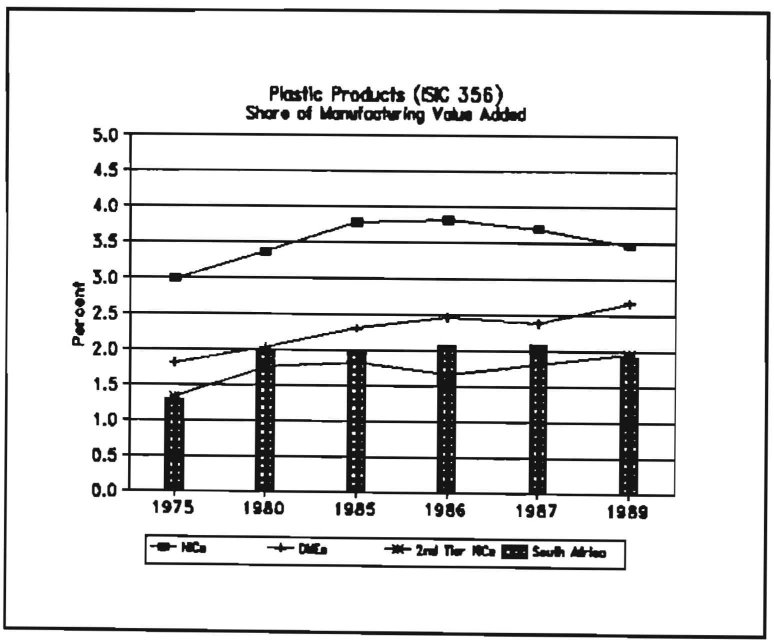
The field work and interviews referred to in this chapter are based upon interviews with representatives of a random sample of thirty firms in the plastic converting industry conducted in 1992. Details of this survey are given in Appendix F. In addition several leading figures in the industry were also interviewed.

The South African Plastic Products Industry (ISIC 356) Compared Internationally

The plastics converting industry has been characterised by far greater diversity of technologies and markets served than the polymer industry. It is also more labour intensive and more fragmented. Plastic products serve a wide variety of markets so growth tends to be constrained by GDP growth unless a lower cost structure allows substitution for traditional materials (metal, glass, cement, wood etc) or exports. The ISIC category which most closely approximates the plastic converting industry is Plastic Products (ISIC 356). It is used here as a proxy for the plastic converting industry.

The Plastic Products industry's contribution to manufacturing value added is about 2%, similar in share size to second tier NICs and developed market economies (see Figure 32). The NICs stand out in this figure by their average contribution to MVA was over 3.5% in the late 1980s. This suggests that the possibility exists, theoretically at least, for South Africa to almost double the size of its plastic products industry. In all three categories of countries, NICs, 2nd Tier NICs, and DMEs, Plastic Products' share of MVA rose over the 1975-89 period, as it did in South Africa. As Table 8.1 shows the average annual growth rates in plastic products value added in South Africa was inferior to the NICs and the 2nd tier NICs over 1975-80 period. Over the 1980-89 period South Africa's performance was worse than all three groups of countries.

Figure 32



Sources: UNIDO, Global Reports, 1988/89, 1989/90, 1990/91, 1991/92, Statistical Annexes.

Notes: The values used in the graph above are the averages of the countries listed under each heading:

NICs	2nd Tier NICs	DMEs	DMEs continued
Argentina	Columbia	Australia	Japan
Brazil	Cyprus	Austria	Luxembourg
Hong kong	Indonesia	Belgium	Netherlands
Korea	Jordan	Canada	New Zealand
Mexico	Malayasia	Denmark	Norway
Singapore	Morocco	Finland	Portugal
Taiwan	Peru	France	Spain
	Philippines	Germany	Sweden
	Sri Lanka	Greece	Switzerland
	Thailand	Iceland	UK
	Tunisia	Israel	USA
	Uruguay	Italy	

Table 8.1 Annual Average Growth in Plastic Products (ISIC 356) Value Added
(percent p.a.)

	1975-80	1980-89
NICs	15.4	3.5
Second Tier NICs	10.9	6.1
DMEs	7.4	8.0
South Africa	8.7	1.2

Note: Value added in nominal US $
Source: UNIDO Global Reports, Statistical Annexes various years

Ownership and concentration

The South African plastic converting industry emerged as a significant sector of manufacturing during the period of rapid economic growth in the 1960s. Much of the skill necessary to develop the industry came from immigrant workers, mainly from Europe and Germany in particular in the 1950s (The Star, 24-10-91:25). Indeed these immigrants tended to dominate the industry and became such a tight knit group that they became known colloquially as the 'kunststoffen mafia' (polymer mafia).

Control began to shift as the local chemical conglomerates began production of polymer locally. AECI entered the PVC market in 1955 and subsequently began to develop downstream interests in the converting industry. Rapid expansion of the PVC converting industry through the 1960s brought about two dominant groups, AECI (AE&CI as it was then) and Duropenta Industries. AE&CI absorbed a number of its smaller competitors and the recession in 1971 allowed it to take over its main rival, Duropenta. It promptly shut down three Duropenta factories.[2] AE&CI's turnover rose by 200% and its market share from 25% to 41%, of the remainder only 14% was met by local production, the balance was imported (Innes, 1984:211). This corporate strategy of absorbing the competition was continued in the 1980s when AECI's plastic piping dominance was challenged. This led to a joint venture when the AECI subsidiary was joined with Paxit Pipekor to form a new company called DPI. The degree of concentration involved led to a Competition Board hearing which ultimately approved the deal in November 1987 (Business Day, 18-11-87:1).

This process of sectoral concentration in certain sectors of the Plastic Products industry is similar to the type of concentration in the international pharmaceutical industry, where no one producer has a very large share of the total market but at the level of individual

2. This pattern is typical of AECI corporate strategy and was repeated again in the paint industry in the 1980s.

product markets just a few companies typically control that market.

If one takes into account AECI's corporate strategies in the paint, plastic raw materials and other industries in which it operated, the evidence suggests that AECI drew heavily upon a classic static industrial organisation model where strategy is a quest for monopoly rents achieved either by locating in sectors where competition is weak or initiating changes to industry structure in order to reduce competitive pressures.

Larger firms in the sample tended to operate in markets with a high degree of concentration (see Table 8.2) and to rely upon their market power or the financial 'muscle' of their parent companies to maintain their market dominance. The inability (or unwillingness) of larger firms to export during the 1980s meant that the only opportunity for expansion lay in the local market, a further imperative to increased concentration of ownership in key sectors. Market dominance and the resultant diminution of expansion opportunities may well drive such firms to export as the possibilities of further domestic expansion are exhausted. Such a situation was outlined by one of the larger packaging firms interviewed. This suggests that there may be a relationship between concentration in the local market and the propensity to export. If so policy makers face the difficult intersection between competition policy, export promotion policy and appropriate pricing in monopolised or oligopolised domestic markets.

The largest single market for plastic is in packaging, which absorbs almost 50% of all polymer. Packaging is a multi-medium industry including paper, metal, glass and other materials. In 1990 plastic accounted for almost 14% of packaging by volume and 29% by value (BMI, 1991:vi). The companies which dominate the packaging industry are active in most materials. In 1991 three companies, Nampak, Kohler and Consol, accounted for 65% of packaging sales. Each one is ultimately controlled by a conglomerate; Barlow Rand owns Nampak, Gencor owns Kohler and Anglovaal is the ultimate shareholder of Consol. The largest packaging firm, Nampak, claims to be one of the largest packaging companies in the world and held 42% of the market, Kohler had 13% and Consol had 10% (FM, Nampak. A corporate report, 4-9-92:14). This concentration has been accompanied by anti-competitive practice. The Nampak executive has admitted to being part of an 'informal cartel' in the packaging industry until 1985 amid allegations of underhand methods used to keep a new entrant, Marathon Packaging out of the market (Sunday Tribune, 9-2-92).

In plastic packaging the concentration is not as pronounced. In the larger, flexible market, the largest seven firms accounted for 46.7% of sales and 44.8% of plastic packaging volume. The leading three firms, Consol, Kohler and Nampak were among the top six

Table 8.2 Market Share, Concentration and Ownership

Co.	Industry	Product Market share %	Product Market share % top 4	Firm Size	Ownership
1	PP woven			L	
2	White goods			na	Conglom
3	Import Agent			na	na
4	Buckets	?	?	S	Indiv
5	Designer items	small	?	S	Indiv
6	Jobbing	?	?	S	2
7	Custom moulding	?		S	Indiv
8	Engineering products	60-65	60-65	S	Indiv/MNC
9	Fabrication			S	24% GERMA
10	Low cost sanitation			S	3
11	Auto components	80	100	S	3
12	H/hold appliance parts	small	?	S	Family
13	Various, auto, h/hold	small	?	S	2
14	Packaging	?	?	M	Conglom
15	Flooring	100	100	M	UK MNC
16	Auto components	55	Top2=90	M	3
17	Custom Packaging	large	>85	M	Conglom
18	Packaging		80	M	Family
19	Packaging, bottles	small	?	M	Family
20	Flexible Hosing	60	100	M	Conglom
21	Rigid sheet	Top2=80		M	Conglom
22	Packaging		Top5=85	M	Family
23	Packaging	1of2 big		M	MNC
24	Plastic Pipe systems	46	100	M	Conglom
25	F/wear, PVC fabrics		100	L	Family
26	Packaging, crates	70	Top2=100	L	Conglom
27	packaging	L		L	5
28	Packaging	dominate	Top2=85	L	Conglom
29	Packaging reel-reel	75-80	90+	L	Conglom
30	Cable	35-38	95 (5)	L	Cong/MNC

Source: Interviews.

(Ibid:45). In the smaller, rigid market, the top 6 firms accounted for 53.7% of sales and 53.4% of the volume. Nampak is the only one of the three largest packaging firms which was not among the top six rigid plastic packaging firms.

In summary the largest market for polymer is not as concentrated as packaging in general nor as concentrated as certain other product area in the plastic converting industry.

Indeed there are segments of the industry in which cut-throat competition is prevalent. The lower barriers to entry in injection moulding make this a convenient point of entry to the industry for newcomers. Whilst a process of concentration was taking place in some parts of the industry, fierce competition among many small firms was developing in parallel. The number of participants in the industry doubled from 507 in 1985 (Manufacturing Census, 1985) to approximately 1000 in 1992 (Spindler, 1992).

The dichotomous emergence of highly concentrated markets along with extremely competitive markets coincided with declining productivity and suggests that there may be a correlation between these two trends.

Productivity

Evidence suggests that productivity in the converting industry may have been declining. Various sources were consulted and whilst there are differences between them they all display a similar trend, static or declining productivity.

Output per employee has declined on average by 0.6% p.a. over the period 1972-90 whilst that for all manufacturing has grown by 1% p.a. (see Table 6.1). This trend is also evident in the National Productivity Institute (NPI) data[1] (NPI, 1989:49 & 63), although Murray (1991) of the NPI finds that labour productivity in 1989 was unchanged compared to 1970. The physical volume of production has increased faster than employment over the 1977-89 period. However over the 1985-89 period this trend was reversed, resulting in the physical volume of production per employee falling at an average of 1.5% p.a. (see Table 4.30). Real wages also declined over the 1985-89 period at an average of 0.2% p.a. (IDC, 1992).

Since the plastics converting industry is a relatively labour intensive industry (compared to other sectors of the chemical industry), an attempt was made to generate a rough guide to South Africa's relative international competitiveness in labour productivity

1. Note: the work of the NPI has been challenged from several quarters and should not be given great weight.

against a sample of countries over a number of years. The sample countries selected are the major sources of plastic products imports into South Africa. This may give some indication of how the local industry will cope with reduced tariffs under the GATT agreement arising from the Uruguay Round.

Table 8.3 SA Plastic Products: Labour Productivity

	Phys vol Prodn (1)	Employ-ees (2)	(1)/(2)
Average growth pa (%) 1977-89	4.6	3.9	0.7
Average growth pa (%) 1985-89	0.4	1.9	-1.5

Sources: (1) South African Statistics 1990 pp12.56 & 12.58
(2) IDC 1992

The methodology followed involved according ratios to sample countries relative to the USA and in this way gaining a relative index of competitiveness among the sample countries. Domestic output and total labour costs in domestic currencies were converted to US $. A three step process was employed as follows:

Step 1: $\frac{\text{(\$) Output (i)}}{\text{No. of Wkrs (i)}}$ divided by $\frac{\text{(\$) Output (USA)}}{\text{No. of Wkrs (USA)}}$

= Relative output per worker (Table 4.31)

Step 2: $\frac{\text{Wage Bill (\$) (i)}}{\text{No. of Wkrs (i)}}$ divided by $\frac{\text{(\$) Wage Bill (USA)}}{\text{No. of Wkrs (USA)}}$

= Relative wage per worker (Table 4.32)

Step 3: $\frac{\text{Relative output per worker}}{\text{Relative wage per worker}}$

= index of competitiveness (Table 4.33)

Where:

	(i)	is the i th country
	($)Output	is the gross national output of the Plastic Products Industry (ISIC 356) in current US $.
	No. of Wkrs (i)	is the number of workers employed in the Plastic Products Industry (ISIC 356) in country (i).

Table 8.4 Manufacture of Plastic Products NES (ISIC 356)
Index of Gross Output per Employee, USA=1
(Ranked by 1985 index order)

Country	1970	1975	1980	1985	1990
Switzerland					
Taiwan					
Malaysia	0.14	0.16	0.22	0.18	
Thailand	0.09	0.07	0.21	0.22	
South Africa	**0.34**	**0.35**	**0.57**	**0.24**	**0.37**
Hong Kong		0.19	0.28	0.25	
China			0.70	0.33	
Singapore	0.21	0.24	0.39	0.35	
Korea, Republic of	0.21	0.16	0.38	0.37	0.56
Austria	0.47	0.68	0.88	0.50	0.88
United Kingdom	0.42	0.47	0.81	0.55	0.94
Germany, Federal Republic of	0.56	0.74	1.06	0.61	1.05
France			1.11	0.71	1.36
Israel	0.81	0.89	0.98	0.74	1.33
Belgium	0.65	1.04	1.36	0.75	
Italy	0.49	0.67	0.95	0.80	1.65
Netherlands	0.74	0.95	1.35	0.81	1.31
Japan	0.60	0.81	1.23	0.96	1.39
United States	1.00	1.00	1.00	1.00	1.00

Source: UNIDO Industrial Statistics
Exchange rates from World Bank (STARS) and
IMF International Financial Statistics, Yearbook 1991

Table 8.5 Manufacture of Plastic Products NES (ISIC 356)
Index of Average Wages, USA = 1.
(Ranked by 1985 index order)

Country	1970	1975	1980	1985	1990
Switzerland					
Taiwan					
China			0.06	0.06	
Thailand	0.06	0.08	0.12	0.11	
Malaysia	0.06	0.10	0.12	0.12	
Korea, Republic of	0.09	0.08	0.20	0.19	0.29
Hong Kong		0.20	0.27	0.23	
South Africa	**0.27**	**0.28**	**0.50**	**0.25**	**0.35**
Singapore	0.10	0.18	0.25	0.30	
Austria	0.34	0.63	0.90	0.51	0.89
Italy	0.32	0.55	0.80	0.52	1.13
United Kingdom	0.41	0.53	0.88	0.55	0.96
Israel	0.33	0.39	0.77	0.56	0.58
Belgium	0.39	0.77	1.06	0.56	
Germany, Federal Republic	0.53	0.88	1.22	0.66	1.24
Netherlands	0.64	1.03	1.30	0.67	1.08
Japan	0.30	0.58	0.80	0.68	1.08
France			1.49	0.88	1.56
United States	1.00	1.00	1.00	1.00	1.00

Source: UNIDO Industrial Statistics
Exchange rates from World Bank (STARS) and
IMF International Financial Statistics, Yearbook 1991

Table 8.6 Manufacture of Plastic Products NES (ISIC 356)
Index of Competitiveness, Relative Output/relative Wage, USA = 1 (Ranked by 1985 index order)

Country	1970	1975	1980	1985	1990
Taiwan					
Switzerland					
France			0.75	0.82	0.87
Germany, Federal Republic	1.06	0.83	0.87	0.91	0.85
South Africa	**1.29**	**1.27**	**1.15**	**0.96**	**1.07**
Austria	1.37	1.07	0.97	0.99	0.98
United Kingdom	1.04	0.90	0.92	0.99	0.98
United States	1.00	1.00	1.00	1.00	1.00
Hong Kong		0.94	1.03	1.12	
Singapore	2.19	1.29	1.58	1.15	
Netherlands	1.15	0.91	1.04	1.22	1.21
Israel	2.44	2.27	1.27	1.34	2.27
Belgium	1.67	1.35	1.28	1.34	
Japan	2.02	1.39	1.53	1.43	1.29
Malaysia	2.25	1.67	1.87	1.53	
Italy	1.53	1.22	1.18	1.54	1.47
Korea, Republic of	2.36	2.01	1.90	2.01	1.93
Thailand	1.53	0.84	1.73	2.02	
China		.	12.20	5.85	

Source: UNIDO Industrial Statistics
Exchange rates from World Bank (STARS) and
IMF International Financial Statistics, Yearbook 1991

Unfortunately data for Taiwan and Switzerland were not available. Data for certain other countries for certain years were also not available. It may be observed in Table 8.4 that between 1970 and 1990 South Africa's gross output per employee ranked consistently in the lower third of the sample. In Table 8.5 it may be observed that ranked by average wage, South Africa performed similarly to the previous table, that is at the head of the lower third of countries in the sample. In short these results suggest that South Africa has had relatively low output per employee and relatively low wages. When these factors are combined in Table 8.6 in an index of competitiveness, it may be observed that South Africa is in a roughly similar position, at the head of the lower third of countries in the sample with the exception of 1980 when it does best, moving about half way up the rankings and in 1985 when it does worst moving to third lowest in the rankings. What this result suggests is that South Africa's low wages may still give it a small advantage over high wage countries like France and Germany, but that it may have been less competitive than China and developing countries in the sample.

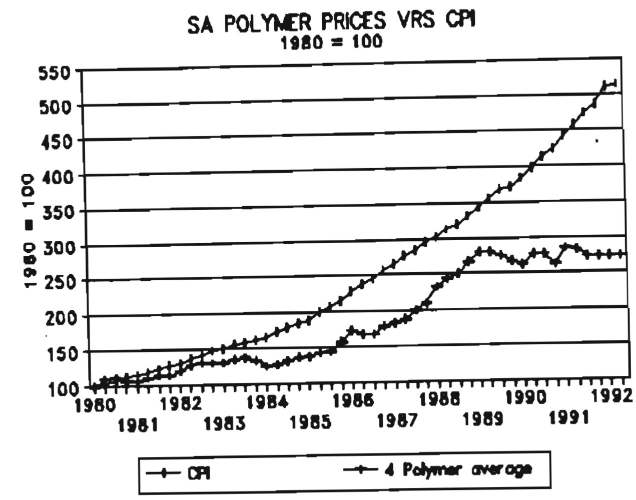
As pointed out above these results are more a rough guide than a definitive calculation. This is because the results are distorted by variations in exchange rates between the currencies of individual countries relative to the US $. An improved methodology, as used by Capdevielle et al (1982) for example, would employ trade weighted exchange rates. Unfortunately the IMF and OECD indexes of key cost and price measures upon which they base their investigation are only available for selected developed countries and similar calculations for South Africa do not appear to have been performed. Ideally comparisons of the type shown above should standardise the capital and labour components of productivity but this is a major task; the Szirmai & Pilat (1990) study for example required a set of calculations extending to some 200 pages.

Capital productivity is also problematic and declining although the Plastic Products industry made better use of capital than manufacturing on average. Again a range of sources reveal a similar trend. The output/capital stock ratio (the value of output per unit of capital stock) is about 5.2:1 over 1985-90, more than two and a half times that for all manufacturing. However this superior performance has been in decline. NPI data show that capital productivity in plastic products has declined at an average of 1.3% p.a. over the period 1970-88, albeit slower than the rate of decline for all manufacturing (-2.8% p.a.) (NPI, 1989:49 & 63). IDC (1992) data for 1972-90 reveals a decline by .09% p.a., again slower than manufacturing's decline of 2.1% p.a.. Whilst manufacturing's output/capital stock ratio has improved by an average of 2% p.a. over 1985-90, that for plastic products has continued to decline at an average of 0.3% p.a.. Although there are differences in the statistics they all point in the same direction, that of declining capital productivity.

Further evidence of this is available from price and output data. Domestic polymer prices have been rising slower than the inflation rate since the mid 1980s as a result of lower international oil prices (see Figure 33). Yet plastic products and end-user prices have risen faster than inflation. Table 4.30 shows that the price indices for plastic bottles and bulk plastic products have risen faster than the inflation rate. These diverging price trends suggest a decline in efficiency in the converting industry which Brand attributes to a combination of old or inefficient machinery or idle machine time (Interview, Brand). Some support was found for this view in interviews where one manager summarised the position with the remark 'we are the world's best maintainers of old machinery'. Table 4.31 summarises responses in the sample of interviews and reveals a considerable proportion of the machinery to be about 10 years old.

The phenomenon of an ageing capital stock is also confirmed by the President of the Plastics Federation of South Africa, Curtis, who has said that "the average age of our converting capacity is way behind that of overseas" (Quoted in Engineering News, 5-2-93:30).

Figure 33



Source: Plastomark
Note: 4 Polymer average is the average of LDPE, HDPE, PVC & PP.

Table 8.7 Price Indices, Selected Materials (1990=100)

	1972	1990	Increase % p.a.
Plastic in bulk forms	8.8	100.0	14.5
Plastic Bottles	4.4	100.0	18.9
CPI	10.4	100.0	13.4
	1985	1990	
Plastic in bulk forms	41.0	100.0	19.5
Plastic Bottles	35.6	100.0	22.9
CPI	49.1	100.0	15.3

Note: Plastic in bulk forms includes monofill type packaging but excludes tapes and yarns.
Source: Statistical News Release P0142.4 (24-3-92), CSS, Pretoria, Table 2.2, pp60.

The Department of Trade and Industry (1990:19) however reports that generally world class technology is used. Examples do exist such as Mega Plastic's beer crate making operation which they claim is the fastest in the world. It certainly has new equipment. Consol's injection moulding factory in Durban producing rigid packaging has also been fully automated (The Daily News, 27-2-87).

However the Department's finding may have been influenced by the nature of the plastic industry representatives who sat on the Working Group. They were from the larger companies. The interviews conducted revealed pockets of world class technology but it was

Table 8.8 Age of Plastics Converting Machinery

Co.	Industry	Firm Size	Machinery Age % < 3yrs	3-6 yrs	6-10 yrs	> 10 yrs
1	PP woven	L				
2	White goods	na				
3	Import Agent	na				
4	Buckets	S				
5	Designer items	S		33		66
6	Jobbing	S				
7	Custom moulding	S			78	
8	Engineering products	S		100		
9	Fabrication	S	70	30		
10	Low cost sanitation	S				
11	Auto components	S				
12	H/hold appliance parts	S				
13	Various, auto, h/hold	S		45	45	
14	Packaging	M		11	11	78
15	Flooring	M			50	50
16	Auto components	M	50	20	30	
17	Custom Packaging	M			10	90
18	Packaging	M	18	18		64
19	Packaging,	M	10	50	40	
20	Flexible Hosing	M	10	15	30	45
21	Rigid sheet	M	20	40	40	
22	Packaging	M				
23	Packaging	M				
24	Plastic Pipe systems	M	15	80	5	
25	Footwear,	L	20	40		40
26	Packaging,	L	47			53
27	packaging	L		15		85
28	Packaging	L	15	60	15	10
29	Packaging	L	10	20	10	60
30	Cable	L				
	Sample Average		26	38	30	58

neither uniform nor widespread.

Other evidence from interviews suggests that those firms planning to export are reinvesting to upgrade machinery and in the process jobs are being shed. This appears to be one of the unfortunate and, if left to employers alone, unavoidable consequences of increased international competitiveness.

The increased number of small firms which have entered the industry also has implications for productivity. Typically small firms enter the industry with second hand equipment, lack R&D resources, capital and other requirements for efficient firms. On the other hand such entrants to the industry are providing employment which is desirable. An industrial strategy will need to straddle both of these aspects.

Productivity in the converting industry is, all other things being equal, a function of machine cycle times. Newer machines generally have faster cycle times than older machines. Being internationally competitive then requires keeping up to date with developments in machinery and regular purchases of new equipment. To some extent local adaptations of machinery can overcome the disadvantage of older machinery. In blow moulding for example some 50% to 70% of the total machine cycle time is accounted for by cooling. If cooling can be speeded up, the cycle time is shortened and productivity improves. A minority of the firms interviewed had attempted to equip their machines with additional cooling devices, so there would appear to be considerable potential for this option short of acquiring new machinery.

Considerable under-utilization of capacity also exists. Interviews provided two insights into the reason for this. Because the exchange rate has been declining the cost of imported machinery has been rising. Thus some firms seek competitive advantage by not running their machines to full capacity and 'husbanding' them so that capital outlays will be required less frequently. The other source of capacity under utilization is time lost to rework, set-up, change over time and stoppages of work for technical reasons. Most of the firms interviewed did not work over weekends, sometimes for reasons of trade union resistance to this practice.

It is difficult to draw generalisations from the interviews conducted because such a wide range of technologies and firm size were covered. However many interviewees stated that their defect and scrap rates were higher than would be the case in Europe. Many of the firms interviewed did not seem to see the importance of these issues to productivity. The few that did were also active in speeding up cooling times, speeding up change over times etc. and also gave the impression of being the most dynamic firms. It is difficult to determine what made some firms appear more dynamic than others. The impression gained from interviews was that the quality of the management and their understanding of new or 'world class' manufacturing techniques was an important factor. In addition one firm stated that the basis of their competitive advantage was their access to tool making skills (in this case all Germans and Englishmen), the fact that they employed a German technical person and that they monitored machinery developments continuously.

The evidence presented above suggests that the age of machinery is handicapping productivity but that opportunities also exist to improve productivity without large scale reinvestment.

Scrap rates and defect rates have not only impacted on capital productivity, but they are fundamental to the industry's cost structure. Murray (1991) found that 54% of all costs were concentrated in the raw materials. This accords with responses gained during interviews, although of course there is considerable variation depending upon the process employed. Scrap is in some instances unavoidable for example when holes are punched but in many cases it arises from edge trim and flash, or colour variations and incorrect set-ups. Nearly all are related in some way to quality assurance and can be reduced by focusing on the root causes, again without considerable outlays of foreign exchange or capital.

To approach productivity issues in this way will not avoid investment entirely. Investment in training is unavoidable if productivity and quality issues are to be addressed. If strategic unionism emerges in the industry this is likely to be the path it would follow as it leads to skill gains for workers. It is also likely to sustain employment levels in the short term in that it will limit the introduction of new, labour shedding, machinery and equipment.

Employers on the other hand are more likely to opt for recapitalisation, automation and labour shedding strategies in the belief that this will give them greater control over production and higher efficiency. Such strategies will also require some training of key personnel. Between these two diverging paths there are of course numerous opportunities for compromise between employers and organised labour.

The review, in this section, of productivity in the Plastics converting industry is suggestive of declining productivity. However before a firm statement could be made about total factor productivity a more detailed analysis is required than has been possible here. Such an investigation could usefully probe the existence and nature of a relationship with declining capacity utilization and whether or not any causal relationships exist between the market structure and productivity.

Export Competitiveness : Obstacles and Opportunities

The Plastic Products industry has since the 1970s been a very weak exporter. The obstacles to successful exporting which have emerged are discussed in this section. Those identified by interviewees are summarised in Table 4.30. A major obstacle is the domestic price of polymer which makes up about half of the costs of production. Polymer prices have been discussed in an earlier chapter.

Table 8.9 SA Converting Industry Export Competitiveness

Input	Advantage	Disadvantage
Capital goods	*Good at maintaining old machines	*All imported at world prices + freight *Duty and surcharge payable
Tooling		*SA tool steel: inferior quality *Size limit 650x650x650 mm, so big tools imported *Local market cannot justify big tooling investment *Local steel prices are import parity
Polymer	*Standard grades reasonably good quality	*High prices approx. 20-30% above NWE prices *Some local PP inferior
Skills	*Toolmaker wages only 20%-30% of German rates in $ terms	*Number of highly skilled toolmakers limited *General shortage, have to import
Technology	*At the leading edge in certain products eg PVC hose, check-out bags and crates	*Technology agreements limit exports to Southern Africa
Utilities	*Cost of land, buildings, infrastructure	*Transport costs to the coast
Macro economics		*High inflation rate
Trade regimes		*Sanctions in some countries *Tariff barriers in Africa
Local Market	*Coproduct diversity & combining technologies *Possible 'package' of services from co-operating competitors	*Too small to provide a base for exports (small runs)
Scale		*Smaller producers lack skill & resources to export

Source: Interviews.

It was to be expected that exporting firms would make use of GEIS, given the fact that many of the products exported from the plastic converting industry would qualify for the highest GEIS incentives. This was the case in so far as the larger exporting firms are concerned, indeed it was critical to their export successes in Europe and the US. However some small firms which were exporting, albeit limited volumes, were either unaware of GEIS or chose to avoid the paperwork and payment delays associated with GEIS.

Capital goods

All the firms in the sample used imported machinery, for the most part of West European, Japanese or Taiwanese origin as South Africa has only a very limited machine tools industry. Importing machinery puts South African producers at a disadvantage because although they pay the same price as machinery importers in other countries, local firms must add freight charges, customs duty and surcharge which means that by the time machinery is installed in a South African factory it is at a higher cost than international competitors. In addition the declining value of the Rand is an important contributory factor leading to the ageing of capital stock. These factors have contributed to placing South African converters at an increasing disadvantage relative to those economies which have developed machine tools sectors.

Many of those interviewed were distrustful of the domestic machine tools industry. However one firm interviewed had begun to build its own blow moulding machines which they regarded as on a par with German machines in so far as quality was concerned. The local industry periodical, PSA, also records a firm, Elvinco, as producing its own blow moulding machines. It describes them as "solid but simple, being intended largely for the African/Third World type market where machine minders are not overly skilled." (PSA, October, 1991:14) Both this company and the one interviewed intended to consider exports once they had met their own needs.

Tooling is a critical component in this industry particularly so for injection moulding where the mould is the focal point of design and skill. Some respondents found locally produced tool steel to be of inferior quality. For very large moulds the maximum local 650mm cube size steel is inadequate, necessitating imports.

Although computer aided design (CAD) has had a large impact on tool design it is not so easily translated into a machined steel mould. Consequently there remains a significant gap in the tool making production chain for skilled labour at the stage of mould making. This could be exploited by relatively cheap (in US $ terms) South African labour[1]. One converter is doing so and exporting moulds to Nigeria with NWE as a future target. However the extent of such developments are likely to hinge around South Africa's ability to address skill formation issues, which are considered in the next section.

There is also a growing international market in rented tools which could be penetrated.

Skills

Historically the crucial mould making skills have been provided by European immigrant workers and indeed this is still the case to a considerable extent. However with the declining exchange rate over the last 10 to 15 years many have returned to Europe whilst others have reached retirement age (The Star, 24-10-91:25). This shrinking skill base including a shortage of skilled tool and die cutters was identified by all but two respondents (see Table 4.31). It is also the reason why several of the larger firms interviewed source their tools overseas. It may also be that the large number of small firms in the industry lack the resources to take on apprentices, leaving the larger firms and the state to carry the burden, a less than satisfactory situation as it turns out. One Johannesburg respondent volunteered that recent advertisements for apprentice tool makers had not elicited a single response! He was also frustrated by the fact that although some of his black workers were 'very good' they were illiterate and he knew of no institution to develop their skills. Another firm has responded to this lack of training facilities by sending people overseas for training. Clearly this sector is just one more that has been hampered by apartheid's absurd education policies.

The location of skills may also help to explain South Africa's historically poor performance in exports of plastic products. Some officials of the Plastics Federation of SA point out that much of the manufacturing and design skill base in the industry resides in the small firms which lack resources and incentives to export. In contrast, the Federation officials believe, the larger firms which have the resources to compete internationally lack this skill base. Some interviews in the sample confirmed this view.

Recently published World Competitiveness Reports have found that South Africa had no particular advantages in any area of competitiveness. In fact it found that South Africa's weak human and skill resources were the biggest detractors from its competitiveness. Many respondents stated that poorly skilled blacks inhibited productivity. One firm pointed out that

1. This appears to be largely a function of the Rand's declining value against other major currencies.

Table 8.10 Plastic Converting Industry, Skills and Training

Co.	Industry	Firm Size	Shortage of tool making skills?	Tools made	Attitude to training levy
1	PP woven	L			unaware
2	White goods	na	Yes	Locally	na
3	Import Agent	na	Yes	na	na
4	Buckets	S	?	?	?
5	Designer items	S	Yes	Locally	OK
6	Jobbing	S			unaware
7	Custom moulding	S	Yes	Locally	unaware
8	Engineering products	S	No	IH	unhappy
9	Fabrication	s	no	locally	
10	Low cost sanitation	S			good
11	Auto components	S	Yes	IH	opposed
12	H/hold appliance parts	S	Yes	IH	OK
13	Various, auto, h/hold	S	Yes	Locally	?
14	Packaging	M	Yes	HQ	OK
15	Flooring	M			good
16	Auto components	M	Yes	IH	?
17	Custom Packaging	M	yes	HQ(JHB)	OK
18	Packaging	M			opposed
19	Packaging,	M	Yes +	IH	unaware
20	Flexible Hosing	M	Yes	IH	OK+
21	Rigid sheet	M	Yes	O/seas	OK
22	Packaging	M	Yes	Locally	OK
23	Packaging	M	Some	O/seas	
24	Plastic Pipe systems	M	Yes (1)	IH	OK+
25	F/wear, pvc coated fab	l			na
26	Packaging, crates	L	Yes	IH+O/seas	OK+
27	packaging	L			
28	Packaging	L	yes	?	?
29	Packaging reel-reel	L	Yes	O/seas	OK+
30	Cable	L	Yes (2)	IH	na

Source: Interviews.
Notes:
Locally = Made in a South African tool room but not in the firm
IH = In house
O/seas = Made overseas
unaware = Respondent unaware of Plastic Industry Training Board levy.
OK+ = Respondent more than satisfied with introduction of Plastic Industry Training Board levy.
(1) = Technologists specifically
(2) = Supply of tool makers in Pietermaritzburg and Port Elizabeth satisfactory

new machinery imported from Europe had to be downgraded or made less sophisticated so that its operators could operate it.

The decision by the newly established Plastic Industry Training Board (PITB) to impose a 0.75% levy upon all employers' wage bills in the industry from 1992 signals the fact that organised employers have finally come to appreciate the urgency and seriousness of the problem in this sector. The need for an industry wide levy was reasonably well accepted by most of the firms in the sample (see Table 8.10) and is an important step forward for the industry. However judging by opinions aired by several respondents, the Federation did not adequately inform and clarify the issue with all of its members. Many of the concerns raised could have been satisfied by a clear explanation.

Some of the concerns expressed arose out of the manner in which training developed in the industry. In the absence of any larger training or skills enhancing scheme larger companies set up and developed their own training schemes at their own expense. They are reluctant to see these replaced by industry schemes, partly because they believe they are better trainers than the PITB. On the other hand small firms have tended to do very little training and in effect their training costs have been subsidised by the larger companies, who would now like the burden to be equitably shared. Small firm resistance is not only focused on the costs of the levy but also underpinned by the, not unrealistic, fear that they will be unable to fully utilise the PITB scheme and that they will now be subsidising the larger firms.

The advent of the PITB is an encouraging and important initiative in the industry but, unfortunately, it has been tarnished by the failure of the employer organisation to involve those whom they expect to educate. Organised labour was not consulted at all about the establishment of the Training Board. This is not surprising as many respondents were hostile to and condemnatory of trade unions.

There is already a reluctance by the government to register training boards which do not include representatives of organised labour and this should be a requirement for all training boards. Once represented on the PITB organised labour might give careful consideration to proposing that all employees in the industry make small contributions. My experience in the industry suggests that those who pay are more likely to demand that they get their money's worth.

Despite these shortcomings the establishment of the Training Board is a step forward and provides a basis upon which to build skills in the industry if its shortcomings can be corrected.

In its early years it appears that the PITB will concentrate upon production skills which are designed to improve manufacturing practice and efficiencies. However there are two other crucial skill areas which also need to be addressed; artisan training and industrial design training.

The majority of respondents interviewed regarded locally trained artisans engaged in tool and die manufacture as inferior to West European artisans, although a minority claimed that some were as good as their European counterparts. The historical shortage of artisans created by the racial barriers to entry for blacks obviously needs to be corrected. However the lack of lifelong training for artisans also needs to be corrected. The increasing entry of blacks into the artisan market may help to galvanise the predominantly white (and often bigoted) artisans to advance their skills. Indeed this appears to be contemplated by NUMSA in its recent grading proposals to the Metal Industrial Council in which it demands two additional artisan grades above artisan level. This pragmatic approach does have the disadvantage of perpetuating the racial pecking order in the skills hierarchy, at least in the short to medium term.

Industrial design skills also appear to be in short supply in general and in particular to small firms who lack the resources to make use of the scarce supply that has existed. At a broad level increasing the supply of industrial design skills appears to be an important requirement necessary to energise the plastic converting industry. The mechanism of delivery of such skills to small firms is more complex and requires more detailed research. Nevertheless some tentative suggestions are made in the final chapter.

In summary skill formation must rank high on the list of prerequisites for the creation of a dynamic and innovative plastic converting industry with particular attention to be paid to small firms.

<u>The role of the domestic market</u>

Most producers in the industry aim to serve only the local market. The domestic market holds both limitations and opportunities. A limitation imposed by the domestic market is that batch sizes are generally smaller than those undertaken by international competitors. Larger markets justify larger batches and investment in technology designed to reduce set-up and changeover times. In addition producers in DMEs have tended to segment their markets to a greater extent and are thus able to concentrate on fewer products, further reducing the time spent on set-up, changeover and inventories. Nevertheless large production runs are not a panacea for international competitiveness. One respondent claimed to have 'Rolls Royce' quality machinery and production runs of internationally comparable length, and yet was still unable to match Taiwanese producers despite their shorter runs and poorer quality machinery.

Local producers with a wider range of products do have some advantages. They can offer a better 'package' deal. One large firm interviewed has used this to advantage in cooperation with other firms and was optimistic about more similar deals. In one extreme case a firm's limited scale of operation was the basis of competitive advantage; a vacuum forming process is used, involving tooling costs of only R25 000 whereas larger volume business would require injection moulding technology with tooling costs of R800 000. This respondent has been a successful exporter into US markets for several years. However this advantage appears restricted to small niche markets.

Several respondents reported that the local market was too small to justify investments of world scale capacity, and that consequently they did not envisage the possibility of exports. Indeed exports were not considered at the time the investments were made. However one firm encountered was in the process of making a large investment with output destined for export but using imported (tariff free) polymer.

Managers' attitudes have been influenced by the inward looking industrial policies and political isolation of apartheid and it is to be expected that this has influenced their attitude to exporting. Almost all respondents appeared to assume that significant sales in the domestic market would be a prerequisite for any export effort. There appeared to be no thought of making exports the major part of the business, which is perhaps understandable given historical polymer prices in South Africa and the anti export bias of the trade regime.

Lack of Cooperation

Lack of economies of scale can be compensated for to some extent by institutionally induced changes to market structure. In certain cases dynamic comparative advantage is associated with large firms in, for example, South Korea and northern Germany. On the other hand it has been demonstrated in Taiwan and mid-Italy that industrial dynamism is also possible by small and medium enterprises. The Italian performance is frequently held up as an example; it has been one of the largest net exporters of clothing, footwear and furniture even though during the mid-1980s average firm sizes in these industries were just 5.3, 17 and 5.7 employees respectively.

Analysts of these phenomena have suggested that it is the type of firm and the relations between them which are more important than mere size. In particular cooperation among small firms in such areas as marketing, purchasing and design has demonstrated that it is possible to achieve efficiencies in these areas without the infrastructure typical of the large-scale hierarchical firm.

Unfortunately cooperation in the South African industry has been hampered by a number of factors. Small firms are very wary of cooperation amongst themselves as theft of intellectual property is an ever present danger. They are also wary of the bigger polymer manufacturers upon whom they depend for credit and prompt delivery. This suspicion extends to the Plastics Federation as it tends to be controlled by the larger converters and polymer producers. But underlying these factors is the intense competition among smaller producers and the relatively low levels of profit attainable at this link in the production chain as a result of the historically uneven distribution of profits along the production chain.

On the other hand, Curtis, the President of the Plastics Federation of SA, has implied that a lack of cooperation among firms is not a problem, even in that most difficult of areas, between large firms and small firms:

> "Converters and raw material suppliers are co-operating and certain converters are also getting together to mount export campaigns." (quoted in Engineering News, 5-2-93:30)

Only limited evidence of cooperation was encountered among the firms interviewed. Indeed some reported just the opposite. For example certain export orders have been so large that they have been beyond the capacity of any one firm. However because firms could not cooperate to meet such orders they were lost.

Low entry barriers, competition and profits

Lower entry barriers in some sections of the industry such as injection moulding exist by virtue of the durability and price of second hand machinery. This ease of entry is both an advantage and a disadvantage. It is advantageous in that persons with artisan qualifications who have worked in the industry find it comparatively easy to branch out on their own. The fact that historically the vast majority of such cases were whites should not, but may well, detract from the possibilities that would exist for historically disadvantaged groups if training in the industry became more colour blind. Some evidence was encountered to suggest that younger persons branching out into business on their own, after some service in the industry, benefitted from a mentor in some form. Given that much of the experience in the industry is in white hands, racism may limit prospects for blacks attempting to follow this path.

The maintenance of old machinery and the introduction of imported second hand machinery appears to have resulted in an ever increasing supply of machinery and increasing competition for limited markets. To survive in markets with this type of 'cut throat' competition some firms disregard factory regulations so as to undercut those that comply. For example one small firm only employs casual labour for up to the three day limit set out in the Metal and Engineering Industrial Council Agreement so as to avoid having to take workers on as full time employees thus saving on the tax and other levies which are applicable. Such conditions make for precarious profitability in markets where this occurs.

The missing dimensions which prevent such sectors playing an energising role in economic development are at least twofold. Firstly a policy environment which encouraged an export orientation could reduce the level of competition for the domestic market and even foster cooperation between small firms. Secondly certain constraints among many small firms (design and technical skills) limit their innovative capacity and ability to generate new products and markets, leaving them to contest existing markets.

Manufacturing practice

Some indication of the sample's proximity to 'world class manufacturing' may be gleaned from the fact that only one firm placed emphasis on accounting practices emphasising efficiency[2]. Similarly only seven firms in the sample claimed to practice JIT (see Table 4.32). It was not possible to verify these claims but other indicators suggested that not all of them were entirely valid. Some firms would like to practice JIT to keep down their raw material inventories but complained that polymer was not available on a daily delivery basis.

In so far as quality standards and systems are concerned the sample suggests that these tend to be more common among the larger firms. Surprisingly four of the firms were using the ISO 9000 system and three of these were exporting, suggesting some coincidence in the occurrence of these two indicators.

Inventories in general appeared large, but there were all sorts of explanations for them. Some Durban plants were dependent on consignments of raw material from the Transvaal of a certain size which pushed up raw material stocks. Large finished stocks were associated with exporters and those who used rapid response to orders (from stocks) as a marketing tool. In other cases powerful customers made the retention of a certain level of finished stocks conditional upon granting the order.

Respondents were asked to estimate how far their operations were from the 'world leading edge' in a general question encompassing technology and practice. Very few respondents were able to claim that they were at the leading edge. Most estimated that they were about 10 years behind. Some of the local products which appear to be more

2. See Bessant (1990) in this regard.

Table 8.11 Exports and Manufacturing Practice

Co.	Industry	Firm Size	Direct Exports % of sales	Quality Standard	JIT
1	PP woven	L		ISO9000	yes
2	White goods	na			
3	Import Agent	na			
4	Buckets	S	nil		no
5	Designer items	S	nil		no
6	Jobbing	S		NO	no
7	Custom moulding	S	nil		no
8	Engineering products	S	<3		no
9	Fabrication	S	V SMALL		no
10	Low cost sanitation	S	NIL	own	no
11	Auto components	S		Own	yes
12	H/hold appliance parts	S			no
13	Various, auto, h/hold	S	nil		no
14	Packaging	M	NIL	SABS0157	no
15	Flooring	M	NIL	own	yes
16	Auto components	M	nil		yes
17	Custom Packaging	M	nil	own	some
18	Packaging	M	10-15	own	no
19	Packaging, bottles	M	nil		
20	Flexible Hosing	M	5		no
21	Rigid sheet	M	<5		no
22	Packaging	M	nil		yes?
23	Packaging	M	<2	ISO9000	
24	Plastic Pipe systems	M	13	ISO9000	no
25	Footwear,	L	7-8	ISO9000	yes
26	Packaging,	L	nil		no
27	packaging	L	10-12	na	yes
28	Packaging	L	substantial	own	no
29	Packaging	L	10		no
30	Cable	L	<3		no

Source: Interviews.

internationally competitive (although not necessarily manufactured by world best practice plants) include retail check-out bags. This is partially attributed to their invention in South Africa some years ago. The character of domestic demand appears to have played a role in expanding this market; a large proportion of local shoppers use public transport and require robust packaging to carry their groceries. In response special grades of HDPE have been developed locally. Substantial exports are made and if polymer were available at internationally competitive prices at least one firm would attempt to become a 'world player' in the retail check-out bag market.

Packaging is the largest single user of plastic. Innovation in packaging across the world has been driven by the changes in the gender composition of workforces and locally by the great need of the large supermarket chains to merchandise. Kohler Chairman Ian Willis has made some bold claims about the quality of the local packaging industry;

> "We are better, by a long way, than the United States." (FM, Packaging Special Report, 21-8-92:61).

Van Leer, a global packaging group, claims that it is "At the leading edge of technology.." (Van Leer brochure, undated)

Despite these claims Kohler's Willis detects a 'slight weakness' in South Africa's packaging industry, particularly in the manufacturing processes:

> "There are three sources of creativity - the design house, the ad agency and the packaging company itself. The tendency is for these to be in descending order of creativity, but in ascending order of practicality." (Ibid)

One of the constraints inhibiting the advance of packaging, is the unsophisticated material handling processes used by packaging customers. This for example has required heavier gauge bottles than would be the case in NWE. As a consequence 'downgauging' (producing the same item with less polymer but with the same strength) innovations have been hampered.

In addition to those leading edge technologies mentioned above the relatively high proportion of PP used in bulk material packaging suggests South Africa may have potential in this area. Good quality plastic pressure pipe is also made in South Africa. Domestic swimming pool cleaning equipment is one of the industry's bright stars in recent years with exports to many countries.

Technology Learning and Innovation

According to Amsden (1989) in order to compete, late industrialisers are dependent on the assimilation and adaptation of imported technology, in other words on learning. Attempts were made during interviews to determine whether this process was taking place or indeed whether genuine new technologies and products were being developed. One large firm interviewed had developed and patented several new products in South Africa. They had not gone further to try and market or licence these products because of the cost and difficulty of enforcing patents.

Historically South Africa has produced a number of innovative world beating products, for example, plastic retail check out bags and the polystyrene trays inside boxes of fruit. One small firm interviewed claimed to be at the leading edge of low cost township sanitation systems. This firm spent a higher proportion of sales on R&D than any other interviewed. It had entered into a joint venture with the CSIR and was jointly developing technology with their help. Unlike most other firms this firm was licensing its technology outwards to other countries. Other local success stories are swimming pool cleaning equipment and Richard Bibins' patented wall hairdryer and shaver units (PSA, September, 1992:37).

Mono Containers, a Nampak subsidiary, is considering exporting its locally developed (foam) cup-making technology to Europe with a view to serving the European market from Europe (FM, Nampak, A corporate report, 4-9-92:54). Nampak operates one of the largest and most diverse packaging research units in the Southern Hemisphere. It employs 44 staff including 22 graduates and 6 diploma graduates and has links with a major international packaging research centre run by Carnaud Metalbox in the UK (Ibid:64). Plastic Concepts, a small firm employing 10 people, has produced 100 new products between its start up in 1986 and 1991 (The Star, 24-10-91:25). There is thus evidence of some capacity to innovate and develop new products and technologies.

Several firms, particularly those involved in producing more technologically advanced products, were licensees of foreign technology. But for most small and medium sized firms which generally lacked any formal R&D capacity, this took place informally through the activities of the leading persons in the firm. Their learning activities typically included reading the trade journals, attending seminars and most importantly making overseas visits to developed economies, usually in NWE and the US. Such visits regularly included attending trade shows and exhibitions and other attempts to keep abreast of the latest developments. This ability, as one interviewee put it, 'to steal with our eyes' during international visits and adapt this knowledge for their own use appears important but is very difficult to measure.

There does appear to be some relationship between firm size and innovation. Phillip Townsend Associates Inc conducted a series of studies of the US plastic converting industry. Among a sample of 1 103 US firms they found that much of the innovation in PVC came from firms using between 4 500 and 22 000 tonnes per annum (Modern Plastics, July, 1987:61). Among a sample of 1 100 LLPDE and LDPE users they found that the most innovative firms were those using 11 350 to 22 700 tonnes per annum (Modern Plastics, May, 1987:63). These are described as 'mid-sized' firms in the study but in South Africa this is the scale of some of the largest plastic converting firms, most of which are linked to conglomerates.

From the information available it appears that in South Africa both small and large firms are innovative to some extent. Consequently an industrial strategy will need to accommodate this duality. Technology learning capabilities in the plastic converting industry, as with several other aspects, exist in certain firms but on the whole do not appear to be widespread, leaving much room for improvement.

Research and Development

Currently polymer and plastic research is confined to two levels. At the more abstract level there are two universities which have polymer institutes, Stellenbosch and Pretoria. The problem to be addressed at this level is the low number of graduates.

At the next level, a more industry-specific problem-solving level, two kinds of facilities exist. One is the CSIR which has a limited capacity (20 researchers) in the Polymer Programme. It sometimes enters joint ventures with small businesses. The other are the research facilities offered by the polymer producing companies. Sentrachem's polymer marketing is done by Hoechst who have recently established a technical assistance centre for plastic converters which is able to draw upon Hoechst's vast international experience. As competition among the polymer producers increases it is likely that one form it will take is this kind of service. Demand for such services is also likely to increase as firms move into more R&D intensive type activities.

Internationally the chemicals and plastic converting industries are increasingly taking on the role of providing services to customers (see Klasch, 1989 and CEFIC, undated). This requires a high level of vertical cooperation along the *filière* in R & D. This cooperation needs to commence at an early stage of product design development. Such collaboration and joint development will need to be facilitated and encouraged.

Conclusions

The plastic products industry accounts for a similar proportion of MVA as the DMEs and the second tier NICs but about half that of the NICs. Accordingly the possibility exists, theoretically at least, for South Africa to almost double the size of its plastic products industry. This would require a large expansion in exports.

Although productivity in the industry has been declining, data suggest that in terms of labour productivity South Africa has been more competitive than some high wage countries which export into South Africa. However in this respect it is less competitive than most of the countries which export into South Africa. The industry's historical base of imported skilled labour appears to be shrinking. This together with the poor level of skills, consequent upon the historical neglect of this crucial area, is beginning to be addressed at an industry level by organised employers. Although most respondents were in favour of an industry training board the rather unpolished manner in which the levy was implemented and the exclusion of organised labour may detract from its prospects of success. Skill formation in production skills, industrial design skills and relevant artisan trades are likely to be important determinants of development in the Plastic converting industry.

Capital productivity is also declining with ageing machinery. Despite the productivity trends identified, improvements to manufacturing practice and skill levels could off-set these to some extent without resorting to recapitalisation. Nevertheless some recapitalisation is needed but currently this is inhibited by the political situation and the declining exchange rate.

Despite the general ageing of capital stock, pockets of leading edge technology exist. Some firm-based R&D capacity has existed but for the most part R&D spending appears to have been low or informal and difficult to measure. R&D has been informal in many firms but this should nevertheless be nurtured so as to off-set the dwindling skill base.

The structure of firms in the industry may be separated into two groups: the larger firms which for the most part are subsidiaries of conglomerates or MNCs and the small and very small, typically family owned businesses. All these firms have needs for services such as, R&D, financial, marketing expertise and technical advice. These can be met in either of two ways. They can be met from within the hierarchical firm or the services typically provided by the hierarchical firm can be provided from outside of the firm by an infrastructure intended for this purpose and possibly organised on a cooperative basis. The coexistence of hierarchical and small firms does not have to be mutually exclusive as has been shown in Taiwan. A strategy to accommodate these differences is advanced in the final chapter.

In summary a wide variety of factors will need to be addressed if the Plastic converting industry is to break with its recent historical trajectory. Key among these will be access to plastic raw materials at world prices (or lower), access to lower cost capital goods and a considerable effort to enhance skills and improved manufacturing efficiencies. Insights gained from the limited sample of firms interviewed suggest that the more dynamic firms, in a broad sense, were characterised by one or more of the following features; design skills, 'world class manufacturing' skills (includes complementary accounting skills) and larger firms with the capital necessary to purchase top quality machinery.

Consequently a strategy to dynamise the plastic converting industry should focus heavily upon design, artisan, and operator skills, as well as managerial training in the nature of 'world best practice' manufacturing.

As these supply side issues are addressed an export orientation for the industry becomes increasingly feasible. The means and mechanisms through which the state could shift support to this industry are discussed more fully in the final chapter. Suffice it at this stage to point out that export incentives have been an important aid to some, particularly larger, firms. To bring small and medium sized firms within the fold of potential exporters, incentives will need to be less demanding of working capital on the part of the firm.

The advantages for the state to shift its support from the upstream end of the *filière* to the Plastic converting industry are several. The propensity for employment creation is greater and the barriers to entry (in certain sectors) are lower. A sophisticated plastic converting industry is also a prerequisite for any manufacturing strategy which seeks to develop more elaborately manufactured product industries. This is because plastic parts and packaging are associated with a vast number of manufactured products.

CHAPTER 9

TRADE IN PLASTIC RAW MATERIALS AND PLASTIC PRODUCTS

Introduction

South Africa has experienced an historical trade deficit in chemicals. Indeed it was the persistence of this phenomenon which was instrumental in prompting the Department of Trade and Industry to convene the Working Group for the Promotion of the Chemical Industry in 1990. Although the ISI model did work well in lowering imports in the 1960s and 1970s it began to falter in the 1970s as the impact of resource diversion for military/strategic reasons began to tell. Earlier chapters have discussed the impact of this strategy upon the oil and petrochemical industries and the manner in which the South African chemical industry has lagged behind world trade trends.

The balance of payments is a constraint upon economic development in South Africa and the chemical industry contributes significantly to this difficulty. In 1990 chemical imports were R 6.6 billion accounting for about 15% of total imports (Commissioner for Customs and Excise, 1990). In this year imports were about 2.7 times the value of exports (Ibid). Petrochemicals and plastics accounted for almost half of these imports. Consequently strategies to develop manufacturing will need to take account of the impact they are likely to have on chemical imports, given the wide dispersion of chemical intermediates into so many industries. Equally any proposed strategy to develop parts of the commodity plastics *filière* must take account of the impact it may have on trade and what contribution it can make to reducing or reversing the chemical industry trade imbalance.

This chapter begins at a general level in reviewing some of the emerging issues in international trade and its rule book, the GATT. It proceeds from there by narrowing the focus on South Africa and reviews South Africa's chemical sector trade and the changing nature of its production base before examining in more detail the trade flows and trade regime for plastic raw materials and plastic products. It concludes with specific and detailed discussion on the nature of the tariff regime for plastic products.

Very little attention is given to trade in olefins as the only one produced locally (propylene) that is also traded is imported in limited quantities, tariff free. None is exported. Ethylene is neither imported nor exported.

The challenges facing South African firms wishing to enter international trade markets in the post apartheid era are manifold. It will require not only coming to terms with GATT, new quality standards and environmental issues, but also managing the changes these forces will require on the shop floor. It is suggested that these issues come together in a nexus of issues at shop floor level and in so doing create an historical window of opportunity for trade unions to improve the lot of shop floor workers.

The two stages of the commodity plastics *filière* which account for virtually all trade are, plastic raw materials and plastic products and for this reason the discussion in this chapter proceeds under these two headings, firstly trade in polymers (SIC 3513) and thereafter trade in plastic products (SIC 356).

It is argued that trade policy issues are important levers in a package of instruments required to redress the historical imbalance in the commodity plastics *filière* which has favoured the upstream at the expense of the downstream. This could benefit important consumer groups and expand exports from further along the value adding chain, in this case plastic products. The linkage between tariffs and domestic pricing is further clarified and suggestions are made about possible tariff reform where no alternative mechanism can be found to keep domestic prices down. A need for better quality information is identified and a proposal to address this need is made.

Before proceeding a comment on trade data is necessary. Four separate sets of data on South Africa were consulted in this study: IDC (1992), data provided by the Central Economic Advisory Service, data from the Monthly Bulletin of Trade Statistics and a set of data specially prepared by the IDC for this study. The IDC (1992) data is limiting in that trade between the South Africa and the 'independent homelands' (the TBVC states) is treated as external trade. In addition none of the data bases has any consistency with any of the others. It was possible to check for internal consistency in only one of these data sets and this was lacking. Data specially provided by the IDC were used for the more detailed discussion as they were the only detailed data available which could be classified in ISIC industry sectors relatively easily. However the data presented should be treated with some circumspection for the reasons given.

International Trade and ISO 9000

The rules of international trade are governed to a large degree by the General Agreement on Tariffs and Trade (GATT). Some 90% of world trade is conducted under the auspices of GATT agreements.

Traditionally international trade discussions have focused upon tariff and non tariff barriers to trade. However in recent years additional issues have begun to gain a higher profile. Raised environmental awareness has introduced environmental considerations into trade issues. As DMEs have come to rely for their competitive advantage upon knowledge rather than production, the protection of intellectual property has come to the fore. This was evident in the Uruguay Round of GATT negotiations. Also, the increasing globalisation of production and marketing has brought forth a demand for consistency in the quality of products. This issue is relevant for South African exporters, both in the effect it has on product quality and on workplace organisation.

If a producer has to modify his/her products so that they can be sold in another country, that producer faces a technical barrier to trade. There are three types of technical barriers: national regulations, national standards and certification.

Differences in national regulations arise for example from differing measures designed to protect public health, safety or the environment. Food products for example are particularly prone to such standards.

Secondly differences exist in national standards, for example, metric and non metric measurement systems. Thirdly testing and certification procedures to ensure a product conforms with national standards or regulations may also differ.

Attempts in the EC countries to harmonise standards had made such little progress by 1984 that a decision was taken to change the approach from trying to define the technical details of the product to trying to specify its objectives. It is this type of approach which appears to underpin the work of the International Standards Organisation (ISO). The ISO comprises 90 national standards institutes from 41 countries. Its overall purpose is to promote smooth and equitable growth in global trade and improve international communication and collaboration. Based in Geneva, the ISO developed a series of standards published in 1987. These include ISO 9000, 9001, 9002, 9003, and 9004. Most registrations in the chemical industry are for 9002 but for ease of reference here the generic term 'ISO 9000' will be used for all.

These ISO 9000 codes are essentially quality auditing procedures. However they are not to be equated with quality management. Rather ISO 9000 ensures "that the controls are in place for suppliers to produce to the specification agreed with the customer." (Giles & Williams, 1991:31). Put differently, ISO 9000 is an "international protocol for documenting operating procedures in establishing a quality system". (Chemical Week, April, 1992:30). ISO 9000 is more of a mechanism than a goal in quality management, that is, it is not so much concerned with attaining high levels of quality but rather with achieving *consistency* at a given quality standard.

To become registered a company has to submit to third party checks and audits by authorised standards institutions. In South Africa the South African Bureau of Standards (SABS) is so authorised.

EC countries were quick to adopt ISO 9000 standards to facilitate trade between themselves. The US has been slower but with the approach of European unification, US chemical producers rushed for ISO 9000 registration. Japan has been even more cautious, since they already have such high quality standards. Nevertheless the Ministry of International Trade and Industry (MITI) is considering adopting the ISO standards.

Implementing ISO 9000 can take considerable resources. The cost of an audit ranges from US $ 10 000 to $ 20 000 and the documentation of operations can take two years, which tends to discriminate against small and medium enterprises. Du Pont has made extensive efforts to measure the results of implementing ISO 9000. At one European site it recorded a production cost drop of 10%, an output increase of 10%, an on-time delivery increase from 70% to 90%, an improvement in first-pass yields from 70% to 92% and a rise in final assembly yields from 92% to 96%. (Chemical Week, 29-4-92:49).

For South African exporters, particularly those targeting the EC market, ISO 9000 certification appears almost unavoidable. Indeed a number of the sites owned by the larger firms are in the process of seeking ISO 9000 registration, aiming for competitive advantages in foreign (and domestic) trade. If the globalisation of the industry continues, as it appears it will, the importance of international standards can only increase. ISO 9000 has several other advantages which may also contribute to better manufacturing practice. These include, reduced rework and maintenance costs, streamlined production, company-wide standardisation of operations, and expedited customer and government agency inspection. (Chemical Week, 29-4-92:42).

A further advantage in ISO 9000 is that it can lead to improved functioning of environmental programmes, in those firms which have them. In early 1993 the ISO began establishing an environmental management system (SABS, 1993). At the same time the SABS was preparing a code of practice based on ISO 9001 for local environmental management systems, and will feed its ideas into the ISO.

In addition, following the ISO route holds out potential advantages for organised labour in the following ways. Introducing ISO 9000 requires a company to involve employees at all levels of the firm, not only in documenting the procedures, but also in critically evaluating them. As the Witco Vice President puts it "Line workers buy into the program as they begin to critique procedures." (Quoted in Chemical Week, 29-4-92:44). It is in this nexus of issues that potential for greater shop floor industrial democracy lies for trade unions in that it offers shop floor workers an opportunity to influence the nature of work and the way in which it is organised. In addition clearer identification of tasks performed will make for easier identification and recognition of skill competencies and job grading which are the fundamentals of proper wage bargaining. Health and safety issues, which are often inseparable from work organisation and environmental issues, can be infused into the process.

There is thus a nexus of issues and opportunities involved here flowing from ISO 9000: international trade issues, manufacturing quality standards and the workplace reorganisation and manufacturing systems which accompany it, environmental concerns, employee involvement and industrial democracy and health and safety issues.

As firms adopt ISO 9000 (or similar systems) there is thus an historical window of opportunity for organised labour to improve its lot. Whether organised labour is able to seize this opportunity and exploit it creatively remains to be seen.

The nexus of issues here also presents industrial strategists with a number of options. Should the introduction of production systems designed to ease access to international markets be left to firms and if so will they be able to manage the industrial relations risks which accompany attempts at work reorganisation? Could small firms wishing to introduce such systems not be assisted with financial support in some way? Would it not be beneficial if trade unionists trying to cope with these new issues received some training on these subjects and/or some financial assistance in order to develop appropriate responses? If so industry may be spared an uninformed resistance to change by organised labour.

Such questions merely scratch the surface of a large cluster of interrelated industrial policy issues which are relevant for all manufacturing and which fall outside the scope of this study. What is clear, even from this rather cursory discussion, is that the salient features of policy initiatives to address these issues should be an emphasis on the integration and coordination of the various thrusts.

Overview, Chemical Industry Exports and Imports

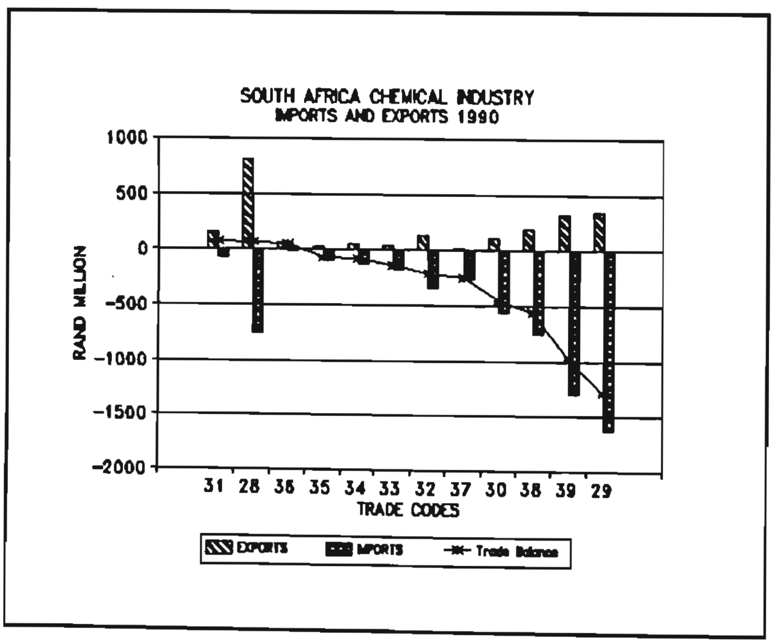
The crisis in South African manufacturing is manifest in its export structure. The predominance of primary and intermediate goods stubbornly refuses to give way to more elaborately manufactured exports. Hence manufacturing's share of all exports in 1968 and

1987 was a little over 37% whilst mining's share grew from 46.7% to 57% over the same period (Kahn, 1991a:Table 5).

In 1990 South Africa's chemical exports were valued at R 1.9 billion and accounted for about 3.5% of total exports (SAFTO). Exports of Chemicals over 1972-87 hovered between about 17.5% and 18.5% of all manufacturing exports before falling to just over 15% in 1990 (Hirsch, 1992:9)

Overall the South African chemical industry has lagged behind world trends in the proportion of sales exported. This proportion hovered between 5% and 9% from the early 1970s to 1990 (see Figure 7). The two sectors concerned here (plastic raw materials and plastic products) fit this general pattern. Exports of plastic raw materials (ISIC 3513) as a proportion of sales hovered between 3% and 5% over the 1972-90 period and between 0% and 2% for Plastic Products (ISIC 356) for the same period (IDC, 1992). In all South Africa only had a positive trade balance in three out of twelve chemical industry categories in 1990 (see Figure 34) resulting in an overall negative chemical trade balance. This profile remained typical of the industry in the late 1980s and early 1990s although certain sectors replaced one another (see Figure 35 for 1993 imports and exports).

Figure 34



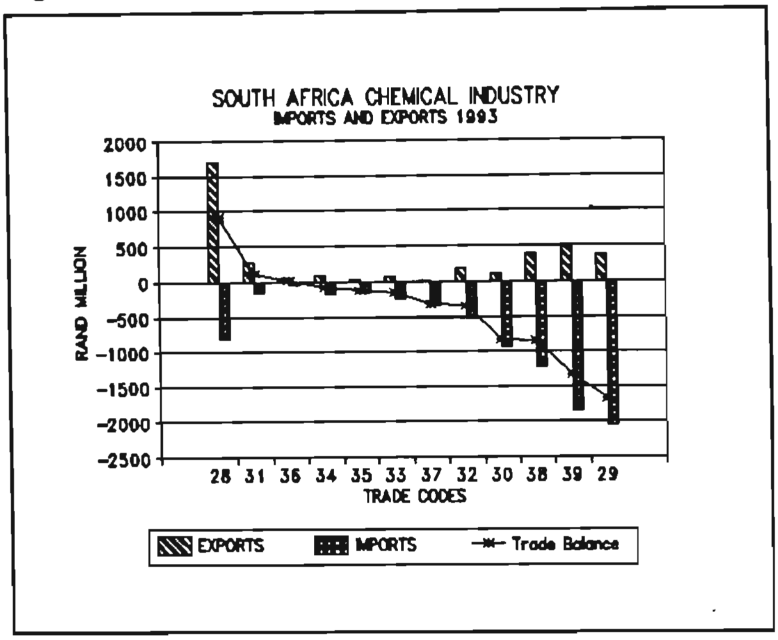
Trade Codes

31	Fertilizers
28	Inorganic
36	Explosives
35	Starches, glue
34	Soap, wax, candles
33	Cosmetics, toiletries
32	Tan., dyes, paints
37	Photo material
30	Pharmaceuticals
38	Miscellaneous
39	Plastics & articles 29 Organic thereof
29	Organics

Source: Monthly Bulletin of Trade Statistics, January - December, 1990.

Bell (1992) identifies a significant decrease in the average annual growth rate in chemical exports from 17.3% p.a. over 1970-80 to 3.2% p.a. over 1985-90 (measured in constant 1985 US dollars). The origins of this may be found in the composition of chemical

Figure 35



Trade Codes

28	Inorganics
31	Fertilizers
36	Explosives
34	Soaps detergents
35	Starches glues
33	Cosmetics
37	Photographic materials
32	Tanning & dyeing
30	Pharmaceuticals
38	Miscellaneous chemicals
39	Plastics, articles thereof
29	Organics

Source: Department of Trade & Industry

exports. They are concentrated in just three of eleven categories, 'organic', 'inorganic' and 'artificial resins & plastics and articles thereof', which together account for 65% of all chemical exports (see Table 9.1). It is the third of these three categories ('artificial resins & plastics and articles thereof') which embraces the lower two links of the plastics *filière*. But before moving on to these links in more detail the structure of organic and inorganic exports

Table 9.1 SA Chemical Industry Exports, (FOB) percent of total (current prices)

CCN	CATEGORY	1980	1985	1990	Avg. Growth '80-90 (%) p.a.
28	Inorganic Chemicals	55	37	36	-4.0
29	Organic Chemicals	4	15	15	14.1
30	Pharmaceutical products	4	6	5	2.4
31	Fertilizers	3	8	7	7.9
32	Tanning & Dyeing extracts, paints inks	7	6	6	-1.5
33	Essential oils, perfumery, cosmetics	1	1	2	6.0
34	Soap, washing preparations, waxes	2	1	2	1.0
35	Albuminoidal substances, glues, enzymes	1	1	1	0.3
36	Explosives etc	5	3	3	-5.3
38	Miscellaneous chemical products	6	9	9	3.6
39	Artificial resins & plastics, articles thereof	13	12	14	1.5
	TOTAL	100	100	100	

Source: Monthly Bulletin of Trade Statistics, Jan-Dec 1990.

are examined a little more closely to search for the origin of the decline in export growth just referred to.

Inorganic exports have long been the mainstay of South Africa's chemical exports but through the 1980s their share of exports has declined from over half of chemical exports to about 36% by 1990, an annual average growth rate of -4% (in nominal Rands) which, allowing for inflation, is a substantial decline in real terms. In Chapter Four the decline of the agricultural and explosives sectors was recorded. If the trends apparent in Table 9.1 continue, organic exports will overtake inorganics to become the leading export category. This table also shows an increase in fertilizer exports from 1980. This is probably a result of poor domestic demand as no new capacity was installed over this period.

Inorganic exports rest on a narrow range of items - just 6 of the 53 categories (of exports) accounted for over 70% of the value of exports (see Table 9.2). This narrow base rests upon an equally slender production base. For example titanium oxides originate from SA Tioxide near Durban which is an old plant well below world scale utilizing an environmentally suspect technology. Phosphoric acid exports largely originate from Indian Ocean Fertilizer at Richards Bay using phosphates from Foskor the state owned phosphate rock mining company in Phalaborwa. This plant is also more than 20 years old. The remaining sectors in Table 9.2 are also closely linked to mining activities. In short the largest category of South Africa's chemical exports tend to be lower value added type commodities, with a strong mining base.

Table 9.2 SA Inorganic Chemical Exports, Percent of CCN 28 (current prices)

CCN	CATEGORY	1989	1990
28.04	Hydrogen, nitrogen rare gasses	8	11
28.09	Phosphoric acids	16	8
28.23	Titanium oxides	7	10
28.25	Inorganic bases metal oxides	22	16
28.25	.03 Vanadium oxides & hydroxides	19	16
28.35	Phosphates	2	10
	TOTAL	76	71

Source: Monthly Bulletin of Trade Statistics, Jan-Dec 1990.

Bell (1992) offers as the explanation for the much slower growth in chemical exports over 1985-90, the considerable excess capacity which existed worldwide in commodity chemicals during the 1980s (Bell, 1992:22). This together with declining world commodity prices suggests that South Africa would benefit from a greater emphasis on higher value added and/or more elaborately manufactured production for export.[1] In the *filière* under consideration here, plastic products offers that opportunity, provided a suitable industrial strategy is followed.

Organic chemical exports grew at about the inflation rate over 1980-90 (see Table 9.1). Like inorganic exports they rest upon a similarly narrow base, just 4 of the 42 trade codes account for about 60% of exports in the organic category (see Table 9.3). The phenols and ketones which account for about 40% of these exports originate mainly from SASOL and the furfuryl alcohols from the small Smith Chem plant at Sezela, south of Durban which uses sugar cane bagasse as its feedstock. Again the backward linkages into mining and agriculture are evident.

Table 9.3 SA Organic Chemical Exports, percent of CCN 29 (current prices)

CCN	CATEGORY	1989	1990
29.05	Acyclic alcohols, methanol, butanols	8	11
29.07	Phenols, phenol alcohol	16	10
29.14	Ketones, acetone	21	33
29.32	Heterocyclic compounds, furfuryl	12	11
	TOTAL	57	66

Source: Monthly Bulletin of Trade Statistics, Jan-Dec 1990.

Exports of plastic raw materials and articles of plastic also rest upon a narrow base, in this case 5 of the 26 trade codes account for about 75% of the exports in this category CCN 39 (see Table 9.4). Some 60% of exports from this category are polymers, unbeneficiated plastic raw materials, which originate from just 5 plants.

Table 9.4 SA Plastics and Articles Thereof, Exports, percent of CCN 39

CCN	CATEGORY	1989	1990
39.01	Polymers of ethylene	11	14
39.02	Polymers of propylene	1	18
39.04	Polyvinyl chloride (PVC)	46	29
39.23	Plastics packaging, lids, bags crates etc	9	7
39.26	Miscellaneous plastic articles	6	7
	TOTAL	73	75

Source: Monthly Bulletin of Trade Statistics, Jan-Dec 1990.

1. Data discussed in a previous chapter demonstrated that the Plastic Products Industry was a higher value added industry than the Plastic Raw Materials industry but this need not be the case for all plastic converting operations.

In summary South Africa's chemical exports rely on a very narrow production base, a significant proportion of which has questionable international competitiveness. Much of South Africa's chemical exports are linked to mining, particularly if SASOL's and AECI's coal feedstocks are taken into account. They are predominantly lower value added type products. The higher value added type products such as pharmaceuticals, household consumer items such as soaps and detergents, inks etc account for very limited proportions of exports. Explosives, South Africa's one fully world scale chemical sector also makes a very limited contribution to exports.

The value of South Africa's chemical imports have exceeded exports for many years, although the import penetration ratio for chemicals fell from 25% in 1965 to 15.1% in 1985 (Kahn, 1991a:Table 1). Exports have been about one third of imports since 1980 although this ratio has ameliorated somewhat since 1990 (see Table 9.5). In 1990 chemical imports were R 6.6 billion - about 2.7 times exports.[2] Petrochemicals accounted for almost half (48%) of all chemical imports in 1990 (plastic raw materials and plastic products accounted for 21% and organic chemicals for 27%). The next largest category accounted for just 12% of chemical imports.

Table 9.5 Chemical Industry Export / Import Ratios

1980	1981	1982	1983	1984	1985	1986
0.31	0.23	0.23	0.31	0.26	0.34	0.34
1987	**1989**	**1990**	**1991**	**1992**	**1993**	
0.31	0.38	0.38	0.42	0.34	0.47	

Sources: 1980-90 data: Monthly Bulletin of Trade Statistics.
1991 data: Commissioner of Customs and Excise, RSA.
1992-93 data: Industrial Development Corporation.

Consequently any attempt to reduce South Africa's chemical trade imbalance might find it worthwhile to concentrate on the organic chemicals and plastics industries where the largest imbalance exists. An additional advantage is that, to a large extent, these sectors form part of one production chain. This study focuses on some of the more important chemicals within the wider petrochemical *filière*.

The changing composition of chemical exports identified here makes it more

2. This and subsequent figures in this paragraph are calculated from Monthly Bulletin of Trade Statistics, January - December, 1990.

important, from a trade point of view, that the decline in inorganic exports is off-set by growth in exports from other chemical sectors. Similarly the larger objective of turning the negative chemical trade balance into a positive one needs to be borne in mind in the examination of the plastics *filière* trade patterns and in identifying opportunities for its expansion.

Before proceeding to a more detailed examination of trade issues in the commodity plastics *filière*, it is appropriate to consider certain developments in the arena of international trade which will have to be addressed by firms wishing to penetrate world markets in the post apartheid period.

Synthetic Resins & Plastics Raw Materials (ISIC 3513)

This industrial sector has had a long standing negative trade balance which grew at an average of 4.1% p.a. between 1969 and 1990. The import growth rate slowed to 0.2% p.a. over the 1985-1990 period as the growth rates for imports and exports slowed. (see Table 9.6). The positive aspect of this recent change is that exports grew faster than imports thus reducing the negative trade balance.[3] Figure 36 illustrates the trade imbalance over the 1969-89 period in the last two links of the plastics *filière*; plastic raw materials (ISIC 3513) and plastic products (ISIC 356).[4] The value of exports of plastic raw materials (ISIC 3513) is between 4.4 and 5.1 times the value of plastic products (ISIC 356) exports (see Tables 9.7 and 9.13). In other words raw materials are being exported rather than beneficiated products.

Table 9.6 Plastic Raw Materials Trade
Average Annual Growth Rates (%) (1985 Rands)

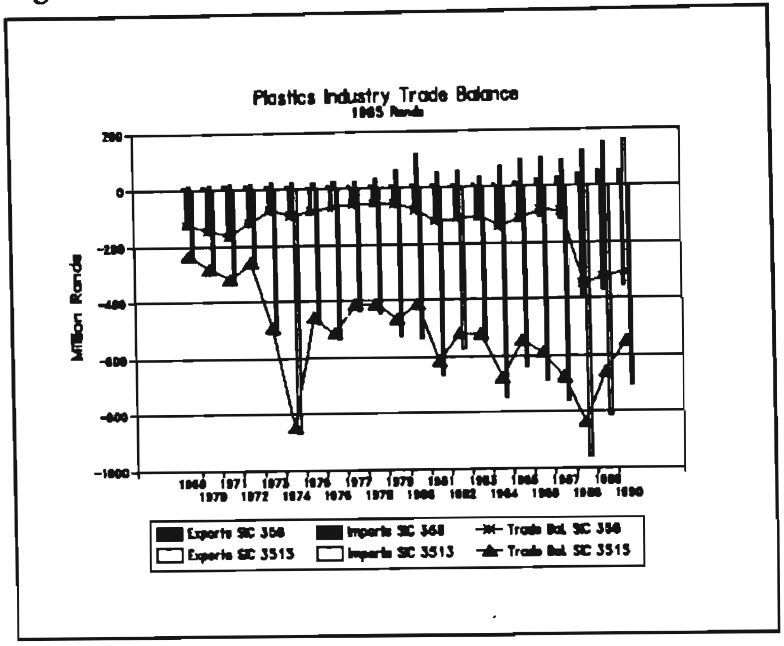
Synthetic resins, plastic raw materials (SIC 3513)	1969-90	1969-87	1985-90
Exports	12.6	11.2	10.9
Imports	5.1	6.5	2.1
Trade Deficit	4.1	6.0	0.2

Source: CEAS

3. If the reader finds these trends unlikely at first glance, it may be helpful to point out that they are arithmetically possible and, in this case, a function of the relatively large share of trade accounted for by imports.

4. The statistically convenient category, ISIC 356 Plastic Products is again used in this chapter as a proxy for the plastic converting industry.

Figure 36



Source: CEAS

The explanation offered by business for the limited chemical exports has been summarised as "raw materials at uncompetitive prices, the high cost of capital equipment and the heavy tax burden." (Sentrachem Annual Report, 1990:7). To this can be added the olefin supply problems identified in an earlier chapter and the trade regime (discussed below).

The improvements in plastic raw materials exports, post 1988, are largely accounted for by increased exports of LDPE, HDPE and LLDPE and SASOL's PP plant coming on stream in 1990 (see Table 9.7).

The value of PVC exports, long the mainstay in this industry, has declined after the 1989 high in international chemical prices in line with international price trends. PVC exports may increase again if Polifin proceeds with its announced PVC expansion. Until then PVC exports may be expected to decline further if tariff protection is lowered (see below) and if international prices continue declining. Prices fell so low in 1990/91 that AECI considered closing 36 000 tonnes capacity suggesting that they are not amongst the lowest cost producers (Interview, Fraser). Currently the lowest cost producers are the large US plants built during the 1989 boom.

AECI's (now Polifin's) LDPE and LLDPE plants also made sizeable contributions to exports. Although they have benefitted from an increased ethylene capacity after 1988 they look set to decline. Recent exports of LDPE were a result of displacement in the local market by low cost Turkish imports possible in terms of a preferential trade agreement with Turkey. LDPE deep sea exports will cease with the Turkish trade preference agreement in 1993

(Interview, Baker). Thereafter AECI only envisaged exporting into Africa because they saw no long term strategic advantage, no cheap gas based feedstocks, limited local markets and a capital cost disadvantage. This was despite the fact that SASOL assists exports with a lower ethylene price and in some instances where long term market considerations apply, were prepared to go below the 'fuel alternate value' price for ethylene.

Table 9.7 Synthetic Resins and Plastic Raw Materials: Exports, Certain Items

EXPORT QUANTITIES ('000) TONNES				
ITEM	1988	1989	1990	1991
PP	1.2	0.4	35.0	62.4
PVC	26.7	63.1	53.9	44.6
LDPE	1.9	3.9	7.0	17.6
HDPE	1.2	1.2	2.8	9.9
VINYL ACETATE & OTHERS	9.5	3.9	12.4	8.1
LLDPE	0.2	0.1	0.9	1.6
PS	0.8	0.9	1.1	1.2
NYLONS	0.1	0.2	0.1	0.2
POLYURETHANES	0.1	0.1	0.3	0.1
POLYCARBONATES	0.1	0.0	0.0	0.0
ABS	0.0	0.0	0.0	0.0

Source: IDC

EXPORTS FOB VALUE R/MIL				
ITEM	1988	1989	1990	1991
PP	3.8	1.9	56.4	114.2
PVC	70.3	126.2	93.2	82.9
LDPE	6.6	10.6	14.4	37.9
VINYL ACETATES & OTHERS	24.4	14.7	40.2	25.0
HDPE	4.0	3.4	9.5	23.6
PS	3.3	5.0	4.8	4.9
LLDPE	2.0	0.5	2.2	4.8
NYLONS	0.7	0.9	0.5	1.5
POLYURETHANES	0.7	1.0	1.6	0.8
POLYCARBONATES	0.7	0.3	0.3	0.3
ABS	0.0	0.0	0.1	0.1
COLUMN TOTALS	116.6	164.7	223.1	296.0
TOTAL SIC 3513 EXPORTS	193.6	251.3	285.3	396.0
SHARE OF SIC 3513 EXPORTS (%)	60.2	65.5	78.2	74.8

Source: IDC

GEIS export incentives are applicable to polymer exports at Category 2 level (lower value added type products) but are not regarded as significant as the payments are very limited. Due to economies of scale and the need to keep capacity utilization high, polymer plants probably would have exported without GEIS incentives. This is an example of a weakness in GEIS: the payment of export incentives to firms which would have exported in any event.

In an earlier chapter the extent of foreign technology licensing for the processes used in polymer production was discussed. In some cases these have expired, such as PVC, but in others they still operate, certainly this is the case with SASOL's new PP plant. In this case it was obvious that it was to be an export plant and any limitations arising from BASF's technology license were presumably overcome.

AECI and Safripol are linked to international partners, ICI and Hoecsht respectively. These linkages are important in gaining market access in that they allow the local producers to 'plug into' the global marketing networks of large companies provided that the quality of the product is adequate. Both ICI and Hoechst have restricted exports of polymer from AECI and Safripol respectively at times, for quality and other marketing reasons. This is now changing in Safripol's case as quality has improved and they have had some of their material marketed in prime European markets. ICI's withdrawal from commodity chemicals and the advent of Polifin, with SASOL as the major shareholder, may reduce the importance of ICI linkages in facilitating access to world markets.

PVC exports have been chiefly to the Far East and Hong Kong, presumably destined for China. Most of the PP is exported to the Far East, Africa and the Middle East. Petrochemical capacity has grown rapidly in recent years in the Asia Pacific region, much of which is low cost gas based. This has been compounded by the large wave of (naphtha based) Korean petrochemicals which have come on stream in the early 1990s. Nevertheless potential for expansion of polymer exports into that region exists. But competition is likely to be fierce. However China is one of the largest importers of polymer, a situation likely to continue for some time if its balance of payments permits. China imports about one third of the world's 1.5 million tonnes of PP traded annually. Market access is eased by MNC joint venture partners and the comparatively small South African volumes which do not pose a serious threat to the major producers.

Africa is an obvious market for South Africa but it is notoriously risky and difficult business, in particular securing payment in internationally accepted currencies. Market access is also difficult as a result of tariffs in some cases and difficulty in penetrating the 'inner core' of persons who conduct much of the trade. Much trade in Africa relies upon informal contacts.[5] Exploiting market potential in Africa will in all likelihood require innovative financing or barter or counter trade arrangements because about half of most African

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5. D Moss, Opportunities for two way Chemical trade in sub-Saharan Africa, Opportunities for Export of Chemicals, Seminar of SA Institution of Chemical Engineers, 26-2-92, Johannesburg.

country's foreign exchange is used to service foreign debt.

Although South African exports occur from a narrow base, the same is not true for imports. The 11 polymer types in Table 9.8 account for only about 40% of the value of imports in this industry whereas they account for about 70% of the exports. This may be partly attributed to the absence of an aromatics (petrochemical) unit and the consequent need to import aromatic based plastics.

Table 9.8 Synthetic Resins and Plastic Raw Materials: Imports Certain Items

IMPORT QUANTITIES ('000) TONNES				
ITEM	1988	1989	1990	1991
PVC	38.2	18.1	17.5	40.5
NYLONS	29.1	25.4	26.2	24.6
LDPE	38.6	12.4	9.0	22.1
PS	17.4	7.7	9.5	15.8
PP	23.9	24.1	12.9	11.5
ABS	0.0	7.9	9.3	8.4
HDPE	39.7	23.9	10.5	7.3
VINYL ACETATE & OTHERS	6.4	5.7	27.4	6.1
POLYURETHANES	5.2	4.9	4.4	5.0
POLYCARBONATES	2.2	2.9	2.1	2.5
LLDPE	0.9	1.1	0.4	0.3

Source: IDC

IMPORT FOB VALUES R/MIL				
ITEM	1988	1989	1990	1991
NYLONS	141.8	153.4	161.0	160.5
PVC	136.0	74.6	71.7	121.5
LDPE	117.3	38.0	23.3	59.7
PS	75.8	32.4	39.4	57.9
POLYURETHANES	39.3	42.7	45.6	53.3
ABS	0.0	43.3	47.3	45.7
PP	72.4	69.0	37.4	30.8
VINYL ACETATE & OTHERS	23.6	23.8	88.3	25.8
POLYCARBONATES	15.7	27.7	20.3	25.4
HDPE	112.6	67.6	30.1	22.3
LLDPE	4.1	4.4	2.4	2.4
COLUMN TOTALS	738.5	576.8	566.7	605.3
TOTAL SIC 3513 IMPORTS	1521.5	1541.6	1429.0	1628.4
% OF TOTAL SIC 3513 IMPORTS	48.5	37.4	39.7	37.2

Source: IDC

The composition of polymer imports represents the mirror image of the preceding discussion on exports. A large share of imports has been accounted for by the more exotic polymers such as nylons, and the engineering plastics such as ABS and polycarbonates which, with limited exceptions, are not manufactured in South Africa. Also imported are a large number of speciality grades. This again highlights the dilemma faced by local polymer producers as to the appropriate number of grades to produce.

It also highlights wider industrial strategy concerns for manufacturing. South Africa has a relatively diverse manufacturing sector which means that the demand for a wide range of chemicals and plastics exists. Consequently, with the chemical industry in its current condition, any rapid expansion of manufacturing is likely to be accompanied by an equally rapid rise in chemical and plastic imports and any attempt to expand manufacturing should take this into account. An alternative is to develop a comprehensive program to develop the chemical industry first or together with any effort to develop manufacturing. This would require a much broader based study than the rather limited one undertaken here.

Within the limited focus here on the commodity polymers, one of the incentives to import is the differing degree of vertical integration which exists linking the plastics raw materials industry and the plastic converting industry and the pricing arrangements which accompany it. Plastic converting subsidiaries which are part of a vertically integrated firm are usually obliged to buy polymer from within the group, whereas competing converters, not vertically integrated, seek competitive advantage in lower priced imported polymer when it is available. Vertically integrated chemical conglomerates may give preferential pricing to their downstream subsidiaries. This is a real concern for others trying to compete downstream and a difficult dilemma for competition policy. Promoting exports of plastic products may require vertical integration which will in turn encourage imports by others not vertically integrated unless mechanisms can be put in place to remove a price advantage for imported polymer and fears of differential pricing by local polymer manufactures can be put to rest. This would be facilitated by a clear distinction in the pricing system and the trade regimes applicable to the domestic and export markets.

Trade regime: Synthetic Resins and Plastic Raw Materials (ISIC 3513)

> "....most of our chemical plants are still sized for the internal market and not for exports. The effect of this strategy is that plants are not world scale sizes and we lose the economy of scale and *therefore have to consistently fight for higher protection.*" JH Fourie, General Manager SASOL Limited. (my emphasis) (Fourie, 1992:3).

Most of the plastics raw material industry developed under the ISI policy and was protected by tariffs or import prohibitions from imports. During the 1980s the state introduced a wide ranging deregulation of trade which led to the removal of non-tariff barriers and a reduction in tariffs for this industry. This section analyses the details of these developments in respect of commodity polymers.

At the outset it is worth noting that not all tariffs are the result of industrial policy imperatives. For example the 10% ad valorem tariffs on ethylene and propylene which applied from before 1965 until their removal was recommended (in late 1991), were imposed for fiscal reasons and not industrial or trade reasons. (BTI, 1991:19). This also applies to the various import surcharges which have been imposed from time to time.

A review of the history of the trade regime for the commodity polymers reveals that almost without exception significant tariff or non-tariff protection was introduced from the commencement of production.(see BTI, 1991) This is acknowledged by the major companies, for example AECI records that:

> "Import control has been the major factor behind the rapid expansion of the South African (chemical) industry in the past two decades." (AECI Annual Report, 1982:12)

This accords with the strategy of import substitution being pursued at the time. In 1982 the state announced its intention to abolish all forms of import control. This was the beginning of South Africa's second and most significant trade liberalisation episode (Bell, 1992). The announcement led to a discussion at the Plastics Federation industry committee concerning the removal of quantitative trade restrictions which had been one of the sources of polarisation between polymer producers and converters. This committee comprised a representative each from AECI, Sentrachem and SASOL and three from the Plastic Converters Association. The Plastics Federation President Mr Roger Cockram was pleased with the results of these discussions at the time:

> "The plastics industry committee recorded a major achievement in industry cooperation when it submitted to the Board of Trade and Industries a document formulating the basis on which polymer manufacturers were willing to see the elimination of import control. The industry is now awaiting the government's decision." (Rand Daily Mail, 11-11-83)

It proved to be a long wait.

At this time AECI's annual reports stress the need for the careful dismantling of non-tariff barriers and it was not until mid 1990 that import control on PVC was finally removed. According to AECI the failure to substitute import control with adequate 'anti-dumping' measures led to significant decreases in profitability and promptly led AECI to make application for 'anti-dumping' measures (AECI Annual Report, 1990). Consequently, despite eight years warning, AECI still seems to have been inadequately prepared for the opening of its closed monopoly market to competition. The protection granted by government is typically an ad valorem tariff together with a reference price.[6] There are no additional special anti-dumping provisions.

LDPE production began in 1965 and in 1966 a 20% ad valorem tariff was introduced in addition to import control. For many years AECI was granted the only import permit. In 1983 the 20% ad valorem tariff was strengthened by a reference price (of 93c/kg less80% of the FOB price) for the first time. This coincided with the discussions concerning the removal of import control. In 1987 this tariff was raised to 170c/kg less 90% and the ad valorem tariff lowered to 10% where it has remained since. Import control on LDPE was removed in 1988. The removal of import restrictions in South Africa ended the polymer monopolies' blissful existence in a closed market. This coincided with a period of high international prices and tight supply. Shortly thereafter as international prices began to fall AECI was granted additional tariff protection. The reference price was increased again in 1989 to 275c/kg less 90% and then lowered again in the same year to 255c/kg less 90%. The trade regime for HDPE has followed a similar pattern.

In 1991 the PP ad valorem tariff was cut from 20% to 10% but the reference price increased from 90c/kg to R2.30/kg. Ad valorem duties tend to be lower than tariffs in countries from which South Africa imports and are used as evidence of South Africa's move to liberalise trade (BTI, 1991). As has been pointed out this is illusory in view of the reference price mechanism.

Producers regard reference prices as 'anti-dumping' measures. They point out that even a small share of the world's traded polymer could meet the entire domestic demand. There is validity in this claim. Indeed just 0.025% of the 1990 world trade in LDPE could have met domestic demand.[7]

6. A reference price creates, through the use of a formula, a 'floor price' below which the price of imported material cannot go. On the other hand, if international prices rise, then the amount of tariff to be paid reduces until the ad valorem percentage based tariff begins to apply.

7. Calculated from, Parpinelli Tecnon, 1991:II.29 and Plastics Federation of South Africa, Annual Report, 1991:8.

The early cooperation in the plastics industry committee on the removal of import controls appears to have waned as it failed to bear fruit for the converters. One suspects that the three large companies may have been active in lobbying the government in order to delay the removal of import controls.

The combination of import controls, surcharges for fiscal purposes and reference price tariffs have all contributed to high Effective Rates of Protection (ERP). The ERP distinguishes between the nominal protection applicable to a traded good and the protection afforded to the value added created in the course of production. It is defined as:

> "the excess of the remuneration of domestic factors of production (domestic value added), obtainable by reason of the imposition of tariffs and other trade barriers, as a percentage of value added in a free trade situation." (Balassa & Schydlowsky, 1968:349)

For an explanatory discussion of the concepts of comparative advantage and effective rate of protection see Annexure C. The high levels of ERP in the plastics industries are evident in Table 9.9. According to the studies referred to in Table 9.9 these two plastic sectors were among those with the highest ERP. A recent study by Belli et al (1993) also found the two plastics sectors being considered here to have high rates of effective protection. Synthetic Resins and Plastic Raw Materials had the second highest ERP of the 76 sectors measured by Belli et al.

Table 9.9 Effective Rates of Protection (%)

Sector	1984/5 a\	1988 b\
Synthetic Resins, Plastics and Man-Made Fibres	143.2	348
Other Plastic Products	53.6	215
All Manufacturing	33.1	30

Sources: a\ Bureau of Economic Policy Analysis, Pretoria, quoted in Holden (undated).
b\ IDC (1990), Bylae D, Aanhangsel D9. (available in Afrikaans only)

All of the three ERP studies referred to here concur that the ERP for the upstream sector (plastic raw materials) was significantly higher than the downstream sector (plastic products). The level of nominal tariff protection afforded each successive stage in a production chain is usually higher than the preceding stage (Grubel 1971:4). If a normal cascading of nominal tariffs down the production chain had applied, one would have expected the ERP lower down the production chain to be higher than for the upstream sectors. The fact that the reverse is the case here, is suggestive of the kind of tariff reform which may be required to improve the prospects of the plastic converting industry. It also demonstrates the point that tariffs on inputs are equivalent to taxes on the users of those inputs. As a result it is likely to be difficult for exporters of plastic products to be competitive on world markets.

These studies ranking the effective rates of protection across industries are useful. All other things being equal, it is reasonable to anticipate that resources would be pulled towards those sectors with higher levels of effective protection and away from those with lower levels of effective protection. This is indeed what has happened in the commodity plastics *filière* as has been argued in preceding chapters. The evidence in Table 9.9 confirms this view.

The importance of the tariff on polymers has been highlighted in preceding chapters where it has been argued that it is in fact the lynchpin of pricing up and down the production chain. In an endeavour to test this argument further the Effective Tariff Protection on polypropylene was calculated (see Annexure C). The net foreign exchange costs of tariffs on polymer is also determined. These calculations are preceded by an introductory overview of the concepts of comparative advantage and domestic resource costs.

The calculations in Annexure C strengthen the argument identifying polymer tariff as the critical lynchpin of pricing and the need for a careful review of these tariffs.

If exports of plastic products are to be expanded, producers will need access to world priced polymer. Consequently the real issue to be faced is, should the trade regime allow domestic producers to be exposed to the full severity of notoriously cyclical commodity prices? A solution may lie in two directions; firstly increasing vertical integration (and unlocking the value added being accumulated by Polifin) or a pricing system which has the same effect, and secondly shifting the bulk of exports one link further down the chain. These possibilities are taken up in the final chapter.

It is worth noting in passing that many of the additives, stabilizers, etc. used in polymer manufacture carry a 10% tariff despite not being produced locally.

The state has announced its intention to remove or lower tariffs on polymer. What effect would this have? Would it improve the international competitiveness of the industry as the conventional view holds? The effect is not easy to predict. One view is that dumped polymer would close down uneconomic units and lead the three major producers to vertically integrate to the point where within 5 years they would own 90% of the converting industry (Interview, Brand). AECI on the other hand point out that a lowered differential between domestic and export prices will serve to allocate increased importance to polymer exports which would tend to increase exports. This does not seem convincing given the pricing structure in the industry.

Whilst polymer producers are quick to condemn dumping and to call for protection against it, they, like their international competitors, practise dumping. Polymer producers have followed a two tier pricing system with export prices considerably lower than domestic prices:

> "...more often than not exports take place at prices which do not recover full cash cost (direct costs excluding depreciation) of production. A lower price in the internal market could therefore render projects with an export bias uneconomic." (DTI, 1990:32)

This view is supported by Belli et al (1993). They measured the anti-export bias of plastic raw materials and recorded a negative result both with and without GEIS using domestic input prices (see Table 9.10).[8] This means that the value added in production for export is negative. In short, domestic prices, supported by the reference price system, have subsidised exports which have made higher capacity utilization rates possible. This has some bizarre consequences. One plastic converter interviewed re-imports South African polymer from Zimbabwe because prices are lower than domestic prices.

In the light of these facts it would appear that the sensible thing to do is to phase out exports of plastic raw materials and to convert that material locally and to export instead higher value added and/or more elaborately manufactured plastic products. Strategies to achieve this are considered in the final chapter.

A second implication of these findings is that the removal of tariffs may well have the combined effect of increasing imports <u>and</u> reducing exports if the removal of tariffs is unaccompanied by other measures. Such other measures are also explored in the final chapter.

Table 9.10 shows that the anti-export bias in Other Plastic Products without GEIS is also negative, indeed the highest negative value of the 70 manufacturing sectors measured. Even with GEIS there is an anti-export bias. Belli et al's measurements underscore the need for a radical restructuring of the price structures in the plastics *filière* if exports are to be expanded.

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8. The anti-export bias coefficient is a measure used to compare the effects of domestic policy on incentives to export. See note to table.

Table 9.10 Anti-export Bias Coefficients

Sector	Anti-Export Bias with GEIS		Anti-Export Bias without GEIS	
	I(w)	I(d)	I(w)	I(d)
Synth. Resin & Plastic Raw Materials	2.76	-5.48	4.44	-3.13
Other Plastic Products	0.86	1.27	3.13	-16.37
All Manufacturing	0.82	1.03	1.30	1.89

Notes: a) I(w) = Value added calculated assuming exporters can purchase input at world prices.

b) I(d) = Value added calculated assuming exporters can purchase input at domestic prices.

c) The coefficient indicates the extent to which policies increase value added in production for the domestic market compared with the extent to which policies increase value added in production for exports (vis-a-vis hypothetical free trade conditions). If policies raise value added for domestic production more than for export, the anti export bias coefficient is greater than one. If, on the contrary, policies render exports more attractive than domestic production, the anti-export bias coefficient is less than one. If the value added for domestic or export production is negative, the coefficient is negative also.

Source: Belli et al, 1993, Table 6.

The efficiency of the trade regulating administration is important, particularly in view of the volatile international commodity prices. Several polymer producers and converters interviewed complained that the trade authorities respond slowly to international price changes and are unable to effectively police the existing regulations. They also allege corruption among customs officials. On the other hand long term investments require a knowledge of the tariff regime and the period for which it will operate. A system such as Malaysia's which is transparent and has a degree of 'automaticity', leaving little to official discretion has much to commend it (Vergara & Babelon, 1990:88).

Trade: Plastic Products (ISIC 365)

The plastic products industry has had a consistent negative trade balance for many years. It grew at an average of over 4% p.a. for the period 1969-90 despite exports growing faster than imports (see Table 9.11 and Figure 36).[9] Exports accounted for between zero and 2% of the value of production over the period 1972-90 (IDC, 1992). Considering the 1969-87 period in Figure 36, the trend is a gradual decline in imports and exports. The surge in

9. Calculated from Month Bulletin of Trade Statistics, January-December, 1990.

imports and exports in 1988 is attributed to the introduction of the Harmonised Tariff Code system in that year.[10] This also partly accounts for the rapid growth in exports over the 1985-90 period shown in Table 9.11 and also detected by Bell (1992:Table 5) although he does not mention the tariff code reclassification. Given the data available it is difficult to determine what trends were operating over 1985-90, although from 1988 to 1990 it appears that exports increased and imports marginally decreased.

Table 9.11 Trade in Plastic Products NEC (ISIC 356) Average Annual Change (%) (1985 Rands)

	1969-90	1969-87	1983-87	1985-90
Exports	7.9	5.2	26.8	29.1
Imports	4.8	-0.9	-0.4	23.2
Trade Deficit	4.4	-1.9	-4.4	22.4

Source: CEAS

South African plastic products export growth over the 1983-87 period, when better data are available, was 26.8% p.a. albeit off a very low base (see Table 9.11). This compares well with world growth in similar exports over 1984-88 of about 18% to 19% p.a. (see Table 6.24). This data suggests that South Africa did participate to some extent in the surge in the world trade of plastic products in the mid to late 1980s, despite its handicaps.

Exports of Plastic Products

Two introductory remarks are necessary at the outset. Firstly much of plastic consumption is in the form of a very wide variety of packaging, which if exported would be categorised as the product packaged, not as plastic products. Other plastic products which are exported are auto components and textiles (eg carpets and synthetic fibres) which are captured under separate tariff and industry data headings. This makes it difficult to identify the full extent to which plastic has been exported. Secondly plastic products may, for convenience, be divided into two classes; tradeables and non-tradeables. Holloware such as empty bottles and containers and some pipes may be regarded as non-tradeables as they amount to 'shipping air' in the trade jargon.

South Africa has consistently had very low exports of plastic products for a long time.

10. G van Wyk, IDC statistics office, personal communication.

An attempt was made to determine if this has been true for other economies. Table 9.12 shows the proportion of plastic products exported from a sample of countries during the 1980s (see notes to table). Compared to this sample South Africa has had unusually small exports of plastic products. This reinforces the view that there are serious impediments to exports of plastic products which will need to be removed if exports are to expand.

Turning now to more detailed trade data[11], they show that the largest category of plastic products exports is a miscellaneous category described as 'Other'. And the largest sub-group within this code is unfortunately also described as 'other'! (see Table 9.13). No detailed data appear to exist for this 'other'. It is believed that 'other' includes one of South Africa's few success stories, swimming pool cleaning equipment. Kreepy Krauly for example exports 75% of its output.[12] One small firm interviewed was engaged in the most unlikely export of golf tees to the USA! These are presumably also classified as 'other'.

The destinations for exports give some idea of the markets in which South Africa has been competitive. These are listed in Table 9.14. Southern African countries are the recipients of a large proportion of exports. Interestingly South Africa has been able to export some 'Other' and some pipes, tubes and fittings into the USA.

One way of determining how internationally competitive plastic product exports have been is to measure the extent to which they are exported into DMEs. Western Europe is taken here as a proxy for DMEs. Some 21% of South Africa's 'Other' exports went to Western Europe. In the 'Closures' group 40% was exported to the UK, largely Nampak plastic bags of various types. Tubes and pipes, being hollow, are more costly to transport, only 10% going to Europe. Bathroom fittings apparently travel better with almost 70% of exports going to Europe, mainly Austria and Germany. Less than 2% of 'Floor coverings' went to Europe whilst 27% of 'Tableware & kitchenware' went to Europe. This is the largest proportion of any category exported to Europe and supports the view expressed by some interviewees that South Africa's tableware and kitchenware is of high quality. At least one of the major local producers of these items has also introduced wide ranging measures which will take it closer to world class manufacturing standards (Interview, Thee).

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11. Unless otherwise indicated the following discussion deals with 1991 exports.

12. Kreepy Krauly, Marketing Director, 14-1-93.

Table 9.12 Exports of Articles of Plastic NES as Proportion of Plastic Products NEC (ISIC 356) Gross Output (percent)

Country	1984	1985	1986	1987	1988
Newly industrialising Countries					
ARGENTINA		1.1	0.4	0.6	0.9
BRAZIL					12.9
KOREA REP.	5.1	5.2	7.4	8.3	9.0
MEXICO	4.8	5.6	1.2	2.1	4.8
Average	4.9	4.0	3.0	3.7	6.9
Second tier Newly Industrialising Counties					
COLOMBIA	2.1	2.0	2.1	1.4	1.2
CYPRUS	32.3	30.5	34.7	33.3	12.2
INDONESIA	0.3	0.0	1.6	2.0	0.9
JORDAN	37.8	27.2	21.0	17.9	12.1
MALAYSIA	11.3	10.1	12.1	13.3	15.0
PHILIPPINES	7.0	8.3	8.6	7.0	11.1
SRI LANKA	25.3	48.9	61.0	16.3	8.9
THAILAND	13.1	11.5	9.6	15.1	19.2
Average	16.1	17.3	18.8	13.3	10.1
Developed Market Economies					
AUSTRALIA	0.6	0.6	1.0	1.5	1.5
AUSTRIA	25.4	26.0	26.3	25.3	27.4
BELGIUM	44.8	43.9	42.9	41.5	40.3
CANADA	2.5	3.0	3.0	2.9	12.2
DENMARK	54.7	55.2	55.0	55.3	54.3
FINLAND	30.3	31.1	29.5	31.6	27.1
FRANCE	9.4	9.7	9.1	9.6	9.6
GERMANY,FR	13.6	15.1	15.4	15.5	16.2
GREECE	4.0	2.8	2.9	3.6	2.4
ISRAEL		12.4	12.9	15.6	9.9
ITALY	12.5	13.8	13.2	12.1	10.0
JAPAN	1.1	1.1	0.9	0.8	1.3
NETHERLANDS	36.8	37.3	35.2	35.1	36.2
NEW ZEALAND	8.3	8.0	7.6	7.4	5.3
NORWAY	12.4	11.3	10.9	11.9	13.8
PORTUGAL	4.3	5.7	6.5	8.7	9.3
SPAIN	3.7	3.8	4.0	4.5	3.7
SWEDEN	33.7	34.2	36.3	35.5	34.4
UK	8.0	8.5	8.2	8.1	8.0
USA	1.6	2.2	2.2	2.1	2.4
Average	16.2	16.3	16.2	16.4	16.3
SOUTH AFRICA	**0.7**	**1.2**	**1.0**	**1.2**	**0.9**

Sources:
1. National gross output from UNIDO Industrial Statistics, February 1992 for ISIC 356, Plastic Products NEC.
2. Exports from United Nations International Trade Statistics Year Book, 1988, Vol 2, New York, Table 893 page 227, Articles of Plastics NES. This is not an ISIC category and there is thus not a complete overlap with ISIC 356. This is not critical as the object is not to determine absolute proportions of gross output exported but to determine whether South Africa is a relatively large or small exporter of plastic products or not.
3. Exchange rates from International Financial Statistics Yearbook, 1991, International Monetary Fund, Washington.

Notes
1. Results were affected by currency devaluations, in Brazil for example, and led to anomalous results being excluded.
2. South African exports are for the Southern African Customs Union but do not materially affect the results as comparisons with other data sets reveal very similar results.
3. Gross domestic output in local currencies were converted to US$ of the day.

Notes to Table 9.12 continued.

4. Results for Singapore (in the Newly industrialising Countries group) ranged between 27% and 35% and were excluded due to their distorting effect upon the average.

Table 9.13 Plastic Products Exports (ISIC 356), FOB, R/mil				
HS CODE DESCRIPTION	1988	1989	1990	1991
3926 OTHER	9.8	15.9	22.4	25.5
3923 CLOSURES & BAGS	18.1	25.0	23.1	22.2
3917 TUBES PIPES HOSES & FITTINGS	4.0	5.9	0.8	10.0
3922 BATHROOM FITTINGS	1.1	2.1	3.5	6.6
3918 FLOOR COVERINGS	4.6	5.0	4.7	5.3
3924 TABLEWARE, KITCHENWARE	2.1	1.8	3.6	4.4
3925 BUILDERSWARE	1.1	0.9	0.9	2.6
TOTAL	40.9	56.5	59.0	76.6

Source: IDC

Table 9.14 Plastic Product Exports Destinations (1991)		
HS Code	Description	Destination of largest values
3926	Other	Zimbabwe, UK, USA, Australia.
3923	Closures	UK, Southern Africa.
3917	Tubes Pipes and fittings	Southern Africa, USA, Hong Kong, Australia.
3922	Bathroom fittings	Germany and Austria.
3918	Floor coverings	Southern Africa.
3924	Tableware	Southern Africa.
3925	Buildersware	Southern Africa.

Source: IDC

What this suggests is that notwithstanding South Africa's high cost structure, there is an, albeit limited, capability to export into sophisticated product markets. Similarly there is a capability to export mining, agricultural and infrastructural type piping and fittings into regional markets which stand to benefit from regional peace and reconstruction initiatives. What is not captured here are the PP exports which would probably be classified as textiles. At least one major textile group, Romatex, is exporting PP based products because they have been more competitively priced (Romatex Annual Report, 1992:7).

Many exporters of plastic products are taking advantage of GEIS and auto industry export incentives. Plastic products qualify for GEIS benefits at level four, the highest level. Some large exporters said that they could not export without GEIS assistance. This is not surprising given the extent to which most polymers are above world prices.

Another factor which is important in determining the prospects for exports of plastic products is the level of tariff barriers faced in the target countries. Some large exporters believe that if South Africa's GATT status is revised to that of a developing country, the lower tariffs applicable will make it much easier for them to penetrate NWE and other markets.

Would exports grow if polymer prices were reduced to NWE levels? Two plastic converting firms in the sample interviewed gave unqualified affirmative answers to this question. Both were large and already exporting. Typical of the remainder of the responses were qualified answers along the lines of: 'yes if we could make money/find the product/be competitive'. The question put to firms was deliberately phrased as 'NWE levels' because that is the level of pricing Sentrachem suggest will be possible if they proceed with their Mossel Bay cracker project. However as has been pointed out, US Gulf prices are generally lower than NWE and given the large volumes of petrochemicals coming on stream in Korea, it is likely that in the next few years, Far East spot market prices may be even lower than US Gulf prices.

Export restrictions as a result of technology licensing are an important consideration. Several interviewees claimed that the restrictions on exports imposed by technology licencing agreements was a significant barrier to exports. One large foreign owned packaging company stated that they have no intention of exporting. Since most of these licences originated in the developed economies this tended to deny South African producers access to these markets. This view is confirmed by Mr Curtis, the President of the Plastics Federation of South Africa:

> "In many instances local companies in the plastics industry are restricted from exporting to the more lucrative world markets by their technology agreements".. (Quoted in Engineering News, 5-2-93:30).

Such restrictions give added weight to the need for local producers to find innovative ways of building upon the licensed technology they already have to produce new products and technologies. However there are firms which have found ways to avoid some of the export restrictions in technology agreements. For example Nampak's subsidiary, Tuffbag at Isithebe, has recently entered into a licensing agreement with Bowater of the UK for the production of PP woven bags (a growth area in the industry). "Tuffbag now looks set to penetrate more decisively the export markets in Australia, South America, Asia, and the rest of Africa." (FM, Nampak, A corporate report, 4-9-92:28) In doing so "Tuffbag has stuck to the short-run, added value, big-bag end of the market, which appears to be the most profitable sector" (Ibid).

Imports of Plastic Products

Import levels of plastic products (ISIC 356) have hovered between 2% and 4% of domestic demand since 1972, excluding the period after 1988 when the trade codes were altered (IDC, 1992). Although imports have been at a relatively low level they have still been approximately twice the value of exports.

A disaggregation of imports (see Table 9.15) reveals the largest single item as the mysterious 'Other' (code 3926) again, and within that category the equally mysterious 'other' is the largest sub-category. Another sub-category within 'Other' which is identifiable are large values of cassettes and protective clothing. 'Tubes pipes hoses etc' (code 3917) imports are dominated by sausage casings (nearly 40%) destined for the food industry and pipe fittings (21%). In code 3923, 'Closures & bags' stoppers, caps, lids and bottles account for just over half of the value. Presumably these are speciality type containers for cosmetic, pharmaceutical and hair care type products. In 'buildersware' the main import is venetian blinds.

Table 9.15 Plastic Products Imports (ISIC 356), FOB, R/mil

HS CODE DESCRIPTION	1988	1989	1990	1991
3926 OTHER	70.8	74.2	69.9	82.2
3917 TUBES PIPES HOSES & FITTINGS	35.5	41.5	49.6	66.4
3923 CLOSURES	27.4	31.2	34.1	41.9
3924 TABLEWARE, KITCHENWARE	10.2	13.0	13.2	19.1
3918 FLOOR COVERINGS	11.4	14.2	13.2	18.7
3922 BATHROOM FITTINGS	3.5	4.3	5.2	7.1
3925 BUILDERSWARE	2.5	2.7	2.2	2.1
TOTAL	161.2	181.0	187.4	237.6

Source: IDC

The origin of these imports was largely NWE, Hong Kong, Taiwan, Korea and the US. This would appear to approximate world trade patterns; Europe and Asia account for 76% and 19% respectively of world exports of plastic strips etc (SITC 58343) and for 78%

and 12% respectively of plastic packaging, containers and lids (SITC 8931).[1]

These are the countries South African producers will have to compete against in export markets. The fact that these countries are able to land and sell their plastic products in South Africa despite the transport costs and tariff payments is a measure of the degree of improvement that will be necessary for South African producers to compete.

Tariffs for the plastic converting industry

Tariffs are typically 20-30% ad valorem together with a reference price for those tariff lines which have had tariffs imposed. This level is generally higher than that applicable to polymers, presumably to off-set the effects of the reference pricing system for polymers. It seems reasonable to assume that a reduction in tariffs without other changes, would lead to inefficient producers exiting the industry and increased imports in the short term. Several firms interviewed did not know if there were tariffs applicable to their products or not but larger firms, threatened by cheap imports, were acutely aware of the relevant tariffs.

Tariffs, as has been amply demonstrated in South East Asian countries, may be utilised to promote efficiency and competitiveness among domestic producers. It is thus necessary to consider what changes may need to be made to the existing tariff regime for the plastic converting industry.

In the following sections tariff categories are examined to determine the tariff structure as well as recent trends in trade. In some cases possibilities for changes to the tariff structure are highlighted.

Each tariff code (at the 4 digit level) is considered in turn.

HS CODE 3926 Other articles of plastic

This code is the largest source of imports and exports of plastic products. Within this code 4 sub codes account for most of the imports and interestingly, most of the exports. These 4 sub codes all have a 30% tariff and 5% surcharge, except one which is tariff free (39269015). In real terms, over the 1988-91 period imports have shrunk by 6.4% p.a. and exports increased by 14.4% p.a., a very promising trend. There appears no reason to change this structure on the basis of the information available.

1. Calculated from United Nations, 1990, Vol 1, pp781 & 454.

HS CODE 3925 Buildersware of plastics

This code accounts for the smallest volume of trade in the plastic products industry. It has a 30% tariff and 5% surcharge. In real terms, over the 1988-91 period imports have shrunk by 13.0% p.a. and exports increased by 5.5% p.a., again an encouraging trend. The main imports are venetian blinds and the main exports 'other'. The bulky nature of the products may make significant tariff reductions possible. This would also be in the interests of a large low cost housing programme as this would have the effect of lowering domestic prices which are typically set at import parity. Local venetian blind manufacture warrants investigation.

HS CODE 3924 Tableware, Kitchenware and other household articles

Despite a 30% tariff and a 15% surcharge, imports (60% from the Pacific Rim countries) have grown, in real terms by 5.4% p.a. over 1988-91. Exports also grew over the same period by 8.5% p.a. in real terms. Generally the quality of South African products is considered good, indeed that may be the problem. They may, in some instances, be superior to the Pacific Rim goods which serve the same purposes. It appears that at least some local producers are aiming at the higher end of the market (27% of exports were to NWE) and that the Pacific rim imports are aimed at the lower end of the market. More detailed research is needed.

HS CODE 3923 Bags, bottles, closures, stoppers, and lids

This is the third largest category of imports. The main import codes in this section have a 30% tariff and a 5% surcharge. Over the 1988-91 period exports shrunk by 5.1% p.a. and imports (66% from Europe) grew by 0.3% p.a. in real terms. This is largely packaging, bottles and lids, presumably of a more elaborate or specialist kind. It does not seem from an environmental point of view desirable to increase imports of plastic packaging. However much of it packages food and other consumer items and in the interests of bringing these costs down for low income consumers, lower tariffs should be considered. The packaging business and the major producers in it appear large enough to make the necessary adjustments to become more competitive over a period of time.

Technology agreements restraining exports appear to be prolific in the plastic packaging industry. As a bargaining lever, reduced tariffs could be withheld from countries which refuse to allow these agreements to be modified to allow exports from South Africa.

HS CODE 3922 Bathroom fittings

The main source of imports here has a 30% tariff and 5% surcharge protection. Imports over 1988-91 have grown at 7.4% p.a. and exports at 42.2% p.a. in real terms. This most favourable export trend is unfortunately among one of the smaller codes.

HS CODE 3918 Floor coverings

The 2 largest sub-codes in this category, accounted for 87% of imports and have a 20% and 30% tariff, respectively, together with a reference price and both have a 5% surcharge. The source of imports is split almost evenly between Western Europe on the one hand and Korea and Taiwan on the other. Over 1988-91 imports have grown at 2.1% p.a. whilst exports have shrunk by 6.6% p.a. in real terms.

It is necessary to consider the background to this sector in order to place the suggestion which follows in perspective. There have been only three producers of cushion flooring in South Africa. All three were multinationals. In response to a proposed merger of two of these three producers the Competition Board allowed the merger on the understanding that tariffs would, in future, be lowered. The remaining (two) producers employ less than 200 employees and tend to focus on the upper end of the market. The production process utilises imported raw materials and outdated equipment which was also imported. The size of the local market is less than 40% of the size needed for minimum efficient scale of production.

The Taiwanese and Korean imports are particularly competitive in the lower end of the market. Indeed, one code (39181035) accounted for about 60% of imports over the last 3 years. There is no local production of products competing at this lower end of the market and yet there is a 30% ad valorem tariff and a reference price. In the interests of lower income consumers it would seem reasonable to remove the tariffs on code 39181035.

Alternatively, since a major new investment is needed to produce efficiently this business area seems to be a suitable target for an industrial restructuring package which might include IDC financing and in the process perhaps a wresting of control of this sector away from the MNCs which currently dominate it. If a world scale capacity plant were installed local polymer manufacturers may be persuaded to manufacture the raw material locally. At the same time exports may be possible after restructuring. A restructuring package would be particularly appropriate in the context of a rapidly expanding housing sector.

HS CODE 3917 Tubes pipes hoses and fittings

This is the second largest category of imports. Imports in this code group encompass a wide variety of pipes, fittings and sausage casings. Almost all the codes with tariffs in this section are 20% or 30% together with a reference price and a 5% surcharge. Imports have grown at 5.5% p.a. and exports by 13% p.a. in real terms over 1988-91. Local producers make good quality pressure pipe (with mining applications) and PVC piping.

If a mass housing programme takes off, scales of production should increase for products with housing applications. This should allow tariffs to be reduced for bulky and less easily transported items such as rigid piping. The high level of concentration in rigid piping suggests that tariffs can be relatively easily used to regulate domestic prices.

Export Incentives

To promote export led economic growth, successful East Asian economies have allowed direct exporters access to intermediate inputs at world prices. This has meant that they were able to choose between locally produced or imported intermediate inputs. Imported inputs were tariff free. This included capital goods. The practice in South Africa is only to allow tariff free imports for those items which are not locally produced. Even this tariff free access is not without difficulty.

First a firm must register as an exporter with the Board of Tariffs and Trade which requires proof of this status and is a 'very involved' process.[14] Registering as an exporter entitles a firm access to the customs duty draw back system. This provides for duties paid on imports of intermediate inputs to be recovered once proof of exports is available. This disadvantages small exporters in that they must carry the burden of working capital costs until they are able to recover the duty some six to twelve months later. In order to circumvent this expense a firm could apply for an exemption of duty. Such an application has to satisfy the Board of Tariffs and Trade that: imported inputs will only be used for the export of the end products specified, that using imported inputs is justified, and that local producers cannot supply the inputs, together with an estimate of the amounts involved.

Indirect exporters (suppliers of intermediate inputs to final exporters) in East Asia also had access to their intermediate inputs at world prices, that is tariff free. They too were free to choose between local and imported intermediate inputs. In addition intermediate exporters

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14. SAFTO representative, Durban 7-1-93.

also benefited from export incentives such as soft loans, technical assistance and short term credit. The mechanism used for achieving this was the domestic letter of credit. This is a local 'back to back' letter of credit whereby the indirect exporter is able to raise finance upon the 'collateral' provided by a final exporter's letter of credit.[15] In South Africa banks have little regard for letters of credit, chiefly because they can be very technical and detailed and a failure by the supplier to meet one of the requirements can lead to the loss of the export order or large penalties. Consequently they prefer post dated cheques. Local banks may be prepared to open a credit in favour of an indirect exporter on the strength of an irrevocable documentary credit from overseas. However even if an indirect exporter clears this hurdle the way is still not open to import intermediate inputs tariff free. This requires permission from the Board of Tariffs and Trade. According to the Board of Tariffs and Trade it is possible, although rare, for an indirect exporter to be given a duty free permit. If both the direct and the indirect exporters apply such an application 'will be considered'.[16]

The General Export Incentive Scheme (GEIS) introduced in April 1990 offers cash payments to exporters which are graduated according to the level of beneficiation of local products. The local content requirement in GEIS means that exporters have to choose between the duty drawback/exemption scheme or GEIS. The major weakness of GEIS is that exporters are tied to locally produced intermediate inputs which are often set at local domestic prices thus disadvantaging the local exporter.[17] However some polymer manufacturers do make polymer available to converters for export purposes at (discounted) 'export prices', which are confidential. The impression gained from field work is that for most polymers such 'export prices' lie somewhere between the (higher) local domestic price and the (lower) actual export parity price for such polymer. PVC for example is sold to exporters at 75% of the domestic market price.

Theoretically polymer exporters should be indifferent about selling their products on export markets or to local converters (for export purposes) at export parity prices. Hence the possibility exists within the current industrial policy and trade regime to redirect material to

15. Such local "back to back" letters of credit are to be distinguished from those typically available in South Africa. If a South African exporter does not produce the goods itself, and if s/he has an irrevocable documentary credit from overseas, then the exporter's bank may be prepared to open a credit in favour of the producer on the strength of the credit received from overseas. This typically applies to export agents rather than to suppliers of intermediate inputs as in East Asian NICs.

16. Mr Bester, Deputy Director Board of Tariffs and Trade, Pretoria, telephonic interview, 27-1-93.

17. Earlier Chapters have established that local market polymer prices are typically set at import parity level. Consequently and as a result of relatively high tariffs, local prices are significantly higher than international prices.

more elaborately manufactured products for export.

In summary the structure of the trade regime for exports is designed more to protect local producers than to facilitate exports. In addition almost all interviewees in the industry complained about the inconsistent and ad hoc nature of the state's development plans and the accompanying range of incentives. This has caused many to lose confidence in these schemes and the trade regime.

Conclusions

Whilst the end of apartheid and South Africa's engagement with GATT are bringing about an increased outward orientation of the chemical industry simultaneously with a restructuring of that industry, it is argued that there are also other more subtle imperatives flowing from these changes affecting the workplace shop floor. The increasing globalisation of production and marketing has brought forth a demand for consistency in the quality of traded products which is expressing itself in the form of ISO 9000 quality consistency auditing procedures.

The adoption of ISO 9000 systems is increasingly becoming a prerequisite for exports into Europe and other developed countries. The adoption of these trade directed systems brings together a nexus of issues on the shop floor; manufacturing quality standards and the workplace reorganisation and manufacturing systems which accompany such systems, environmental concerns, employee involvement and industrial democracy and health and safety issues. In this nexus there lies a wealth of opportunity for more subtle and people orientated industrial policy instruments of the 'soft technology' type. It is also argued that the adoption of ISO 9000 systems presents organised labour with an historical window of opportunity.

The detail of such packages of policy instruments are beyond the scope of this study although it seems clear that through careful attention to coordination and interconnections, much could be done to improve the quality of export manufacturing and the quality of shop floor life. As an added bonus there may even be positive environmental spin offs.

Overall the South African chemical industry has lagged behind world trends in the proportion of sales exported. The chemical industry has also had a long standing negative trade balance. Within chemical exports just three trade codes account for 65% of exports. Inorganic chemicals has been the largest of these but its share has declined through the 1980s as a result of declining exports. The source of these exports is a narrow production base which has questionable international competitiveness. Much of South Africa's chemical exports are associated with mining, minerals and agriculture, particularly if the coal feedstocks used by SASOL and AECI are taken into account. They are predominately less elaborately manufactured type products. Hence industrial strategy should attempt to increase exports from further along the value adding chain, ideally to the most labour intensive points.

The changing composition of exports through the 1980s has resulted in petrochemicals becoming increasingly important. SASOL has a number of export orientated projects under construction, such as its alpha olefins facility, which may be expected to reinforce this trend in future.

The main feature of plastic exports is that plastic raw materials exports far exceed the export of plastic products. By itself this is an opportunity to expand plastic products exports by giving plastic converters access to this material at export parity prices to produce higher value added products for export. This would benefit South Africa as plastic raw material exports have negative value added. There may also be financial benefits for polymer producers which are making losses on exports.

The history of the trade regime reveals the reluctance of the polymer producers to relinquish their cosy protected status and to face world competition. Tariff reform which has occurred during the 1980s and early 1990s has encouraged restructuring in the polymer manufacturing industry. This in turn, is changing the composition of plastic raw materials exports. As restructuring takes place traditional exporters, reliant upon higher protected domestic prices, are being replaced by other somewhat more internationally competitive exporters. However even the latter are still reliant to some extent upon protected domestic markets for profitability. New exporters (SASOL's PP and Safripol's HDPE) are taking over from long standing exporters (eg. AECI's PVC). Plastic raw material imports are far more widely based than exports and reflect the lack of domestic aromatics production.

Further evidence presented strengthens the importance of the polymer reference price in determining pricing in the *filière*. All indications are that tariffs for plastic raw materials will be a key lever in any industrial strategy. However it needs to be borne in mind that reducing nominal tariffs on polymer without a corresponding reduction for plastic products using such polymer, will result in greater protection for manufacturers of plastic products than they enjoyed before.

Exports of plastic products have been a much smaller proportion of sales than a sample of NICs, second tier NICs and DMEs. Notwithstanding South Africa's high cost structure, there is an, albeit limited, capability to export into sophisticated product markets which provides a base upon which to build export expansion. On the basis of the sample interviewed most plastic converters are reluctant to export and will require considerable assistance and incentives.

The impediments to exports of plastic products are chiefly the cost of intermediate inputs, technology agreements and the trade regime. All require attention. It has been suggested that in order to promote exports, both direct and indirect exporters should have the option to access their intermediate inputs from tariff free imports rather than cash incentives such as GEIS which will encounter difficulties with GATT regulations.

If local polymer were available at export parity prices or a price approximating world prices, and some form of export incentive scheme such as GEIS remained in operation, then the latter should only be applicable for domestically sourced polymer, as there appears to be no merit in unnecessarily increasing the consumption of imported polymer. In short what is required is a small advantage in favour of locally produced inputs rather than the absolute preference given in the past.

The vast number of types of plastic products produced locally and imported makes setting appropriate tariffs difficult. There may be many tariff lines on which tariffs are paid but where there is no domestic production of the item concerned. Tariff reform is required in particular in one area. The category 'other' is the conduit for much of the imports and exports of plastic products and greater clarity is needed about the nature of these products.

Those setting tariffs need to be frequently updated with information on which plastic products are being locally produced in order to better manage tariffs. This is necessary because the practice of import parity pricing requires that tariff levels be kept as low as possible in order to keep the cost of living down. A better system for the collection of these data would allow a faster response time by the authorities to changed circumstances.

There are only about 1 000 participants in the industry and with an address list from the Plastics Federation it should not be too difficult to set up a cheap computerised data base of what is being produced, imported and exported so as to better inform those setting tariffs. The threat of tariff removal would act as an incentive to firms to respond.

Such a venture may also be self funding to some extent if it also developed a plastics products 'Yellow Pages' function for those seeking sources of supply. This idea is similar to the CSIR's Chemdata publication which is intended to achieve the same objective for the chemical industry.

Further suggestions to correct the historical imbalance in the commodity plastics *filière* are made in the final chapter as a part of the industrial strategy options for the *filière*.

CHAPTER 10

PETROCHEMICALS IN SOUTH AFRICA: FUTURE OPTIONS

Introduction

South Africa lacks proven reserves of crude oil and significant natural gas resources as well as proximity to large markets which make exports of petrochemicals an unlikely development strategy. This chapter argues that there are other reasons in addition to these that reduce the prospect of a large petrochemical industry developing in the short term. Nevertheless a growing economy will need the wide range of products that have their origins in the petrochemical industry. In addition it is a strategic industry with long lead times and planning horizons. Consequently it is important to identify what prospects exist for meeting such demand and what the accompanying advantages and disadvantages are likely to be. Accordingly this chapter outlines a research agenda for more modest options for the petrochemical industry with some of the attendant advantages and disadvantages. In the process recent state initiatives to determine future strategy for the petrochemical industry are criticised. Similarly the different interest groupings punting each of the future options are identified and discussed.

It is argued that it is undesirable to leave the development trajectory of the petrochemical industry to competing private interests which must ultimately put their own interests before those of the country. Finally a framework for the process of restructuring SASOL to meet social policy objectives different from the previously dominant military/strategic ones is outlined.

Could South Africa opt to be a major player in petrochemicals in the short term?

Could South Africa, despite being poor in hydrocarbon resources (apart from coal and coal bed methane) opt for a large petrochemical sector like other hydrocarbon poor NICs such as Taiwan and especially South Korea?

South Korea for example, has "no discernible advantages in producing petrochemicals", but has recently embarked upon a headlong rush into large petrochemical projects (The Economist, 1992, Vol 322:7750, p87). Ethylene capacity, as a result of the construction of 6 naphtha crackers, soared from 505 000 tpa in 1989 to 3.2 million tpa by the end of 1992 (Ibid). This veritable petrochemical flood has been attributed to two factors.

The recent deregulation of the tightly regulated and compartmentalised petrochemical industry, and the fierce rivalry between the South Korean Chaebols (Tanzer, 1991:60). It is still too early to tell whether this huge initiative will be successful or not.

As has been discussed earlier, the key factors needed to succeed in petrochemicals are guaranteed supplies of competitively priced hydrocarbons and cheap capital. South Africa meets neither of these requirements, leaving aside for the moment the various potential but as yet unproven hydrocarbon reserves or processes. (These are essentially: natural gas offshore at Mossel Bay, direct liquefaction of coal technology and coal bed methane gas). South Africa does have large proven reserves of cheap coal but the capital costs in producing petrochemicals from coal have been prohibitive to date. When further factors are considered such as proximity to major markets and construction capabilities (both of which South Korea has) the picture appears gloomier still. Current world overcapacity and low profitability in petrochemicals are a further reason to be wary of investments in large expansions of capacity. However this is an industry with longer planning horizons than most and overcapacity does occur periodically in this commodity chemicals business.

Given the correct mix of industrial policy and macro economic environment there is no *a priori* reason why in due course, giant projects similar to those recently undertaken in South Korea, if on a lesser scale, could not be tackled in South Africa.

However this is unlikely in the short term at least. There are several reasons for this in addition to those already mentioned. Firstly adequate research may not exist.[1] Research within the larger companies may well be able to fill this gap, only they regard it as confidential. Presumably these companies do share their research when they undertake joint ventures from time to time. For example AECI and Sentrachem built Coalplex as a joint venture. Recently AECI and SASOL jointly took over Sentrachem's fertilizer plant at Phalaborwa. SASOL, AECI and Engen in the late 1980s, undertook joint research into the direct liquefaction of coal, at the Central Energy Council's bidding. (The results remain secret.) The advent of Polifin may be expected to bring to bear the combined expertise of SASOL and AECI experts in this area.

However participating in the ownership of individual plants or joint R & D efforts for particular chemical complexes is quite a different matter from collectively pooling available knowledge for the purposes of determining an industrial strategy for the South African

1. The most recent publication on the industry, Enigma Marketing Research's latest report, The Chemicals Industry in South Africa, may have filled this gap to some extent. At a cost of R 4 469 it has not been available to me.

petrochemical industry. Too many vested interests and corporate rivalries get in the way. This failure is starkly apparent in the Report of the Working Group for the Promotion of the Chemical Industry. This report although acknowledging the need for an industrial strategy, fails to develop one, other than to plead for a government 'hupstoot' (DTI, 1990). Corporate rivalries also limited the possibility of an optimum petrochemical strategy emerging in the work of the 'Sander Committee' (Petrochemical Industry Study Group) as has been discussed in Chapter Six. Although the Sander Committee went further than the Working Group in that it did elaborate calculations in an effort to identify the best route forward for liquid fuels and petrochemicals (they are virtually inseparable strategies) it was regarded as only a 'screening exercise' in order to "indicate a direction. The rest was up to the Industry itself" (Minutes of the Petrochemical Industry Study Group, 24-11-89:4).

This is indicative of a lack of direction offered by the state at the time in so far as petrochemicals and liquid fuels were concerned. Despite the massive interventions in the form of SASOL and Mossgas, something of a vacuum appeared to have developed in the state's ability to look forward to future developments in this industry. Perhaps the mounting criticism of Mossgas had made the state less bold. The initiative for the establishment of both of these committees arose from (then) Deputy Minister Dr Theo Alant's concern with the chemical industry trade imbalance. The practical work and calculations were performed largely by a team of AECI researchers. In Japan this type of analysis would be done by MITI.

Unlike MITI no attempt appears to have been made by the state to forge a consensus over the actual way forward. It would seem that the ideology accepted by the group was that put forward by Sander at the outset (see Chapter Six) which amounts to a commitment by the state to a 'hupstoot' at the upstream end for a project/s to be determined by the private sector and open competition all the way down the chain. This despite the understated acknowledgement by the Working Group that:

> "It is questionable whether market forces alone will achieve the necessary objectives, as the circumstances in the upstream end do not comply with the conditions for a perfectly competitive market." (DTI, 1990:29)

For reasons which have emerged in previous chapters and which will be expanded in this chapter, it is most undesirable to leave the future of the country's petrochemical industry to a small number of companies which ultimately must put their own interests before those of the country as a whole. There are a variety of reasons for this, some of which are briefly identified here.

The petrochemical industry is a source of primary inputs to a wide range of industries. A private business must tailor its investments in this area to meet its business strategy, either local or international or both. This may require such facilities to be located overseas (such as Sentrachem's proposed purchase of certain petrochemical facilities in Australia) which impacts upon the balance of payments and job creation. In short the criteria and objectives of national development and private enterprises do not necessarily coincide and where the social costs of divergence between these two are high, government needs to be cautious about leaving 'the rest up to the Industry itself'. These dangers are discussed further in a more detailed assessment of the various private sector proposals.

In South Africa's case where state involvement in exploration (Soekor) and synfuels and petrochemicals (SASOL, Coalplex and Mossgas) has been massive, a whole 'raft' of regulations have been developed to keep these enterprises afloat which cannot suddenly be terminated. Yet on the other hand their continued existence gives rise to criticisms of 'cross subsidy' and a reluctance to invest by those who will not benefit from such regulatory support. Alternatively successful calls for deregulation may lead to a wastage of resources.

In the petrochemical industry the stakes for the country are large and so are the risks. A state role of at least 'concerned stewardship' seems appropriate.

A prerequisite for a national industrial strategy is a comprehensive and detailed analysis of South Africa's capabilities across the wide range of petrochemicals and their derivatives, together with an assessment of international markets and competition, import propensity and export potential. Regrettably such a task is beyond the meagre resources of the present study.

Secondly a political policy decision would be necessary to devote the very considerable capital and other resources necessary, to such a major petrochemical growth strategy. This is unlikely to be a popular decision in the foreseeable future for at least two reasons. Public perception of the chemical industry has been badly tarnished by the state's ventures into SASOL and Mossgas, despite the fact that these are not really chemical plants, but rather refineries producing liquid fuels. Mossgas in particular has attracted unanimous condemnation as a 'white elephant' in the media not only because of the processing route chosen (gas to liquid fuels) but also due to the fact that construction costs were (in real terms) approximately double the initial amount approved. Worse was to follow. First a consultants' investigation in 1993 found just 12 years worth of gas and later in 1994 Mossgas reported that only two years supply remained without further investment (see below). Such a political policy decision will, without very strong justification, also prove unpopular with those who are concerned about unemployment levels and the very capital intensive nature of large petrochemical projects.

From the vantage point offered by this study it is possible to make some general observations about more modest options for a future South African petrochemical industry. Since this has not been the central focus of this study it does not pretend to supplant the research needs described above, but merely offers a framework within which such research could be conducted. The crucial strategic question to be answered by such research is, where will South Africa source its next one or two tranches of petrochemicals?[2] In seeking answers to this question, as is indicated below, researchers will have to look to geographic locations both within South Africa and outside of South Africa, and to the various options in types of feedstock available such as coal, crude oil, natural gas etc.

More modest options for the petrochemical industry

There appear to be six possible petrochemical industry strategies for the sourcing of feedstocks and/or raw materials. Four of these options are unlikely to result in world beating low cost producers. One makes this claim although it is yet to be proven whilst another seems too uncertain to rely upon. In short these are:

1. Leapfrogging upstream petrochemical production and importing the petrochemicals and polymers required.
2. New development in coal based petrochemicals.
3. Further development of SASOL, Secunda into petrochemicals.
4. Developing a petrochemical centre based upon imported feedstocks.
5. Gas based petrochemicals utilising off shore gas at Mossel Bay.
6. Await developments in the Southern African region.

Each option is dealt with in turn below. A further option, building a purely export orientated petrochemical complex is not considered as those interviewed were unanimous that such a

2. Tranche as used here means a certain capacity of petrochemicals. In capital intensive industries with large economies of scale like petrochemicals the capacity is usually large. The exact plant capacity of a petrochemical complex is a function of many variables, feedstock type, co-product benefits, technology etc. By way of example the six Korean naphtha crackers recently completed are 350 000 tpa. The benefits of economies of scale above about 300 000 tpa are not very large, although some crackers are double that size.

project was not commercially viable.

Those options which involve the building of additional capacity all face the difficult issue of timing, or a trade-off of risks in deciding when to bring such a plant on stream. It is likely that potential investors will vie with each other in a race to bring the next tranche on stream.[3] The trade-off of risks which investors face is between winning the race (and 'cornering the market') on the one hand and the amount and period over which exports have to take place - in the context of a race it may be assumed that the winner will have to commence production before domestic demand can absorb all of the plant's output and that the balance will have to be exported (at lower prices). The larger the proportion which has to be exported and the longer the period over which exports have to take place, the lower the returns on the investment may be.

1. **Leapfrogging upstream petrochemical production and importing the petrochemicals and polymers required.**

This option envisages dispensing with further petrochemical production and importing the necessary petrochemicals or derivatives/polymer. This may be possible if a large speciality chemicals industry existed which could add value to intermediate commodity chemicals and export the result. Unfortunately this does not presently exist.

I am not aware of any economy of comparable size which has attempted, as a matter of deliberate policy, to leapfrog basic petrochemicals in its development plans. Certainly there is no lack of arguments against such a strategy: reliability of supply, strategic importance, large inventories etc. South Africa has by default, consequent upon the military/strategic nature of SASOL and Mossgas, been obliged to pursue this type of leapfrogging approach, especially in so far as aromatics based petrochemicals and engineering type plastics are concerned. The result, as has been shown, is a costly import bill and a trend away from engineering type plastics to commodity plastics. Petrochemical feedstocks for the synthetic fibre industry is an example. In order to produce PET (polyester) its precursors (monoethylene glycol and terephthalic acid) are imported. This together with less than half efficient minimum scale plants, led to a 173% tariff (of the reference price type) on staple synthetic yarn (Levy, 1992:32).

One country which is attempting something of a leapfrogging approach is Japan (see

3. Sentrachem's media strategy since the late 1980s has consistently sent strong signals to competitors that they intend to be a part of the next group to invest in petrochemicals in South Africa.

Spitz, 1988:528). Always reliant upon imported naphtha, government planners in the 1970s decided that the petrochemical industry faced viability problems in the long run. This appeared to lead to the view that naphtha feedstocks could be leapfrogged and petrochemical intermediates imported. This assisted in overcoming land shortages and environmental problems. However the threat of unsecured feedstock supplies was overcome by significant investments in oil rich gulf states, such as Saudi Arabia, accompanied by agreements to purchase output. This is regarded as a form of international vertical integration (Oman, 1989:107).

The Sander committee treated this ('leapfrogging') option as their 'base case' against which were compared six other options. The methodological approach used was a comparative, rather than an absolute, assessment of the alternatives, projected over 25 years from 1990 to 2015. The results were viewed from two perspectives: a foreign exchange analysis and a total cost analysis. They concluded that the 'leapfrogging' or 'base case' was not the most favourable option.

For these reasons as a long term strategy leapfrogging appears to be less than optimal. However as a short term or intermittent strategy the prospects seem better. At least it leaves open other options. Indeed intermittent leapfrogging is partially dictated by the large economies of scale of petrochemical production. This leads to imports of chemicals growing in between tranches of petrochemicals coming on stream. This is so because any new investment is likely to require the local market to absorb a significant proportion of output. Consequently there may be intervals between the point at which local supply meets demand, and a future point when the market has grown sufficiently to warrant a further investment. In the interval imports may have to make up the difference.

2 New development of coal based petrochemicals

At current crude oil prices of $16-$20 a barrel, new synfuels and indirect liquefaction of coal based petrochemical projects cannot compete, not because of the price of coal but because of the heavy investment necessary to extract petrochemicals from coal. Projections suggest that oil prices will not reach a level justifying further synfuels investments in the short to medium term.

This scenario precludes further petrochemical sources from new 'greenfields' indirect liquefaction of coal based investments in the short to medium term.

The Sander Committee research came to a similar conclusion. They examined four options which fall under this heading:

Option

B. Coal based synthetic fuels case assuming 40% self sufficiency maintained by the construction of four new synfuels plants, methanol as a fuel.

C. A variation of B.

F. Chemicals from coal based synfuels plants. That is 400 000 tpa of chemicals from each of 4 synfuels plants yielding the full range of olefins (C2s to C4s).

G. Chemicals from coal. Methanol would be produced from coal and converted predominantly into chemicals via a modification of AECI's Methanol To Chemicals (MTC) process.

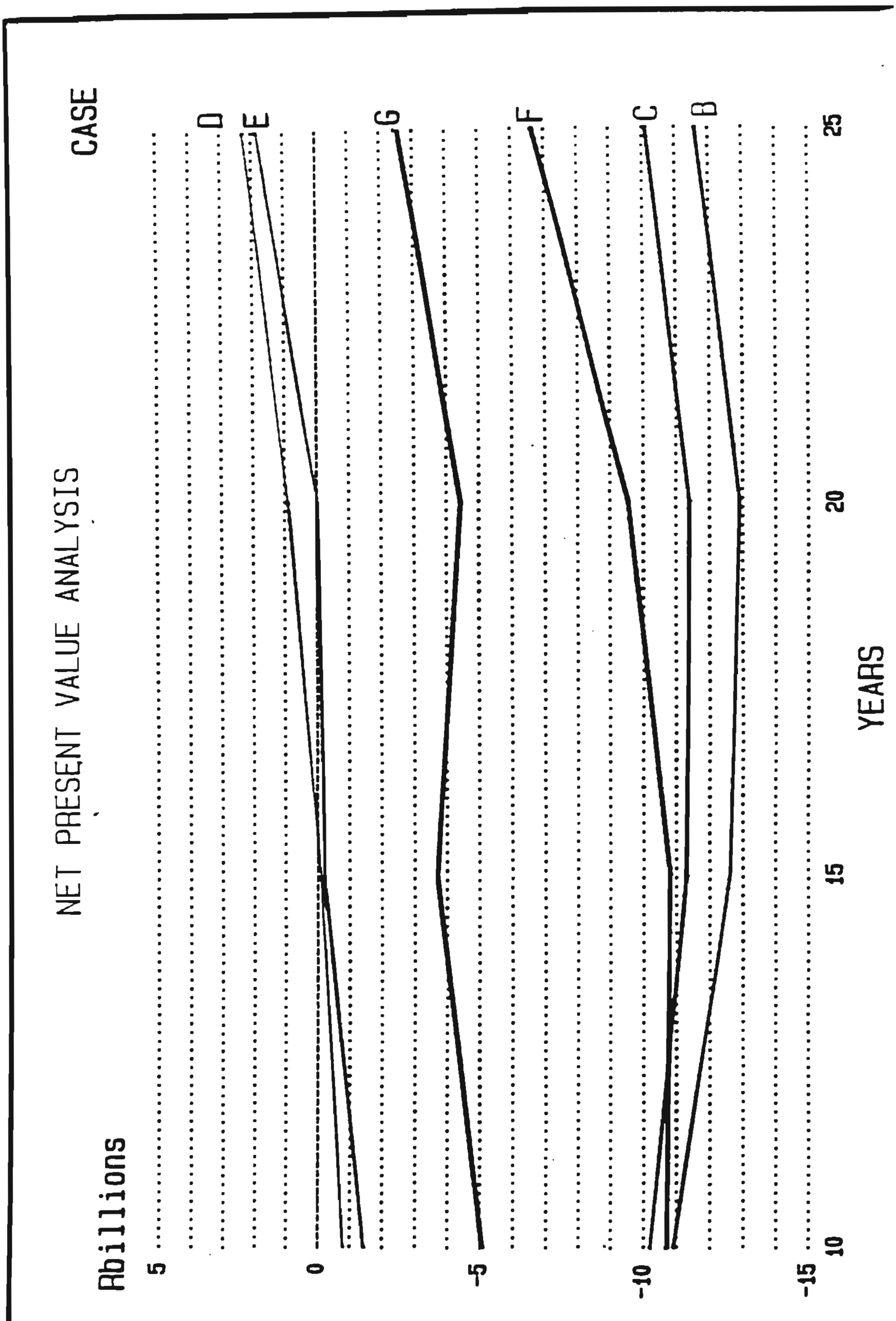
These were found not to be the best options, all of them being negative according to the net present value (NPV) analysis conducted. They are summarised in Figure 37 where each of the letters (B,C,F,G) above are represented by a line on the graph.

The direct liquefaction of coal may prove to be different. Both the direct and the indirect (synthesis) liquefaction of coal were pioneered in Germany and used there extensively during World War 2 in the production of liquid fuels. The difference between the direct and indirect processes lies mainly in the extent to which the chemical structure within coal is broken down. The direct route leaves most of the original aromatic chemical units intact. Whereas in the indirect (synthesis) route (used by SASOL) coal is first reduced to its basic components (carbon monoxide and hydrogen) before being catalytically synthesised to the desired products.

Research and development on the direct liquefaction of coal has continued in South Africa, more recently in the form of the Weskem project (see Lloyd, 1991b). As a result of SASOL's (synthesis) process, aromatics are almost entirely absent from its process. This has led to a national shortage of aromatics and growing imports of these products and their derivatives. The Weskem project is intended to meet this need through the direct liquefaction of coal into a 200 000 tpa aromatics complex at a cost of about R3.6bn (October 1990 values) (Ibid:7).

This is not yet a commercially proven technology, unlike SASOL's indirect

Figure 37. Net Present Value Analysis, SA Fuel & Petrochemical Case Studies



Source: Minutes of the Petrochemical Industry Study Group, 24-11-89)

Notes to Figure 37.

1. Each line represents an option as follows:
   - A. Base case - refinery expansion
   - B. Coal based synthetic fuel case - 40% self sufficiency via conventional fuels.
   - C. Coal based synthetic fuel case - 40% self sufficiency - methanol as a fuel.
   - D. Conversion of fuel streams to chemicals at SASOL Secunda
   - E. Steam cracking of liquids to produce chemicals
   - F. Chemicals from coal based synfuels plants.

The relevant options are discussed in more detail in the text.

2. The discount rate was not recorded in the assumptions made. The South African government's Central Economic Advisory Services usually uses a discount rate of 8%.

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liquefaction route. The Weskem project is 'very close' to commercial viability.[4] However its location in the North West Transvaal (because of the particular kind of coal required) means that it will largely be orientated to import substitution for the Reef. This will disadvantage a plastic converting industry orientated towards exports. Nevertheless if it is commercially robust without high tariff protection or subsidies then there would seem no inherent reason why it should not proceed and obviate rising import costs provided that exporters needs were also catered for. It would also further exacerbate the geographically dispersed nature of the industry.

A third potential source of hydrocarbons may also prove viable in time. This involves the extraction of what is commonly referred to as 'coalbed gas', (coalbed methane) which could theoretically be converted into petrochemicals. European countries have a long history of producing and using gas associated with coal mining. However interest in developing this resource independently of coal mining is a recent development. In the US 5 000 coalbed gas wells are currently in operation. According to a recent National Energy Council study the highest potential exists in the Waterberg basin in the northwest Transvaal and the southeast portion of Transvaal coalfield near Paardekop-Amersfoort.

In summary South Africa has very large coal reserves as a potential source of fuels and chemicals. The economic viability is likely to be a function of dwindling global oil supplies, coal processing technology and the exchange rate if the Rand continues to decline.

3 Further development of SASOL into petrochemicals

This position has been advocated by Lloyd (1991a). The thrust of his argument is to further expand and develop SASOL petrochemical potential to provide those basic

4. Personal communication P Lloyd, Industrial and Petrochemical Consultants (Pty) Ltd., 22-1-93.

petrochemical building blocks currently missing from SASOL's slate of products. He suggests that "we potentially have most of the feedstocks we need.." within SASOL (Lloyd, 1991a:4). This could be achieved by relieving SASOL of its responsibilities to produce fuel, and altering the support regime or subsidy to favour petrochemical production rather than synfuels. The cost of this altered subsidy, he believes, would be about the same as the costs of the current synfuels support/subsidy system. Presently SASOL's petrochemical products are not directly subsidised. However, they have, as backing, considerable support from the regime of support for synfuels.

The effect of Lloyd's proposal would be to increase oil imports to make up the loss in synfuel output. Conversely chemical imports would be reduced and replaced by SASOL petrochemical production. In short, it is a proposal to substitute lower cost crude oil imports for more costly chemical imports, which on the face of it sounds like a good idea.

The difficulty with Lloyd's (1991a) proposal is that it ties the petrochemical industry even more closely to SASOL's coal based cost structure. It would locate these plants, presumably, inland close to SASOL. This may be a handicap if in future, a switch had to be made to imported feedstock. It is possible that at a future point in time SASOL could switch to imported feedstocks of crude oil, transported inland by extending the existing pipeline which currently covers most of the distance. This would require SASOL's Secunda works to be converted into a conventional refinery and/or naphtha cracker complex, like its current Natref refinery in Sasolburg. SASOL's decision to prospect for oil in the Namibian off-shore fields may represent a strategic exploration of this option although it is more likely an attempt to secure regional supplies for its Natref refinery. However from the petrochemical and plastics industrial strategy point of view, a more export orientated sector would ideally be located at the coast rather than inland and consequently industrial strategy should be encouraging a gradual relocation of this industry to the coast.

In addition, if it is intended that private enterprise should invest downstream of SASOL's petrochemical feedstocks, as Lloyd implies, then he would appear to have overlooked the concern major competing firms have in making investments downstream of SASOL.

Some of SASOL's competitors which are also customers for its feedstocks are, whether rightly or wrongly, serious about developing independent feedstock sources. They find it strategically unacceptable to be in competition with their feedstock supplier. This difficulty could be overcome by limiting SASOL's downstream involvement (and forefeiting the advantages of vertical integration) or by returning SASOL to its pre-privatisation public utility role.

A further difficulty with Lloyd's proposal is the geographically dispersed nature of the industry, a point he himself makes. He also, correctly, draws attention to the synergies that exist for petrochemical producers in close proximity to each other and interconnected by pipelines.

All of these reasons suggest the need for South Africa to identify a place which is ideally going to be developed as THE future petrochemical centre for South Africa. The choice of locations in turn depends upon the view taken of likely future feedstock sources. In short, either oil or coal. Coal means an inland location and oil a coastal location. The volume of coal required tends to dictate that the complex be sited near the coal source and in South Africa most proven coal reserves lie inland. Given the economics of coal chemistry, South Africa seems best advised to opt for imported feedstocks (oil, LPG etc) notwithstanding the declining exchange rate. This then dictates a coastal location, either Richards Bay or Durban due to their proximity to the PWV. Durban already has an existing refinery infrastructure, but it may lack sufficient land near the existing refineries.

If SASOL could produce BTX aromatics based upon its Secunda operations at competitive prices, then presumably they would have done so by now. Yet such plants do not feature among the list of plants announced to date, despite the fact that SASOL is not averse to import substitution type plants, as a matter of policy (SASOL Annual Report 1991).

The final, and most weighty, difficulty with Lloyd's proposal is that it relies upon the maintenance of the support/subsidy for the liquid fuels industry which we have seen is of the order of R 1 billion p.a. possibly for a good many years to come. The value of the imports saved, in Lloyd's estimate, would have been at least R325 million in 1990. If so then even if adjusted for inflation, it would be more beneficial to end SASOL's subsidy and to continue importing petrochemicals. The impact upon the balance of payments of scrapping SASOL entirely makes such an option extremely unlikely.

The Sander Committee investigated the option of converting fuel streams to chemicals at SASOL Secunda (Case D). It was found to be the best option (of those considered) for the long term development of the chemical industry, and in terms of NPV analysis had the best returns. It is not clear from the minutes and supporting documents of the Sander Committee whether the synfuel support regime was assumed to continue to operate or not. The projection was based on ethylene and propylene only, with some ethylene glycol and derivatives coming on stream in 2006, which means that the lack of the other olefins and aromatics would not be solved if this option were followed.

Nevertheless a variation of this position has of course been pursued by SASOL. In recent years it has expanded capacity in ethylene and propylene and is currently developing a world scale alpha olefins plant along with various other projects. SASOL sees further expansion of its facilities as the way forward for South Africa (Interview, Marriot).

Currently SASOL has ethylene and propylene capacity considerably in excess of domestic demand. Is there potential for further capacity of these olefins? There is but at a price. Further potential for ethylene extraction from the Secunda plants would require utilising a more costly route than that currently used (Interview, Marriot). Potentially there is also a relative abundance of further propylene, which could probably be extracted at more competitive prices than ethylene. Whether they are world competitive or not will have to be determined at the time such investment is considered. In the context of reduced support for synfuels as suggested above, exploiting this potential will require a commercial decision by SASOL.

Whether or not SASOL further expands olefin capacity, currently it is the major source of olefins and is likely to remain so until at least 1996. This then requires an industrial strategy in the short term if the plastics *filière* is to become more internationally competitive.

4 Developing a petrochemical centre based upon imported feedstocks

As we have seen, a most remarkable feature of the petrochemical industry is that this giant industry is reliant upon just 2-3% of crude oil processed for its feedstocks (Shell International Petroleum Company, 1966:194). An obvious implication is that in future as global oil resources become scarce, the relatively small petrochemical off-take and the higher value added products it produces, are likely to assure the petrochemical industry of feedstock supplies.

During 1993 the IDC were persuaded that a conventional cracker at a coastal location was a good option to investigate and invested some 2 800 person hours in this project. It also indicated a commitment to underwrite about 50% of the envisaged R 7.8 billion costs.

A petrochemical processing centre, based upon imported feedstocks could be established at the coast, possibly Durban or Richards Bay, for the following reasons. To produce petrochemicals a conventional oil based route would be naphtha sourced from oil refineries which, when cracked, yields a wider slate of products than are currently available from the indirect liquefaction of coal. The long term trend against naphtha feedstock in favour of lighter feedstocks (eg gas) was arrested after the 1986 oil price crash and the rapid growth in demand for propylene, which is available in much lower proportions from lighter feedstocks than from naphtha. The choice of feedstocks for South Africa will require careful study, but the international trend seems to favour flexibility of feedstock choice to offset fluctuations in price and supply (Vergara and Babylon, 1990).

Recently a strategy has been advanced by Exxon which calls for increased back integration into refineries (see Heathcoate, 1992). Essentially they argue that the broad diversity of feedstocks available from refineries, and the feedstock flexibility this offers, together with other synergies, make for increasing cost advantages if basic chemicals units are integrated into large refineries. Should this prove to be a strategy with local application then our attention is directed to South Africa's largest crude oil refineries, Genref and SAPREF in Durban. Genref appear to share the Exxon view and have intimated in public statements during 1991 and 1992 that when their current phase of capacity expansion is complete they will be looking to enter the chemical market. The clearest view of their thinking emerged in a newspaper report in January 1993. Engen Chemicals General Manager Peter Sutherland is reported as saying that it would be premature to set up a major ethylene cracker before the end of the century, an obvious tilt at the Sentrachem proposed Mossel Bay cracker and a warning to the IDC who are rumoured to support the Sentrachem proposal. In its place Sutherland invokes a "world-wide swing towards smaller plants which extract chemicals out of the hydrocarbon stream" and argues for extracting smaller volumes, more in line with domestic demand, from the refining process (The Daily News, 21-1-93:18).

Either Genref or more likely, the two refineries together, should have adequate capacity to produce sufficient feedstocks necessary to meet local demand in basic petrochemical building blocks utilising plants of sufficient economies of scale as to warrant only limited tariff protection.

The Sander Committee's Case E, labelled 'Steam cracking of liquids to produce chemicals', envisaged a new refinery at Richards Bay (due to a land shortage in Durban) with an associated naphtha cracker built in 1993, followed by a further cracker in 2009, followed by a further refinery in 2011. The crackers would be world-scale yielding 600 000 tpa of ethylene with a wide range of products including one of the aromatics, benzene from which styrene would be made. The feedstock would be surplus gas oil from the local refineries and supplementary imported naphtha.

This option (Case E) was the only other option to show a positive NPV and led the Committee to conclude:

"For the cases considered in the study, the total cost and NPV analysis showed that the best options for the long term development of the chemicals industry in South Africa were either the steam cracking of liquids or the conversion of existing fuels streams at SASOL Secunda to chemicals production." (Minutes of the Petrochemical Industry Study Group, 24-11-89:3)

If left to the market this option may require a remarkable degree of co-operation among competing firms. For example it might require the co-operation of Shell and BP (the owners of SAPREF) and Engen who for their own commercial reasons may not be comfortable with such an arrangement. It would also mean increased penetration by large multinationals and a conglomerate (Engen is a part of the Gencor Group) into one of the strategic commanding heights of the economy. Furthermore, a Durban or Richards Bay based naphtha cracker would obviate the need for a gas cracker in Mossel Bay. Sentrachem has invested considerable research expenditure on their Mossel Bay petrochemical complex proposal which they are presumably reluctant to abandon without reward. In short, either a remarkable level of co-operation will have to be forthcoming from some unlikely quarters or state intervention will be required as has so often been the case in other countries (Vegara and Babylon, 1990).

Since the petrochemical industry occupies a 'commanding heights' position in the economy careful consideration ought to be given to the opportunities afforded foreign investors in this area. In a globalised industry such as chemicals, MNCs are the primary source of technology and access to markets. However they are also an important mechanism for the transfer of wealth from developing economies to developed economies. A balance has to be found in gleaning what is useful for South Africa from MNCs whilst not allowing them to dominate the local market. Other developing and industrialising countries have exercised control in various ways. South Korea for example, which currently has about six times the petrochemical capacity South Africa has, severely limited foreign direct investment and has only recently allowed up to 50% without state approval (Asia-Pacific Chemicals, June, 1992 and Balassa, 1991). Given South Africa's location within the global petrochemical industry, further foreign direct investment ought to be limited to minority shareholdings. Alternatively arrangements such as operate in India could be introduced. It requires foreign exchange leaving the country in the form of dividend repatriations to be balanced by export earnings over a period of seven years (Patel, 1992:14). In general Wade's (1991) prescription appears appropriate: welcome MNCs but direct their sales towards exports and their input purchases towards local suppliers (Wade, 1991:363).

Unfortunately South Africa's signature of the Marrakech Agreement (arising from the Uruguay Round of the GATT negotiations) precludes an explicit linkage between foreign investment and exports. However it would appear that the same result could be achieved if it were approached indirectly by the creation of other conditions which did not explicitly refer to export requirements. Such arrangements require further investigation.

The involvement of foreign investors in the off-shore financing of local projects also requires careful consideration. There has been considerable capital flight from South Africa in recent years by conglomerates such as Anglo American, De Beers and Rembrandt. The chemical conglomerates are not immune to this disease. Overseas investment and the utilization of off shore borrowing to finance local projects are just two possible mechanisms through which capital flight may take place. Sentrachem the proponent of the Mossel Bay cracker, a focus of our attention in the next section, is exploring both of these possibilities. Indeed the recent attempt by Sentrachem to purchase the Australian company Chemplex for between R330m and R490m, caused such concern that the then Minister of Finance (Keys) threatened to halt or limit such outflows (Business Times, 22-11-92:2 and Business Day, 23-11-92:1). Sentrachem invoked the 'international diversification' argument to justify its intentions. This may not appear unreasonable in the context of a globalised chemical industry, however it is difficult to distinguish which of the company's intentions were uppermost in their minds, shifting capital off-shore or international diversification. Reports of foreign funding for the proposed Mossel Bay petrochemical complex range from $250 million to $400 million (ECN, 9-9-91 and Business Day, 15-8-91:1).

These considerations suggest that considered state policy is required in respect of foreign investment in the 'commanding heights' of the petrochemical industry. Similarly caution is needed if the state is to avoid extending the dominance of the upstream end of the industry at the expense of the downstream. There is a wealth of experience in Latin American countries, South Korea and Taiwan amongst others to be drawn upon in this regard. A study of the latter two in particular yields insights into the complex process of achieving the desired balance between upstream and downstream industries.

5 Gas based petrochemicals utilising off shore gas at Mossel Bay

The discovery of natural gas at Mossel Bay should have been good news for the domestic petrochemical industry and the country's economic growth, because utilising it for chemical manufacture would have been a more productive use of this natural resource. Alas, the exigencies of military/strategic policy decreed that the gas be used for liquid fuels instead, and large amounts of capital have now been sunk into the Mossgas refinery. The existence of this refinery makes it more difficult to determine the future optimal use of this gas.

Sentrachem has been the main proponent of a proposal to use the gas, or a share of it, for chemical purposes. They have proposed a gas cracker associated with the Mossgas synfuel refinery and have spent considerable sums on research into the various options ranging from a R 500 million ethane cracker to a R 6 billion combi cracker. A decision was, happily as it turns out, delayed until the CEF had completed an investigation to determine the extent of the gas fields off Mossel Bay and whether or not they could support petrochemicals as well as the Mossgas refinery.

The Deloitte & Touche Management Consultants' investigation found just 12 years worth of gas for Mossgas, not sufficient to meet its planned operational life (Financial Mail, 6-8-93:64). Consequently Sentrachem's hopes of building a gas cracker for petrochemical production at Mossel Bay have been crushed for the time being and until, if ever, suitable gas reserves are found.

Should sufficient gas supplies be found to justify the investment, it is worthy of careful consideration. Careful scrutiny of its impact upon the balance of payments and social rates of return is needed, particularly if local gas feedstocks have to be supplemented by imported feedstocks. (See Annexure C, page 408 in this regard). A preliminary calculation made by Sentrachem at my request shows the Local Cost of Foreign Exchange to be 2.50 R/US$, a more favourable figure than the current 2.80 to 3.00 R/US$ exchange rate. Unfortunately several discussions with Sentrachem concerning the assumptions made could not overcome Sentrachem's need for confidentiality and thus this figure has very limited validity.

The lynchpin of this project would have been the transfer price of gas and other feedstocks from Mossref to the cracker. This gas is a scarce resource and its selling price would need careful consideration and public debate with a view to ameliorating the burden of Mossgas on the fiscus.

If Sentrachem's proposed gas cracker project had proceeded they anticipated exporting about 70% of output. National considerations suggest that such a resource based approach, which amounts to exporting large volumes of precious natural gas, in the initial years at least, into often heavily traded and cyclical global commodity markets, is a less than optimal path to follow. It would be far better to beneficiate this to plastic products and to export those. As this study has shown Sentrachem's simple expectation that the plastic converting industry would blossom of its own accord merely because somewhat cheaper polymer was available is wide of the mark. Rather a package of factors conducive to growth and development in the plastic converting industry such as is detailed in the final chapter will be even more necessary and urgent if and when a gas cracker is built.

Further exploration for gas may yield better results but timing will be crucial. Unless the unforseen materialises it appears that if a gas cracker is built it will miss the widely anticipated global economic upswing in 1995/6, an optimal time at which to bring such a project onstream.

An argument against such a gas based source of petrochemicals is that it would yield the same narrow band of petrochemicals as is currently the case. This may, from South Africa's national perspective, be sufficient reason to opt instead for a liquids (eg. naphtha) cracker even if it is less profitable than a gas cracker from an individual firm point of view.

A related proposal was to abandon Mossgas as a petrol refinery and convert it instead into a petrochemical complex. This would require SASOL, as the licensor of the technology, to waive its right to prohibit manufacture of petrochemicals. It would be a more productive use of the gas but would require the courage to write off a large investment and to invest a further, although much lesser amount, to make the conversion. This is not a new suggestion.

An earlier confidential proposal by certain chemical companies to halt the construction of the Mossgas refinery and to replace it with a chemical complex was rejected by the De Waal Committee (set up to consider this proposal) in the following terms:[5]

> "From the analysis above it is clear that all these projects are unattractive from an investor's point of view. The Mossel Bay gas project is only socially acceptable, for the case where the real oil price increases by 2% per annum. The analysis does, however, show that at this point in time the Fuels project is more acceptable from the community's point of view and until a better proposition for the use of the gas is identified that the fuels project should continue." (De Waal Committee Report, 1991:6)

In this analysis the nearer the Mossgas refinery came to completion the more remote became the possibility for 'a better proposition for the use of the gas'.

A petrochemical complex at Mossel Bay is suitably placed for exports. However it is

5. What Can South Africa do about Mossgas?, A view compiled by industries associated with synthetic fuels and chemicals, August 1991.

disadvantaged relative to domestic polymer markets and the additional transport costs would need to be taken into account.

A related but important point concerning a possible petrochemical complex (either in addition to the existing refinery or instead of it) is the prospecting associated with it. This is intimately bound up with the Mossgas refinery itself. Currently the parastatal, Soekor, has conducted their prospecting behind a thick veil of secrecy, in association with various dubious international concerns. The costs to the fiscus, via the Central Energy Fund - R835 million between 1965 and June 1987 (Soekor, 1987:7) - of these activities and the returns there on, (one small refinery, just one eighth the size of SAPREF, at disproportionately high cost) requires very careful public scrutiny. This necessitates the removal of legislation making such public scrutiny illegal. Indeed continued hydrocarbon prospecting in South Africa's unyielding waters requires serious review particularly in the light of the most recent reports on the Mossel Bay gas fields. Originally the gas fields were expected to have a lifespan of some 20 years. In 1994 this figure was revised to 12 years and later revised again to only a two year lifespan. A further investment of approximately R600 million (1994 Rands) would be required to extend their life for a further 3 to 8 years (Business Day 18-10-94 & 24-10-94).

This revelation has awakened renewed interest in a petrochemical complex based on imported feedstock. The CEF, IDC and Sentrachem are investigating a new variation of this proposal. They contemplate converting Mossref into a small crude oil refinery integrated with a petrochemical complex which would use as one of its feedstock streams the remaining gas at a cost of R 2.4 billion and R 4 billion respectively (Businesss Day 6-9-94 and 7-9-94).

Ultimately, whether or not chemicals constitute the future optimal use of the Mossgas gas, will be a function partly of technological development in gas extraction and also, hopefully, a careful estimation of the social rates of return to be expected therefrom.

6 Await developments in the Southern African region.

The additional factor introduced into the discussion under this heading is the question of (Southern African) regional trade balances and regional economic development. A variation of option four (developing a petrochemical centre based upon imported feedstocks) involves a coordinated energy and petrochemical approach in the Southern African Region.

Following the unbanning of political organisations in South Africa political developments in the Southern African region began to move steadily towards economic cooperation. In August 1992 the Southern African Development Coordinating Council

(SADCC) countries signed the founding documents for the Southern African Development Community (SADC)[6]. Following this the energy sector of SADC adopted a draft Protocol on Energy Cooperation in March 1994 to promote regional cooperation in this sector.

Three developments in the sub-continent deserve monitoring. Prospecting off the Namibian coastline, the Phande natural gas fields in Mozambique and developments in the Cabindan oil basin in Angola. Favourable developments in these areas may hold out hope of one of the key requirements being met: a guaranteed and competitively priced supply of hydrocarbon feedstocks.

To meet South Africa's petrochemical needs Angola could sell either crude oil or naphtha or plastic raw materials to South Africa. In 1994 Angola's production facilities could not produce sufficient volumes of naphtha and limited their potential sales to crude oil. However if peace were to break out in Angola and economic development took place, it is conceivable that its refinery capacity could be expanded making naphtha exports possible and ultimately investment in a petrochemicals complex associated with a refining complex may occur making possible exports of plastic raw material to South Africa.

Such developments would help to balance Angola's trade account with South Africa. Cabindan oil output is largely tied to US markets by the US oil companies which operate that field and because of the price premium Angola's crude can command in the more environmentally concerned US. But South Africa has had negotiations to purchase Cabindan crude (Bamber, 1991:38) (although the outcome is not known) and South Africa may become a more quality sensitive crude oil purchaser with the scheduled introduction of lead-free petrol in 1996.

It is unfortunate that the only certain supply of oil in Southern Africa (Cabinda) is so bedevilled by political uncertainty that major investments there appear unlikely for the foreseeable future.

In so far as Phande gas is concerned SASOL entered into a pact with the Mozambiquean state owned Hydrocarbon Company (ENH) for the exploration of natural gas deposits at Phande in Southern Mozambique in 1992. The project envisages transporting the gas by pipeline to South Africa (Reuter News Service Africa, 27-2-92). In this context it is interesting to note that SASOL has also carried out an "extensive study of the economic factors for a synfuels plant based on natural gas. A dry natural gas feed for the production of synthesis gas was assumed." (O&GJ, 20-1-92:56). Phande gas is apparently 'dry' gas that

6. The SADC countries are: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

is largely methane and lacking in ethane and propane, according to the head of Sentrachem's Strategic Raw Materials Project (Interview, McIver). Later, in 1994 the SADC launched a large study into the region's natural gas potential which may herald regional cooperation in this area in future.

SASOL and Engen are involved in prospecting for oil off the Namibian coast. Overall there appears sufficient commercial incentive for South African firms to invest in searching for a regional supply of hydrocarbons as much as their sense of political risk will allow.

In summary amongst the six options identified here, three large rival South African chemical/fuel corporations are each pursuing their own corporate strategy in answer to the question: where will the next tranche of olefins come from? The three strategies pull in three different directions. SASOL says SASOL. Sentrachem says a Mossel bay gas cracker and or an integrated crude oil refinery/petrochemical complex. Engen says a refinery based complex. The important point is that each corporation, for its own strategic reasons, is attempting to pull the country down its particular path, irrespective of what may be in the best interests of the country. Advocates of the 'free market' will find nothing amiss and pay tribute to the constructive competition emerging here.

However it is not quite so simple. Public funds and public interest are involved, directly or indirectly. The IDC is preparing to commit large sums of public money to a petrochemical complex. SASOL is partly owned by the IDC and has had IDC participation in some of its recent projects. Engen might too require IDC participation. Tax benefits in terms of Section 37(e) have been made available to several SASOL projects and for the Mossel Bay gas cracker, if it proceeds and either one may require tariff protection at some point. In so far as private capital is concerned, large projects such as these, would remove significant proportions of investment capital from the available pool. There is also the issue of monopolistic rent which may be extracted by those who straddle commanding heights with limited or no competition.

The crucial question is, should this reach of the commanding heights of our economy be left to corporate rivalry or are there not social and economic reasons for the state to direct and set forth the direction development should take in this strategic area more deliberately and in more detail than the Sander Committee did? This has certainly been the case in Japan and the successful NICs. Wade (1991) in his analysis of successful East Asian economies found that:

> "government 'led' rather than 'followed' the preferences of private market agents in the heavy and chemical industries... Within 'high-intervention' industries, (state)

leadership episodes are concentrated at the stage of creating distinctly new capacities (whether in new or existing industries), especially when such creation faces large indivisibilities or other entry barriers" (Wade, 1991:303 and 304).

South Africa is now at the conjuncture when a similar decision must be made to bring on stream new petrochemical capacity in the next few years. It is also appropriate for the state to lead this episode, for the reasons just canvassed and for the following additional reasons.

The issue is really who will decide and how will the decision be made? One way or another a decision will be made. Should it be state or should it be left to private enterprise? In considering an answer it needs to be borne in mind that the configuration of the larger scale upstream sector influences the configuration of risks and opportunities for the smaller scale downstream sector.

In retrospect it can be seen that the South African state has 'led' forcibly, in the local petrochemical industry. The first petrochemical complex (the Sasolburg naphtha crackers) in the 1960s was in pursuit of Import Substitution Industrialisation policy. The second (Coalplex) was both ISI and strategic. The third much larger intervention (the SASOL Secunda complex) was driven by military/strategic considerations. The fourth, Mossgas was the ultimate in military/strategic investments.

Is this history of intervention involving commercially unwise decisions made for military/strategic reasons by an embattled regime, sufficient reason, in the emerging new political dispensation, for a more democratic state to abandon intervention in this key strategic area? It would appear not. Indeed since the (apartheid) state (albeit an illegitimate one) pursued a high level of intervention in the petrochemical industry and is largely responsible for its present unsatisfactory situation, is it not then incumbent upon the state to now extract or lead the industry from this and to redirect it into a more viable development trajectory?

My tentative views on the direction which ought to be pursued have emerged in the foregoing discussion. However it is to be stressed that these are no substitute for the detailed research, costing and calculation which must precede selection of any one, or combination of these options, and which may well arrive at different conclusions. Furthermore the largely intermediate input nature of much of the chemical industry means that petrochemical industry development should not be divorced from wider development strategies for manufacturing.

The difficult process of extracting the industry from its present predicament comprises essentially two restructuring tasks. Firstly to move away from the internationally uncompetitive sub-world scale plants which have emerged as a result of import substitution policies. Secondly to progressively remould those parts of the industry which are coal based away from coal and towards alternative and more internationally competitive feedstock requirements. There is of course some overlap between these two objectives.

In so far as the first of these tasks is concerned, tariff reductions and the threat of tariff reductions have already brought about some restructuring. Some plants have closed and others have expanded capacity and in some vertical integration of ownership has occurred. An industrial strategy to facilitate this process across the entire chemical industry is beyond the scope of this study. Suffice it to say that considerable dislocations to job security are arising which suggests that a concerned state will want to make this process as painless as possible. A tripartite industry forum would be a useful beginning.

The second task is no less difficult in view of the huge sums of public money originally invested in coal based plants and the current large institutional shareholdings in companies like SASOL and AECI. SASOL towers above AECI in its impact on the economy and accordingly most of our attention should be directed to it. SASOL requires a structural adjustment programme perhaps along the lines of that carried out by the Dutch State Mines (now DSM) in the early 1960s. It transformed this coal mining and chemical (initially coal based) company into the current DSM, a respected international chemical company. The Dutch government gave considerable attention to the impact of the changes on the regional economy and to job security and skills transformation. A number of fortunate circumstances eased this transition. There was a reasonably high level of co-operation between the company, the state and organised labour. However the critical element appears to have been state assistance in the form of low interest loans (Interview, de Wit).

The transformation of SASOL could follow four processes, which are identified in outline here. Some further detail emerges in the subsequent discussion around industrial strategy for the commodity plastics *filière*. All four processes could begin concurrently but each successive process is likely to have a longer life span than its predecessor.

Phase One must result in the removal of the veils of secrecy, both corporate and statutory, which prevent the citizens and motorists of South Africa knowing the extent to which they are supporting SASOL's mega profits and the oil industry through the petrol price. Without these facts planning is extremely difficult. However obtaining the necessary data from SASOL (the only possible source for certain key information) will not be easy because SASOL will have an obvious vested interest in ensuring the outcome suits its objectives. A key element of such an investigation would be to determine the extent of transfer pricing between SASOL's synfuel operations and its various subsidiary and related companies. Needless to say what follows is based upon such information as is available and may well need to be revised once all the facts are to hand.

Phase Two provides for an immediate prohibition upon further investments by SASOL in new projects which depend upon the coal based synfuel process until the cessation of the synfuels support and the re-regulation of the fuel industry has been achieved. A re-regulated fuel industry would presumably relieve SASOL of its obligations to produce fuels and its subsidy. Phase Two could run concurrently with Phase One. Indeed it may provide the leverage necessary to achieve the goals of Phase One. Once the liquid fuels industry has been re-regulated (and the subsidy issue clarified) further investments in new projects based upon the synfuels process should be allowed to proceed subject to the following conditions:

a) they should provide the most competitive option available to South Africa.

b) as far as possible no subsidy of any kind or tariff protection should be relied upon for the viability of such projects.

c) new projects should be intended to husband the synfuels process into its twilight years whilst simultaneously using it as a platform for the emergence of a reorientated and vigorous company. For example there may well be further reserves of propylene which could be competitively extracted.

Certain of the notions in these conditions may appear contradictory, such as being 'internationally competitive' whilst 'husbanding' at the same time. It is unavoidable that the judicious management of this national asset will require grappling with these sometimes contradictory imperatives. Difficult decisions will have to be made.

Phase Three will require a process of monitoring SASOL over a period of years in a re-regulated environment. This may require subsidies and/or some other form of state intervention.

Phase Four will concern a plan for the final phasing out of synfuels. It may involve consideration of the merits of nationalising SASOL in order to give effect to the gradual phase out of coal based synfuels. During the course of Phase Two it is likely that some form of tripartite planning body will be set up to consider the shorter term restructuring options. Having accomplished such a task it could shift its attention to the longer term task of planning for the eventual closure of the synfuel plants at Secunda and the activities which will replace them.

Conclusions

This chapter has discounted the possibility of a major petrochemical initiative or episode for the South African economy in the short to medium term. It has reviewed recent state initiatives to determine a direction for petrochemicals in South Africa. These were criticised for not having gone far enough to be meaningful and for leaving such important matters to be determined by corporate rivalry.

If this conclusion is contrasted with recent developments in South Korea it may be criticised, in that it may be argued that state deregulation of the petrochemical industry has brought about a massive wave of investment and capacity expansion in a short period of time. However it should be borne in mind that in South Korea's first two petrochemical complexes there was much state involvement and that the recent episode has arisen in the context of competition between six major producers, orientated largely towards exports. This level of investment as well as both domestic and international competition is a far cry from South Africa's situation in the early 1990s.

By contrast South Africa's second petrochemical complex (SASOL Secunda) arose by default from military-strategic synfuel considerations very different from the competitive commercial-strategic petrochemical considerations which prevailed in South Korea. Furthermore there is no prospect of the kind of competition evident in South Korea emerging from the options considered in this chapter. Indeed only one of the projects is designed to be largely export orientated. In short it is argued that South Africa's petrochemical development is still in its infancy and has not yet reached the stage of development at which competition is better able to overcome the problems of economies of scale, concentration and foreign ownership.

An important public policy issue has been raised in this chapter concerning the extent to which the petrochemical commanding heights of the economy should be allowed to develop as a consequence of corporate rivalry or alternatively the extent to which the state should be involved in shaping this direction to the benefit of the nation. The extent to which direct or indirect state support may be required and the lessons to be learnt from East Asian NICs add weight to the argument that the state should not lightly withdraw its guiding hand in this matter.

A framework for further research on the larger, longer term questions of petrochemical industry strategy has been identified. The strategic position of the petrochemical industry and the nature of the options identified form part of the argument made for the necessity of more deliberate and meaningful state direction in these matters than has resulted from the recent state initiatives. In the final chapter the form or process through which the state should intervene is addressed. It argues for the involvement of the major players, organised employers, organised labour and the state to be brought together to determine direction.

CHAPTER 11

CONCLUSIONS, INDUSTRIAL STRATEGY OPTIONS AND POLICY IMPLICATIONS

The role of government is not only to push the process by coordinating upstream industries, but also to lower entry barriers at the downstream end to facilitate the induced response.

Robert Wade, Governing the Market, p354

Introduction and Broad Policy implications

This chapter sets out strategy options for the commodity plastics *filière* in the short term. Longer term options depend heavily upon the source of the next tranche of chemical building blocks which is unclear at this stage. In the short to medium term and until such time as there is domestic competition for Polifin's virtual monopoly on the olefin supply, a deliberate strategy is needed to optimise the development of the commodity plastics *filière*. Once there is competition in olefin manufacture, the strategy options below will need to be reviewed, not because the existence of competition will necessarily obviate existing problems, but because the nature of the problems will have altered.

In a broad sense a choice has to be made between an upstream-led or downstream-led developmental path for the commodity plastics *filière*, although ideally the objective would be to try and get the balance between the upstream and the downstream 'right' within the constraints of pressing social and economic needs including high levels of unemployment and large disparities in wealth.

The strategy proposals which follow have a twin thrust: lowering intermediate input prices as part of a package of measures designed to dynamise the more labour intensive plastic converting industry, whilst at the same time maximising the potential of existing facilities, where cost effective, and adding as much value as possible in the process. Such objectives include maximising employment opportunities at lower capital costs, but with reasonable wage levels in a context of higher levels of investment. Concurrent broad objectives are raising productivity and an improved trade performance.

Despite South Africa's lack of oil resources and meagre natural gas resources, the analysis in previous chapters has shown that there has been a history of resource based capital intensive development at the upstream end of the *filière* and that this has been strengthening relative to the downstream plastic converting industry. The plastic products industry has the advantages of greater value added and employment generating capacity per unit of capital stock employed. These are important considerations in the light of high and increasing levels of unemployment as well as underdeveloped exports from the plastic converting industry.

Plastic articles play an important role in the lives of the poor. Domestic commodity plastic markets are dominated by packaging, much of it around basic foodstuffs. Dire levels of poverty in South Africa make basic foodstuff costs a critical concern for humanitarian and social stability reasons. The contribution made by plastic products to mass housing and improved lifestyles will be many and more varied than the few examples which may be canvassed here. A broad consensus around the need to provide electricity to large numbers of low income households has emerged. Since the generating capacity exists, low cost infrastructure will be crucial to the success of this project. At the street and dwelling level, much electrical cabling and wiring is plastic coated, often with PVC. This represents about 20% percent of the materials cost of electrical cable manufacture (Interview, Meiring). The supply of potable water to large numbers of low income dwellings is also much needed. At the dwelling level plastic piping and plumbing fixtures are often competitive with competing materials such as metals and asbestos-cement. Plastics also play an often discrete but indispensable role in the furnishing of modern homes in a wide variety of applications from crockery and cutlery to kitchen appliances. In addition plastics are employed in a vast number of applications in mining, manufacturing and agriculture, where lower priced plastic may filter through basic cost structures and impact upon the cost of living.

Cogent reasons therefore exist for much greater attention to be given to the development of downstream sectors in the *filière*. This implies husbanding, nurturing and dynamising the plastic converting and fabrication industry, strengthening it and expanding it whilst at the same time targeting internationally competitive prices for its products on both the domestic and international markets. Caution however is necessary to avoid a reversal of the present situation in which downstream producers would come to dominate the *filière* as heavily as upstream producers have in the past. Later in this chapter a tripartite institution responsible for the formulation of industrial policy is proposed. This mechanism, including employer representatives from all links in the chain, is intended, *inter alia,* to monitor and avoid continuing imbalances.

Assumptions for an industrial strategy for commodity plastics

Before embarking upon a more detailed discussion of policy options certain assumptions need to be stated. Industrial strategists have before them, theoretically at least, a full armoury of policy levers and instruments with which to pursue their ends. To operationalise these successfully usually requires a sophisticated and fine-tuned bureaucracy. To the extent that this bureaucracy does not exist, the industrial strategist's armoury is reduced. Such a bureaucracy appears to exist in certain industries in South Africa, such as the liquid fuels industry. But for the most part it will be assumed that this level of sophistication does not exist elsewhere at this stage, implying that it needs to be built and accordingly policy suggestions made here will take this into account. However it need not necessarily be built along the lines of the overweening and stifling stereotype. Rather the state should be facilitative in creating the 'space' for institutions and organisations of civil society to interact with business and the state more readily. For example the state could avoid significant costs in policing environmental regulations by creating the legal 'space' within which trade unions and environmental organisations could take up breaches of regulations. However it is acknowledged that such roles accorded to civil society are not appropriate in all cases. For example implementing a science and technology policy will require revitalising much of the national innovation system. This type of approach to state bureaucracy underpins the suggestions which follow.

Certain assumptions also have to be made about macro economic policy. The assumption here is that a stable real exchange rate policy will be pursued, endeavouring to create a more predictable environment for exporters.

Policy Framework

The policy suggestions which follow are cast within three broad variables:

- The cost structure within the *filière*
- Human resources and technological capacity
- The institutional environment

The first concerns the basic cost structure in the *filière* and suggests ways in which the cost of key inputs could be lowered or improved, principally raw materials, capital and labour. Environmental costs are also considered. In tandem with these suggestions trade policy is also advocated as a means to both reduce the cost of key inputs and to reorient plastic products producers towards improved export performance. In doing so it is recognised that in the short term at least, this will have to be done from behind a barrier of tariff protection. Competition policy is crucial to this endeavour particularly in this *filière*, which at one end is dominated by monopolies and at the other has certain markets characterised by cut-throat competition.

Simply delivering low cost key inputs to the *filière* will be insufficient to make it a more dynamic industry. Proactive development of the other key areas of international competitive advantage will need to be addressed. This second variable embraces strategies to develop human resources and technological capacity.

The third variable concerns the institutional environment for policy formation and industrial relations within which the developmental strategy suggested here may be played out. The remainder of this chapter elaborates the three policy framework variables in the order in which they have been outlined here.

The Cost of Inputs

The regulatory regime which has prevailed in recent years appears not to recognise the connection between the upstream end of the *filière* and the downstream end. Consequently export promotion is organised chiefly around GEIS incentives which focus on the final exporter and neglect the upstream arrangements. At the same time state and/or motorists and/or taxpayers have also been supporting SASOL, Polifin and the crude oil refining cartel. In between these two links in the production chain (petrochemicals and the plastic converting industry), tariffs are supporting the polymer manufacturers whilst at the downstream end tariffs are protecting prices for the plastic converting industry.

If however the plastics production chain is seen as just that, a chain made up of interconnected links, then it is possible to explore the possibilities for removing state (and citizen) support at three points in the chain (SASOL, polymer tariffs, and GEIS), and at the same time reduce input costs and create the conditions in which a more dynamic *filière* might emerge. Part of this process will involve redistributing advantage lower down the chain. For an industrial strategy focusing upon exports and national reconstruction, the objective must be to insert raw gas and olefins into the upstream end of the *filière* at below world prices and to ensure that this advantage is passed all the way along the chain to plastic converters.

In exploring the options available for lowering the cost of key inputs to the commodity plastics *filière* each of the four principle considerations are considered in turn; raw materials, capital, labour and energy. The discussion of raw material costs follows the direction of value adding chain, ie. it commences at the upstream end of the chain and works its way downstream to plastic products. Feedstocks are key determinants and they are dealt with first. However before considering options which may exist to lower input prices at the upstream end, the implications for the liquid fuels industry of using changes to the regulations to the liquid fuels industry as a lever to lower key petrochemical input prices are considered.

Petrochemical input prices and the Liquid Fuels Industry

Lowering petrochemical input prices into the commodity plastics *filière* requires consideration of the complex interrelationships between the liquid fuels industry and petrochemical prices. SASOL is at the heart of the complex interrelationships between the liquid fuels industry and the petrochemical industry in South Africa. Previous chapters have shown how petrochemicals in South Africa are inextricably bound up with the liquid fuel industry. The state's preoccupation with 'strategic' considerations in the fuel industry distorted the petrochemical industry and indirectly raised petrochemical prices. Ironically public money in the form of taxes and fuel levies were used to do so. Indeed, in one sense, the way in which the state has set up SASOL's support regime makes it operate as a wealth siphon, siphoning wealth away from motorists and taxpayers and into the pockets of SASOL and its shareholders. The extent of this redistribution of wealth needs to be brought into the public domain urgently for obvious public policy reasons.[1] But it also has a direct bearing upon the choice of a path for petrochemical development, depending upon the economic viability of SASOL without its regime of support. Furthermore the structural unemployment crisis is being exacerbated by SASOL's spate of capital intensive investments made possible by its regime of support. SASOL's superior profit performance is largely attributable to the support it receives through the liquid fuels regulatory regime. SASOL shareholders also require clarity about the extent to which their investments are at risk. Many of these shares are held on behalf of large numbers of pension fund and insurance policy contributors. There is thus urgent need for a comprehensive study of SASOL in order to determine the social rates of return yielded by this mega-investment and the appropriate levels of protection. Such an investigation is beyond the scope of this study.

The advent of Polifin introduced the era of 'fuel alternate value' pricing into the

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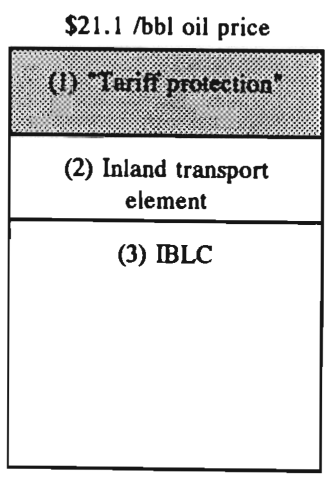
1. Various interested groups attending the National Economic Forums Liquid Fuels Task Force, with different motives, attempted to do so. The National Economic Forum comprised representatives of organised business, organised labour and government.

upstream end of the *filière*. Since the prices of the raw gas streams which Polifin buys from SASOL are tied to the base petrol price, the first option to consider is the possibility of lowering the base petrol price. This would have the twin advantages of lowering a basic energy cost to the economy as well as inserting lower priced petrochemical priced feedstocks into the *filière*.

The base petrol price has essentially three elements as set out in Figure 38. The price at which the oil industry uplifts SASOL's synfuels comprises only elements (2) and (3) in Figure 38. Lowering the IBLC will also impact upon the crude oil refining industry. The IBLC represents their 'refinery gate price' thus lowering it will reduce refinery margins. This is possible as it is known that refineries in Western Europe have survived with very low refinery margins. However refiners there compensate for these low margins by vertically integrating down to the retail sector. This is not currently permitted in South Africa. The point is that tampering with the IBLC has potentially very large knock-on effects in the rest of the liquid fuels industry.

Figure 38 Elements of the Base Petrol Price



Notes: 1) "Tariff Protection" represents payments from the Equalisation Fund which insure that SASOL receives at least a crude oil equivalent of $21.1 per barrel.
2) Inland transport comprises the (theoretical) cost of transporting liquid fuels into the interior from the coast.
3) The IBLC (In Bond Landed Cost) is the theoretical cost of importing refined liquid fuels.
All of these elements are explained in greater detail in Annexure B.

Refinery margins and profits have been secret for many years, however there is some reason to believe that there is scope for significant reduction without threatening the viability of these refiners. Indeed during 1994 the LFTF secured two agreements which involved small reductions in the formula determining the benefits to SASOL and the crude oil industry. Some analysts have suggested that South African crude oil refinery profits are 600% of those commonly earned in NWE. The Automobile Association study also records very good profit levels in the refining industry. The crude refining industry is somewhat similar to the auto assembly industry in South Africa, in that there are too many small producers. Consequently the re-regulation of the liquid fuels industry should be carried out in such a manner as to encourage a process of rationalisation of the refining industry as it expands refining capacity.

Reducing element (2), the inland transport cost is also possible. The simplest way would be to reduce the Petronet pipeline tariffs. However Petronet's parent company, the parastatal, Transnet, has recently been privatised. It has a large pension fund deficit and requires Petronet's contributions to assist in making up the shortfall. Again the point is that there are consequences to be faced in making such adjustments.

Reducing element (1), SASOL's 'Tariff protection' would not directly affect SASOL's 'fuel alternate value' price as it is a subsequent 'add-on'. Obviously it would lower SASOL's turnover, profitability and possibly its ability to meet its commitments to the 'fuel alternate value' pricing formula. What are the other likely consequences of a reduction in the synfuels subsidy/support? Firstly it is likely to lead to a reduction in the (pre-tax) petrol price which has benefits for the whole economy. Secondly the cumulative effect of the removal of the support and a lower petrol price will significantly impact upon SASOL's share price rating. It will also reduce SASOL's cash flow which it has been using to finance its current wave of investments. Reduced profits are likely to cause SASOL to have to solicit capital markets by the usual means in order to raise investment capital, which in turn is likely to exercise a restraining influence upon SASOL's investment splurges. Thirdly, it would also level the playing fields of opportunity between coal based and oil or gas based petrochemical players to some extent. This, in it's turn, may serve to widen the range of basic chemical building blocks available at more competitive prices.

An initial obstacle that would need to be dealt with, will be an agreement given by government to SASOL that 'tariff protection' will be kept in place until the end of 1995 (SASOL Executive Director Du Toit quoted in Business Day, 29-7-92:7). In addition to this SASOL has a 'parachute' clause in its 'claw-back' loan agreement with the Central Energy Fund (see Annexure B). If SASOL's subsidy is lowered, its loan repayments to the state (CEF) are correspondingly lowered as well, leaving SASOL virtually unaffected. However the implications for CEF cash flow and its ability to repay Mossgas debt would probably be affected. This will need careful consideration by a state under pressure to increase its social spending.

A reduction in SASOL's 'tariff protection' is likely to make SASOL more determined to break out of its 9% ceiling share of the retail market (through the 'Blue Pump' scheme). If it were to be given greater access to the retail market through official structures, changes to the Ratplan Agreement would have to be negotiated with the crude oil refining industry which would be unwilling to concede market share to SASOL.

Broadly stated, the present regulatory regime reflects a delicate 'compromise' between two aggressively opposed camps - the (state backed) synfuels industry and the crude oil refining companies.[2] The processes of political democratisation and reintegration into the global economic system are placing stress upon this historic 'compromise'. Any changes to this regulatory latticework which did not embody an 'equality of misery' principle for these two camps could easily unleash a titanic fight between these two forces which could have far reaching and potentially very damaging consequences for the country. Underpinning the regulatory regime is the regulation of the pump price of petrol (Retail Price Maintenance or RPM). If a 'shake out' in the liquid fuels industry was precipitated, one of the first casualties would be RPM. Once petrol discounting at the pump took place retailers would have to compete which in turn would require them to cut costs. One of the easiest costs for retailers to cut would be labour costs. If the obligatory 'no self service' clause in the Ratplan were thus undermined some 70 000 jobs would be jeopardised.

The preceding brief review of the ramifications and implications of piecemeal change in the liquid fuels industry for petrochemical industry purposes strongly suggests that suddenly pulling away one or more of the main props supporting this fragile latticework of regulations would be ill advised and may have unintended consequences. Instead equity considerations suggest moving along a path of steadily evolving change towards a more benign regulation of the liquid fuels industry, that is, decreased regulation in some areas and possibly increased regulation in others. In particular the need to guard against the propensity in the industry towards a cartel or oligopolistic practices requires controls. Such an approach will stand better prospects of carrying along with it the various interest groups which make up the industry and avoiding confrontation. A government and particularly a Department of Minerals and Energy Affairs with firm resolve to manage the process would be desirable.

An extensive (but unpublished) government study of regulation in the oil industry was carried out in 1990. It found no reason to change the prevailing system apart from certain marketing aspects (CEF Chief Executive, Lourens van den Berg, quoted in Davie, 1991b:17). Government has begun to reconsider such issues and commenced another investigation into

2. Excluding Natref which is 60% owned by SASOL.

deregulation of the liquid fuel industry (Business Day, 23-9-92:7). In addition the National Economic Forum's Liquid Fuels Task Force (LFTF) began a review of the regulatory regime governing the industry in late 1993.

Finally, but most importantly for our purposes here, if the price which SASOL receives for its petrol were lowered, then the 'fuel alternate value' of raw gas to SASOL would be correspondingly lower, potentially leading to lower olefin prices. This is only a potential benefit. It assumes that SASOL and Polifin maintain their 'fuel alternate value' pricing formula. If SASOL's petrol profits are under threat, a more likely response from SASOL may be to try and off-set this by attempting to raise the price of raw gas rather than decrease it. Nevertheless, in the final analysis, the 'fuel alternate value' will be lower.

In summary a reduction in the elements of synfuels support, could lower the value of petrol to SASOL and consequently hold the potential to pass on benefits to the commodity plastics *filière* in the form of lower raw gas prices. A reduction in synfuels support/subsidy is unlikely, by itself, to yield world priced olefins, therefore other measures must also be considered. These are elaborated in the next section.

The appropriate transfer price of raw gas streams

> "Most successful exports were based on those materials which are available locally at world competitive prices..." (Romatex Annual Report, 1992)

Thus far the discussion has accepted the 'fuel alternate value' as the appropriate transfer price for SASOL's raw gas streams. However the question still remains; is the 'fuel alternate value' formula valid? What is the appropriate transfer price for a petrochemical stream from the upstream source (SASOL) across the ownership boundary to the ownership of the next link in the production chain? This difficulty is similar to the problems faced in Latin American and South East Asian economies discussed in a previous chapter. Such problems are amplified in a small market with a single producer such as South Africa. Before 1994 pricing was left to a combination of the market and a state which lacked any clear industrial strategy for the *filière*, resulting in uncompetitive pricing. With the advent of Polifin and the 'fuel alternate value' formula the *filière* clearly has low cost intermediate inputs at the upstream end on the basis of a defensible formula.

However the 'fuel alternate value' formula may camouflage a quite different public policy issue: Polifin may be purchasing SASOL's gas streams at too *low* a price. If so then the economic viability of SASOL's synfuel operations may be compromised and its need for a subsidy/protection correspondingly inflated.

What then is the appropriate transfer price for these raw gas streams and what are the alternative mechanisms and options for determining an appropriate price for these gas streams? The appropriate pricing mechanism must balance the trade off between the need for low cost inputs into the commodity plastics *filière* against the need to minimise any subsidy which SASOL's synfuel operations may require.

There are several possibilities:

a) **Import parity pricing**: this is not an option as SASOL's coal based raw gas streams are unique in composition and the infrastructure to import such gases does not exist (a part of the missing link problem). These gas streams are in effect non-tradable and the market cannot operate, unlike the South Korean, Taiwanese and other examples considered earlier where their petrochemical feedstock is naphtha which is a frequently traded commodity. Naphtha provided additional import parity leverage for the state arising from this additional link in the chain.

b) **A cost plus formula**: that is the cost to SASOL of the raw gas stream plus a reasonable return. This concept was used by SASOL prior to 1981 to determine its ethylene prices. It gave an estimate of what ethylene would cost at the beginning of the year and by mid year revised the figures, backdating the new price to the start of the year (The Daily News, Plastics Supplement, 25-8-81:1). This was obviously unsatisfactory for downstream producers who had to commit themselves to contract prices which could not be backdated. The present difficulty is to establish what the cost to SASOL is, particularly the share of capital costs, of producing a by-product integral to its process. The calculations, if possible, would be extremely complex. A second difficulty in employing a cost plus formula is that all the risks and the benefits will be transferred onto Polifin.

c) **A price determined from the polyethylene price**: The ethylene price has been determined by formula from the polyethylene price which was an import parity price. It would be possible to extend this concept one link further back upstream to the raw gas price. For example if the polyethylene price was 100 units, the ethylene price might be 50 units and the raw gas stream might be half again of the ethylene price.

The two formulae would be driven off the import parity price which, as has been pointed out, is a function of the polymer tariff. The approach carries with it the danger of perpetuating a management mind-set which sees lobbying for higher tariffs as an important strategy to compensate for operations which are not internationally competitive. Assuming a constant tariff there will be some long term inducement to improve efficiencies as a result of improvements to efficiency internationally.

d) **Regulation:** The state could simply regulate the raw gas stream price. However the difficulty in determining an appropriate price for these gas streams will remain with the regulator. This would not be a very elegant or politically astute approach in the present economic climate.

e) **Promote vertical integration:** This process has been virtually thrust upon SASOL and AECI and could be promoted still further by removing the ownership boundary between the first and second links in the chain created by the advent of Polifin. There are several possibilities, for example: encourage SASOL and Polifin to merge into a single business. AECI's interests in Polifin might be exchanged for shares in SASOL itself. The present SASOL and Polifin would then be one entity and the transfer price would become academic. Instead the real focus of debate could then become the tariff on polymer. A further advantage of this approach is that SASOL's profitability could be determined across the full range of its operations. This would allow the more profitable activities to 'cross subsidise' the less profitable, thus reducing the need for an external synfuels subsidy. A countervailing tendency may weaken this approach. The aggregation approach envisaged here runs in quite the opposite direction to the corporate strategy pursued by SASOL itself in recent years.

Even if SASOL and Polifin were integrated into a single concern a further pricing problem would remain and that is the price at which such an integrated concern would sell ethylene to other customers. The present formula arrangement between Polifin and Safripol for determining the ethylene price could simply continue. Promoting vertical integration suggests that SASOL also take over Safripol (in exchange for cash or SASOL shares) which would then make the ethylene price academic as well.

How might vertical integration be promoted? There are several possibilities. One is to follow the Taiwanese example in the way it dealt with its first PVC producers. It simply forced them to merge into one business. Another option is to follow the French example of the early 1980s. In order to rationalise and restructure the reluctant French chemical industry, the leading private chemical companies were nationalised. Once the restructuring objectives had been attained a process of privatisation followed. This option could involve the nationalisation of at least SASOL's Secunda operations, Polifin (or key parts of it) and Safripol (the Sentrachem/Hoechst joint venture). The advantage of nationalisation is that it obviates SASOL's current need to meet blue chip shareholder expectations in so far as profits are concerned and allows more resources to be redirected to development downstream. The disadvantages of nationalisation are likely to include vociferous condemnation by the local business community, scaring nervous international investors and possibly damage to South Africa's international credit rating. The international implications of nationalisation may be amplified if the shareholding of major international firms such as Hoechst (in Safripol) were nationalised. Furthermore local shareholders, primarily insurance policy owners and pension funds would probably lose money and this may arouse internal popular discontent.

Another option involving nationalisation would be to make only the synfuels part of SASOL a public utility. This would be easier to justify politically and it could then be used to provide low cost liquid fuels and petrochemical feedstocks. The potential disadvantage of this is that such a public utility might well require a subsidy. During 1994 rumours in the industry suggested that SASOL synfuels was inflating its (coal) input prices and deflating its (chemical) output prices with the net result that the synfuels activities appear less profitable than might otherwise have been the case. It is reasonable to expect the political process to take some time to come to a decision to declare a part of SASOL a public utility. During this period SASOL might structure its other activities in such a way as to commercially prejudice the synfuel utility. Consequently very careful monitoring and a capacity to rewrite commercial agreements would be an important element of such an option.

Instead of nationalising, could the state use the Equalisation Fund contributions from the petrol price to buy out other SASOL shareholders? If this plan was announced simultaneously with notice of the withdrawal of subsidies, two to three years ahead, shareholders would presumably be keen to sell. However even at its lowest share price in 1993/4, SASOL's market capitalization was approximately R10 billion and since the 'tariff protection' subsidy is worth only just over R 1 billion p.a.

this would not be possible within two to three years. If other elements in the petrol price build up from which SASOL benefits were included, this would not change the time frame dramatically.

f) **Increased competition**: Increased competition is unlikely to arise at only the raw gas stage. On the contrary increased domestic competition would require (in view of Polifin's degree of vertical integration) investment in a similarly integrated operation. Such a large investment may require state assistance in some form. Furthermore even if there were two producers it is not certain that they would not collude on prices in some way thus defeating the object. Indeed since the lynchpin of pricing in the *filière* is the polymer tariff, adjustments to this may be a far simpler way of introducing real competition into the *filière*. This possibility is taken up below.

Pricing Ethylene

Assuming that an appropriate pricing arrangement for the raw gas streams had been achieved, the next hurdle would be to ensure that some of the benefits were passed on in the ethylene price.[3] How might this be done? Again there are several options. Many of those outlined above in relation to pricing the raw gas streams may be applied *mutatis mutandis* to ethylene pricing. There are two central options here.

Firstly a relatively simple measure would be for the state to regulate the ethylene price at the level of one of (or a combination of) the lower priced international markets, such as the US Gulf which is likely to remain the global price setter (Vergara & Babylon, 1990:9).

Would SASOL's viability be seriously threatened if its ethylene price were lowered in this way? Based upon 1991 ethylene sales and company financial statements, the loss to SASOL would have been R173 million or 2.3% of sales. This of course is a larger share of after tax profit (16.6%) but notwithstanding such a loss, SASOL would still have been the most profitable chemical company in the world according to Fortune Magazines' top Global 500 corporations at 11.7% (profit as a share of sales) (Fortune Magazine, 27-7-92).

There is only one option which stands out as a means of improving the input pricing structure along the *filière*. If the preceding analysis is correct and the polymer tariff is the lynchpin of pricing along the *filière* then the obvious option is to reduce or remove the

3. A similar approach could be applied to propylene.

appropriate polymer tariffs.[4] The effect of lower polymer tariffs on the ethylene price inside Polifin is somewhat academic as it is essentially an accounting question. However this is not the case in regard to the price at which Safripol would purchase ethylene.

If polymer tariffs were removed Safripol and the olefin customers within the Polifin group - if Polifin complied with the Competition Board ruling not to discriminate - would, for the duration of the prevailing agreement, be able to pass lower prices upstream to Polifin in terms of the formula agreement. However when the prevailing agreement expired, Polifin might not be willing to renew it because of the costs involved. Instead of continuing with the formula, Polifin may prefer to raise the price of olefins to Safripol (and its subsidiaries) in some way. This would ultimately force Safripol out of business or into a merger with Polifin.

Lowering polymer tariffs seem likely to bring about, in one way or another, further vertical integration or restructuring at the upstream end of the industry. This would be an acceptable outcome, from South Africa's point of view, provided the necessary checks and balances were in place to govern the enlarged monopoly.

This (zero tariff) option amounts to ethylene prices continuing to be a function of 'import parity one step removed'. If it is assumed that Polifin wishes to keep its ethylene customers and no further vertical integration takes place, Polifin may have to sell its ethylene at below world prices. This may be necessary in order to keep its customers in business because they are not the most efficient producers. In other words world-priced polyethylene (imports) in feeding backwards (upstream) to the ethylene price, has to pass through an inefficient conversion mechanism requiring lower than world priced ethylene.

Whether Safripol and Polifin's polymer operations could survive a zero tariff is not clear. However lower tariffs are a convenient tool, if handled correctly, to goad the polymer industry to greater efficiency and lower prices. If polymer tariffs were reduced to zero would this be sufficient to meet the objective of world priced inputs? It seems not. This is because the import parity (CIF) price will be above world prices as it contains transport insurance, wharfage and related costs. These costs added about 22% to the NWE FOB price in August 1992.[5]

How then might world priced (or lower) inputs be inserted into the domestic commodity plastics *filière*? To overcome the disadvantages of import parity pricing identified

4. Given the level of vertical integration already achieved by Polifin various stringent checks and balances become necessary and a review of polymer tariffs is called for. The need for such checks and balances would be increased if further vertical integration took place.

5. Figures provided by Safripol for HDPE and PP.

above, the polymer import CIF price could be substituted by the export FOB price, which is likely to be at or below world prices, as shipping, insurance and other costs are not yet included. Using the export FOB price the same calculation (extrapolating backwards) could be made to determine the ethylene price. This would require the state to regulate that the export parity (FOB) price be the one used. Given that polymer exports from most countries take place at 'dumped' prices and that the preceding analysis has shown that domestic polymer producers are least competitive in periods of low world polymer price such regulation could be ruinous for Polifin and Safripol.

However both Polifin and Safripol offer polymer to customers at below typical domestic prices for export purposes. The problem such exporters have is that they have been powerless to secure long term contracts on this basis. This has made it difficult to justify investments in machinery and equipment dedicated to exports. The question thus arises, how might the state secure long term export parity pricing for converters wishing to export?

One option would be to impose an export tax on raw polymer to discourage polymer exports for so long as there was a domestic market (ultimately intended for export) for that polymer at (FOB) export parity prices. Such discouragement should not be an onerous burden for polymer producers since they should be indifferent as to whether polymer is sold on the domestic market or the export market, provided the price is the same. This would then make polymer available at world or below world prices (since transport and related costs to the export destination are excluded). An important feature of such an export promoting policy would be transparency in setting the export parity prices. This is because some plastic converters claim (in confidence) that the polymer manufacturing monopolies are playing 'king maker' by selling at different 'export' prices to different converters. (Further variations of this option are considered below.)

Finally, it cannot be assumed that even a vertically integrated producer would be profitable without tariff protection or a subsidy of some sort.

In selecting from among the above options two guiding notions should apply. Firstly, vertical integration should be accompanied by other measures necessary to prevent rent seeking by the large monopoly which Polifin represents. To the extent to which future policy promotes further vertical integration then the need for accompanying measures is increased. Secondly and most importantly, will the option selected result in lower than world priced olefins being inserted into the plastics *filière*? Nearly all of the options outlined above are likely to result in significantly reduced polymer prices for domestic converters.

In the short term, if feedstock continues to be obtained from SASOL at the 'fuel alternate value', then the reduction or removal of tariffs on commodity polymers is called for. Setting the appropriate tariff level as well as the costs to taxpayers and/or motorists of allowing SASOL to sell its gas streams at the 'fuel alternate value' needs detailed and careful evaluation. If it is found that such an arrangement prejudices the economics of SASOL's synfuels operations and public policy makers are not willing to trade off the disadvantage to SASOL's synfuels operations against the advantages to the commodity plastics *filière*, then the price of the raw gas stream will need to be set by some transparent and equitable mechanism.

On balance, two of the options outlined above or a combination of them appear more attractive. The encouragement of further vertical integration in the petrochemical and polymer industries but only with attendant measures to constrain the resultant monopoly. This would bring the industry further in line with international developments. Secondly a mechanism to bring domestic olefin prices into line with world prices.

Most of the above options have implications for SASOL's profitability and possibly its survival, whatever its ownership structure. This necessitates a review of SASOL's capacity to absorb lower profits on fuel and/or raw gas stream sales. There are two factors which will help SASOL in this regard. Firstly chemical production is concentrated at SASOL 2 and fuel production at SASOL 3. The significance of this is that SASOL's loan obligations to the CEF are governed by an agreement which reduces the payment of loans to the extent to which SASOL 3 does not receive protection.[6] To this real 'safety net' may be added the second: the results from the current spate of investments. One industry analyst expects SASOL to do well in 1994 and 1995 as a result of returns from new projects coming on stream in the context of improving domestic and international economic growth (Tison, 1992).

Should these benefits prove inadequate the state also has room in which to manoeuvre, short of a cash subsidy or nationalisation. (A more open and public process for arriving at subsidies is considered below.) The state's interest in SASOL is through the IDC's 20% (and declining) ownership, the state pension fund's 10% ownership, tax returns and of course the regime of regulatory support governing the liquid fuels industry. Several options thus exist for the IDC and/or the Receiver of Revenue to forego some returns in order to fund lower petrol and/or olefin prices in the reasonable hope that these would be recovered from taxes on increased output and employment downstream. If the state were to forego certain income it would presumably want to be sure that an adequate mechanism was in place to provide

6. The SASOL 3 'claw-back' agreement referred to in Annexure B.

internationally competitive olefin prices.

From the direction of the foregoing discussion it may be apparent that what is in process of being proposed here is an idea borrowed from Japanese and Korean export promotion policy of the 1960's and 1970's, adapted for local conditions. In Korea "the main effect of subsidies was to make intermediate products available to Korea's export sector at international prices" (Hasan, 1976:21), whilst at the same time promoting efficient backward linkages from exports and exporting output from the most labour intensive processing stage (Westphal et al, 1979:248). Suppliers of exporters were permitted tariff free access to intermediate inputs in order to encourage backward linkages. There are striking parallels between South Korea and South Africa. South Korea also suffered from inefficient petrochemical production and had to develop an incentive and disincentive regime to accommodate this. As a result of these inefficiencies South Korean producers were given additional import substitution incentives (Westphal et al, 1979:241). Japan during the late 1960s and early 1970s pursued preferential price policies for naphtha, the feedstock for their petrochemical industry (Greene, 1991).

Assuming that a mechanism has been adopted which will provide competitively priced olefins to polymer manufacturers, the next policy hurdle is a mechanism to ensure that this advantage is passed on down the *filière* and not simply appropriated at the next step, polymer manufacture.

Trade Policy: Tariffs for commodity polymers and plastic raw materials

Strategies to pass lower prices down to the next link in the production chain have been used in South Korea and Taiwan. In Korea's case the pricing system was far from transparent, as Yusuf et al lament: "so overwhelming was the scope of the government's economic jurisdiction and regulatory activities, that it requires some ingenuity to make very much of the pricing system..." (Yusuf et al, 1985:47).

In South Africa's case it appears comparatively simple. The tariff reference price has been identified as the critical lynchpin of the pricing structure up and down the *filière*. With this in mind the most obvious mechanism to induce lower domestic commodity polymer prices from the monopoly producers is through a reduction in tariff protection.[7] The reduction of tariffs thus far has been instrumental in restructuring this sector and should

7. This has also been discussed above as one means of inducing lower olefin and raw gas prices.

continue as it is central to the competitiveness of the entire plastic *filière*. However it should proceed in a planned manner with advance warning, avoiding the pitfalls of the present ad hoc approach.

The reduction or removal of tariffs on commodity polymers in a globally over traded market may give rise to the concern that local producers will collapse in the face of import competition. However the costs of exiting an industry can be high for local chemical conglomerates. In addition to the cost of sunk capital there are other perhaps more important considerations, such as a conglomerate's strategic market position. The commodity polymer business is high volume with correspondingly high turnover. These high turnovers contribute to the firm's market power even if profits are not that good. The loss of that scale of turnover may well make other operations within a conglomerate's portfolio more vulnerable to takeover. Consequently there is reason to suspect that neither Polifin nor Sentrachem/Hoechst will lightly abandon their positions in the polymer industry. On the other hand the lack of preparedness, by AECI, for the removal of import control on PVC, despite eight years warning by the state, suggests that more than just warning is required. Tariff reductions are a convenient goad with which to prod polymer manufacturers to expand to world scale capacity and increase efficiencies. Other inducements to invest, such as the tax regime, are discussed below.

Assuming that polymer manufacturers receive olefins at world or lower than world prices, (as suggested above) at the same time as tariffs are reduced by a corresponding amount, their relative position should be improved or at least unchanged. In addition there is no reason to believe that Polifin and Safripol would not make the necessary investments and adjustments to improve their productivity, indeed there are signs of this occurring already. However tariff reductions could lead to an increase in commodity polymer imports in the short term if these producers do not bring operating efficiencies up to world standards.

The speed at which tariffs could be reduced or removed is a difficult issue not least because it will depend upon international prices which are difficult to predict. Tariff reference prices, set in Rand terms, are the key consideration in so far as polymer tariffs are concerned. It would appear reasonable to reduce this Rand value by 15% to 20% p.a., in real terms. An inflation rate of 10% p.a. would achieve this in about two years (assuming the Rand reference price remained unchanged).[8] Given the discrepancies between domestic and

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8. South Africa's general commitment in the Marrakech Agreement (arising from the Uruguay round of GATT talks) is to lower tariffs by one third over five years. As at September 1994 the actual tariffs (as opposed to the GATT ceilings) for polymer had still to be determined.

say, North West European (CDV) prices, this would bring domestic prices to those levels in 2 to 4 years, which should be sufficient time for local producers to get their house in order. At some stage in this process the ad valorem tariff (typically 10%) would take over from the reference price. To the extent that olefin prices are reduced or regulated downwards the process of tariff reduction could be accelerated.

In formulating strategy, consideration of equity issues and the effect that strategy may have on ownership concentration also needs to be taken into account particularly in the South African context. Korea ensured low input prices to downstream sectors protected by tariff barriers and in the process facilitated the growth of Chaebol (large conglomerates). Taiwan attempted to adopt a more egalitarian approach. It also ensured low input prices to downstream sectors, comprising many small and medium sized enterprises, but more carefully avoided the vertical integration of ownership than Korea (The Economist, 5-3-88:6).

However the Taiwanese approach did not preclude the emergence of large petrochemical conglomerates like Y C Wang's Formosa Plastics Group which is vertically integrated in petrochemicals (Wandycz et al, 1989). In 1988 it had sales about 4.5 times the size of SASOL's. Both approaches employed state involvement at the upstream end to achieve policy objectives. A key lesson from these models is to have a comprehensive approach which encompasses the entire length of the *filière* rather than fiddling with this or that link in the chain and expecting the results to trickle further up or down the *filière*. An additional lesson that may be drawn from this is that the emergence of large, vertically integrated petrochemical companies is to a certain extent unavoidable in petrochemicals, but this need not necessarily preclude the coexistence of competing small and medium sized enterprises.

Trade and pricing policy for plastic converters and fabricators

Key objectives in a strategy designed to expand the plastic products industry include the expansion of higher value added economic activity of lower capital intensity and the expansion of employment. Lower prices may be expected to increase local demand and may also lead to some substitution of plastic for other materials. However without general economic growth, expansion in domestic markets is likely to be somewhat limited.

Exports from the Plastic Products industry have been shown to be relatively small and it is in this area that considerable growth potential lies. A growth in exports would help to reduce the industry's trade imbalance and contribute to an improvement in the balance of payments. Expansion of manufacturing exports is necessary to reduce South Africa's dependence upon primary materials which have been experiencing declining terms of trade. If a general effort is to be made to expand manufacturing exports, plastic products which are integral to so many manufactured items will need to be internationally competitive in order to facilitate such a general effort.

Successful competition in international markets will require improvements in the industry across a range of issues such as product quality, the capacity to develop new products, marketing, intra-firm and inter-firm efficiencies. Access to world priced polymer will be more a prerequisite than a panacea for success.

Undoubtedly such significant reductions in polymer prices as have been suggested above, must be of assistance to would-be exporters. However polymer at world prices would simply put South African converters in the same position as their international competitors. In fact, somewhat worse off, if the disadvantage of shipping costs, wharfage, insurance etc. to export markets are taken into account.

Consequently for plastic product exporters, the objective should rather be the provision of polymer to converters at lower than tariff free import parity prices. A benchmark below this level would be the South African FOB price obtained by polymer exporters. If this were required by regulation for polymer manufactured into plastic products for exports, the proportion of a polymer producer's output sold at FOB prices is likely to increase over time, as exports increase, and may eventually threaten their survival. (Because they would be selling a large proportion of output at depressed world prices.) A mechanism is necessary to counter-act this possibility.

In recent years the negotiated price for ethylene includes provision for a type of profit sharing mechanism, whereby the actual ethylene price is a function of the polymer producer's ex-works selling price. There seems to be no reason why a similar pricing mechanism should not be employed lower down the *filière* instead, between polymer sellers and converting exporters.

Put simply: polymer manufacturer (A) sells polymer to plastic converter (B) at the South African FOB price. (B) then converts the polymer into a plastic product and exports it. Part of the profit from the export selling price is then passed by (B) back to polymer producer (A). Both (A) and (B) stand to gain. The same pricing system could be regulated for those plastic products deemed necessary for national reconstruction such as PVC used as sheathing for electrical distribution cables or water piping etc, although the returns are likely to be lower. A variation of this idea, in the form of discounts, has been used in the past in commercial agreements between polymer manufacturers and converters.

For this system to operate successfully there would have to be transparency of local polymer FOB prices. This should not be difficult as they are in any event collected by Customs & Excise. The final link in the system could then be self regulating, ie. by negotiation between the parties, provided of course that the state required them to negotiate the prices. This could be done quarterly or at some other suitable regular interval. Other important items in such negotiations would be the extension of credit and the period over which credit would be extended. This has been a contentious issue in the past.

Traditionally such negotiations have taken place but between the individual polymer manufacturer and the individual converter. The consequence has been accusations of arrogance directed by small converters towards the large polymer manufacturing companies. In addition the larger polymer users have been able to negotiate more favourable rates but not the small volume users.

To avoid such problems, and drawing upon the Taiwanese model, it could be required that the polymer manufactures association negotiate the prices with the plastic converters association. By requiring the collective associations to do this a number of policy goals may be addressed, albeit indirectly. By requiring them to cooperate in their collective self interest other objectives may also be addressed. This may assist in defusing the tensions and suspicions rampant both between the plastic converters themselves and between plastic converters and the polymer producers. If it was required that only one price be agreed upon, this would reduce the ability of conglomerate linked converters to use their 'muscle' in a way that did not benefit all converters. Opportunities for small and medium enterprises would be more balanced by removing the price advantage larger converters currently enjoy. By conducting the negotiations for the commodity polymers jointly both the producers and the converters would have to address the issue of one type of polymer being substituted for another as a result of differential pricing. Finally the monopolistic polymer manufactures would be faced with the collective strength of the converters who would have access to alternate supplies (imports), which would act to balance the power relationships more equitably. Direct negotiation seems preferable to past practice of indirect negotiation, via memoranda submitted to the Board of Tariffs and Trade.

In addition to a more equitable distribution of profit among the producers along the links of the chain, the pricing structure suggested above would help establish a 'virtuous cycle'. Import competition would act as an incentive for polymer producers to improve their product quality and their relationships with their exporting customers, perhaps in the form of technical and marketing assistance. The monopolistic polymer producers have, in the past, neglected this relationship although there are recent indications that this may be changing. Improved customer service by polymer producers may, in turn, encourage purchasing of domestically produced polymer rather than imported polymer. Simultaneously it should help exporters to move away from lower value added type products towards higher value added type products. This in turn has advantages for technology and skill development. There is also the possibility that smaller plastic converters, inexperienced in export, could be assisted by the larger polymer manufacturing companies (Polifin, Sentrachem and SASOL) which are experienced exporters, perhaps developing further something of the trading house type activities integral to the Korean Chaebol. In addition the possibility of larger profits in the plastic converting industry, also holds out the possibility of higher wages there.

The final links in the *filière* follow broadly two streams from the plastic converters. On one hand, final products go to wholesalers and or retailers and then finally to consumers. On the other hand, intermediate products, such as packaging, serve a variety of other industries. How can it be ensured that lower polymer prices will be passed on to these final links in the chain, rather than the profit catchment merely being shifted down the chain a link or two? There is no easy solution to this problem.

Many converters argue that in their highly competitive markets a period of accumulation is necessary to recapitalise. To some extent this may be unavoidable in the short term at least, particularly in oligopolistic markets. As the industry grows some increase in competition may be expected in oligopolistic markets which may help to pass on lower prices to consumers. However in a small market like South Africa no reliance can be placed upon this.

Tariff regulation will be crucial as imports are and will become, the principal competition. In oligopolistic markets tariff reduction will remain an important instrument for improving the prospects of lower prices reaching consumers. The need to accurately monitor production and trade is again highlighted. Finally a vigilant Competition Board will also make an important contribution.

These are all partial answers to a difficult problem, but taken together, offer some reasonable hope for consumers. In the final analysis, it is clear that the bias in the pricing mechanism suggested here is in favour of the downstream sectors and their exports. This is warranted by the lower capital labour ratios and the particularly low level of exports from the plastic converting sector.

It should be noted that a large share of the polypropylene market lies in textile applications. The pricing system suggested above will need to be taken into account when determining tariffs for the appropriate sectors of the textile industry. The same applies in respect of export incentives.

Tariff policy for the Plastic Products Industry[9]

Tariff policy possibilities in the short term are governed by the nature of the industry, (it is highly differentiated with uneven strengths and weaknesses) and the limited abilities of the Department of Customs and Excise. A simple uniform tariff structure is unlikely to have the desired results although it would be simpler to administer. Rather a carefully nuanced and differentiated tariff structure would best meet the desired policy objectives. Such an approach regrettably does not seem immediately possible in South Africa. On the other hand too differentiated a tariff structure without adequate policing lends itself to corruption. Thus an attempt is made in the following suggestions to bear these conflicting demands in mind and to try and strike a compromise between them.

In the light of the poor international competitiveness of South Africa's plastic converting industry it would be undesirable for South Africa to lower tariffs significantly in the short term. Nevertheless since the plastic converting industry serves basically two markets, consumer items and intermediate inputs across the economy, it is important for broader developmental objectives to get prices as low as possible. Since most plastic items are import parity priced, lowering (not removing) tariffs is the obvious choice. However where other mechanisms can be found within the domestic market to achieve lower prices behind tariff barriers, then these should be preferred. Increased competition is one possibility although this is limited where oligopolistic production occurs in the domestic market. The complexity arising from the myriad products produced makes this difficult but not impossible. An easier, from an administrative point of view, although less nuanced approach is to regulate tariffs. Either way a more careful regulation of tariffs would be beneficial. Some suggestions in this regard have been made in Chapter Seven.

Tariff reductions would seem feasible as two developments take place. Firstly as polymer and other input prices are lowered and secondly as the industry's manufacturing practice improves and international competitiveness improves. The process of achieving tariff reductions should be carried out in accordance with the suggestions made below concerning institutions and processes to deal with tariffs and the tripartite industry forum.

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9. This discussion excludes plastic articles normally considered to fall within the auto components, textile and other industries.

Engineering plastics

Engineering plastic volumes have grown slower than commodity polymers. In packaging applications (roughly half of polymer consumption) they are forecast to grow slower than commodity plastics over 1990-95 (BMI, 1991:75). This is a result of their extremely limited local manufacture, the pattern of domestic demand and limited hi-tech type products produced by the converting sector.

A strategy which emphasises too strongly a rapid switch to hi-tech engineering polymer type products will boost imports. Rather this should wait until the prospects of increased local production of aromatics and downstream engineering polymer plants looks more certain. This seemingly unavoidable delay is disadvantageous in that, from a technology development and more sophisticated applications point of view, South Africa may continue to lag behind world trends. Two partial solutions offer some consolation.

Firstly, in the interim, remaining tariffs and surcharges on engineering plastics not produced locally should ideally be removed. In this way imports from the Far East, at generally lower prices, could be imported, converted to higher value added products and targeted at markets in Africa, NWE and North America. The automobile industry may also benefit from this in view of the shift in the local content programme from weight to value. However one must bear in mind that, to a certain extent, engineering and commodity polymers are interchangeable, depending upon the application. One would need to guard against imported engineering polymer being substituted for locally produced commodity polymer intended for domestic consumption and thus unnecessarily increasing imports. Hence, where this applies, the timing of this tariff removal would best coincide with the introduction of the suggested pricing system and reduction in commodity polymer tariffs.

Secondly whilst waiting for the domestic petrochemical and engineering polymer industry to restructure and develop, something of a compromise solution seems possible in the short to medium term. Relative to other polymers made in South Africa, polypropylene production far exceeds domestic demand and further potential propylene exists at, what SASOL claims are internationally advantageous prices. Polypropylene, being a C_3 polymer, is more amenable than other commodity polymers to a wider range of applications and to near engineering plastic status by the addition of fillers and additives. It also has comparatively large applications (44% by volume) in the textile industry and implications for strategy in that sector. This already forms a part of the plans of a leading company in that sector.

"In recent years the Group's polypropylene operations have competed successfully against imports and in international markets. Polypropylene based textile operations have been consolidated under Extruded Fabrics to take advantage of the competitive cost structure of local polypropylene polymers. The objective is to focus technological capability in this product area which has growth opportunities both domestically and internationally."

"Most successful exports were based on those materials which are available locally at world competitive prices such as wool, polypropylene, and acrylic." (Romatex Annual Report, 1992:7)

In addition, as international auto manufacturers have sought to reduce the number of materials used and lower the costs of using engineering polymers, the chief beneficiary among the commodity polymers has been PP. Himont for example has developed PP auto dashboards and instrument panels, with PP structural frames, PP foamed padding and PP synthetic leather covers. This facilitates recovery and recycling as only one type of polymer is used.

It would appear sensible, then, to exploit SASOL's relative propylene/PP advantage in the short to medium term. This seems preferable to pursuing (as Taiwan and other countries with more developed petrochemical sectors have) a shift into engineering polymers, which would mean a surge in imports with the consequent negative impact on the balance of payments.

Institutions and processes to deal with dumping, tariffs, subsidies and export incentives

Since dumping is a real threat in commodity polymers, especially during global recessions, consideration needs to be given to this problem. A conventional response is to think in terms of quantitative or non-quantitative import restrictions. The difficulty with such measures is that they pass on the costs (of less than competitive local producers) to precisely the wrong constituency, the plastic converters, the very sector to whom this strategy is attempting to deliver polymer at less than world prices in order that it may lower prices and expand. There are two ways to avoid this pitfall. One is to make anti-dumping protection conditional upon the maintenance of satisfactory domestic polymer prices and below world prices for exporters. This condition is important not least because the polymer industry currently regards their level of protection as merely an anti dumping device, albeit an inadequate one from their point of view. An alternative to tariffs is subsidies, effectively spreading the costs of keeping such a producer in business across the entire society. Unfortunately subsidy applicants are likely to find that they are merely one in a long queue.

Both suggestions of course create opportunities for rent seeking but no more so than the current system utilised by the Board of Trade and Industry. Indeed the possibilities for rent seeking could be reduced, and the process of democracy advanced, if applications for such subsidies required a far more public inquiry than has been the norm to date. Such an inquiry could consist of permanent members such as organised polymer manufacturers, organised plastic converters, organised labour and the Board of Trade and Industry. It is important that applications for assistance be entertained only if they come from industry associations as this will tend to reduce the potential for rent seeking which is usually firm orientated. Such a practice will also force objections from within the industry to be sorted out 'in-house' beforehand, thus eliminating the need for the time consuming practice of allowing rival firms to comment upon state proposals.

Hearings would be public and other interested parties would be entitled to make written and oral representations. Naturally a company seeking subsidies would need to disclose its financial position, a further disincentive to rent seekers.[10] Subsidies would need to be restricted to limited fixed periods, requiring a further inquiry in order to be reinstated.

It is acknowledged that certain resources, people's time and energy etc, will be needed to operate such a system. However there is no reason to suppose that the overall costs to society would be that much higher than the current system, which has been far too cosy a relationship between big companies and the state. Such hearings should be held expeditiously. Although a concern here has been rent seeking by employers, corruption among the state bureaucrats should not be overlooked. The more open system proposed here may also serve to limit the opportunities for the latter. It will also offer the benefits of building democracy, so sorely needed in South Africa.

Such inquiries raise the issue of the quality of information available to participants. This is addressed below along with research and development.

<u>Export Incentives</u>

In an earlier chapter certain key elements for export expansion were identified: tariff

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10. There is considerable merit in requiring all income tax returns to be public as a general measure against corruption.

free access to intermediate inputs for both direct and indirect exporters and back to back letters of credit[11], probably underwritten by a state financial institution. The following section deals with suggestions in this regard.

a) The Polymer Industry

Some polymer manufacturers have been exporting. One thrust of the strategy proposed here is to promote the local beneficiation of this previously exported plastic raw material by way of exports from lower down the production chain. The incentive for polymer producers to allow and promote local beneficiation should be the opportunity to share in the benefits of final export sales. However export incentives ought to enable suppliers of intermediate goods (polymer producers) to benefit.

GEIS was scheduled to be phased out in March 1995 according to Org Marais, Former Minister of Trade and Industry (FM, 23-8-91:65). In addition South Africa's admission to GATT may also require some earlier adjustments to GEIS. If some form of GEIS or export incentive is to remain in this *filière*, then these events present a timely opportunity to restructure such incentives.

Ideally only plastic raw material which cannot be beneficiated locally should be exported. However since an objective of the strategy being suggested here is to nudge and drive the polymer producers to expand their plant capacities to 'world scale', the scale of additional tranches of capacity will in all probability result in increased polymer exports at times, regardless of incentives. Consequently export incentives should ideally be redesigned in such a way that direct exports of intermediate inputs such as polymer would not be assisted. Instead they would only be assisted if they were intermediate inputs into final export products. In taking this line of thinking further, if exporters are to be given higher status in South African industrial policy than those who produce only for the domestic market, then final exporters should exercise some measure of control over the incentives which are passed back upstream to intermediate input suppliers. The additional benefit of such an arrangement in the plastics *filière* is that it would redress, to some extent, the power imbalance between the plastic converters and the polymer monopolies.

There is also an important although less tangible issue which needs to be addressed and that is the lack of collaboration and cooperation between the polymer producers and

11. Credit schemes enabling indirect exporters to obtain credit for exports.

plastic converters. This is a difficult issue to address head on. Indeed it may be best addressed tangentially from several different directions (examples of this below). However one means of addressing it directly would be the establishment, by the Department of Trade and Industry (DTI), of a forum of stakeholders purely for the purposes of engendering cooperation. (This idea is taken up in more detail below.) Another might be for the DTI to be given a general standing instruction to try and increase cooperation wherever possible in its dealings with stakeholders in this *filière*.

b) **The Plastic Converting Industry**

Currently GEIS and Phase 6 export incentive schemes are important to plastic converters in ameliorating the anti-export bias. However assuming that state financial assistance, if necessary, will enter the pipeline at the upstream end and should reach converters in the form of lower polymer prices, then the objective would be to move away from cash incentives at the downstream end and towards other forms of assistance which improve international competitiveness and export marketing. These are addressed elsewhere in this chapter under various headings, principally, capital goods, export marketing, technology restrictions, research and development and skills.

Since the plastics converting industry provides intermediate inputs to a wide range of other manufacturing industries it is important that it is not excluded from whatever export incentive schemes may operate in those industries it supplies. For example in South Africa a comparatively large proportion of polymer is consumed by packaging. Much rigid plastic packaging is in the form of bottles and closures, which if empty, are generally non tradeable. Consequently there is a need to link export incentives for final exporters back to the plastic packaging supplier. This is intended to enable the latter to provide packaging at less than the current domestic value so as not to disadvantage the export prospects of the food exporter. Domestic plastic packaging prices will be comparatively high as it is suggested that tariffs on these products remain but at reduced levels.

One mechanism to achieve this backward pricing linkage is to encourage or require packaging suppliers to enter profit sharing agreements whereby the plastic packaging supplier provides packaging at an FOB price in exchange for a share of the profits from export sales. Another means would be to structure any export incentive in such a way as to make intermediate suppliers direct beneficiaries, rather than through just conventional commercial arrangements. This is intended to protect the interests of small converting firms against the power of large customers. In addition the state could play a facilitative role in encouraging such backward linkages by providing better information to link suppliers and customers.

Another option would be to allow plastic converters which are indirect exporters access to imported polymer free of tariffs and surcharges.

A reduction in import barriers (in accordance with the forthcoming implementation of the Marrakech Agreement) in South Africa's target markets would also help to increase exports. The analysis in preceding chapters suggests that although South Africa's international competitiveness in plastic products is relatively low, it nevertheless still has prospects in certain high wage countries. Consequently South Africa's reclassification in terms of GATT as a developing country or other means to improve access to those markets would be important for export expansion. If international competitiveness improves over time then the range of target markets could be widened.

The large firms in the polymer industry are experienced exporters, most are connected to MNCs. On the other hand small and medium sized plastic converters will, almost as a prerequisite, require assistance in identifying and serving export markets. The experience in successful East Asian economies is that successful exporting requires considerable promotion efforts on the part of the state agencies (Wade, 1991:368). Consequently the prospects of export success for the plastic converting industry are tied to some extent to the general level of manufactured exports together with the state's willingness and ability to fund export promoting activities.

International developments suggest that increasingly the role of the state is to provide the 'operating platform' from which internationally competitive firms can launch their forays into world markets. A critical element in this approach is the supply of good quality market intelligence and supportive trade missions and diplomatic initiatives. The South African DTI could do far more in these areas. In this regard there is much to be learned from South Korean government's export marketing activities.

The longer term objective, in the plastic converting industry, would be to steer export assistance to small and medium firms through structures of cooperation between them, so rewarding cooperation. This is necessary for various reasons. Small firms especially lack the capacity to master all the considerable skills necessary to export successfully. It is a means of counteracting the unusually high levels of mutual suspicion and distrust currently existing in the plastic converting industry. Cooperation maximises the advantage which lies in the synergies of skills and capacities these producers have in generating products for export. In the longer term cooperation on issues such as R&D and technology could be facilitated from this basis. A greater role by the DTI (or other appropriate state agency) in export promotion could, in the course of carrying out such functions, arguably find opportunities and means to encourage the type of cooperation currently lacking in the *filière*.

For the short term, engendering this cooperation will not be easy. Marshalling of producers to collectively meet large orders will take energy and time to begin with. SAFTO's restructuring along industrial lines should assist. Ideally some form of government agency which is proactive in seeking out potentially cooperative firms and drawing them into export business is needed. To begin with a few small offices in strategic locations, staffed by 4 or 5 suitably skilled persons would be adequate to coordinate state and commercial bank deals, freight forwarders, SAFTO, facilities offered by the Department of Trade and Industry etc. The costs would be small in comparison with South Africa's many, and often times duplicated, state funded bureaucracies.

Disincentives are appropriate for those that blatantly refuse to cooperate. The simple but effective South Korean expedient of terminating an offender's electricity supply seems unlikely to be within the range of powers granted to the Department of Trade and Industry. Publicising offenders is a less harsh but sometimes telling form of censure. This could be encouraged by placing a general responsibility on firms, trade and industry organisations and institutions to make such lapses in cooperation public. Beyond this there is a spectrum of disincentives ranging from the compilation of 'black lists' of such firms, to the withdrawal of incentives and so on, depending upon the power the policing agent for industrial development is able to muster.

Breaking into export markets requires persistence and investment in the effort. It takes something like 2-3 years work to develop an export business in Africa.[12] In the past the state has used tax incentives by way of exemption on export marketing expenses (Section 11(bis) of the Income Tax Act phased out in March 1992). This was subject to misuse and abuse and withdrawn for that reason. Nevertheless some incentive of this type is necessary. Perhaps it could be administered differently - by for example the industry association - using peer group policing. This might be linked to a small levy the value of imports and exports. Taiwan for example imposes 0.05% levy to fund such export marketing assistance.

One source of considerable potential assistance to exporters is the Department of Trade and Industry. However its 'Trade' branch is currently separate from its 'Industry' branch.

12. Moss D Opportunities for two way Chemical trade in sub-Saharan Africa, presentation at 'Opportunities for export of chemicals seminar', Small Tonnage Interest Group of SA Institution of Chemical Engineers and SA Chemical Institute, Alrode, 26-2-92.

There would appear to be merit in merging these two activities for industries which are identified in order to expand exports.

Successful marketing of exports is related to quality systems, which for exporters means the ISO 9000 system. This can be a fairly lengthy and time consuming system to install and as far as can be ascertained tends to be restricted to the larger firms. It is difficult to make detailed practical suggestions here other than that assistance, both financial and in the form of expertise should be given to small and medium firms in order to facilitate their adoption of the ISO 9000 system.

Capital Goods

Capital costs at all levels of the *filière* are a large share of production costs. This is especially true in the petrochemical and polymer industry in which projects also have long lead times.

Widespread agreement exists among employers that the cost of capital in South Africa is too high. To remedy this there are two schools of thought among employers:

a) those that argue for the removal of various tax subsidies such as Section 37(e) and who favour instead a plan for the progressive reduction of corporate tax from the current 48% to about 35%,

and

b) those that argue for maintaining the level of corporate tax at approximately the same level and to provide selective tariff, surcharge and tax incentives to targeted capital investment along the lines currently practised by the state.

The cost of capital is an economy wide problem closely bound up with the fiscal crisis and thus an important part of the 'great economic debate'. In so far as investment for domestic markets is concerned, the impression gained during field work for this study (in 1992) is that other factors such as political uncertainty and levels of violence have more to do with the current investment strike than the tax regime.

In so far as investment for exports is concerned it would seem that, in terms of capital goods, South African investors are at a relative disadvantage if we exclude for the moment, Section 37(e) incentives and the IDC's soft loans to exporters. Consequently if exports are to be expanded, this will have to be corrected in some way. The obvious options are one or the other of the two approaches outlined above. Tariff and surcharge relaxations are a further option. The impact across the economy of each option would need to be evaluated. Such an evaluation is beyond the scope of this study.

Nevertheless some comment upon the current incentives is possible. Ideally an industrial strategy aimed at creating an indigenous machine tools industry is needed. The limits and deterioration of this industry in South Africa have been highlighted by Kaplan (1991) together with some tentative suggestions for an expanded capital goods sector. In so far as injection moulding tools go, even the provision of good quality tool steel from local steel producers at competitive prices would be a useful start. Short of the rapid development of the local machine tools industry, it appears reliance upon imported machinery and equipment will remain a feature of the plastic converting industry.

The use of credit by Korean economic planners was a key ingredient in their success (Byung-Nak Song, 1990). This is partially recognised by the IDC. It subsidises loans to install export capacity. Money is lent at 9% provided that 60% or more of the production is exported. The difficulty for those plastic converters hoping to enter the export market is to secure export markets for 60% of output. Indeed it discriminates against small producers. To remedy this a sliding scale would seem more appropriate so that those who begin exporting a small proportion of output may also benefit.

An important aspect of credit, especially for small firms, is immediate access to subsidised short-term credit to finance working capital for export purposes. To address this such IDC loans could be extended to working capital. A two tier structure could operate, with preferential rates being applicable to domestically produced inputs.

These suggestions would necessitate changes in the IDC to expand its emphasis from large projects to include small ones and to extend its operations into all major plastic producing regions of the country. Some restructuring to make it more 'user friendly' to small firms and to reduce paper work and 'red tape' seems desirable. Investment intended for identified national reconstruction initiatives could also be assisted in this way.

Whichever mechanism is used, facilitating investment in new machinery and equipment will impact upon jobs. Jobs are already being lost to new technology as the aging capital stock is replaced. Investment incentives aimed at promoting exports will only speed up this inevitable process. Some mechanism to secure employment will be necessary, the difficulty lies in identifying the appropriate location for this. Tying it to subsidised interest rates generates difficulties in determining the duration of the protection in an industry like the plastic converting industry which has such varied technologies. A partial solution to the problem of job loss may be to empower organised labour in this area with rights to challenge unilateral shop floor restructuring. In addition it would be equitable to subsidise investments in human capital (such as training) to at least the same extent as capital is subsidised. The principle of neutrality between capital and labour would appear to be the minimum requirement given the extent of South Africa's unemployment problem.

These suggestions taken together and along with the others made here, give some hope that jobs lost would be off-set by new jobs arising from new investment in response to the pricing structure and other elements of the strategy suggested here.

Energy costs

Electricity prices in South Africa are internationally competitive (SACOB 1991). However the structure of tariffs yields discounts to large consumers and discriminates against small producers.

For the plastic converting industry, energy costs are an important consideration. One small firm which has become a successful exporter acknowledged that their theft of electricity during their start-up days was an important advantage which made it possible to get the business established. Since ESKOM is prepared to subsidise large capital intensive projects like Alusaf, through the structure of its electricity charges, there is no reason why similar advantages should not apply to assist labour intensive small firms in the plastic converting industry to get established particularly as exporters.

Labour Costs

As has been shown in a previous chapter South African wages in the Plastic Products industry are generally lower than those in the developed economies but higher than those in the newly industrialising countries. On wage costs alone South Africa cannot compete with the low wage economies. However lower real wages for low income South African wage earners does not seem an appropriate (or even attainable) policy objective especially in the light of the low standards of living they experience and the strength of organised labour. The conventional thesis, that there is an inverse relationship between the level of wages and the number of jobs, does not seem to be uniformly supported by the evidence especially if the experience of the Asian NICs is taken into account.

The alternative to lower real wages is to focus instead upon improving productivity and increasing the output per unit of wage costs. The analysis of the international competitiveness of the Plastic Products industry provides the key for policy recommendations in this area. Increasing productivity is at the heart of the policy suggestions made here and the evidence collected in this study suggests that there is considerable scope for improved productivity. An area in which large gains are possible in many firms, lies in the reorganisation of production processes on the shop floor and the reorganisation of work which will accompany it.

Typical production systems which may be considered here are Kanban, Kaizen, JIT, self managing teamwork, multi-skilling and flexibility (see for example Bessant 1990, Best 1990, and Imai 1986). Human resource management initiatives frequently accompany these changes. Among such are employee involvement initiatives, de-layering of management hierarchies, enhanced training and others. Such initiatives also have the potential to yield 'whole' jobs (as opposed to the work fragmentation which has occurred under Taylorist production regimes) and new levels of industrial democracy in South Africa. For the purposes of this discussion these may be grouped within the notion of 'world best practice'.

On the other hand there are several such initiatives within this package of production systems which if implemented on their own, can seriously undermine trade unions. These include an emphasis upon the individual at the expense of the collective, individual performance appraisal, the use of temporary labour and sub-contracting. No doubt both employers and unions will attempt to 'pick plums' from among these possibilities. The outcome of this struggle will determine whether a redistribution of power in the workplace materialises or not.

This complex nexus of issues is elaborated further below.

Environmental costs

The indications are that the petrochemical and plastics industries are among the less environment-friendly industries. They are large users of energy and have greater environmental impact than their US counterparts. Only detailed environmental auditing can reveal the extent of this impact. Such mechanisms are beginning to be developed by the SABS. An obligation upon firms to conduct regular environmental audits appears to be a cost effective approach requiring a minimum of bureaucracy. To avoid the 'referee and player' syndrome such environmental audits need to be carried out by independent parties and most importantly the results need to be publicly available.

Post consumer plastic waste is a growing problem, worldwide, from the point of view of environmentally sustainable development (given the fact that plastic is not bio-degradable) as well as from an aesthetic point of view. Those countries which have introduced some form of obligatory recycling are accumulating growing stockpiles of plastic waste which they have been struggling to get rid of. Following in the footsteps of other toxic substances, exporting it to less powerful economies is one option. To avoid becoming a dumping ground for waste plastic and to encourage recycling of local waste, South Africa should consider an import prohibition or very high tariffs on scrap and recycled plastic unless domestic supply cannot meet demand, which seems unlikely.

South Africa has enjoyed a comparatively high level of plastic recycling in comparison with Western Europe. This is a function of South Africa's traditionally higher virgin polymer prices. A reduction in virgin polymer prices, as suggested above, is likely to have a negative effect on polymer recycling.

Whether or not domestic polymer prices are lowered, South Africa will need an appropriate strategy to deal with the growing problem of plastic pollution. International experience suggests that recycling is the route to follow. How could this be promoted?

The collection and sorting costs of plastic need to be reduced. To facilitate this, all new plastic products should be required to carry the international symbols identifying the type of plastic the item is made from. This may also assist export marketing of new plastic products as they will be seen to be environmentally conscious and this will also facilitate the recycling of same in the importing country.

An ideal opportunity exists to link waste recycling to job creation programmes or public works which are currently receiving increasing attention. For example the state and municipalities could offer a reward per kilogram of waste plastic, to anyone who cared to collect it and bring it to certain collection points. A recent initiative like this in one township proved very successful. Plastic bottles and containers if separated out at this point could fulfil a constant need government hospitals have for dispensing containers in efforts to keep medicine prices down. Targeting one township or area at a time can help reduce transport costs.

Another option is to introduce a deposit system for plastic bottles although this is more complicated. Plastic incineration as an energy source has not yet emerged in South Africa but this is another alternative and is preferable to land filling.

If the collection costs of scrap plastic can be overcome, it may also find a useful application in building materials for low cost housing.

Competition Policy

In a small market like South Africa, industries such as the petrochemical industry with large economies of scale tend to operate in monopolistic or oligopolistic markets. Unfortunately the corporate strategies of the major chemical firms in the local industry have compounded the problem. AECI, for many years the leading local chemical firm, is the clearest example. For many years it followed a corporate strategy apparently underpinned by models of classic static industrial organisation in which it sought to locate in areas of weak competition or to initiate changes in the industry structure so as to reduce competition.

There are essentially two approaches to dealing with this problem and a choice has to be made between them. Free marketeers tend to argue for increased competition, whilst those who, in Wade's (1991) terminology, would 'govern the market', argue for the controlled existence of monopolies. For the purposes of the task at hand the latter appears to offer the better solution. The type of controls will be various but as has been argued above, lower tariffs will be important in allowing competition into the domestic market.

Porter (1990) has emphasised the need for firms to adopt strategies which will lead to dynamic competitive advantage. However changing local management's mind-set, away from the tried and trusted strategies which they have relied upon in the past to direct the local chemical industry will be no easy task. Certainly government's role is likely to be restricted to suggesting, nudging, urging and at most subsidising in some way the costs firms incur in engaging consultants and advisors. There may however be a window of opportunity for the Government of National Unity in the immediate post apartheid period to employ 'soft' policy options (in conjunction with 'harder' options such as tariff liberalisation). It could bring firms together under the banner of 'Reconstruction and Development' and try and bind them through moral suasion into a process of 'making a fresh start' and in this way influence corporate strategies.

Forward integration and dominance in the plastic converting industry

Pricing mechanisms, as have been suggested above, may also act as a strong incentive for polymer manufacturers to integrate forward into the converting business and to enter into competition with their customers, an understandable cause for concern among such customers. This gives rise to fears that the big chemical companies, (two of them have links to large South African conglomerates), will take over and dominate the converting industry.

These fears may be allayed to a certain extent by a quick review of the present structure of the industry. It is a widely diverse industry with a wide range of technologies, skills and markets and is accordingly not easily corralled by large companies. Packaging is the largest single market for all polymers, 47.6% by volume in 1990.[13] This market is dominated by three firms, Nampak, Kohler and Consol, each of which is owned by a conglomerate and unlikely to surrender its lucrative business easily.

Outside of packaging, Polifin and to a lesser extent, Sentrachem, tend to prefer and are more forward integrated in the lower value added commodity bulk or mass market type products which tend to have limited export potential (ie Southern Africa) due to the nature of those products. An exception is Mega Hi-Tech's (Sentrachem) auto bumper export business. However this may be turned to advantage as some of these products such as piping can play a major role in housing and national reconstruction, provided that their prices can be kept low. The obvious mechanism to do this is by tariff reduction. Excluding packaging, the indications are that export potential outside of Southern Africa is stronger in more design intensive or speciality type niche markets, which thus far tend not to have been favoured by the large companies outside of packaging.

SASOL, prior to the advent of Polifin, was not forward integrated at all. As primarily an energy business, it is ill equipped to make a foray into the converting or carpeting industry. It is as yet unclear what impact SASOL's majority shareholding will have on the businesses AECI put into Polifin. Nevertheless SASOL has the resources to make considerable acquisitions and may be expected to do so either directly or via Polifin. A likely target will be polypropylene usage in the textile industry, an area in which growth is strong, exports are significant and further potential exists. Once Polifin has invested in a new (ethylene based) PVC plant it may be expected, depending upon the capacity of the plant, to expand its subsidiaries which use PVC so as to assure itself of a significant 'base load' for its new plant. Polifin will be balked in PP for so long as Sentrachem and Hoechst control Safripol and its marketing arm. As has been argued earlier, the advent of Polifin requires very active monitoring of prices accompanied by a competition agency capable of eliminating discriminatory pricing. Indeed vigilant state regulation of prices, as has occurred in South Korea, may become necessary.

There are several instances where conglomerates have used their financial muscle to remove smaller, more efficient producers. At the same time it must be recognised that only

13. Calculated from BMI, 1991 and Plastics Federation of SA figures.

the very largest of South Africa's plastic converting businesses approximate 'world scale'. Drawing the line between inefficient conglomerates silencing competition by takeover on the one hand and genuine attempts to achieve a scale of operations capable of competing internationally, on the other, will require careful examination. Nevertheless measures will be necessary to improve the chances of small firms surviving where they rub up against subsidiaries of conglomerates. Among the measures required will be a more rigorous Competition Board capable of more rigorous investigations as well as other efforts to bring about cooperation among small and medium enterprises, discussed below.

Concentration and Cooperation

The plastic converting industry can be characterised by two phenomena: domination by conglomerates in certain (often oligopolistic) markets and a proliferation of small firms (often in cut-throat competition) in others. A twin approach is needed to deal with the two phenomena identified here: one to develop the capabilities of larger firms and another to develop the capabilities of small firms.

The experience in the US has been that plastic converting firms equivalent in size to some of South Africa's largest firms have been the most innovative. In South Africa these firms are typically linked to conglomerates. The extent of domination by conglomerate owned firms could be reduced if policies were adopted which de-linked the plastic converting firms from their conglomerate owners. De-linking firms from their conglomerate parents may expose them to greater threat of forward integration by the chemical conglomerates, SASOL, Polifin and Sentrachem. Such forward integration is already the case to some extent. Further forward integration need not be rejected out of hand because of the advantages vertical integration offers and the possibility that the international competition will be vertically integrated. Such developments would need to be monitored by a more dynamic Competition Board with enhanced powers and an ability to take industrial policy into account. For example the extent to which exports of plastic products would be increased as a result of such forward integration would be one important yardstick for the Competition Board to apply in approving such takeovers.

Simultaneously it is suggested that policy aimed at small firms should attempt to lure and corral them into a number of industrial districts in the major centres. One already exists to some extent in practice to the east of Johannesburg around the offices of the Plastics Federation. Best defines industrial districts as "dynamic constellation(s) of mutually adjusting firms" (Best, 1990:235) in which a mixture of co-operation and competition prevails. The intention would be to promote the design and innovative capabilities of small plastic converters. The promotion of this objective could also form a part of the lure to attract such firms to the proposed districts, in the form of the technical advice and information centres elaborated on below. Such centres could also provide advice on export marketing advice as well as functioning as coordination points for cooperative export efforts. Other aspects of the strategy elaborated here such as lower energy prices and access to soft credit could be linked to participation in such industrial districts.

Human Resources and Skills

The key skill bottlenecks in the *filière* which need to be addressed are: illiteracy among the black workforce, the supply of operators and artisan toolmakers, industrial designers, polymer technologists, production engineers and chemical engineers. The replacement of blacks by whites in the Industrial Chemicals and Refinery industries suggests that much more attention needs to be given to the training of black process operators. Indeed the complex issues of affirmative action for previously disadvantaged race and gender groups requires urgent attention. Skill formation and training appear to offer the most viable route to correcting past distortions in the labour market. Such initiatives are more likely to succeed than heavy handed state intervention if left to negotiations between organised labour and business, subject to the general requirement that they be able to demonstrate progress over time. There are signs that the state is tentatively moving in this direction although as has been seen in the case of the Plastics Industry Training Board the state has thus far been reluctant to oblige business to involve organised labour.

Human resource development is the weakest link in South Africa's range of capabilities according to International Competitiveness Reports. The costs of correcting this historical deficiency is likely to be large. Setting the exact levels of spending appears best left to negotiation between business and labour in each industry in the first instance.

The level of contributions by employers to the Plastics Industry Training Board, currently 0.75% of payroll, is wholly inadequate for the task at hand.[14] To encourage greater spending on training, by both employers and employees, such expenditure should at least be tax deductible. Should the fiscus allow, then state contributions should be made to

14. In Australia, which does not have South Africa's legacy of apartheid education, a training tax of 1.5% of the wage bill has been introduced.

the industry training boards provided that, they are representative of organised business and organised labour, have mapped out and agreed appropriate career paths and that these training programmes have been discussed and synchronised as far as is practicable with institutions of adult education and of higher learning such as technikons and universities.

The Chemical Oil & Allied Industry Training Board was struggling to launch itself over 1993-94 and will, when operational, cover the upstream end of the *filière*. The intent of the employers in this case is simply to gain accreditation for their own training schemes and to increase the supply of trained artisans, a matter in which they have the support of the whites only unions and oddly, the black consciousness union as well (Interview, Bonner). The ideas suggested above may equally be applied to the Chemical Oil & Allied Industry Training Board.

Research, Development and Technological Capacity

The insights gained from this study suggest that South Africa needs to develop a national innovation system, an issue beyond the ambit of this study. The contribution which the findings of this study can make to this larger question is to point out the weaknesses evident in this *filière*, and what might be done to correct them, thus providing something of a case study for the wider issues. The low levels and in some instances, non-existent levels of R&D spending suggest that incentives are necessary to increase the level of R&D spending.

Technology licensing agreements are important limitation upon exports from the plastic converting industry. Firms will have to be encouraged to renegotiate the terms of these agreements. If unsuccessful they will need a channel to the Department of Trade and Industry enabling the complaint to be taken further at government level. New technology licensing agreements restricting exports will have to be avoided as far as possible.

Dealing with the constraints imposed by foreign technology licenses on local beneficiation and modification will require active state intervention. The reluctance of foreign investors to develop technology locally also requires attention.

In so far as manufacturing is concerned proposals exist for a National Manufacturing Research Centre (see De Lange, 1992). If industry specific sub-branches of such a centre could be established at regional level, to facilitate access by small firms, then this would add another complementary level.

In the plastics converting industry the objective of the broader research and development environment should be to facilitate the development of new products and to provide a reservoir of innovative ideas that can be turned into practical projects. This has to be addressed at a number of different but complementary levels: university, industrial design school and plastics technology. Most importantly these inputs have to reach, or be accessible to firms 'in the field'. Ideally, technical advice centres, for want of a better term, should be set up in the major centres.

It is important to recognise that much of the skill base in the industry exists informally, in the capacity of its managerial staff. This ability, as one interviewee put it, 'to steal with our eyes' during international visits and adapt this knowledge for their own use is important. It is a critical capacity which should not be undermined whilst it continues to exist and consequently the local technical advice centres suggested here, should have a facilitative bias to try and develop and formalise these skills. At the same time industry experts point out that this is a declining skill base (Interviews, Naude and Huisman). Preparation is obviously needed to begin replacing this shrinking skill base. The objective here would be to establish a 'virtuous cycle' beginning with the accreditation of existing (often informal) skills and using a package of incentives and rewards, to encourage skill formation and incremental innovation (dealt with in more detail below).

The final challenge will be to create an interaction and intercourse of ideas up and down these various levels of research, development, technical advice and 'hands on' knowledge.

The need for much better information about the industry has been identified. The chemical and petrochemical industries are located in the 'commanding heights' of the economy and the nature of their development is a matter of considerable importance from a public policy point of view as has been demonstrated in this study. Yet South Africa with its strong heritage of secrecy among the business community and the state, and its weak Central Statistical Services is poorly placed to provide quality information.[15] Compounding this problem is the global phenomenon that quality information concerning the chemical and plastics industries has been very largely privatised.

A neutral and authoritative body is sorely needed to monitor the industry and provide the public, employers and labour with accurate information, both local and international, bearing in mind that the petrochemical industry is a global industry. This is clearly the state's responsibility, and would fit most usefully as an adjunct to a new Ministry of Industrial

15. See Meth (1991) for an account of CSS shortcomings in manufacturing employment and output statistics.

Development and Planning. Unfortunately neither the CSS nor the IDC have the tradition. What is important, from the chemical industry point of view, is that such a body should be industry specific and chemical industry focused. It would also seem advisable that although state funded it should have a considerable measure of independence from the state, business and organised labour. Equally important its research findings should be publicly available at low cost.

The rationale for this suggestion is that if public policy formation about crucial areas of the economy such as the petrochemical industry are to be made more democratic, the basic facts (which are not readily available) will need to be made available so that individuals and interest groups may formulate their views upon facts and not upon conjecture and speculation. Secondly the centralisation of such a facility will ensure economies of scale in the gathering of imported and expensive resource material, which would be of benefit to companies, state departments, industrial negotiating forums and the public at large.

A further justification for state expenditure on generating and distributing information and knowledge about the industry both locally and internationally lies in its importance to firms in the design of their corporate strategies.

The need to regularly monitor tariff codes and production referred to earlier could also be absorbed into the functions of such a research and information unit. It may also develop links with organisations like SAFTO which have begun to restructure on an industry basis. Problems in extracting the requisite information from local producers will be significant. Penalties, perhaps in the form of fines, seem the simplest measure of securing compliance with requirements for the provision of information.

'Soft' Technologies and 'Virtuous Cycles'

Evidence collected in both the polymer industry and the plastic converting industry, suggested that a small proportion of firms had begun to employ, what has been termed above as 'world best practice'. This type of 'soft technology' offers fabrication industries in particular (such as the plastic converting industry) an opportunity to improve productivity at comparatively low cost. Indeed diffusion of the know-how to implement such systems is something which government could facilitate by employing one or more incentives. Continuous incremental innovation lies at the heart of this notion of 'world best practice'. Many incremental gains can come from shop floor contributions. The Japanese talk of 'mining the gold in workers heads'. Indeed it could be argued that since apartheid has stifled workplace interaction, in particular between white supervisory staff and black production workers, then there exists a reserve of shop floor contributions which have gone largely untapped. If so, then it may follow that the end of political apartheid provides an opportunity to harvest a better than average contribution from shop floor workers.

However persuading black workers to relinquish voluntarily some of the 'gold in their heads' is unlikely to be an easy task, given the impact apartheid has had on the shop floor relations and the industrial relations system. The challenge facing management is how they might create a virtuous cycle which mobilises this tacit knowledge on the shop floor, links it to formal knowledge which in turn is linked to incremental gains in productivity and efficiency. This seems only likely to materialise to the extent that the firm is able to win workers co-operation and loyalty.

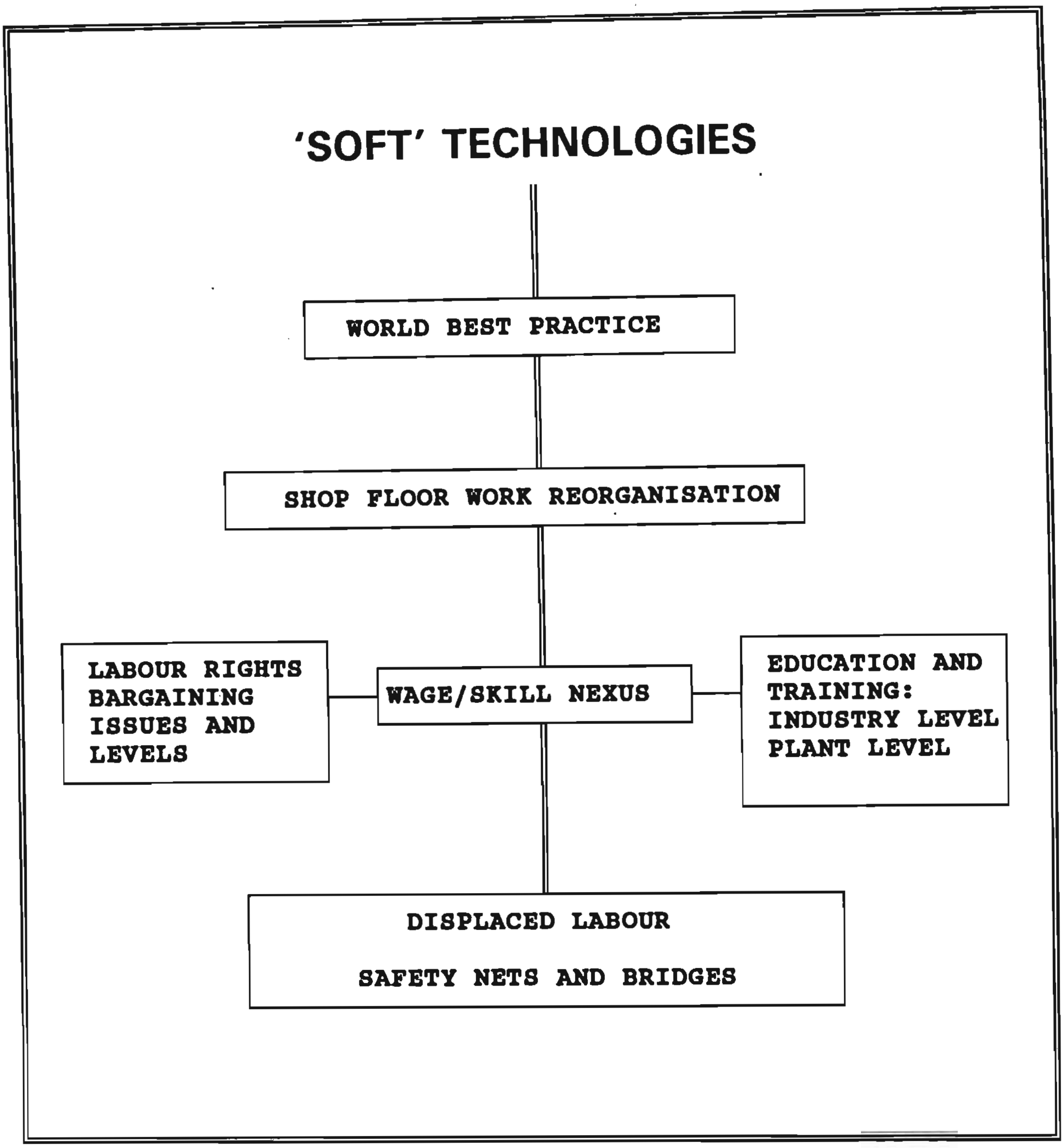
Such co-operation and loyalty is unlikely to be forthcoming until two fundamental concerns for shop floor workers are addressed; job security and rewards for their intellectual contributions.

Such complex issues lie mostly beyond the ambit of this study however a basic framework or approach is offered here in an attempt to address these issues at a general level. The framework proposed is set out schematically in Figure 39. This model proceeds from the assumption that the adoption of 'world best practice' production systems will lead to the reorganisation of work on the shop floor which in turn requires changes to job descriptions and the skills necessary to fulfil such job descriptions.

The organisation of work, individual job descriptions, wages, rewards and skills become inextricably caught up together in a 'skills/wage nexus'. These issues will need to be negotiated between management and workers, most usefully at the firm level. A part of the incentives necessary to attract labour into active participation in 'world best practice' techniques will be the need to link the incentive/reward system to skill acquisition so that human capacity building becomes an integral part of the system. Such negotiations are likely to be difficult and time consuming at first. Consequently it would be helpful if a basic framework of wages and conditions of employment as well as education and training programmes was addressed by industry training boards thus leaving more negotiating time for production and reward issues at the firm level. This dual level approach would have the additional benefit of providing an opportunity for the development of some form of wage policy at the industry level.

In order for shop floor workers to negotiate effectively in such a dual level approach some improvement in their rights to firm information and in their bargaining status could well

Figure 39 Schematic Model for Uplifting Production Efficiencies, Skills and Rewards



assist the process.

Skill will only be enhanced if training takes place. This has been discussed above. However it is important to note that in this innovation driven model, skills need to be seen as both those competencies which will both enable the worker to cope as the production process evolves as well as enabling workers to contribute to that process of innovation and evolution. This suggests that competencies should be more generic than specific and that the training scheme/s offered should allow for core competencies to be developed to higher and higher levels along a broad career paths. If there is to be mobility of labour between firms in a changing industrial landscape, competencies will need to have national recognition and certification. At the same time allowance will need to be made for firm level training. Both of these are accommodated within the current model adopted by the Plastics Industry Training Board (discussed earlier).

Perhaps the most difficult aspect of implementing this model will be dealing with worker's major uncertainty - job security. Job guarantees would be ideal but may be difficult to sustain in a restructuring industry. Some form of safety net or bridge to new job opportunities will need to be developed to accommodate those who are made redundant by the apparently inexorable labour shedding march of technology (of both the 'hard' and the 'soft' varieties).

Firms will need to offer, almost as a precondition, some form of security to their workforces. This could be coupled to training and some form of unemployment income over and above the meagre payments made by the Unemployment Insurance Fund. It is acknowledged that this aspect of the framework is the least developed and requires further imaginative development.

Institutions, Policy Formation and Industrial Relations

The process of change management which introduces industrial restructuring is almost as important as the changes themselves. Indeed they are not entirely separable. Insights gained from this study emphasise the need for much greater care and attention to be given to the process of change. Examples of this include the experience of the Plastics Industry Training Board levy, the complaints about state inconsistencies and the impact of industrial restructuring on job security.

The strong centrist apartheid state drove the economy down a path intended to meet its own domestic public policy objectives mediated only by business lobbying. In order to avoid similar pitfalls of a different kind in future, far more open and consensual decision making processes are required which empower the previously disempowered relative to the state. That is labour and previously disenfranchised groups such as black civic organisations.

Firstly an economy-wide frame of reference seems necessary so that all participants in the economy have a sense of the direction being pursued and the general targets at which policy is to be aimed. The tripartite National Economic Forum (NEF) comprising organised business, labour and government established an embryonic institution within which national and sectoral economic trajectories could be devised. If its deliberations are conducted transparently and its decisions publicised in advance, complaints by business about the lack of predictability in policy may be addressed. Indeed their very participation in the process may go some way to dealing with this complaint.

At the industry level the introduction of this or any other strategy will have to be accompanied by discussion and negotiation among all the stakeholders in the industry, organised employers, organised labour and the state, ideally an industry sub-committee under the auspices of the NEF. Changes in tariff levels to induce greater efficiency among the polymer producers may also cause jobs to be shed. Recapitalisation of the existing converting operations, particularly for export is likely to be labour shedding. These difficult issues will need to be negotiated with organised labour. Overall a move to higher levels of industrial efficiency along the lines of the 'new competition' will require a new kind of collaboration between capital and labour which can only arise from discussion and negotiation at both the industry and the firm level in which there is an adequate requirement for the disclosure of information on the part of business.

The Plastics Federation has operated a Plastics Industries Committee comprising the three large companies (SASOL, AECI and Sentrachem) together with the Association of Plastic Processors of South Africa (APPSA). It has dealt with contentious issues in the industry such as the trade regime and acted as a "Pre-Clearing-House for response/recommendation to Pretoria in an effort to speed up policy-decision making" (Spindler, 1992:14). This provides a nucleus to which organised labour and the state could be added to provide the plastics *filière* with an industrial strategy planning and negotiating forum. Many employers and employees in the industry are not a party to employer associations or trade unions. Incentives to correct this would help to generate strong institutions and more broadly based policies.

An institutionalised industry forum at a national level appears essential if in the formation of industrial policy issues there is to be a levelling of opportunity. In previous attempts such as the Working Group for the Promotion of the Chemical Industry, organised labour was excluded. It is important for the latter to be included since in the formation of public policy objectives they represent an important group which has historically been unrepresented and which needs to be heard. An inclusive process will also have more legitimacy during the difficult and sometimes painful implementation phases. In such a forum organised labour will lack expertise. Such disadvantages could be addressed by statutory support and (differential) government funding for participants in tripartite institutions of this type.

Such institutions will work better if it is within their power to control resources such as cash or access to incentives. Active participation and more equitable outcomes should then replace rent seeking and unnecessary industrial action.

However on its own such an institution is likely to fail. This is so because ultimately the restructuring and adjustments which need to be made must be made by firms and the trade union organisation in those firms. Neither the management nor the union leadership appear particularly well prepared for the firm level adjustments which are necessary. Given the generally antagonistic relationships between managers and unions in the industry, with considerable distrust on both sides, some form of assistance appears to be necessary if this relationship is not to spill over into unnecessary lock-outs and strikes. Assistance could usefully be directed at training, for both managers and union leadership in how firms could be made more efficient through work reorganisation. Legislative changes will be necessary to secure for workers access to relevant information about their firm and their inclusion in strategic decision-making.

Job security is a fundamental issue for ordinary workers. Unless a mechanism is found to address this need apart from the very limited retrenchment packages common in the industry, workers will find it difficult to accept the wider objectives of any industrial strategy, even if their trade union leadership is involved in its formulation. The resolution of this difficult issue, perhaps more than any other, will influence the prospects for attempts, driven by industrial policy, to make the commodity plastics *filière* more dynamic.

ANNEXURE A

ETHANE'S ALTERNATE VALUE AS INDUSTRIAL GAS

Prices as at September 1992

Given:	1 cubic metre ethane	= 66.04 Megajoule
	1 Kg ethane	= 51.923 Megajoule
	1 cubic metre industrial gas	= 18.9 Megajoule
	1 Gigajoule industrial gas	= R17.685 (average)

Therefore:

1. 1 Kg ethane = 51.923 Megajoule

Therefore

1 tonne ethane = 51.923 Gigajoule

1 Gigajoule industrial gas costs R17.685, therefore the value of 1 tonne ethane as industrial gas is:

51.923 Gigajoule X R17.685

= R 917.85

Conclusion:

The value to SASOL of ethane, as industrial gas is approximately half that of the value to SASOL as ethylene, if ethylene is R 1 800 per tonne. Ethane is also worth more as industrial gas than as petrol. However it should be borne in mind that this is somewhat of a theoretical exercise in that other gases of lower calorific value would need to be included to make industrial gas and there is a limited market for industrial gas.

ANNEXURE B

Introduction

The Petroleum Products Act (No. 120 of 1977) and other legislation[1] placed a veil of secrecy over the petroleum industry. It was only in May 1993 that the government produced a document outlining the workings of the oil industry.[2]

PART ONE

The Oil Industry's regulatory regime and SASOL's 'support'

There are eight principal elements to the oil industry regulations which are summarised below.

1. The In Bond Landed Cost (IBLC)

The IBLC is the official import parity price of refined product. It is the price at which South African refineries and SASOL sell refined product to the liquid fuel wholesaling and marketing companies, the so-called 'refinery gate' price.

Although SASOL is paid an import parity price, this does not mean that, under normal conditions, it would import refined products.

The theoretical (IBLC) price is based on an average of four refinery prices; one refinery in the Persian Gulf (Bahrain) and three in Singapore. Those less trusting of the 'Seven Sisters' and their kind may have their curiosity aroused to learn that three of these refineries belong to multinational oil majors which also operate refineries in South Africa. This (IBLC) theoretical model envisages that crude is shipped from the Persian Gulf to Singapore, refined there and the resultant refined product shipped to South Africa.

The IBLC model is criticised on the grounds that it is crude oil which is imported and not refined product (petrol, diesel etc). This is true, however the commercial basis for building refineries in South Africa rests upon the notion that by importing crude and refining

1. The Central Energy Fund Act (No. 38 of 1977), the National Supplies Procurement Act (No. 89 of 1970) and the Import and Export Central Act (No. 45 of 1963).

2. During the period when research for this study was being conducted the secrecy provisions in this area made it almost impossible to conduct research in this area. Subsequently as official information has become available it has been possible to make corrections where necessary.

it locally, the cost of locally produced liquid fuels would be lower than directly imported liquid fuels. In this sense the IBLC acts merely as a form of tariff protection for local refineries in order to protect their refining margins (Department of Mineral and Energy Affairs, 1993).

The validity or otherwise of a form of tariff protection for local crude oil refiners is beyond the scope of this study.

Within the model of the IBLC, several issues are identified which serve to raise the IBLC above a 'realistic' import parity price. Firstly Singapore and Bahrain prices are higher than Rotterdam and Mediterranean spot prices. If Singapore and Bahrain are to be the reference points then the shortest route between the Gulf and Durban is not via Singapore. Secondly the shipping costs from Singapore to Durban built into the model apply to refined product, which attracts considerably higher freight and insurance rates than crude oil, which is the commodity actually imported. If refined product vessel freight rates are to be a part of the model, then larger and less expensive vessel freight rates could be built into the model. Finally, the four reference refinery prices used are (higher) 'posted' prices and not 'spot' prices.

2. Inland Transport Costs

Transport costs from the coast into the interior are built into the petrol pump price and are based on Petronet's rates.

SASOL is paid a price for its synfuel products which includes inland transport costs. This is criticised because in fact SASOL produces its synfuels from local coal and does not transport any product inland from the coast.

The opposing view is that SASOL is merely applying a commonly accepted economic principle of locational advantage. That is, it sells its product on the inland market, at the price that the next nearest supplier could sell it for, and since the next nearest suppliers are at the coast, it is entitled to the inland transport cost allowance.

A choice between these two opposing views is strongly influenced by the view taken of SASOL. That is, can it be regarded as a normal commercial operation, if so, it would be entitled to its locational advantage. Or should it be regarded as a strategic installation to which conventional commercial criteria should not be applied? This is a question of public policy yet to be decided in post apartheid South Africa.

The transport cost is the theoretical cost of railing product from the coastal refineries to the interior, 10.2 cent/litre in August 1992. In practice crude oil is piped from Durban to SASOL's Natref refinery in Sasolburg at far less than the cost of railing it, believed to be only about 3c/l. This provides Petronet (the state pipeline company) with windfall profits.

To complicate matters further, Petronet's parent company, Transnet (state owned) has run up very substantial deficits in its pension fund and accordingly is trying to hold onto every available source of revenue for this purpose. Consequently a further public policy issue arises: should motorists contribute to the elimination of this pension fund deficit through paying higher petrol prices (via the inland transport cost) or is this something that should be shared among all taxpayers and dealt with in the state budget?

It is obvious that SASOL's synfuel production does not rely on imported crude oil at all. Nevertheless it is reimbursed as if it did. This is estimated to be worth about 6 cents/litre to SASOL.

SASOL's Protection

3. 'Synfuel Protection' or 'Tariff Protection'

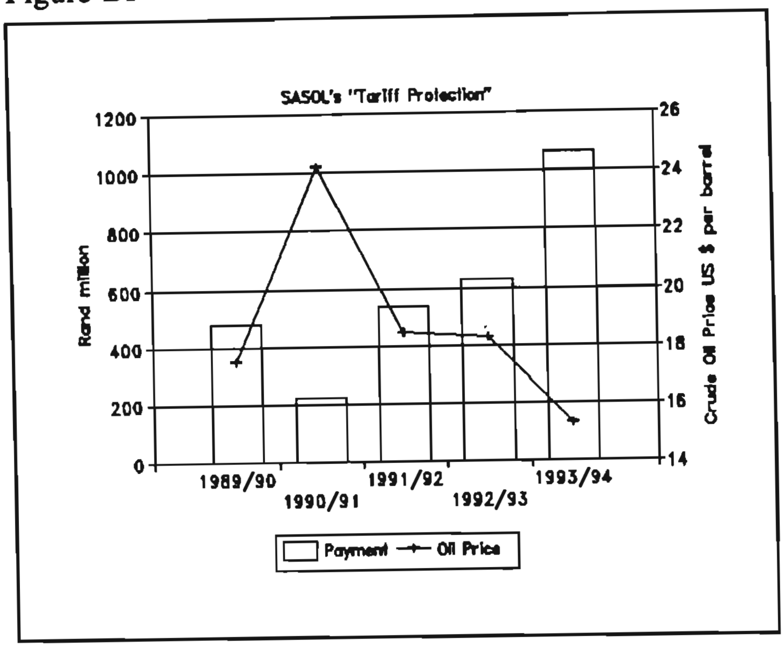
SASOL's synfuel output is uplifted by the wholesaling companies at the IBLC. However should IBLC crude oil equivalent price be below a US 23$ / barrel floor price, then SASOL receives the difference from the Equalisation Fund which is funded by a levy on the petrol price. Since 1-7-89, government has guaranteed SASOL a US 23 $/barrel oil equivalent floor price for its petrol (SASOL Annual Report, 1990:18).[3] This is very important to SASOL in periods of low oil prices. Should the oil price rise above US 28.7 $/barrel SASOL is required to contribute 25% of such profits to the Fund. Income to the Equalisation Fund is derived from a national levy on the petrol price. SASOL regards the cumulative effect of the way in which this calculation is made as 'tariff protection" (Sunday Business Times, 8-11-92). The continuation of protection is an important public policy issue and negotiating lever for government.

The difficulty with SASOL's 'tariff protection' arrangement is that it has an inverse relationship with the crude oil price (see Figure B1). Consequently when South Africa's international competitors are enjoying low energy prices, South African motorists have to contribute more to SASOL, raising local transport costs. Unfortunately the converse does not

3. On 17 December 1993 the National Economic Forums Liquid Fuels Industry Task force reduced this figure to US $21.8 and again on 18 June 1994 to US $21.1 per barrel.

apply - when oil prices are high, petrol prices in South Africa are also high although the payments to SASOL are lower as is evident in 1990/91 year when the Iraqi war drove up crude oil prices. It is only when crude oil prices are above $28.7 / barrel that the converse begins to apply and this has been a rare occurrence in recent years.

Figure B1



Note: 'Payment' represents payments to SASOL from the Equalisation Fund.
Source: Department of Mineral & Energy Affairs

4. The SASOL 3 'Claw-back' Agreement

On 25-2-91 SASOL bought the outstanding 50% share of SASOL 3 from the (state owned) Cental Energy Fund (CEF) for R617 million. In order to pay for this share SASOL borrowed R2 283 million from the CEF at 16 % interest. By agreement if 'tariff protection' is lowered, first the interest and then the capital amount will be reduced in proportion to the impact such a reduction has on SASOL's guaranteed $23 / barrel oil price.

5. Wholesaling and Retailing Arrangements for Synfuels

The wholesaling of liquid fuels requires a network of pipelines, storage tanks and delivery vehicles capable of handling volatile fluids. The costs of developing such a network is considerable and for this reason the government has permitted 'product swaps' between different producers and wholesalers for the purposes of serving the market more efficiently.

The result for the motorist, is that if for example, they fill up with Shell petrol in

Cape Town, the chances are very good that in fact the petrol was produced at Caltex's refinery in Cape Town, rather than at Shells' refinery in Durban. Similarly in Pretoria the chances are very good that whichever brand of petrol the motorist chooses, they will in fact be getting petrol produced by SASOL, and so on across the country.

Although there are dangers in allowing such collusive practices, there are also benefits for motorists, if such a system is managed properly. Competition in petrol wholesaling would require much larger investments in transport and storage facilities, which would be passed on to motorists.

The advent of SASOL introduced two problems: the surplus crude oil refinery capacity and SASOL's lack of any distribution network. A deal struck between Government and the oil industry covering both of these areas. In so far as product distribution was concerned, the oil companies agreed or were obliged to purchase (uplift) 91% of SASOL's output, in proportion to their market share, at the prevailing IBLC and to sell it through their wholesaling and retailing networks. In return for this SASOL was not allowed to own or franchise its own petrol stations and was restricted to direct marketing of not more than 9.23% of all petrol retailed through its 'Blue Pumps' on the forecourts of the other oil companies. In so far as refining capacity was concerned, crude refiners were required to shut down capacity in order to make room for SASOL production in the market in exchange for which they were compensated with a generous protection (the IBLC).

Later the oil companies claimed that they were incurring lower returns as a result of these arrangements, and successfully negotiated a 'synfuel upliftment levy' payment from government. This took the form of a levy on the petrol price routed through the Equalisation Fund to the oil companies.

Without the protection of a government strongly supportative of SASOL, the structure of this agreement makes SASOL very vulnerable. If for some reason the cooperation of the oil companies fell away, SASOL would have no wholesaling and retailing infrastructure through which to sell its product. This is an important bargaining lever in future for both a democratic government and the oil companies.

6. Fixed Wholesale margin

The Petroleum Activities Return Agreement (PAR) allows the state to set the profit of the wholesalers (5.56 cents/litre in August 1992). The wholesalers are the crude oil refining companies which also market 91% of SASOL's fuel.

7. Delivery Cost

This is a payment to refiners for delivering their product, often by road tanker, 2.9 cents/litre in August 1992.

8. Fixed Retail Margin

The state sets a fixed margin of return for retailing operations in cents per litre of petrol sold.

PART TWO

What would the cost of closing SASOL be?[4]

Could South Africa afford to close SASOL? One element of this decision will be the foreign exchange implications and the job losses that will arise. A precise calculation of the effects of SASOL's closure ought to be made before any such decision is made. What follows is a rough estimate designed to establish the approximate order of magnitude of the figures involved.

Some of SASOL's activities may be assumed to survive if the regulatory support is withdrawn.

Assumptions

The following will Survive:

SASOL One (currently being converted into a chemical plant and consequently not eligible for support)

NATREF (an inland oil refinery)

Sigma Colliery (continue selling to SASOL 1)

Secunda Collieries (either through sales to ESKOM or exports via Richards Bay)

SASOL Technology (in modified form)

Prices Candles

Gascor part originating in Sasolburg.

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4. This section is based upon 1992 figures which predate the advent of Polifin.

The following May Survive:

Power stations:	on Secunda site may be able to sell power or contribute to the ESKOM grid depending on surplus capacity situation.

The following will close:

Gascor	(part originating in Secunda, replaced by electricity where possible. No direct forex implication, although gas users may need to import machinery to convert to electricity.
Sasol Fertilizers	(Secunda operations. Spare capacity at IOF, Phalaborwa and AECI will make up the shortfall and relocate some jobs to these plants so no forex change)
SASOL Explosives (SMX)	(AECI will make up spare capacity so no forex change)
SASOL Chem	ethylene, propylene and other chemical sales
SASOL Polymers	PP sales

The calculation which follows, like most such calculations rests upon certain assumptions, in this case several assumptions have had to be made about the oil price, SASOL's petrol capacity and others (see Table B1). It should also be borne in mind that it is a snapshot of a particular year (1992) and a fully fledged calculation would need to build in assumptions about the future prices of oil and polymer. Similarly the impact of a continuing decline in the Rand exchange rate will increase the impact of closing the synfuel operations. Several aspects of SASOL's operations have been omitted (which would increase the impact of SASOL on the economy) as this is merely a rough calculation intended to illustrate the point that the costs of closing SASOL will be high.

SASOL's forex savings on petrol alone are about R1.8bn p.a.. This together with SASOL being the only major source of olefins to the plastics industry will mean forex losses of R 2.8 bn p.a., about 1.1% of GDP.[5] This precludes any hasty closure of these plants at least until alternatives exist. (This assumes that the coastal crude oil refineries could, in the event of SASOL's closure, make up the difference. Currently they lack sufficient capacity

5. In 1991 GDP was R267.37bn according to the South African Reserve Bank, June, 1992, Monthly Bulletin.

(Automobile Association, 1992:72). The implication is that more costly refined product would have to be imported until the coastal refineries expanded capacity.)

Table B1. Estimated Forex and Job Losses if SASOL is Closed
(1992 figures)

ITEM	ADDITIONAL IMPORTS R/MILL	LOST EXPORTS R/MILL	JOBS
Petrol 90 000bpd @ $19 bl	1,872.45		5000
Ethylene			100
Propylene			100
PP 33840 tonnes @ R2071.53	70.10	173.66	300
LDPE 77302 tonnes @ R2258/T	174.55		
LDPE 4310 tonnes @ $700/T		9.05	
LLDPE 49049 tonnes @ R1911/T	93.73		600
LLDPE 20830 tonnes @ $600/T		37.49	
PVC 35000 tonnes @ R1886/T	66.01		600
PVC 35000 tonnes @ R1586/T		55.51	
HDPE 110000 tonnes @ $800/T	264.00		
HDPE 10000 tonnes @ $700/T		21.00	570
	2,540.84	296.72	7270
TOTAL FOREIGN EXCHANGE	2,837.56		

Notes: Zero tariff is assumed on polymer imports.
$ = US Dollars
Exchange rate used: R3.00 = $1
Totals may not add due to rounding

On the benefit side of the equation presumably fuel regulations which raise prices could be dispensed with and the converting industry would benefit to some extent from reduced tariffs and thus lower cost polymer.

ANNEXURE C

PART ONE

COMPARATIVE ADVANTAGE AND EFFECTIVE RATES OF PROTECTION

Introduction[1]

The principle of comparative advantage "implies nothing more than maximising the potential economic welfare of a country's residents"[2] (Schydlowsky, 1984:440).

Ricardo's theory of comparative advantage

Historically the notion of comparative advantage is often first associated with David Ricardo's writings on trade theory. His famous theory of comparative advantage was fundamentally concerned with why countries trade and by implication, in which area of production should they best specialise. His theory of comparative advantage requires a country to specialise in the production of those goods whose cost of production (labour cost) is lowest relative to other goods. He compared two countries, England and Portugal and argued that if each country specialises in producing the goods in which they have a *comparative* advantage (greatest relative efficiency), then trade will be mutually beneficial to both countries.

Ricardo employed a number of simplifying assumptions that are inadequate for understanding modern trade and production. He assumed that there was only one factor of production - labour, that there were no intermediate inputs and only two countries. Also many different commodities are produced nowadays making a comparison of each commodity with each other commodity a laborious approach.

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1. Much has been written on the subject of comparative advantage and effective rates of protection, with many nuances and technical complexities. The purpose here is to provide a basic introduction and overview.

2. The existing conditions and resource endowment are given. The distribution of economic welfare within a country is as important as production in achieving optimum welfare but comparative advantage is principally concerned with measurements at the country level.

Domestic Resource Cost

In a more complex world in which a country may produce many commodities, a standard unit of comparison is helpful. Assuming there remains only one factor of production, labour, then the units of labour required to produce say one, US$ of each commodity could be ranked, thus revealing the differing amounts of domestic resources necessary to produce one US$ worth of each commodity. This in its simplest form is the 'Domestic Resource Cost (DRC) of Foreign Exchange'.

In reality, however, the production of most commodities involves several factors of production as well as domestic raw materials and intermediate inputs. The difference between the value of a good and the value of the intermediate goods or raw materials necessary to produce it is equal to the value added. Similarly the value added in producing the same commodity at world prices can also be determined.

A more complex DRC index can be created by ranking the amount of value added in the production of each commodity, instead of units of labour, necessary to procure one unit of foreign exchange. Defining domestic resource costs in this way has important benefits for computation and international comparison. Measuring domestic resource costs in this way is also a statement about the extent of the country's resources committed to the production of each commodity measured in units of foreign exchange. Put differently, it is the cost, in terms of domestic welfare, of earning (or saving) one unit of foreign exchange. It then becomes possible to divide the commodities listed in the index into those where there is a comparative advantage and those where there is not, that is there is comparative advantage in those activities where the value added (DRC) is less than or equal to the shadow price of foreign exchange. Conversely there is comparative disadvantage in those activities where the value added (DRC) is greater than the shadow price of foreign exchange.

Effective Rates of Protection

Many of the calculations necessary to determine the DRC may then also be used to determine the closely related, effective rate of protection.

The concept of the 'Effective Rate of Protection' (ERP) is the main method used to determine the effects of protection on local industry. "The purpose of ERP studies is to determine the way in which the pattern of industrial outputs observed under the existing structure of protection differs from what would be observed under free trade" (Warr, 1992:29).

Before proceeding further a key distinction needs to be made between *nominal* tariff protection and *effective* protection. Nominal protection is the tariff on an imported good. In South Africa these tariffs are imposed by the Department of Customs and Excise at the point of entry into South Africa or the Southern African Customs Union.

The concept of effective protection differs from nominal protection in that it takes into account the tariffs payable upon intermediate inputs as well as the nominal rate of protection. Similarly effective protection needs to take account of export subsidies or other measures which distort prices away from those which a free market may set. Typically ERP calculations have been used to determine the impact a country's pattern of industrial protection has had on the structure of production of its traded goods. Analytically the approach to studying ERP focuses upon the value added rather than upon the value of outputs.

The effective rate of protection is defined as:

> "the percentage excess of domestic value added, obtainable by reason of the imposition of tariffs and other protective measures on the product and its inputs, over foreign or world market value added." (Balassa and Associates, 1971:4)

The crucial advance made by the theory of effective protection over nominal tariff theory, is that it takes into account the entire protective structure. Thus a tariff on a final product will increase value added whilst a tariff on intermediate inputs for the manufacture of the final product will act as a tax upon value added. The net protection therefore has to take the effect of both tariffs into account.

By calculating the ERP for a country's industries it is possible to observe the way in which industrial outputs have been allocated within the economy in comparison with how they might have been allocated under free trade at any point in time.

The ERP measure is superior to the DRC measure in evaluating the desirability of individual industries (Balassa B & Schydlowsky DM, 1968). However a number of qualifications apply.

Firstly the greater value added resulting from a protective regime may be partly attributable to the higher rate of return to capital arising from the protective regime.

Secondly that intermediate inputs are not necessarily invariant to the level of protection. For example if GEIS (export) incentives were significantly reduced, the extent of domestic content (currently required by GEIS) may reduce as imported intermediates were substituted.

Thirdly the assumption that industries operate in competitive factor and product markets is not necessarily valid. Certainly in South Africa, neither the ethylene market nor the (black) labour market[3] have conformed with perfect free market competition during the apartheid era. This could lead to the inclusion within the value added of an 'excessive' rate of return on capital.

Fourthly, as indicated above, ERP measures static comparative advantage and is unable to capture dynamic comparative advantage which may, for example, lie in firms' ability to absorb technology and to make incremental innovations.

A variant of the DRC measure, the Local Cost of Foreign Exchange is dealt with in Part Two.

PART TWO

MEASURING COMPARATIVE ADVANTAGE
LOCAL COST OF FOREIGN EXCHANGE AND EFFECTIVE TARIFF PROTECTION

Introduction

In Part One the theory of comparative advantage and effective rates of protection has been outlined. However the extent to which an economy enjoys comparative advantage or disadvantage is a product of the individual enterprises and industries which make up that economy.

In this Annexure an attempt is made to bring such theoretical approaches to bear upon an individual project and to determine, at that level, the projects' contribution, or otherwise to comparative advantage. More specifically this investigation has the twin objectives of determining whether the resources employed in a large new polymer facility are yielding net savings/earnings of foreign exchange or not and determining the relationship between foreign exchange earnings/savings and the nominal tariff on the polymer in question.

The project selected is SASOL's polypropylene facility as it is the newest and one of the largest domestic producers of polymer. Given that it has newer technology and

3. Constraints were imposed, *inter alia*, by pass laws and the Group Areas Act.

approximates world scale it is assumed that similar computations focused upon older and smaller polymer plants would yield less favourable results.

Local Cost of Foreign Exchange

Many governments influence resource allocation within their boundaries through a variety of measures and in this South Africa has been no exception. Indeed, as has been discussed in the main text, the South African chemical industry has been considerably influenced in this way. Government measures which may influence resource allocation include taxes, investment incentives, the trade regime, exchange rates and of course more direct intervention, in the South African case, the pursuit of military/strategic public policy goals. Within such a policy matrix, firms make investment decisions which, if astute, generate good returns, and encourage the allocation of further resources to such activities. However resource allocation under these conditions is not necessarily synonymous with the optimal resource allocation consistent with balance of payments goals.

Evidence has been presented (in the main text) regarding the trade imbalance in the chemical sector. Such large imbalances, in the context of wider balance of payments considerations, begs questions concerning optimal resource allocation and concerning the means by which such imbalances may begin to be corrected.

Criteria are needed in order to assist in identifying activities in which the domestic economy has a comparative advantage and which would optimise the use of domestic resources and thus assist government in modifying its package of incentives and disincentives to optimise resource allocation.

A helpful criterion in this regard is the Local Cost of Foreign Exchange (LCF). It measures the net foreign exchange savings or earnings, on the assumption that if activity A earns or saves foreign exchange at a lower cost of local resources than activity B, then activity A is to be preferred. It is to be stressed that it is the net earnings of exports or savings on imports, rather than the gross, which represents the balance of payments effects (World Bank, 1976).

The Local Cost of Foreign Exchange may be expressed as:

$$LCF = \frac{V}{S - M}$$

Where:	V	=	domestic value added
	S	=	the CIF price of the imported commodity
	M	=	costs of imported intermediate inputs (World Bank, 1976)

In this expression the numerator represents the domestic resources which must be given up (value added) in order to earn foreign exchange and the denominator the net savings or earnings in foreign currency. The lower the ratio the more desirable the project in that less domestic resources will be given up for each unit of foreign currency and vice versa. In performing such computations difficulties similar to those discussed in relation to comparative advantage and effective rates of protection (see Part One) are encountered.

In the course of this study firms were unwilling to release all of the information necessary to perform LCF calculations. Consequently another route had to be taken within the limitations of the information available. In this instance an attempt is made to arrive at the LCF via a computation of the Effective Tariff Protection (ETP). In the course of the investigation into ETP some additional and helpful policy pointers with regard to tariffs emerge.

Effective Tariff Protection

Effective Tariff Protection is conceptually related to LCF, indeed the two formulas are mathematically related and can be derived from each other (World Bank, 1976). The important distinction between nominal protection and effective protection is discussed in Part One and is equally applicable here. Put simply, ETP is the real level of protection enjoyed by the domestic manufacturer, rather than nominal (apparent) protection to be found in the tariff book.

The production of many commodities involves the use of intermediate inputs some or all of which may be imported and upon which there may be tariffs and other duties levied. Similarly local content programmes can have 'hidden' within them imported inputs upon which duties were levied. In seeking the effective protection, it is thus necessary to 'strip out' such 'hidden' tariff protection, in order to determine the actual protection given to domestic value-added.

The formula for computing Effective Tariff Protection is:

$$ETP = \frac{t - t^1}{S - M}$$

Where:

t	=	tariffs on the final product
t^1	=	tariffs on intermediate inputs
S	=	CIF price of final product
M	=	value of imported inputs/components

(World Bank, 1976)

The ETP reveals the income derived by the domestic producer, as a result of protection, as a proportion of the value added created by the producer.

The formula is applied to the SASOL polypropylene case in Table C1.

Table C1. Effective Tariff Protection: Polypropylene

			Actual	Nominal
1.	TARIFF ON FINAL PRODUCT [t] Ref price R2300 (FOB NWE R1724.53 x90%) 14-8-92. (a)		747.92	
2.	TARIFF ON IMPORTED INTERMEDIATE INPUTS [t']			
2.1	**Capital Cost**			
	Tariff paid 1989 Rands	14,800,000.00		
	Tariff paid 1992 Rands	20,394,638.07		
	Assume Salvage 5%	1,019,731.90		
	Depreciation straight line 20 years (a\)	968,745.31		
	Capital cost tariff per tonne (b)	7.43		
2.2	**Additives, plasticisers,**			
	stabilizers R/tonne, (10%/tonne) (c)	12.8		
	Total (b) + (c)		20.23	
	Tariff on final product less tariff on intermediate inputs (a)-(b+c)		727.69	
3.	IMPORTED (CIF) PRICE OF FINAL PRODUCT			
3.1	FOB NWE, Homopolymer raffia, (b\)			
	US $/tonne, 14-8-92	620		
	Exchange rate 14-9-92	2.7815		
	FOB NWE, Homopolymer raffia, R/tonne	1724.53		
3.2	3.1.1 Freight Insurance (Rands)	300.00		
	3.1.2 Landing (Rands)	13.00		
	3.1.3 Wharfage (Rands)	34.00		
	3.1.4 Foward cover @ 2%	41.43		
	Total 3.1.1 to 3.1.4	388.43		
	Total landed price (Rands)		2112.96	
4.	PRICE OF IMPORTED INTERMEDIATE INPUTS			
4.1	Additives, plasticisers, stablilizers R/tonne (10%/tonne)	12.80		
4.2	Capital depreciation (c\)	16,612,673		
	Assume production tpa (less defects)	130320		
	Depreciation per Rands/tonne	127.48		
	Total imported inputs R/tonne (4.1 + 4.2)		140.28	
	Value added		1972.68	
5.	ETP, NET TARIFF/VALUE ADDED, %		36.9	35.4

Notes:

a\ Depreciation has been proportionately reduced by the proportion of imported capital goods and the tonnage output. It should be borne in mind that in the project under consideration here, surcharges were only introduced towards the end of the project.

b\ SASOL produces a variety of grades of PP. A common grade, homopolymer, Raffia grade, was selected for this example. As a conservative (US prices were lower) indicator of international prices, NWE fob prices prevailing on 14-8-92 are employed.

c\ Assumptions (Rands)

	Rands
1. Capex 1989, Propylene recovery	80,000,000
2. Capex 1989, PP	460,000,000
3. Total Capex 1989,	540,000,000
4. Total (1989) capex in 1992 Rands	744,128,686
5. Imported content 47%	349,740,483
6. Depreciation straight line 20 years, assuming salvage value is 5%	17,487,024
7. Therefore depreciation is	16,612,673

Discussion of Table C1

There are certain caveats to be made about this example. It is assumed that the propylene feedstock has no imported content. As a product of the Secunda works there is no doubt that there is imported content in the capital stock there. However to apportion a share to propylene, which arises as a by-product in the process in any event, is complex, if not impossible.

The effect of imported capital goods is noteworthy. If the imported content of the capital investment is increased from 47% to 90% the ETP increases by only 2.9%. This suggests that the effective tariff protection and the local cost of foreign exchange of this polypropylene plant are not sensitive to the proportion of imported capital stock.

If the nominal tariff is reduced to 10% of the FOB price in this calculation then the ETP drops from 36.9% to 8.3%.

Tariff level; effect on ETP and LCF

If the nominal tariff on polypropylene is reduced to zero in this calculation then the ETP drops to -1%. This is significant from a local cost of foreign exchange point of view. Since the LCF formula may be derived from the ETP formula (see above) it is possible to determine the LCF as follows:

$$LCF = e(1 + ETP)$$

Where e is the official exchange rate (World Bank, 1976).

Therefore LCF = 2.7815(1+.369)

= R3.8079

The result is greater than the official exchange rate and therefore this project has a comparative disadvantage with the current tariffs in place.

However, if the nominal tariff is reduced to zero then the result is cause for less concern as the LCF is neutral from a foreign exchange point of view.

$$\begin{aligned} LCF &= 2.7815(1-1) \\ &= 0 \end{aligned}$$

Conclusions

The tariff, in this case the reference price formula, is the main determinant of the rate of effective tariff protection. The nominal tariff is high; 43.4% of the FOB value and 35.4% of the CIF value. In addition the freight, insurance and related charges of importing from NW Europe amount to 22.5% (of the FOB price) which taken together, amounts to considerable protection in itself. These results strengthen the argument, in the main text, that the tariff on polymers is the critical lynchpin of pricing along the *filière* and the need for a very careful evaluation of the level at which this tariff should be set.

By varying the nominal tariff level it was demonstrated that a clear relationship exists between the nominal tariff level and the local cost of foreign exchange. Only when the nominal tariff was reduced to zero did the local cost of foreign exchange move from a negative result to a neutral result.

These LCF findings support the anti-export bias identified by Fallon et al (1993) and the undesirability, from a local cost of foreign exchange point of view, of maintaining high polymer tariffs. It also demonstrates that the foreign exchange rate for the SASOL PP plant at that time was significantly higher than that prevailing for the economy as a whole. That is the foreign exchange earnings/savings from this plant were negative. Ideally this result should be compared with the results from similar computations across the economy in order to determine which projects were the most favourable ie. where the least domestic resources could be given up for each unit of foreign exchange earned or saved.

ANNEXURE D

INDUSTRIAL ORGANIC CHEMICALS AND POLYMERS

LEVEL 1: CRUDE OIL, NATURAL GAS AND COAL.

LEVEL 2: (FEEDSTOCKS) ETHANE (from Natural Gas), Natural Gas Liquids, Naphtha and Gas Oil from Petroleum refineries, Ethane, Propane and Synthesis gas from Synfuels (only in SA).

LEVEL 3: THE SEVEN MAJOR BUILDING BLOCKS (which constitute 90% of all the raw materials used in the Organic Chemical Industry) :

3.1 Ethylene
3.2 Propylene
3.3 C4 Olefins
3.4 Benzene
3.5 Toluene
3.6 Xylenes (ortho-, meta- and para-)
3.7 Methane

LEVEL 4: 4.1 **ETHYLENE Derivatives:**

4.1.1 Polymerisation to LDPE, LLDPE, HDPE and EPDM rubber (with propylene)

4.1.2 Oligomerisation products, i.e. short chain polymers

4.1.3 Oxychlorination to VCM (PVC)

4.1.4 Oxidation to :

- Ethylene Oxide/Glycol
- Acetaldehyde/Acetic Acid

4.1.5 Alkylation with Benzene to Ethylbenzene/Styrene

4.1.6 Hydration - to Ethanol

4.1.7 Oxo (hydroformylation) with CO and H2 to Alcohols

4.1.8 Vinyl acetate Monomer (VAM) (also from Acetylene) and from Acetic Acid.

4.2 **PROPYLENE Derivatives:**

4.2.1 Polypropylene (PP), homo- and copolymers, EPDM rubbers (with ethylene)

4.2.2 Oligomerisation (short chain polymers)

4.2.3 Oxidation to :

- Propylene Oxide/Glycols
- Acrolein and Acrylates

4.2.4 Ammoxidation - acrylonitrile

4.2.5 Alkylation with Benzene to CUMENE

4.2.6 Oxo to butyraldehyde and higher alcohols

4.2.7 Hydration to isopropanol

4.3 **C4 OLEFIN DERIVATIVES:**

4.3.1 Butadiene polymerisation and copolymerisation to PB and SB Rubbers

4.3.2 Nylon 66 intermediates (Adipic Acid and hexamethylenediamine)

4.3.3 Maleic anhydride

4.3.4 Butenes - comonomers in LLDPE and HDPE (with ethylene)

4.3.5 Isobutylene to MTBE for Gasoline octane improvers (Lead Substitute)

4.4 BENZENE Derivatives:

4.4.1 With propylene to CUMENE for Phenol and Acetone synthesis

4.4.2 With ethylene to Ethylbenzene/ Styrene

4.4.3 Hydrogenation to CYCLOHEXANE and Caprolactam (Nylon 6)

4.4.4 Oxidation to - Maleic Anhydride

4.4.5 Chlorination - to Chlorobenzenes (BHC etc.)

4.4.6 Aniline

4.5 TOLUENE Derivatives:

4.5.1 De-alkylation to Benzene

4.5.2 Toluene di-isocyanate (TDI)

4.5.3 Chlorination to Benzyl Chloride and homologues

4.5.4 Oxidation to Benzoic Acid

4.6 XYLENE Derivatives:

4.6.1 Orthoxylene to Phthalic Anhydride

4.6.2 Paraxylene to Terephthalic Acid for PET (saturated polyesters)

4.6.3 Metaxylene for Isophthalic Acid

4.7 METHANE:

4.7.1 Ammonia and fertilisers (including urea)

4.7.2 Acetylene (also from Carbide)

4.7.3 Methanol for Formaldehyde, Acetic Acid and MTBE

4.7.4 Syngas - hydroformylation with olefins for higher alcohols, phosgene, TDI

LEVEL 5: 5.1 ETHYLENE Derivative uses:

5.1.1 Polyethylenes for extrusion to pipe and film - injection moulding and blow moulding

5.1.2 Higher olefins for :

- LAB detergents
- Higher alcohols (for phthalate plasticisers in PVC) and Synthetic Lubricants

5.1.3 VCM to PVC rigid and flexible compounds (using plasticisers)

5.1.4 Ethylene oxide to Glycol

5.1.5 Styrene for :

- polystyrene (packaging, mouldings, insulation)
- unsaturated polyesters
- ion exchange resins
- paint resins
- SBR elastomers and latexes
- ABS and SAN

5.1.6 Ethanol for solvents

5.1.7 N-Propanol

5.1.8 VAM to PVAs for paints and adhesives

5.2 Uses of PROPYLENE Derivatives:

5.2.1 Polypropylene film sheet, tapes, injection and blow moulding, etc.

5.2.2 Higher alcohols for phthalate plasticiser manufacture for use in flexible PVC compounds film sheet, coated products. Also for mining chemicals (small)

5.2.3 Propylene Glycol for unsaturated polyesters, polyurethanes and other polymers

5.2.4 Acrylonitrile for acrylic fibres, acrylic acid and acrylates

5.2.5
- Phenol for resins, nylon 66, detergents, lube additives
- Acetone for solvents, epoxy resins, methacrylates, isoprene and PIR

5.2.6 Higher alcohols for plasticisers (see 5.2.2 above)

5.2.7 Isopropanol solvents

5.3 Uses of C4 OLEFIN Derivatives:

5.3.1 SB and PB rubbers for tyres, conveyor belts etc.

5.3.2 Nylon 66 fibres and converted articles

5.3.3 Maleic anhydride for unsaturated polyesters (for use with glass fibre), synthetic food acids and other resins

5.3.4 LLDPE/HDPE products - see 5.1.1 above

5.3.5 MTBE for motor gasoline as a lead substitute

5.4 <u>BENZENE Derivative uses:</u>

5.4.1 See 5.2.5 above (CUMENE)

5.4.2 See 5.1.5 above (Styrene)

5.4.3 Nylon 6 for textile fibres and moulded articles (Caprolactam)

5.4.4 See 5.3.3 above (Maleic Anhydride)

5.4.5 Crop protection (now banned)

5.4.6 Dyestuffs and rubber chemicals (Aniline)

5.5 <u>TOLUENE Derivative uses:</u>

5.5.1 See 5.4 above (Benzene)

5.5.2 Polyurethanes for paints, insulation, injection moulding, elastomers, etc. (TDI)

5.5.3 Various specialities

5.5.4 Small specialities

5.6 <u>Derivatives of XYLENES:</u>

5.6.1 PVC plasticisers, resins for paints, unsaturated polyester resins for boats, roof sheeting, tanks, furniture etc. (Phthalic Anhydride)

5.6.2 Saturated polyester resins (PET) for textile fibres and beverage packaging (Coke bottles) (Terephthalic Acid)

5.6.3 Speciality resins (Iso-phthalic Acid)

5.7 Derivatives of METHANE:

5.7.1 Various (Ammonia)

5.7.2 Various, PVC and Polyisoprene (Acetylene)

5.7.3 UF, PF resins (formaldehyde), solvents, esters, VAM and PVAs (Acetic Acid)

5.7.4 See 5.2.2 above, also 4.5.2

LEVEL 6: Some examples of FINISHED PRODUCTS derived from Levels 1 - 5 above :

- Packaging in the form of film (printed and unprinted), crates, boxes, bottles, drums, bags (woven and plain), cups, pots, etc. etc.

- Detergents in liquid and solid form

- Synthetic Lubricants

- Pipes, calendared sheet, leather cloth coatings, wallpaper, cables, shoes etc.

- Automotive: trim, bumpers, panels, hubcaps, washer bottles, light fixtures, cables, brackets, windscreen trim, sealants, paints, etc. etc.

- Paints, printing inks, solvents for all types of applications, etc.

- Textile fibres, fabrics for clothes, upholstery for furniture and automotive, etc. etc.

- Insulation materials, injection moulded articles - furniture, household goods and appliances, electronics, etc.

- Tyres, conveyor belts, rubber goods, etc.

- Furniture, leisure goods, electronics, etc.

- Building materials, including flooring, roof sheeting, cladding coatings, etc. etc.

- ETC. ETC. ETC.

ANNEXURE E

COUNTRY CLASSIFICATIONS

In this study reference is made to three categories of countries: NICs, 2nd Tier NICs and DMEs in various tables and figures. The selection of countries in these groups are drawn from Fostner and Ballance (1990). There are some unexpected omissions, for example India and China, but for the purposes of comparative analysis used here the benefits outweigh these disadvantages. South Africa is included in the DMEs group by Fostner and Ballance but in this study South Africa has been excluded and its data presented separately.

The country groupings are:

Newly Industrialising Countries (NICs)

Argentina, Brazil, Hong Kong, Korea, Mexico, Singapore and Taiwan.

2nd Tier Newly Industrialising Countries (2nd Tier NICs)

Columbia, Cyprus, Indonesia, Jordan, Malaysia, Morocco, Peru, Philippines, Sri Lanka, Thailand, Tunisia and Uruguay.

Developed Market Economies (DMEs)

Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Israel, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and the United States.

In certain of the tables data for all of the countries listed above were not available. In these cases, for example Table 4.2, where only a rough comparison was intended, alternative countries have been included for which data were available. In other cases, for example Table 6.28, those countries for which data were not available were excluded. In each case the countries for which data was available are specified.

ANNEXURE F

PLASTIC CONVERTING INDUSTRY SURVEY METHODOLOGY AND QUESTIONNAIRE

The objective of the survey was, in the first instance, to interview a sample of producers in the plastic converting industry in the Johannesburg and Durban areas. The nature of the questions posed was intended, at a general level, to gain an insight into the quality of the industry and to record problems or difficulties and advantages which firms perceived to be retarding or advancing the development of the plastic converting industry.

In the light of the wide diversity of products manufactured by the plastic converting industry, it was expected that a wide range of firm types would be encountered. Accordingly a flexible format interview was planned, guided by a questionnaire to be used whenever possible (see example below).

The purpose of the survey was not so much to develop a quantitative database on the industry as to develop a qualitative understanding of the issues confronting the industry.

The Sample

The Johannesburg and Durban/Pinetown areas were selected for specific reasons. Johannesburg is the commercial hub of South Africa's foremost industrial region, the Pretoria-Witwatersrand-Vereeniging region. It has a correspondingly large concentration of plastic converting firms which have the added advantage of proximity to the local commodity polymer producers in Secunda and Sasolburg. Durban was selected as it too is an important centre in the plastic converting industry as well as being South Africa's major port. The latter consideration allowed some opportunity to determine whether or not proximity to a port influenced the use of imported raw material and/or the propensity to export.

A commercial register of all known firms operating in the plastic converting industry was used to generate lists of firms in each of the two target areas. The firm population in each of the two target areas was divided into small (less than 100 employees), medium (between 101 and 500 employees) and large firms (over 500 employees). A random sample of firms was selected giving equal representation to the three firm sizes from the firms in the Johannesburg area and the Durban/Pinetown area. In the event of a randomly selected firm being unwilling or unable to participate, the next selected firm was approached until the sample quota had been met.

A total of thirty firms were interviewed: twenty conducted business in the Johannesburg area and ten in the Durban/Pinetown area. Ultimately the sample firms interviewed employed approximately 19% of the plastic converting industry workforce.

The sampling method generated a wide range of firm types. Among the sample is the largest plastic converter in the country as well as one firm which had only two employees including the manager. In the larger firms, specialisation within management sometimes meant that the interviewee's knowledge about the firm was good on certain issues and less so on others. Alternatively where branch plants of a national firm were visited (several fell into this category) they tended to focus on production issues and questions relating to wider issues were referred to 'head office'.

This considerable range of respondents and their often guarded and cautious attitude (discussed below) confirmed the need to employ an open format type approach with interviewees. This enabled flexibility in pursuing those areas which the respondent was more familiar with or willing to discuss, whilst a prepared questionnaire served as a guide to the conversation. During the course of the interviews it emerged that certain firms within the sample were not themselves engaged in plastic conversion.

One such firm manufactured appliances and although it purchased plastic raw material in bulk (in order to gain volume discounts) it resold this to its subcontracting firms which processed the material in moulds, owned by the appliance manufacturer. Another firm was engaged principally in importing and exporting polymer. Yet another firm interviewed might more properly fall within the construction or engineering sectors except that it installed only plastic piping and tanks in the process industries. Only certain types of tanks were purpose made by this firm, otherwise all plastic pipes and fittings were sourced from other firms. Their skill lay in designing systems of pipes and tanks.

Whilst interviews of these types of firms yielded no production engineering data, other insights beneficial to the study were gained. In a sense these firms represented some of the complexity and diversity within the industry and accordingly they were regarded as valid elements of the sample.

Interviewees

A director or another leading person in the firm was approached for interviews in the first instance. Due to non-availability in some cases, and factors such as differences in managerial structure and scale of operations, it was not possible to interview persons in strictly comparable positions. However all those interviewed held senior positions in their firm's management structure.

Most respondents only agreed to be interviewed on condition that confidentiality would be maintained. Despite this undertaking being given several firms placed strict limits on the information they were prepared to disclose. Some refused to permit factory walk-throughs. These factors have limited this study in that certain information is not available or cannot be published. In certain instances information which could enable easy identification of particular firms has had to be withheld in order for this condition to be met.

Factory Walk-throughs

At the conclusion of interviews permission was requested for a walk-through tour of the plant, where appropriate. This was not always acceded to but where it was, additional interesting information frequently came to light. The purpose of these walk-throughs was to gain a first hand visual impression of the production engineering and work organisation aspects. It also offered opportunities to clarify and verify certain information.

Part of the rationale for this approach was an attempt to verify the senior management's (interviewee's) responses and to determine if they were in accordance with the facts on the shop floor. In some instances observations made whilst walking through production areas together with information from other firm representatives encountered there, contradicted that given by the interviewees. Where subordinates gave conflicting information it was often difficult to further verify this with the interviewee, for fear of jeopardising the subordinate's position and affronting the interviewee. Generally where such differences were observed it appeared that the interviewee had exaggerated the firm's prowess in one regard or another, and to this extent the data collected should be viewed with some circumspection.

QUESTIONNAIRE FOR PLASTIC CONVERTER INDUSTRY

1. Main products   % of turnover
   1..................   .....
   2.................   .....
   3..................   ......

2. Market share of largest four producers?
   1............%
   2............%
   3............%
   4............%

3. Number of employees ....

4. Total assets .... (Replacement value)

5. Are you a subsidiary of a foreign/domestic firm? ....

6. Name of holding company and percentage of shareholding?

6.1 How does the (foreign) parent company view its South African investment?

6.2 Is it planning to invest further - why/ not? (assume a political settlement)

7. Perceived basis of comparative advantage. (Probe: strategic focus - mass/niche market, domestic foreign.)

8. Do you have any licensing arrangements with foreign firm/s?

8.1 Extent / nature of restrictive clauses?

8.2 Percentage of sales (if exported) covered by restrictive clauses?

THE SCALE OF PRODUCTION

9. What is the minimum efficient scale of production/batch size in your main product line?
   - plant size.........................
   - Firm size..........................

10. Have these minimum efficient scales changed in recent years?

11. Do you expect these minimum efficient scales to change significantly in future years?

12. What cost disadvantage does lower batch size/scale impose on you?

13. Would you say that generally speaking capacity under-utilization is a more serious problem than lack of economies of scale?

TECHNOLOGY TRANSFER

14. How would you rate the technological capabilities of your firm? (product and process

technology)
Does your firm have the capability to:
14.1 Choose among alternative technologies?
14.2 Utilize current technology to designed standards?
14.3 Adapt technologies?
14.4 Generate new products and processes?

15. What is the predominant form of technology transfer?
15.1 Wholly owned foreign investment?
15.2 Joint venture with foreign investors?
15.3 Importing of capital goods?
15.4 Process and product licences? (with what restrictions?)
15.5 Employment of foreign personnel, sending people abroad?
15.6 Networking with other firms?

16. Estimated distance of your firm from the 'world leading edge'?

17. Does the firm have a defined R&D division? ...
17.1 How many full-time personnel does it have?
17.2 With what qualifications?

18. Total cost of R&D?
18.1 As percentage of sales? ....
18.2 As percentage of profits? ....

INPUTS

19. Where do your capital goods come from?
- local suppliers (with what degree of local content)
- imports

20. Age of capital goods?
% < 3 years old: ....
% 3 or more and less than 6 years old: ....
% 6 or more and less than 10 years old: ....
% more than 10 years old: ....

21. What are your views of the SA machine tools industry?

22. Cost structure:
22.1 Capital goods .... as % of production costs
22.2 Polymer .... as % of production costs

23. What polymer types are you using?

Polymer	Volume (tonnes pm)	Volume (%)	Share imported (%)
LDPE			
LLDPE			

Polymer	Volume (tonnes pm)	Volume (%)	Share imported (%)
HDPE			
PVC			
PP			
PS			
OTHER			

24. What percentage of your polymer is imported?

25. Are these patterns changing over time?

PRODUCTION ENGINEERING

26. Have you made changes to plant layout recently? Why?

27. What is the trend in batch size?

28. What is the trend in lead times?

29. What is the trend in throughput time?

30. Defect rate: as % of sales: ....
as % of output: ....

31. Workforce: direct labour ......(%) indirect labour.......(%)
32. Stock turns:
32.1 Raw materials: .... 3 years ago ....
32.2 Work in progress.......... 3 years ago ....
32.3 Finished goods .... 3 years ago ....

INDUSTRIAL RELATIONS AND HUMAN RESOURCES

33. What problems has the firm encountered in the field of human resources and how is the firm responding?
33.1 With regard to production workers?
33.2 With regard to technical personnel?
33.3 With regard to management?

34. How do you see the role of trade unions?

35. What would be your attitude to co-planning with organised labour at plant and/or national level?

TRAINING

36. To what extent is the low skill level of your workforce a constraint?

37. What in-house training programmes do you have?

38. How effective is the Plastics Federation training?

39. What is your firm's attitude to the recently introduced training levy?

COMPETITIVENESS

40. What are the reasons for local plastic products being more expensive than imported products? (rank top four)
a) High cost of intermediate goods
b) High cost of semi-skilled labour (production workers)
c) High cost of skilled and technical personnel
d) Lack of availability of skilled and technical personnel
e) Short production runs
f) Capital equipment and technology not up to date
g) Other

41. Do you face import competition and is it forcing competitiveness?

GOVERNMENT POLICY ENVIRONMENT

42. Attitude towards government policy:
42.1 Tariffs? (inputs and products)
42.2 Export subsidies/ GEIS?
42.3 Education/training facilities/ system?
42.4 Health and safety regulations?
42.5 Financial services?
42.6 Depreciation allowances? eg Section 37(e)

43. What is your evaluation of government capabilities?

LONG TERM FUTURE OF THE INDUSTRY

44. Could SA have a large plastics converting industry like Taiwan, Korea or Japan?

45. What would this require?

46. If you had polymer at NWE prices would you begin/increase exports?

47. How would you react to the notion of an industry agreement including firms, government and unions working out an agreement on productivity, investment, wages, training, retrenchments etc?

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