

CHAPTER 4

THE DEVELOPMENT AND MANAGEMENT OF AN INTELLECTUAL PROPERTY STRATEGY IN A DEVELOPING COUNTRY CONTEXT: THE CASE OF SASOL

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Abstract

A coherent IP strategy is one of the characteristics of multinational corporations (MNCs), especially in science-based industries. The paper tracks the evolution of the IP strategy of Sasol, a South African petrochemicals and the largest R&D spender in the country, from its origins to its gradual transformation into an MNC. While in its early days Sasol relied on the use of foreign technology and on secrecy as its main strategy for appropriating the results of its own research, the company gradually started experimenting with the patent system in a subsequent phase. The paper shows a clear evolution toward a more coherent patenting strategy combined with an active use of publications, to enhance the international technological credibility of the company.

Using the case of Sasol, it is shown that the ability to create intellectual property is significantly different from that required to manage it. Indeed, the alignment of motives that spurred the mutually beneficial interactions between Sasol and its foreign connections around technological and scientific capability creation generally did not spill over to developing competence in IP management. Hence, much of the evolution of Sasol's IP management function was essentially through costly in house trial-and-error, until the formation of a global joint venture dramatically accelerated the refinement of their IP management processes. This finding reconfirms the potential value of learning from more experienced firms, particularly with respect to aspects like the strategic role of intellectual property, the complementary roles of patenting and publishing in scientific journals, and the need to think strategically about the purpose of a given patent before deciding where to patent. In sum, the case analysis points to the value of a platform where firms that are grappling with the issues raised by the introduction of formal intellectual property can share their knowledge and experience.

1. INTRODUCTION

A coherent IP strategy is one of the characteristics of MNCs, especially in science-based industries. Apart from the exclusive market position granted by patents and the direct financial benefits that firms can realize through the licensing of patents, patents and scientific publications also act as signals of technical competence and legitimacy in the

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field. For large developing country firms operating in such industries, the importance of IP may evolve as they develop and enhance their technological and management capabilities, from their early stages of heavy reliance on intellectual property from external sources to the gradual development of their own internal capabilities. In the early stages, while they may benefit from lax IP protection and easy access to foreign technology for undertaking imitative development, strong IP may enhance access to technology by making it more attractive for the cutting-edge technology creators to enter into partnerships and transfer their technology (Arora, Fosfuri and Gambardella, 2004). As the companies upgrade their technological capacity and develop protectable assets, IP management takes on an increasingly important role.

This chapter examines the development and management of intellectual property at the petrochemical firm Sasol in South Africa, with a special focus on the role of foreign partnerships. Sasol's experience suggests that it is important to separately consider the related but distinct processes of creating new intellectual property and managing it. For each process, the characteristics of the different stages of evolution are defined and the nature of interactions with foreign partners are outlined. In the case of technological development, Sasol evolved through a process of incubation to consolidation and harvesting of capabilities before undertaking processes of diversification and internationalization. At the same time, its IP management process was dominated first by local and then foreign experimentation, and subsequently, local and then foreign models of governance were introduced.

2. LITERATURE REVIEW

Three concepts are helpful for understanding the evolution in the development and management of intellectual property at Sasol and the role played by foreign partners in that process: the nature and role of foreign partnerships, the relationship between intellectual property and technological upgrading, and, finally, the purpose of formal IP processes.

2.1. The Nature and Role of Foreign Partnerships

An extensive body of literature, starting with the work of Dunning (1958), documents how interaction with partners from more developed countries can help countries at lower levels of development to accelerate learning. The mechanisms include exposure to more sophisticated demand, privileged access to new technologies and easier commercialization of inventions (Lall, 2001b; Narula and Dunning, 2000). International business connections can be primarily internalized (e.g. through alliances or the entry of MNCs) or externalized, e.g. through franchising or licensing (Lall, 2001b), and can even occur through the flow of people (Saxenian, 2002; Vang and Overby, 2006).

The most successful examples of upgrading in the recent era, the Asian "tigers", were all outward-looking in their orientation, although the specific development strategies of the

economic regions differed. Singapore relied heavily on the entry of foreign MNCs, while the Republic of Korea on subcontracting to foreign MNC networks, and more recently on out-bound foreign direct investment (FDI) (Lall, 1996).

However the connections take place, common themes emerge in studies of how the contact with the managerial and technological innovations of foreign partner(s) help accelerate local development. Contact with foreign partners provides access to new technologies, and provided that the foreign investment does not crowd out the local productive base, it can increase the total productive base in the developing country (Lall, 2001b). The learning that takes place through more sophisticated supply factors as well as in meeting the challenges posed by more sophisticated demand are also typical benefits of interaction with foreign partners (Blomström, Kokko and Globerman, 2001; Dunning, 1958).

There are two qualifications to the importance of the role of foreign linkages. First, foreign inputs cannot take the place of local commitment and local investment in development. There is by now an extensive body of literature documenting that learning or "spillovers" from foreign investment occur best where there is also investment in the local capacity base (Blomström *et al.*, 2001; Haddad and Harrison, 1993; Marin and Bell, 2006).

Second, foreigners engage in the upgrading of developing country MNCs in the course of pursuing their own goals, and their contribution is greatest when there is convergence between the goals of the different parties (Narula and Dunning, 2000). It is easy to see how both partners benefit when an MNC from the developed world upgrades its production facilities in a developing country, but in the case of IP management the mutual benefit is less clear.

In fact, although there is recognition of the potentially positive role of foreign partners, much of the debate around IP management also demonstrates a concern about the potentially negative effects of foreigners' greater technological and economic capacity. The much larger technological, human and financial resource base of foreign firms may help developing country companies to accelerate their own learning and upgrading, but they may also be at risk of having their contribution appropriated by partners who better understand the purpose and functioning of IP management strategies.

This chapter investigates how Sasol navigated that complex relationship. Although Sasol had a very strong inward orientation – its purpose was to increase domestic fuel self-sufficiency – it nonetheless had very strong foreign links, having been founded in order to exploit the German Fischer-Tropsch (FT) technology for generating fuel from coal and gas, and with strong reliance on foreign consultants. Interactions with foreign partners evolved over the years with important effects on the development and management of IP by the company.

2.2. The Relationship between Upgrading and Intellectual Property

The literature on "absorptive capacity" (Cohen and Levinthal, 1990) documents the constant interaction between learning and innovation, but in the case of large developing country firms, it is possible to identify a shift in emphasis in the importance of each. In Kim's (1999) view, firms shift from imitation to innovation. Initially, most of their technological upgrading efforts are directed at assimilating external technologies and only as they mature, does the creation of new knowledge become more important. Another dimension of this evolutionary process of learning and upgrading of developing country MNCs is in how learning takes place: firms learn first through informal "learning by doing", and only later through more systematic knowledge-creation processes (Bell and Pavitt, 1992; Kumar, 1998; Miotti and Sachwald, 2001). In consequence, little formal intellectual property is developed in developing country firms' initial years.

Formal R&D is seen as one of the more robust indicators that firms have achieved a level of maturity in their evolutionary process (Pack, 2000). In addition, formal R&D has long been recognized as a critical input in innovation (Griliches, 1984; Mairesse and Mohnen, 2005) and the co-variance between innovation, patenting and R&D has led researchers to interpret R&D as an input and patenting as an output of the innovation process (e.g. Acs and Audretsch, 1989, 1991; Almeida and Phene, 2004). In fact, some researchers regard them as different indicators of the same underlying construct – innovative activities (Hagedoorn and Cloudt, 2003). However, although technological capabilities and IP management skills are closely related and co evolve – firms become more aware of the value of intellectual property as they develop more valuable technologies – they involve distinct capabilities, and the expertise needed to manage intellectual property is not the same as that needed to create it. To give a concrete example: it is necessary to understand chemistry to create new gasification knowledge, whereas an understanding of law and economics is needed to manage that new intellectual property.

Previous studies have investigated innovation and the evolution of R&D of developing country firms, but there has thus far been little focused investigation into the evolution of the capacity to formally manage intellectual property. Although formalized IP management is the norm among MNCs in the developed world, IP protection has long been a contested topic (Oddi, 1987; Sell, 1995) and is sometimes seen as an exclusionary measure that makes it harder for less-advanced firms to get a foothold in the global economy.

Insight into the simultaneous distrust and valuing (in the developed world) of formalized IP regimes is provided by Murmann (2003) in his study of the emergence of the chemical industry. For firms with few of their own capabilities and intellectual property, formal protection was a barrier to their upgrading – those firms benefited from freely imitating existing technologies. However, once firms had developed their own intellectual property, a formalized IP management regime emerged. This is because formal IP management allowed them to reap the benefits of their technological advances not only within but also outside the firm. Indeed, scholars who examine the historical evolution of IP systems consistently point out the correlation between higher levels of development and formal IP pro-

tection (Granstrand, 2004; Lerner, 2002). In other words, for a firm like Sasol, the emergence of an IP management strategy is an indicator that the firm has achieved an adequate level of technological advance to justify a formal governance process. This is also because formal intellectual property facilitates interaction with other knowledge-creating firms, allowing them to use their intellectual property as an enabler of further technological development.

2.3. The Purpose of IP Processes

A key element in learning to manage intellectual property is developing an understanding of its purpose. Some form of formal IP process has been in existence for centuries, and so have concerns about the purpose of IP protection. In a review of the controversy surrounding patenting in the 19th century, Machlup and Penrose (1950) identified recurring arguments against the use of intellectual property, a study that is usefully contextualized by more recent work on the theoretical justification of patenting by Mazzoleni and Nelson (1998). Machlup and Penrose documented a concern about the validity of property rights for ideas and resistance to the very idea of intellectual property, a concern that has largely disappeared from the contemporary debate.

However, in terms of the incentives offered by patenting, the terms of the debate have hardly changed. A belief that emerged in the 19th century and is still held today is that inventors are entitled to just reward, tempered by a concern that the temporary monopoly offered by patenting may not be the best way to reward invention. This concern is heightened when considering the issue at the societal level, where the social costs of patenting could potentially outweigh the social benefits, especially when less developed countries are involved. There is likewise tension between the perceived benefits of disclosure versus keeping information secret: patent protection requires technological information to be disclosed and broadly disseminated. In addition, because intellectual property deals with emerging knowledge, there is no clear idea of what the optimal balance between disclosure and secrecy should be. The concern about secrecy in the IP debate is especially heated in developing country contexts where wider disclosure can arguably help accelerate development.

Appropriation is often invoked as an important reason for patenting, but firms' secrecy, investment in brand building and exploiting a first-mover advantage (e.g. through lead times and learning curve effects) are all documented to be highly effective mechanisms to appropriate the benefits of innovation (Levin, Klevorick, Nelson and Winter, 1987). Indeed, a far more nuanced use of patenting emerges in studies of how experienced patentor firms use patents, with a difference in the purpose of patenting in "discreet" and "complex" industries. In "discreet" industries, of which the chemical industry is a typical example, patents may be used to block rival developments (Cohen, Nelson and Walsh, 2000) and to build a "fence" around an invention, thus increasing the value of the invention as a whole (Reitzig, 2004). In "complex" industries like semiconductors, patents are typically used to encourage rivals into negotiations about shared knowledge. In extreme situations, these

can become “thickets”. In all these examples, IP disclosure provides a structured way to facilitate knowledge exchange.

Patents are often used not directly as appropriation devices, but to signal competence – codified evidence of capability that serve as bargaining chips in a “club” of knowledge creators (Hall and Ziedonis, 2001; Schmookler, 1953). Indeed, in that way one of the purposes of patenting is very similar to the purpose of publishing scientific publications. As with patents, scientific publications signal the existence of knowledge assets, but they differ in that they do not function to confer appropriability. Instead, journal articles serve as the currency needed for signaling technical knowledge within the scientific community (Hicks, 1995). Thus, scientific publications strengthen the reputation of the firm as an innovator in its field (Muller and Pénin, 2006) and serve as an important precursor for establishing research partnerships (Lhuillery, 2006). In addition, defensive publications, including in scientific journals, can be used to prevent others from appropriating (i.e. patenting) a given technology.

In short, both patents and scientific publications serve an important purpose as signals of competence, signals for which developing country MNCs arguably have particular need. This complex set of purposes contrasts sharply with the typical and far more “naïve” pattern of patenting in developing countries. Da Motta and Albuquerque (2000) documented that developing countries have a much larger share of individuals patenting, with little company involvement and a lack of continuity in patent activity. In addition, inter-firm technological division or specialization is limited. It is clear that a developing country MNC has to go through a learning process not only in terms of the technology it produces, but also in terms of how best to deploy formal IP protection mechanisms to optimally benefit from its technology.

For a long period, many of these considerations did not seem to be relevant to Sasol. Sasol was operating in a technological niche area and had access to the technology it needed. Only about 30 years after its founding, once Sasol started to diversify (increasing its need for access to new technology) and when the worldwide anti-apartheid pressures were threatening its previous sources of technology, could these considerations be seen as relevant. How Sasol responded provides interesting insights into the use of patents.

3. METHODOLOGY

The study investigates the case of Sasol, the only South African firm on UNCTAD's list of the top R&D spenders in the world (516th worldwide) with an R&D spend of US\$91 million in 2003 (World Investment Report, 2005). Sasol is a useful setting for the research question because it is a science-based firm where technology creation is key to competitiveness, and it has over the course of its history diversified into a range of chemicals. Moreover, as a petrochemical firm, it is in an industry where IP disclosure, especially patenting, has been found to be of particular importance (Mansfield, 1986).

Because this study argues that an understanding of the purpose of patenting and scientific publications happens in concert with, but separately from, technological capacity, it is necessary to find an indicator of technological competency independent of two often-used proxies, patents and scientific publications. We discuss Sasol's synthetic fuel reactors as physical evidence of the firm's ability and effectiveness in its core technology, transforming coal into fuel and chemicals. Given the significant investment in human and financial resources required to develop a fuel-from-coal reactor, these plants can be seen as embodying the most advanced technology of the firm at the time. Using the development of new plants as milestones, the Sasol history can be divided into five eras (see Table 1), initially corresponding to the development of different plants and, in the latest period, to the decision to internationalize.

Table 1. Technological Eras in Sasol from Founding to 2005

	Era	Achievements
± 1950–1975	1st (Synthol) era	<ul style="list-style-type: none"> • German Arge reactor or Low-Temperature Fischer-Tropsch process replicated. • Kellogg reactors or the High-Temperature Fischer-Tropsch process commercially developed.
± 1976–1985	2nd (Secunda) era	<ul style="list-style-type: none"> • Four-fold upscaling of Synthol-based plant in each of Sasol II and Sasol III.
± 1986–1990	3rd (SAS™) era	<ul style="list-style-type: none"> • 16 existing reactors replaced with eight SAS™ reactors with lower capital cost, increased flexibility, lower operating costs and greater capacity than the earlier reactors.
± 1991–2000	4th (SPDTM) era	<ul style="list-style-type: none"> • SPDTM reactor with six times the capacity of German Arge reactors. • Diversification into higher value chemicals: n-butanol, anode coke, ethylene recovery, propylene and polypropylene plants.
± 2001–2005	5th (Globalization) era	<ul style="list-style-type: none"> • Acquisition of German Condea. • Research partnerships with the University of Twente (Netherlands) and the University of St Andrews (UK).

This study traces the trajectory of IP disclosure both of patents and of scientific publications over the five eras. Sasol had no formal IP function or strategy for the bulk of its history, and limited IP disclosure – it filed its first patent only in 1968. The study tracks how the disclosure and governance of intellectual property changed over the course of the five eras at Sasol.

Findings are contextualized through annual reports from the founding of formal R&D at Sasol in 1957 through to 2005, as well as newspaper clippings and company histories (e.g. Collings, 2002). The increasing sophistication of not only technology production, but also IP management is examined by looking at a range of measures. The value of patents is measured through the use of forward citations of patents (Harhoff, Scherer and Vopel, 2003). In the case of scientific publications, the average impact factor of the journal is used as an indicator. Journal impact factors are a measure of the frequency of citation of articles published in a specific journal over a three-year period. They are often used as a proxy for the relative importance of a journal to a particular field, and have proven to be reliable indicators of long-term journal influence in finance and economics (Borokhovich, Bricker and Simkins, 2000), as well as in science (Fok and Franses, 2007).

By global standards, Sasol has a small patent portfolio. The entire portfolio of patent applications filed or acquired by the Sasol Group of Companies during the 50-year period from 1955 to 2005 amounted to 835 patent applications filed in any of 95 countries worldwide¹. When considering the number of patents per era, the numbers are small and only limited statistical analysis is possible. The study therefore makes use of descriptive statistics.

Patent data was sourced from an internally maintained Access database that contains filing dates, countries and technology classification data per patent. Although it is customary to refer to USPTO data for these studies, many of the early Sasol patents were not filed in the US at all, hence the reliance on the internal database in this instance. Patent citations were based on a Delphion database search of Sasol patents. The results from the Delphion search were imported into Aureka (a patent analysis tool) in order to perform mapping and citation analysis. Data on publications in academic journals was obtained from the 2005 Chemical Abstract (CAS) Database.

Studies that use measures like patenting as an indicator of innovation (e.g. Almeida, 1996; Cantwell, 1995) are characterized by an awareness of the imperfections of patenting as a measure of technological advancement. In this study, the "imperfections" themselves are of interest: to the extent that seemingly small events (e.g. the appointment of a patenting advisory board) have a disproportionate impact on patenting and scientific publication activity, it suggests the importance of IP management strategies (in addition to the underlying technological capabilities of the firm) in shaping the nature and extent of IP disclosure.

4. RESULTS

4.1. Technological Growth at Sasol

This section serves to contextualize the more detailed analysis of Sasol's IP management processes by providing a high-level overview of the political and economic context within which Sasol operated, and its technological advancement over the five eras from 1955 to 2005. The subsequent section focuses in more depth on how Sasol learnt to manage intellectual property and the role of foreigners in that process.

4.1.1 *The First (Synthol) Era: Incubation (± 1950–1975)*

Sasol was created in 1950, two years after the National Party came to power with its apartheid policies and very strong inward orientation. The desire of government to increase national self sufficiency was central to the creation of the firm and guided Sasol's strategy for many decades. For example, it only started to explore international markets in the 1990s.

The main concern and main achievement of Sasol during its first period was to take root in South African soil. International expertise laid the foundation for Sasol and the company often sought the advice of a range of foreign consultants. Members of the South African Liquid Fuels Advisory Board and the eventual director of Sasol visited German, UK and US

scientists before deciding on German reactors and technology (a joint venture between Ruhrchemie Aktiengesellschaft and Lurgi Gesellschaft für Warmetechnik) for the production of chemicals and wax, and MW Kellogg Corp. technology for transportation fuels. A number of German and US technicians and engineers came to South Africa to commission the units since there was no local expertise available. In fact, early annual reports refer to them as the "American" and the "German" syntheses respectively, reflecting the strong association with the foreign suppliers of the technology.

The Kellogg reactors were never built on a commercial scale, and problems were experienced not only during commissioning, but also in realizing the full production potential of the design. After researchers from Germany, the UK and the US, contractors from MW Kellogg and a US expert "of world repute on catalysis" (Annual Report, 1957) proved unable to solve the problem, and, in keeping with the spirit of self-sufficiency that spurred the founding of Sasol, in 1957 its engineers and scientists decided to take over responsibility for the US unit. They made significant changes to the original Kellogg design, which culminated in the Sasol Synthol circulating fluidized bed reactor technology (Dancuart and Steynberg, 2004).

This also triggered the founding of a formal R&D department, ending the practice of conducting *ad hoc* research at external laboratories. During its very long initial period, Sasol deepened its understanding of the FT process and established the basic structure of the organization, e.g. the R&D department, technical training units and plants. This time is best regarded as an "incubation" period while the firm focused its efforts on transplanting foreign technology to South Africa.

4.1.2 *The Second (Secunda) Era: Consolidation (± 1976-1985)*

The second era for Sasol took place during the global oil crisis, and was characterized by a deepening resistance against apartheid, both locally and abroad. The South African government developed an increasingly inward-looking and defensive mindset, and, in 1974, announced that Sasol's Synthol technology would be scaled up four-fold for the Sasol II plant. In the light of the global oil crisis in 1978, the government went ahead with plans for Sasol III, a duplication of the Sasol II plant. In order to raise the funds necessary for expansion, Sasol was privatized and listed on the Johannesburg Stock Exchange in 1979, the highest listing in South Africa until that point. However, the government still exerted a strong influence over Sasol policies, for example through tariff protection for Sasol.

Most learning during this phase consisted of incremental learning-by-doing in the course of production rather than significant technological advances. For example, construction of Sasol III took only three years, compared with the five years or 100 million man-hours required for Sasol II. Managing the inadequate human resource base proved to be a significant challenge. Nearly 10,000 unskilled laborers were trained as fully skilled and many thousands more as semi-skilled workers for Sasol II. In 1978, productivity at Sasol I dropped by 8.6 per cent, because of the combined effects of the loss of expertise to Sasol II and demotivation of the remaining workforce. In fact, the corporation defined its main task in 1980 as the restoration of full operational and technical competence at Sasol I (Annual

Report, 1979), and by the end of 1983, the cost of training was expected to exceed 63 million rand, representing almost 5 per cent of the annual turnover for that year.

Sasol II and III placed substantial demands on Sasol – a type of "crisis construction" (Kim, 1998) that resulted in extensive organizational learning. But whereas internationalization played a central role in the crisis construction and learning process of Hyundai documented by Kim, the crisis prompting Sasol's learning was a deepening local orientation: whereas the internationalization of Hyundai resulted in an upgrading of capabilities, the outcome of learning at Sasol in this era was the consolidation of existing local operating capacity. Technology development projects tend to have long time-frames, and a number of initiatives were ongoing. However, the expansion forced Sasol to shift its main focus from creating new knowledge to expanding the application of existing knowledge. The cost of this set of choices only became clear in the next era, when the anti-apartheid struggle was at its most violent and the world responded by limiting international contact.

4.1.3 *The Third (SAS™) Era: Harvesting (±1986-1990)*

The year 1986 marked the beginning of official international economic sanctions against South Africa, accompanied by an academic boycott. Foreigners risked global censure and worse for continuing economic and intellectual engagement with South African firms. As a firm with close ties to the South African government, this presented an especially serious threat to Sasol.

At first glance, it seems that Sasol managed to overcome the constraints of its close association with a tainted government, and to sustain impressive technological growth. The first SAS™ reactor was commissioned in 1995 and by 1999 all 16 Synthol reactors were replaced by eight SAS reactors. SAS™ are Fixed Fluidized Bed reactors with approximately five times the capacity of the Circulating Fluidized Bed Synthol reactors, have lower capital cost and are cheaper to maintain.

Sasol also developed world-class polypropylene and propylene capabilities. It utilized its FT product as feedstock into the propylene plants of AECI (later acquired by Sasol, becoming Sasol Polymers). This technology had been patented by AECI prior to its acquisition by Sasol. Great strides were made with anode coke produced from pitch, and the production of better fuels and an improved catalyst led to a substantial increase in the production of hard wax. But there is of course a time-lag between doing research and reaping economic benefits from it, and the technological advances of which Sasol reaped the benefit during the late 1980s reflect the culmination of work done in both that and the previous era – a type of "harvesting" of its efforts.

In order for a firm to remain competitive, harvesting must be followed by rejuvenation, and the forced isolation was increasingly threatening Sasol's future technological advancement and thus rejuvenation. Sasol's desired technological advances increasingly required in-house technology development (Annual Report, 1990) but these developments continued to require greater research capacity than Sasol had. Sasol was therefore involved in a number of ongoing initiatives for which access to foreign expertise was essential. For

example, Sasol leveraged its relationship with Badger/Raytheon in the US for the development of Sasol Fixed Fluidized Bed reactors, and ultimately the commercial development of the HTFT SAS™ reactors (Collings, 2002). The joint filing of patents in the field of gasification technology by teams of German and South African experts from the Sasol Lurgi joint venture also bears witness to this (see Western European original filings in Figure 1, 1986-1990). These important relationships were being threatened by the global resistance to apartheid.

In short, the political context was threatening to delay Sasol maturing into a company that was technologically advanced enough both to contribute to and benefit from being a fully-fledged participant in the global knowledge creation processes in its industry. Sasol used its existing intellectual property to mitigate that threat, a strategy that is discussed in detail in Section 5.2.

4.1.4 *The Fourth (SPDTM) Era: Diversification (± 1991-2000)*

After Nelson Mandela's release from prison in 1990, economic sanctions and the academic boycott were lifted, and South African firms were free to resume international contact. Sasol was able to draw on a depth of expertise to successfully carry through a long-standing project when it commissioned the commercial Slurry Phase Distillate (SPDTM) reactor in 1993. The process was first developed during the mid-1980s at small bench scale in R&D, by 1998 scaled up to pilot plant size (Sasol, 1998), and a one-meter demonstration unit was developed in 1990.

In its first (Synthol) era, Sasol focused its technology development fairly narrowly on addressing the problem of the poorly performing Kellogg reactor, and the Synthol plant embodies almost the entire in-house technological capacity of Sasol at the time. In contrast, the SPDTM process was developed over the second, third and fourth periods, and also reflects only part of Sasol's technological capabilities: in addition to its deepening expertise in the high and low temperature FT processes, Sasol was by now also active in the manufacturing of a wide range of other chemicals. Sometimes the spur for their development was a desire to take advantage of by-products of the FT process, but in other cases Sasol exploited its increasing understanding of chemicals to serve local markets, e.g. develop explosives for the mining industry in South Africa. It has long been known that the evolution of firms is characterized by technological diversification (Cantwell, 1989; Granstrand and Sjölander, 1990) and Sasol's trajectory from a single product, single technology firm to one with a wider range of products and technologies is therefore typical.

Mainly as a result of the success of its technological development, the 1990s also heralded a change in strategy, with the announcement of diversification into higher value chemicals (Annual Report, 1990). These included an n-butanol plant, anode coke plant and ethylene recovery plant expansion at Secunda, as well as full commissioning of propylene and polypropylene plants in the town of Secunda. The migration into higher value products (Kim and Nelson, 2000; Lall, 2001a; Sachwald, 2001) is also associated with technologically maturing companies.

However, the disruption and sometimes severing of international relationships had a lingering negative effect, for example in the difficulties in (re-)establishing collaborative research relationships. Recognizing the urgency of re-establishing formal international contact, Sasol put a high priority on international joint ventures. These included a joint venture with the German firm Schumann in 1995 (now Sasol Wax), and the merger of Sasol Phenolics with the US-based Merichem to form Merisol in 1997. In 1997, a Memorandum of Understanding was signed between Sasol, Qatar General Petroleum Corp. and Phillips Petroleum Company for the proposed construction of an SPD facility in the Escravos Delta in Nigeria with a capacity of 20,000 bbl of fuel per day and, in 1999, Sasol and Chevron agreed to form a joint venture for the identification, development and implementation of gas-to-liquids ventures worldwide based on Sasol's FT technology. Sasol's actions suggest that it recognized the importance of international linkages to support its increasingly diverse undertakings.

4.1.5 *The Fifth (Globalization) Era: Internationalization (± 2001-2005)*

In 2001, Sasol announced a new corporate vision statement, articulating a desire "to be a respected global enterprise". In 2005 Sasol CFO, Trevor Munday set a goal to generate 50 per cent of Sasol's receipts from operations from non-SA operations by 2010 (Annual Report, 2005). The importance of foreign linkages in terms of technological accumulation became even more marked in this era of globalization.

A number of interventions to upgrade capabilities were initiated at Sasol. Recognizing its limited awareness of the global research landscape, Sasol constituted the Homogeneous Catalysis Advisory Board in 2000, following the appointment of a senior scientist from BP, who accessed his network of international experts in order to obtain advice and guidance on setting up a research group focused on the selective formation of high-value chemicals. No such competency existed in South Africa at the time, and Sasol did not feel confident that it had the ability to independently establish a world-class research group in this field. The Homogeneous Catalysis Advisory Board met four times annually, and assisted in knowledge transfer, competency development, recruitment and training, as well as in the technical auditing of research programs. The Board was formally dissolved in 2003, having achieved its objective to establish a research group that could support and develop technologies for the production of high-value chemicals that are integrated with the FT feedstocks. A number of research groups have been established at local South African universities as a result of the interaction with members of the Homogeneous Advisory Board. Despite the fact that the Board no longer exists in its initial form, many of the Board members continue to collaborate with Sasol and a number of joint publications have followed as a result.

A second panel of experts, the Heterogeneous Catalysis Advisory Board was also constituted in 2000. The objective differed from the Homogeneous Catalysis Advisory Board in that the competencies for developing catalysts for the FT process were well established at Sasol. Only one South African was represented on the Advisory Board, as its purpose was to provide access to international groups with specialized skills or techniques, as well as to

technically review research programs. As a result of their extensive experience and knowledge, the Board members also perform a consultative role on catalyst and process development. The Heterogeneous Catalysis Advisory Board remains active and meets annually at Sasol R&D to interact with local researchers.

In 2001 Sasol also concluded a 1.3 billion euro asset and share purchase agreement with the German firm RWE-DEA for that company's entire chemical business, Condea (renamed Sasol Chemie). The Condea acquisition not only had an immediate effect on Sasol's turnover, but also allowed Sasol to gain access to its R&D laboratories and patent portfolio

Table 2. Geographical Location and Technological Specialization of R&D Laboratories

Corporate R&D	Sasolburg (South Africa) Twente (Netherlands) St Andrews (UK)
Sasol Oil	Sasolburg (South Africa) Cape Town (South Africa)
Merisol	Sasolburg (South Africa)
Sasol Olefin and Surfactants	Sasolburg (South Africa) Lake Charles (USA) Moers (Germany) Brunsbuttel (Germany) Marl (Germany) Paderno (Italy) St Andrews (UK)
Sasol Solvents	Sasolburg (South Africa) Moers (Germany)
Sasol Nitro	Sasolburg (South Africa)
Sasol Polymers	Modderfontein (South Africa)
Sasol Wax	Sasolburg (South Africa) Hamburg (Germany)

Table 2 highlights the eventual broad geographical location and technological specialization of Sasol's various R&D laboratories. Sasol strengthened research partnerships with universities, both at the University of Cape Town and the University of Johannesburg in South Africa, and in 2002 also in the Netherlands and the UK. The focus of the group in the Netherlands, based at the University of Twente, is reactor engineering. The second satellite laboratory is a joint venture with the School of Chemistry at the University of St Andrews in the UK, and was established primarily to support research into homogeneous catalysis. The willingness of especially the foreign universities to enter into research partnerships with Sasol is a testament to Sasol's technological capabilities. A central goal of public research institutions is to enhance their status by doing meaningful research. Universities or public research institutions are more likely to collaborate with firms that they perceive as competent enough to potentially contribute to their own research standing. For this reason, only firms that have established their credibility in the knowledge networks in their field are likely to enter into collaborations with prestigious public research institutions.

4.2. Learning to Manage Intellectual Property

From its founding, Sasol focused on advancing its technological competence, but formal IP management was either not done at all, or done haphazardly. Only after more than three decades of technological accumulation, did Sasol finally start to manage its intellectual property in a strategic way. This section focuses on Sasol's increasingly more sophisticated IP management processes and how they are reflected in its patenting and scientific publication portfolio.

4.2.1. *The First (Synthol) Era: First Forays into Intellectual Property Disclosure*

In Sasol's early days, no attempts were made to publish peer-reviewed research. It was the only firm using FT technology in South Africa, and there was no need to develop mechanisms to share knowledge within the country. Its market was domestic, and in spite of the important role of foreign consultants, Sasol at this point was fundamentally nationalist in its orientation. To the extent that Sasol considered the need to safeguard, it relied on secrecy for protection. For example, the early Synthol technology was never patented or licensed, and remains unique to Sasol. Most internal documents, including research reports (except when written by or for foreigners) were written in Afrikaans, and Sasol was clearly also not concerned about participating in extra-national research networks.

The fact that Sasol's reactors were operational, and, by 1960 profitable, provides concrete evidence of the quality of its work, and when a greater awareness developed about the value of participating in global knowledge networks, research results from this period still proved to be publishable in scientific journals. For example, a number of peer-reviewed papers on the development of Sasol's FT technology (drawing on findings from the early years) were published from 1982 onwards.

The first patent on the Sasol FT process was filed in South Africa only in 1968 and reflects the type of experimentation documented in other developing country contexts (Da Motta and Albuquerque, 2000) rather than a response to a business need. Inexperienced patentees do not operate with a clear understanding of the goals and purposes of patenting, and patenting often results from a "me-too" mindset. Patents in South Africa are granted without substantive examination – they are not examined for novelty and inventiveness. Compared to examined patent regimes in places like Australia, Europe, Japan and the US, South African patents are easier to obtain, but also weaker and generally considered less valuable. At this stage in the evolution of Sasol, the distinction between examined and non-examined patent regimes clearly did not matter. In the period 1971-1975, 15 patent re-filings took place in less developed neighboring countries like Botswana and Lesotho and the so-called "independent homelands", the subsections of South Africa that had been designated "black" areas (Figure 1). Sasol represents a typical developing country firm, experimenting with patenting in a low risk (mainly domestic) environment with only a limited sense of its goals with patenting.

4.2.2 *The Second (Secunda) Era: Local Experimentation*

The pattern of local experimentation continued to dominate when Sasol started to formally publicize its newly developed knowledge around the mid-1970s. It is noteworthy that the milestones during this era are not technological – Sasol was replicating existing technology in its two new plants. However, with privatization, ownership no longer lay with the isolationist government, thus making disclosure easier. The choice between secrecy and disclosure is one of the fundamental IP management decisions firms have to make, and the Sasol case demonstrates vividly that this decision reflects the strategic goals of management rather than the firm's technology. For the privatized Sasol, the influence of its secretive government was reduced.

The example of foreigners played an important role in Sasol's initial IP disclosure. One of Sasol's first journal publications was written in 1976 by German researchers Dressler and Uhde and appeared (in German) in *Fette, Seifen, Anstrichm.* Collaboration with foreign partners, mainly firms from Germany and the US, generated 10 of the 53 journal papers that were published over the 10-year period (see Table 3), and research was published equally in local and international outlets. Thirty-one patents were filed, about half of which were also filed abroad (mainly in Europe, although in certain cases also North America and Australia).

However, there was still no underlying business strategy for its IP disclosure process. For example, the location of patenting activities cannot be ascribed to a specific strategy, either in terms of markets or blocking competitors. There is coal in North America, but no real reason for the Australian filings in the early years. Close association with German firm Lurgi that developed gasification technology together with Sasol (in the Sasol-Lurgi Joint Venture) accounts for some of the focus on Europe. Although the growing awareness of IP disclosure seems to have been triggered in part through the example and participation of foreigners, it mainly reflected local experimentation by Sasol.

Table 3. Sasol Publications in Peer-Reviewed Journals

	1966-1970	1971-1975	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000	2001-2005
	(Final Stage of) Synthol Era		Secunda Era		SAS™ Era	SPD™ Era		Globalization Era
Total peer-reviewed papers published	0	2	16	37	25	31	65	172
Total papers published in ISI database journals	0	0	10	19	17	14	30	124
Average impact factor of journals*	0	0	0.43	0.44	0.78	0.30	0.49	1.30

* Non-ISI journals are coded as having an impact factor of 0.

Source: CAS Database (2005)

Figure 1. Global Distribution of Sasol-Filed Patent Specifications

1966-1970 Symbol Era



1971-1975 Synthol Era



1976-1980 Secunda Era



1981-1985 Secunda Era



1986-1990 SAS™ Era



1991-1995 SPD™ Era



1996-2000 SPD™ Era



2000-2005 Condea Era



- Original filing
- Re-filing of original patent in another country
- △ Original not filed in country of invention

Source: Sasol Patent database

4.2.3 *The Third (SAS™) Era: Foreign Experimentation*

Sasol's engagement with formal IP management processes and its IP disclosure accelerated tremendously during the turbulent late 1980s, to a significant extent as a response to the increasing global resistance to the government's apartheid policies. Technologically, Sasol was at a critical point where its own learning could not be sustained without inputs from more advanced and foreign sources of expertise. However, as a South African firm with close ties to the government, the global anti-apartheid movement directly affected its political legitimacy. The political context made it virtually impossible to enter into new academic international collaborations and even longstanding collaborators, such as the US firm Raytheon, retreated from the relationship with Sasol. Concerned about exclusion from critical knowledge-creation networks, Sasol started using publications to retain a presence – albeit a marginal one – in the knowledge-creation networks it valued.

Virtually overnight, the average impact factor of journals in which Sasol published rose from 0.44 to 0.73 (see Table 2). Sasol was harvesting all publishable papers, including publishing findings dating from its founding. The increase was not sustainable, and in the next era, the average impact factor of journals dropped noticeably to 0.3, suggesting that Sasol might have also been rushing the publication of new insights. The publication strategy reflects an attempt by Sasol to increase its perceived technological legitimacy in the networks of knowledge creation. Sasol's response highlights the importance of scientific publications as a signaling device: by disclosing some of its most interesting research results to the research community, Sasol was able to maintain an informal presence in that community, even though the number of formal collaborations sharply reduced.

Patenting can serve a similar signaling purpose, but it seems that Sasol at that time associated patenting primarily with the potential to appropriate direct financial benefits from new technology. Sasol did not accelerate its international patenting, and, in fact, changes in its patenting behavior were triggered by domestic developments.

In 1987, the increasingly defensive government had decided to further expand the fuel self-sufficiency of South Africa by developing Moss gas, a natural gas exploration and conversion project, also based on FT technology. Although the project siphoned off some of the scarce petrochemical research skills in South Africa, Moss gas did provide a local market for Sasol's know-how – for example, Sasol's Synthol technology was licensed to Moss gas. Sasol accelerated local patent filings at the time that Moss gas was created (Figure 1, 1986-1990).

However, Sasol did not yet know how to manage the patenting process. Where patents were filed internationally, this was done with a limited understanding of the purpose of such patenting. Thus a clutch of patents was filed in an inordinate number of countries (30 or more) during this period. One patent – that has to date only received four citations and two self-citations and is clearly not a core patent – was filed in 46 countries. It is questionable whether the broad country filing strategy was justified. In addition, the nature of the patenting regime in a country was hardly considered. Obtaining a patent in countries where patents are substantively examined provides a strong signal that it is a real inven-

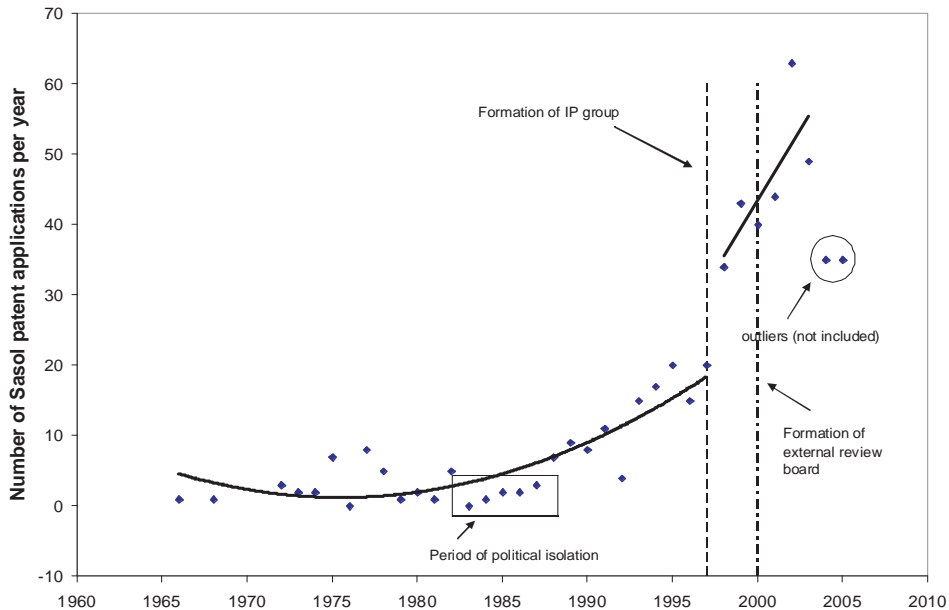
tion, supports more secure rights and is important for signaling purposes. Sasol did not evidence a real awareness of these issues in its early international patenting. In short, although Sasol was clearly realizing that there was value to disclosing its intellectual property, both through patents and scientific publications, disclosure was still a relatively *ad hoc* rather than a managed process.

During Sasol's first and second eras, the process of experimentation with intellectual property took place mostly locally: during this third era, experimentation took place internationally. Although international experimentation achieved Sasol's goal of retaining an international footprint, even given the pervasive anti apartheid sentiment, the costs of this strategy were high. In addition to the direct costs associated especially with patent filings (and as a result of Sasol's expansive filing, some patents were very expensive), the disclosure of a core technology must be carefully managed to ensure that it does not detract from the competitiveness of a firm. Recognizing the need to manage intellectual property more strategically, Sasol developed a number of internal governance mechanisms.

4.2.4 The Fourth (SPD™) Era: Local Governance

In 1996, Sasol introduced a formal IP function, starting the process of actively managing the disclosure of its technology. Until then, patent applications were handled on an *ad hoc* basis by the Company Secretary and an external patent attorney. Sasol adopted a strategy of encouraging Sasol scientists and engineers to pursue careers as patent attorneys, enabling them to be familiar with the technology as well as having the required legal qualifications.

Figure 2. Variation in Number of Patent Applications Filed by Sasol Employees During 1966-2005

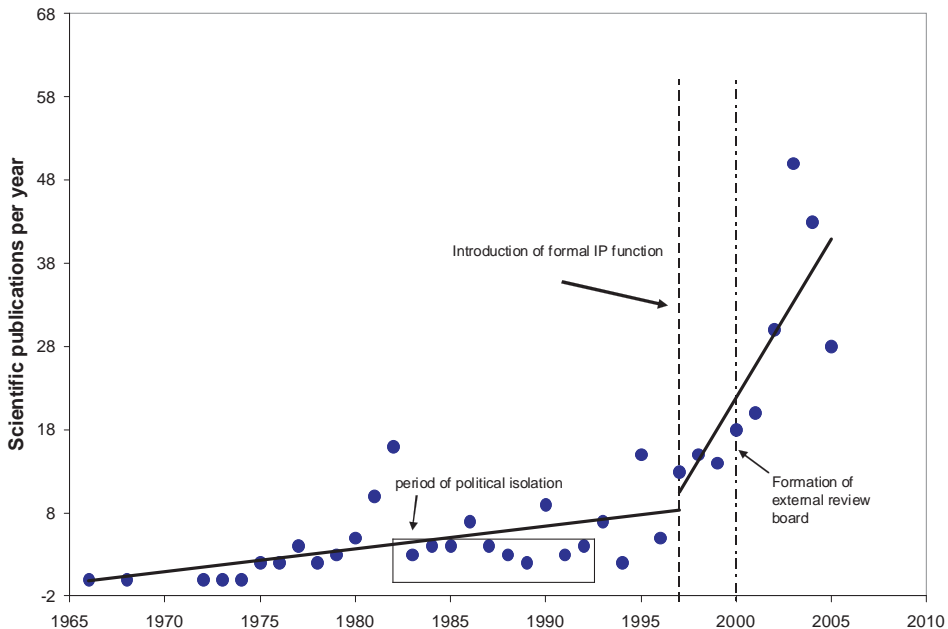


Source: Sasol Patent Database

Apart from the negative effect of political isolation on patenting, a review of overall trends (Figure 2) shows a gradual upward trend in the number of patent applications filed by Sasol up to 1997. After 1997 and the formation of the IP group, a positive step-change in the propensity to patent is evident. (The patent applications which were listed as pending final filing during 2004 or 2005 are not included in the data set, resulting in a lower number of patents for the years 2004 and 2005.) Although there was a more strategic approach to (and thus reduction in) the number of countries in which patents were filed, the number of inventions patented continued to increase. Figure 3 demonstrates a similar change in the propensity to publish in scientific journals with the formation of the IP function in 1997.

However, as the number of patent filings increased, costs also increased dramatically. The discovery of how expensive this process can be led Sasol to more rigorously assess the reasons for patenting. Sasol realized that it lacked the deep pockets of its US counterparts (e.g. ExxonMobil and ConocoPhillips) and through the creation of various IP management bodies in its fourth era, adopted a more focused patenting strategy. This resulted in strict governance on patents, and strong justification was required before an invention was patented. A number of patents were abandoned because they did not form part of the core technology of the company.

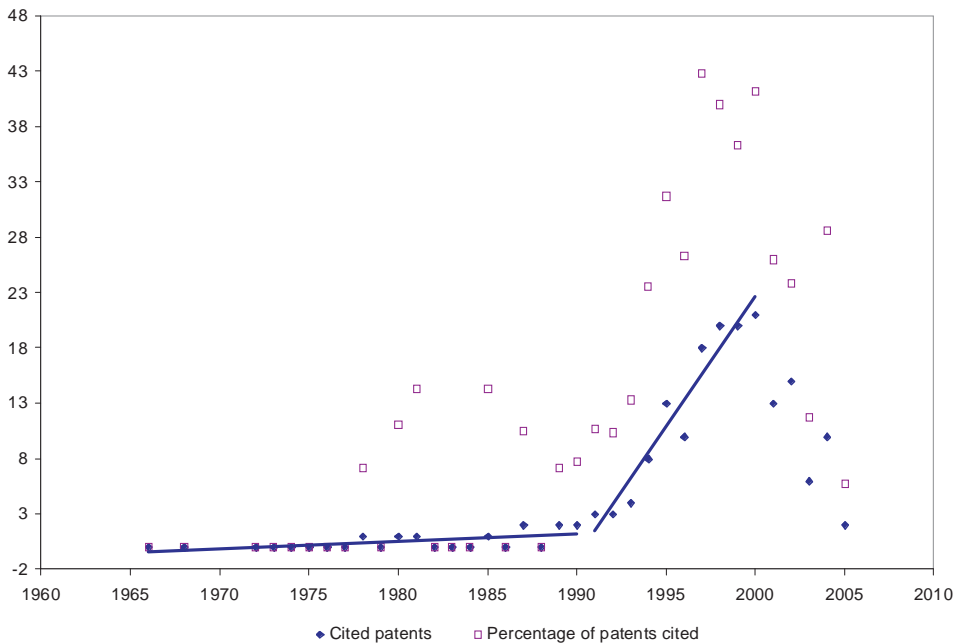
Figure 3. Variation in Number of Scientific Publications by Sasol from 1966 to 2005



Source: CAS Database 2005

In assessing the formalizing of intellectual property it is important to examine its effect not only on the quantity but also the quality of disclosure (i.e. the value that is captured by the firm in exchange for dissemination of knowledge). Forward citations of Sasol-filed patents were counted as a measure of their value, following the methodology of Mowery *et al.* (2002). Figure 4 shows all the Sasol patent applications that had received at least one forward citation prior to 2005. There is a clear change in the curve after the introduction of a formal IP function. The lower count for 2004 and 2005 can be ascribed to a truncation bias as a result of which later patents will have fewer citations. Figure 4 shows that, although the number of patents cited does increase with a greater propensity to patent, the increase in citations was not merely due to an increase in patenting; there is also an increase in the percentage of patents cited post-1990.

Figure 4. Forward Citations of Sasol-Filed Patents (1966-2005)

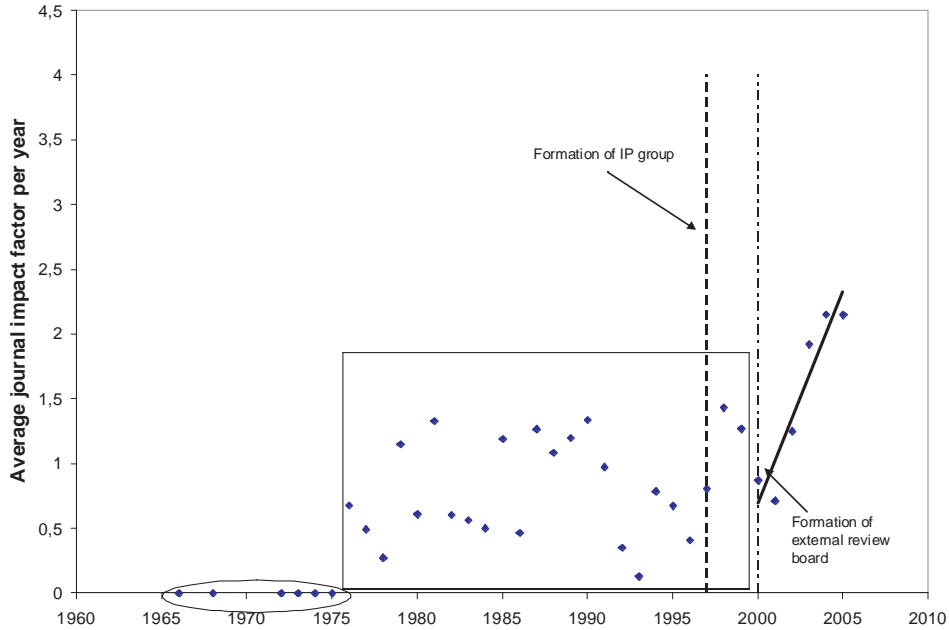


Source: Delphion database of Sasol related US, EP, DE (Germany) and PCT (WO applications) patents and applications.

In assessing the change in value of scientific publications following the formalization of intellectual property at Sasol, an average Journal Impact Factor was used. The data (Figure 5) appear fairly scattered and there is no clear evidence of benefits from the introduction of the IP group, although there is a steady annual rise. To the extent that an understanding of formal intellectual property is a separate process from technology accumulation, this is not surprising. The formalization of the IP function would have created an awareness of the value of disclosure and the appropriateness of patents, but would not have

been able to influence the scientific quality of the research. Quality was instead positively affected by the Homogenous and Heterogeneous Catalysis Advisory Boards that were subsequently established, as discussed in the previous section.

Figure 5. Variation in Average Journal Impact Factor



Source: ISI Journal Database

4.2.5 The Fifth (Globalization) Era: Global Governance

The decision to patent or keep secret is highly strategic and depends on the technology area. Because FT is core to Sasol's sustainable advantage, patenting is an important aspect of developing a licensed technology offering. Having established (mainly through trial and error) local governance principles, in 2000 Sasol refined its IP management process by introducing governance principles gleaned from foreign partners.

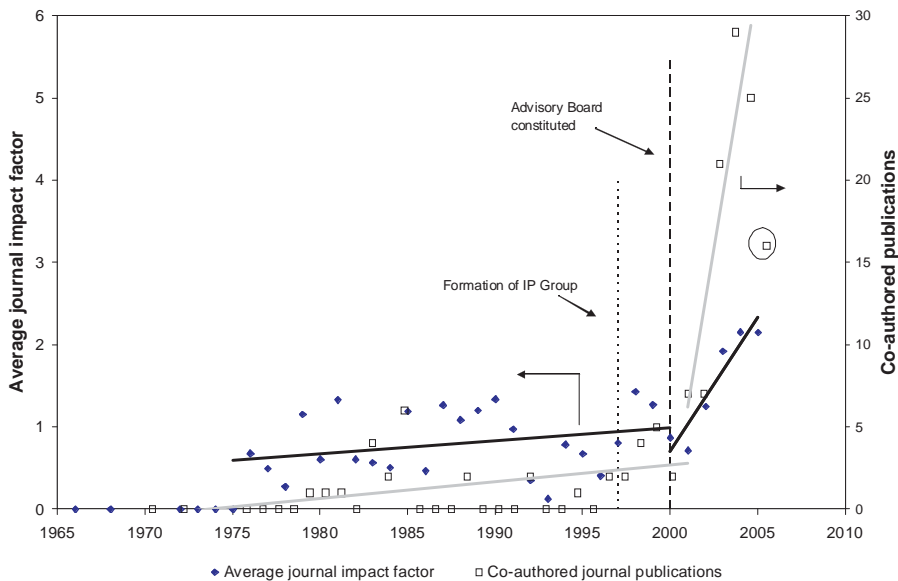
The Sasol/Chevron joint venture that was concluded in 2000 provided Sasol with insight into the IP management process of another leading petrochemical country, and Sasol modeled a number of refinements on Chevron practices. For example, Chevron served as a model for the development of IP review teams to formally decide, per technology area, on the most appropriate vehicle for IP protection (trade secret, patent or scientific publication) in order to manage the business and technological risks associated with disclosure.

The advent of the IP review teams in 2000 heralded a more rigorous approach to patenting. Specific country filing strategies were developed for different technology areas, chosen from a pre-selected list of markets, sources of feedstock or location of synthetic fuel plants. The review teams have proven to be successful in competitor analysis and technology landscaping, increasing the agility of responses in terms of in-house filing strategies and opposition proceedings.

In order to ensure alignment with the corporate strategy, an IP governance committee ratifies decisions taken by the review team. In addition, the organization structure is intended to ensure integration of IP management with wider corporate (rather than narrower R&D) goals. Originating in the R&D department, the IP department now reports to the Chief Technical Officer at the corporate level, although many of the IP technical advisors are based in the R&D function, close to the innovation hub of Sasol. Similarly, patent attorneys are located within many of the business units. So-called “deep dive specialists” and “value chain coordinators” have been appointed to ensure that the patent portfolio has the desired balance between focused specialization and technology integration across process units. Costs are now managed within a budget, which also includes provision for litigation proceedings.

As mentioned earlier, the introduction of the internal IP group had no noticeable effect on the average journal impact factor. However, the establishment of the review team (facilitating more strategic thinking about research) and advisory boards (facilitating better research) was followed by a significant increase in the quality of research, as measured through publications in high-impact journals.

Figure 6. Effect of International Linkages on the Quality of Scientific Publications in Journals



Although there is a close relationship between greater scientific and technological understanding and greater external recognition of intellectual property (as evidenced in Figure 6), it is important to note that Chevron's model was the only external source of knowledge in a process that was developed and refined largely in-house. Throughout its history, Sasol relied on international connections to support its technological upgrading. Indications – e.g. Sasol's large number of foreign R&D laboratories and its research partnerships with foreign universities – are that foreign inputs will only increase in number and importance in its technological advancement. Given the critical role of foreigners in the creation of intellectual property, Sasol's predominantly internal focus in the development of its IP management capacity is striking.

5. DISCUSSION

Technologically, Sasol evolved from a firm with a single enabling technology (the Synthol processor) and a single, commodity product (fuel) to a firm with multiple enabling technologies and numerous products, including higher value-added chemicals. It evolved from a firm with a purely domestic focus to a firm with a strong international focus, operating in multiple geographic regions. Sasol evolved through periods of incubation to consolidation and harvesting, and finally through processes of diversification and internationalization.

At the same time, its IP management strategy also evolved. Experimentation initially played an important role, as did governance later on when the costs of experimentation became clear. In each case, the process started with a local and evolved into a global orientation. Table 4 summarizes the co-evolution of Sasol's technological and IP management strategies.

When comparing the evolution of its technological and IP management trajectories, it is clear that Sasol took much longer to develop an effective IP management strategy than a profitable technological capability base. This could to a certain extent be explained by the fact that firms may need a threshold level of technologies before they stand to benefit from IP management. However, Sasol was experimenting with IP disclosure for at least 30 years before it developed a capacity for strategically managing intellectual property. Part of the reason for this may have been Sasol's original orientation to the domestic market, in which it did not face competition, thus having felt less of a need to protect its IP. However, Sasol could have still leveraged its IP internationally even if it did not intend to enter those markets directly. In addition, even once it began to venture into foreign markets, its IP management capabilities and structures appeared weak and unsystematic.

It is therefore argued that in order to understand why it took so long for Sasol to develop its IP management capacity, it is necessary to consider the role of foreign expertise. The Sasol case reconfirms the important role of foreign inputs in the evolution of technological capabilities. However, in the case of its IP management capabilities, the role of foreigners is far more ambiguous. The evolution of its IP management function was, with the important exception of the Chevron joint venture, essentially through in house trial-and-error. Thus Sasol first made use of legal firms and then developed an in-house capacity for

Table 4. Co-Evolution of Technological and IP Management Capabilities

	1st (Synthol) Era	2nd (Secunda) Era	3rd (SAS™) Era	4th (SPD™) Era	5th (Globalization) Era
	± 1950–1975	± 1976–1985	± 1986–1990	± 1991–2000	± 2001–2005
Characteristic Process	Incubation	Consolidation	Harvesting	Diversification	Internationalization
Technological capabilities	Initial adoption and local integration of foreign technology.	Large-scale replication of technology and consolidation of capabilities.	Increased efficiencies of existing technologies achieved and desire to extend into new technologies for which foreign inputs critical.	Diversification into higher value added products, supported by increasingly diverse underlying technologies.	Corporate goal to generate substantial international sales, supported by joint ventures, acquisition of leading firms, foreign-dominated advisory boards, and establishment of international research laboratories.
IP Management Capabilities					
Characteristic Process	Local Experimentation		Foreign Experimentation	Local Governance	Global Governance
Patenting	Limited domestic patenting toward end of era, not strategically planned.	Accelerated domestic patenting, some foreign filings, mainly in immediate region.	Domestic patenting in order to facilitate licensing to local competitors, complemented by extensive but ad hoc foreign filings.	Development of decision criteria for patenting, based on a focused disclosure strategy.	Importing of foreign practices (e.g. review teams) supplemented with local innovations (e.g. deep dive specialists and value chain coordinators).
Scientific publications	None – although findings from this era proved publishable in 3rd era.	Mainly domestic publishing, following example of foreigners.	Extensive publishing and potentially over-recovery of knowledge in order to establish a credible global presence.	Increase in quantity but not quality of publications.	Sustained publishing in high impact journals.

managing patenting. It first made the mistake of filing some patents in too many countries, and then developed criteria for deciding in which countries to file. It looked to Chevron as a model for its IP review team, but the specialist committees to ensure balance in its patent portfolio again represented an internal innovation.

The nature and the motives of interaction between Sasol and its foreign technology partners differ for technological versus IP management goals. Sasol's foreign technology partners – whether firms or universities – stand to benefit directly to the extent that Sasol can expand its technological capacity: Sasol is potentially a more competent research partner, has a stronger offering as a potential partner in an alliance or merger, and can further advance general understanding of the niche technology in which it is a leader. Where a firm's contribution to a technology partnership is small, there may be little to gain for the foreign partner in becoming involved in not only the technology, but also the IP management of the smaller firm.

Alternatively, if the firm's technology poses a major threat to the partner, the partner may also be less inclined to want the firm to develop expertise at managing its intellectual property. IP management regimes aim at finding a balance between rewarding the inventor and allowing the new knowledge to be used for the greater good. To the extent that an individual firm is more skilled at the "game" of IP management, it is better able to appropriate for itself the benefits of its inventions. This suggests that greater competence in the management of intellectual property will result in Sasol (rather than its foreign partners) appropriating more of the benefits.

Because arm's length partners tend not to reap greater benefit if Sasol becomes more competent at managing (rather than creating) its intellectual property, the alignment of motives that spur the mutually beneficial interactions between Sasol and its foreign connections around technological and scientific capability creation is critical. Most foreign technology partners can be expected to be neutral or even somewhat opposed to Sasol becoming better at negotiating its way around an IP regime. The exception in Sasol's case involves a joint venture. In the case of joint ventures, the interdependencies between the two partners are usually significant, and strict IP governance and a high level of capacity in its management are required from both parties. Within the Sasol/Chevron joint venture, the need for common governance of their IP created a strong enough alignment of motives for Sasol to gain privileged access to the IP management processes of its partner.

The implications of the more common case of the non-alignment of motives of the large developing country firm and its partners are substantial. First, large developing country firms have to go through an extensive and sometimes costly learning process to learn how to gain benefits from participating in a global IP regime. Second, the partners who can probably contribute most to the technological upgrading of the large developing country firms – capable partners, typically from the developed world, in the same or a closely related industry – are unlikely to have the incentive to help the large developing country firm become more capable of managing its intellectual property. Unless motives are very explicitly aligned, for example in a joint venture, the issues of rivalry and appropriation inhibit those partners from sharing their knowledge: indeed, they may even stand to benefit directly if new intellectual property is not appropriated by the developing country firm.

Third, the case reconfirms the potential value of learning from more experienced firms also in the IP arena. The Chevron example was of tremendous benefit to Sasol and dramatically accelerated the refinement of their IP management processes. In order to avoid costly learning through trial-and-error, firms can benefit from advice on aspects like the strategic role of intellectual property, the complementary roles of patenting and publishing in scientific journals, and the need to think strategically about the purpose of a given patent before deciding where to patent. In sum, the case analysis points to the value of a platform where firms which are grappling with the issues raised by the introduction of formal intellectual property can share their knowledge and experience.

6. CONCLUSION

By the end of 2005, Sasol had matured into a fairly typical although small multinational. Much as the first era in Sasol's history had served as an incubation period allowing the firm to transfer assimilated technology and evolve into a truly South African company, the fifth era concluded an incubation period that heralded the start of Sasol's identity as a multinational firm.

Having a coherent IP strategy is one of the characteristics of MNCs, especially in chemical and related industries. Some of the most concrete and direct benefits of a well-executed IP strategy are the direct financial benefits that firms can realize through the licensing of patents. For this study, we were unable to obtain data on licensing costs and revenues, and subsequent research will hopefully be able to tease out the role of licensing in an IP strategy. But the study does provide evidence of how patents and scientific publications act as signals of technical competence and legitimacy in the field. For developing country MNCs – coming from economically less successful regions – such "currency" is especially important to gain access to the relevant international knowledge networks.

This chapter demonstrates the evolution of Sasol's IP strategy. This strategy has lagged behind the development of intellectual property *per se*, and much more than in the case of Sasol's technological capacity base – where the role of foreign connections has been and continues to be critical – IP capacity management has developed through internal trial and error. This is because a stronger IP management capacity at Sasol does not particularly serve the purposes of its foreign partners, and again highlights that the beneficial interaction between partners from more- and less-developed contexts that is most successful is when there is goal convergence between the parties.

Note

- 1 For the purposes of this study, every patent filed in every jurisdiction has been counted separately. There has been no attempt to group patents into patent families.

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