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Technology/Innovation history of post-apartheid South Africa

Wayde Thomas Flowerday

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The aim of this paper is to provide an overview on technological upgrading within South Africa. This paper will pay particular attention to policies that have been implemented to target technological progress and knowledge transfer; research and development subsidies; foreign direct investment subsidies; policies targeting private sector investment; and policies related to educational and vocational training.

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Introduction

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DACST 1996 – White Paper on Science and Technology

After a new government was ushered in, in 1994, the importance of a more coordinated view of science and technology (S&T) was quickly recognized – as a result, the formation of the 'Department of Arts, Culture, Science and Technology (DACST)' took place. The DACST would be dissolved in later years (in 2002), such that science and technology could have a freestanding ministry, as a result the 'Department of Science and Technology (DST)' became an standalone department in 2004 (OECD, 2007).

In September 1996, the South African government released the White Paper of Science and Technology, named "Preparing for the 21st Century". This paper was the first of its kind in South African history, and a major stepping stone to illustrating how government planned to catapult South Africa into the competitive area of the world economy. The paper was a collection of policy plans that were deemed to be essential components of the government's

strategy for creating the 'South Africa of the future' (DACST, 1996) under a system referred to as the 'National Innovation System' (NIS). The changes proposed within the White Paper were compiled as a consensus of opinions by the African National Congress, other political parties, business, the higher education sector, the science councils, labour, NGOs, and civil society.

The policies and changes proposed by the paper followed two broad themes. Firstly, they served the need to promote cohesion between the South African science and technology institutions and the programmes they formed part of. Secondly, they punted the implementation of output measurements for these institutions so that the average taxpayer would have a clear metric of what they were getting for their money. To achieve this vision, the following six robust goals are considered critical by the developers of the 1996 White Paper (Hart et al., 2013):

1. Establish an efficient, well-coordinated and integrated system of technological and social innovation;
2. Encourage creative and collaborative partnerships for individual and national benefit;
3. Aim at problem solving and involving the multidisciplinary use of engineering, the natural, health, environmental and human and social sciences;
4. Include formerly marginalized stakeholders in science and technology policy-making and resource-allocation activities;
5. Ensure that the advancement of knowledge is valued as important to national development;
6. Improve support to all types of innovation fundamental to sustainable economic growth, employment creation, equity through redress and social development. (p. 15)

According to the OECD (2007, p.102), the White Paper "aimed to trigger a more holistic approach to R&D across government, tackling the need to (re)build human capacity, to increase the innovation effort in the private sector, to increase government interaction with private

sector innovation through new funding schemes and greater involvement by the public research institutes (PRIs), and to increase the importance both of longer-term thinking in policy making for research and innovation and the use of the ideas of the new public management movement."

However, as stated by Hart et al. (2013), the White Paper was not ideal, and far from perfect. The paper mentions that social innovation is important, but at no point is social innovation, nor social technology adequately defined. The continued lack of integration of the social sciences and humanities with the natural, environmental, health and engineering sciences still remains a problem within the South African context. Hart et al. (2013) go on further to say that while the White Paper seemed to set robust and laudable goals, it became rather constrained within its implementation beyond restructuring, and could only make limited improvements within the formal components of the previous science and technology structure. Lastly, it is argued that there is not only a lack of focus on constraints to improving the formal innovation system, but also the inclusion of grass-roots, and bottom-up development of technology and innovation.

DACST 1999 – A Foresight Exercise

Following the international trend in the late 1990's, South Africa ran a foresight exercise to provide grounds for analysis of context, and to increase dialogue among stakeholders in the research and innovation policy system (DACST, 1999). This exercise was meant only to analyse existing policy, rather than trigger new policy creation. The key observations from the foresight exercise that became the main focus were (OECD 2007, p. 103):

- Internal rich-poor tension and the need for rural development.
- External North-South tensions, standards regimes and regulatory barriers.
- Opportunities and threats of globalization.
- Sustainable development as a fundamental principle.

- Knowledge/information society imperatives.
- Human resource development both as constraint and necessity.
- Skills loss and reduced capability to absorb new technology.
- Public safety and morals and their impact on the social fabric and economy.
- South Africa's position in the South African Development Community (SADC) and the African Renaissance.
- Raising living standards while protecting the environment.
- HIV/AIDS and its impact on the social fabric and economy.
- Lack of investment in R&D by multinationals in South Africa.

DST 2002 – National Research and Development Strategy

In 2002, some of the institutional and governance proposals of the White Paper were made more explicit when government chose to endorse the DST's[1] national R&D strategy (DST, 2002). The strategy identified the following six main weaknesses within the national innovation system (OECD 2007, p.105):

1. The drop in gross domestic research and development expenditure, which had fallen from 1.1% of GDP in 1990 to 0.7% in 1994, and had been recovering very slowly.
2. The need to maintain a super-critical research and development community, in support of strategic needs and to generate national absorptive capacity.
3. Failure to renew human capital for science and technology, as the predominantly white, male research community was ageing and not being replaced at a rapid enough rate.
4. Declining investment in formal R&D by South African companies, which the strategy document ascribed to the omnipotent presence of globalization.
5. An inadequate infrastructure and legal system to handle intellectual property.

[1] This was after the DACST was split up such that science and technology could have its own department.

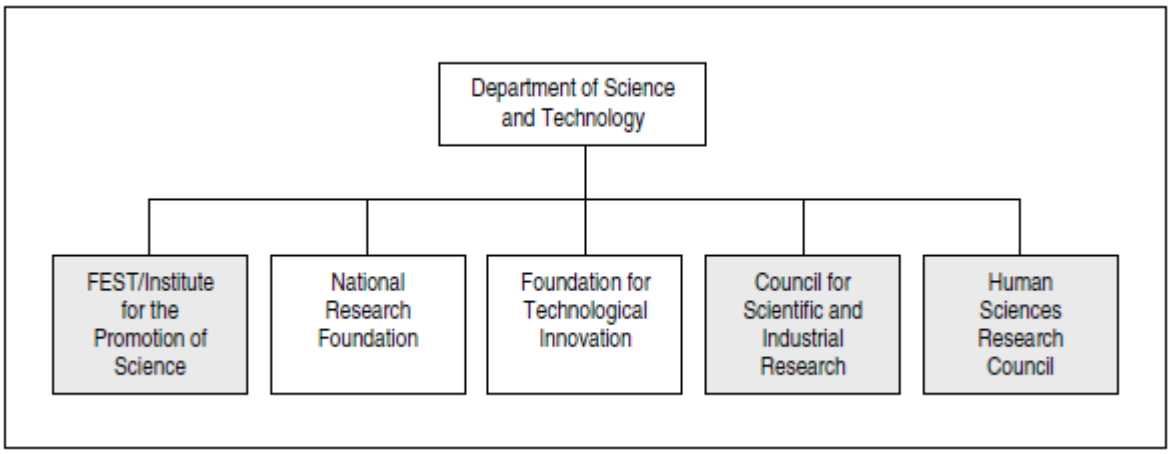
6. Fragmented governance structures in research and innovation funding.

To address these issues, the strategy provided three main courses of action. Firstly, a cluster of innovation programmes would be adopted, most notably in the fields of biotechnology, information technology, manufacturing technology, and technology for poverty reduction (OECD, 2007). Secondly, there would be a strengthening and refocusing of state-funded science, engineering, and technology research in areas in which South Africa has a global advantage[2]. Furthermore, there would also be an increased focus on strategic basic research in areas that fit aspects of industrial and social need. Lastly, the creation of a basis for a more holistic R&D policy by creating a clear distinction between the roles of sectoral departments and the DST, which would play an integrative role across the whole of government (DST, 2002).

In totality, the strategy suggested that over time the DST should consist of five primary agencies. The Department of Education (DoE) would provide one component of the binary funding of research in universities through the General University Fund, while the DST would provide the other component through the National Research Foundation (NRF) and some of the programmes of the Foundation for Technological Innovation (OECD, 2007). In the end, the suggested Foundation for Education, Science and Technology (FEST) was never created, and its function was instead served by the NRF. Thus, South Africa chose to organize most of its research and innovation funding under a single agency (that of the NRF).

[2] These areas included, but were not limited to: Astronomy, paleontology, and indigenous plant knowledge.

Figure 1: DST and agencies proposed in the National Strategy for R&D



Source: OECD, 2007
Note: Shaded areas are representative of research performers, while the un-shaded areas are funding organizations.

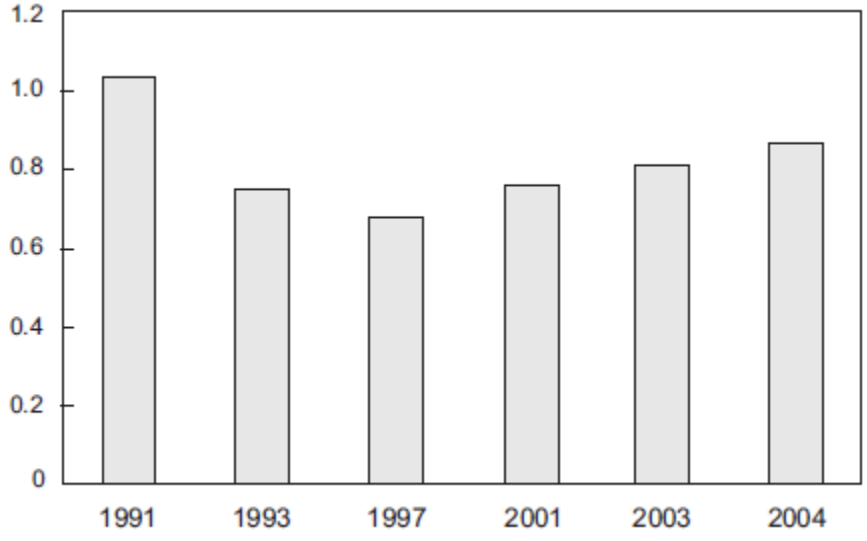
The strategy had another fundamental element to it – that of 'using the bulk of a growing budget for the innovation mission rather than for expanding fundamental research' (OECD, 2007). However, this part of the strategy was never fully implemented. Furthermore, neither the 'Technology and Innovation for Poverty Reduction' programme, nor the programme for Resource-based industries were implemented. According the OECD (2007) these failures in implementation appear to involve significant missed opportunities to use research and innovation to support central social and economic development objectives of the new government.

Box 1: South Africa in 2005

Before this paper continues, it is important to understand the space South Africa was in, in terms of R&D, science, technology, and innovation circa 2005. This was a transitional period whereby policy was shifting, and gravitating towards becoming a knowledge-based economy with a 10 year plan.

In 2005, South Africa's investment in R&D as proportion of GDP was consistent with its status as a middle-income industrializing country. Much like other countries of this nature, it shared the desire to become more R&D intensive. A large proportion of R&D was comprised of business expenditure, which provided a strong base upon which to build (OECD, 2007). According to the 2004/05 R&D survey conducted by the OECD, South Africa's gross expenditure on R&D was 0.87% of GDP, which is a definite increase from the recorded low of 0.69% in 1997[3].

Figure 2: Gross Expenditure on R&D as a percentage of GDP



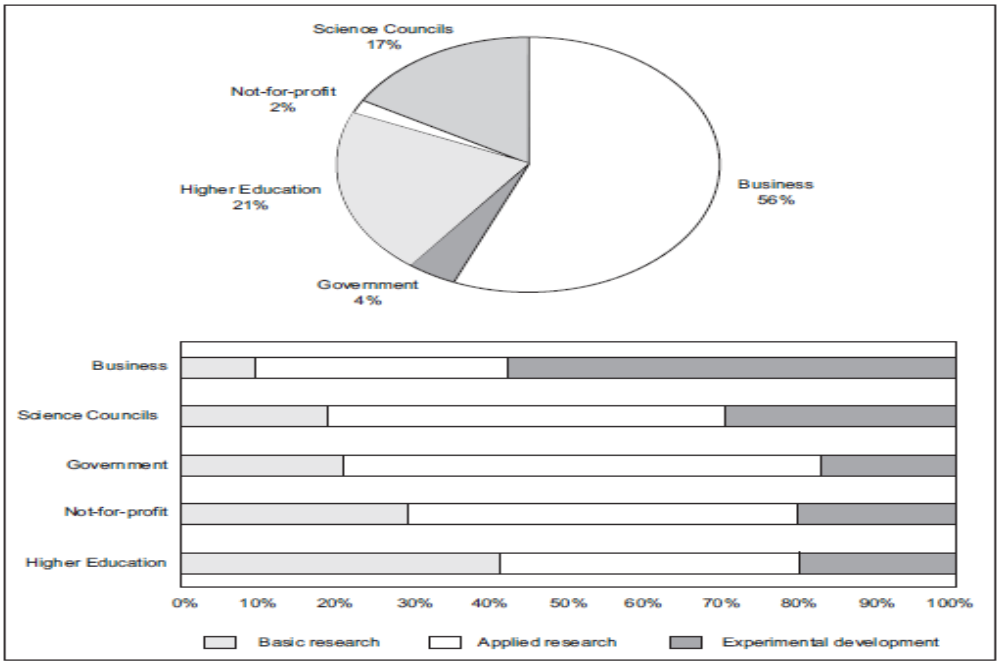
Source: OECD, 2007

[3] This figure stood at 0.76% in 2012.

At the time, government funded 33% of South Africa's R&D, and performed 21%; whereas the business sector funded 45% and performed 58% of total R&D. The higher education sector was responsible for 21% of R&D. About 15% of South Africa's R&D was funded by international sources, and 6% by the non-governmental sector (OECD, 2007). Most of the foreign funding for local business R&D came from parent or associated private-sector firms and organizations abroad, whereas funding for R&D within public research institutes and higher education institutions was derived from a number of competitive public funds (OECD, 2007).

The following figure shows how gross expenditure on R&D was split among the different R&D performing institutions in South Africa, and the type of R&D done by each. Naturally, business is most focused on experimental development, while the higher education sector showed the highest share of basic research.

Figure 3: Type of R&D by performing sector



Source: OECD, 2007

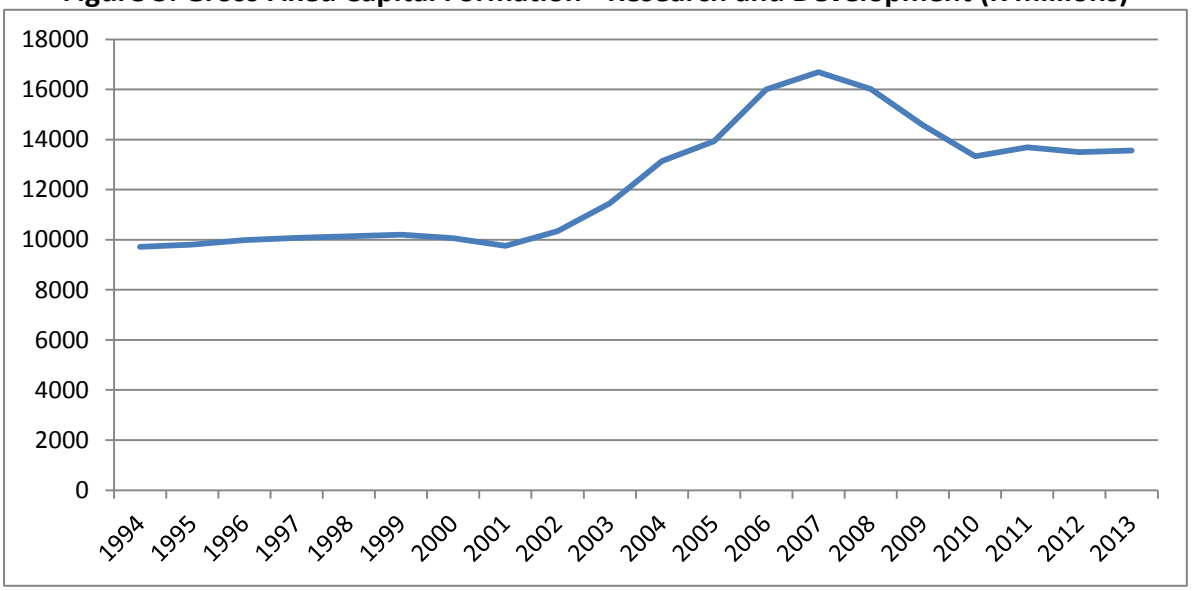
South African R&D activity is most heavily concentrated in the engineering and natural sciences. The following table shows the differences among the classes of R&D performers in terms of the proportion of effort that was devoted to different fields. Business focused most on engineering and applied sciences but also made a significant effort in health. Government is mostly responsible for agriculture, while the higher education sector focused mostly on medical and health sciences, and engineering (OECD, 2007).

Figure 4: Proportions of R&D expenditures by performer and field

	Business	Govern-ment	Higher education	Science councils	Total
Mathematical sciences	1%	4%	5%	1%	2%
Physical sciences	3%	2%	6%	3%	4%
Chemical sciences	7%	2%	6%	2%	6%
Earth sciences	1%	7%	6%	5%	3%
Information, computer and communication	20%	3%	6%	8%	15%
Applied sciences and technologies	13%	1%	3%	3%	9%
Engineering sciences	32%	2%	19%	25%	27%
Biological sciences	2%	12%	12%	11%	6%
Agricultural sciences	3%	39%	6%	22%	8%
Medical and health sciences	15%	19%	27%	13%	17%
Environmental sciences	1%	4%	2%	3%	2%
Material sciences	1%	0%	2%	4%	2%
Marine sciences	0%	5%	1%	1%	1%

Source: OECD, 2007.

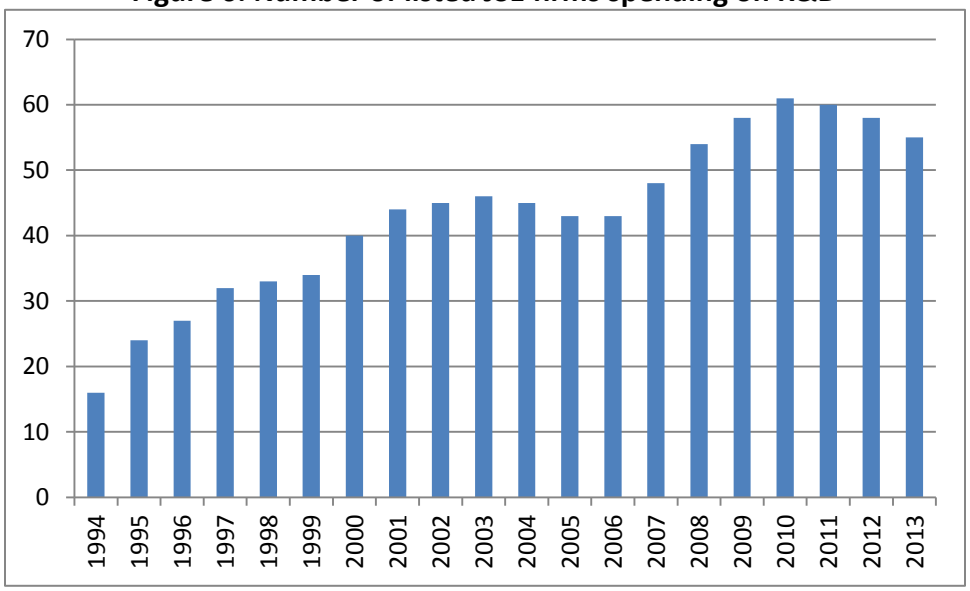
Figure 5: Gross Fixed Capital Formation - Research and Development (R millions)



Source: South African Reserve Bank

As a whole, it is readily apparent that spending on R&D in South Africa has increased since the end of the apartheid era. This spending reached its peak between 2007 and 2008, presumably due to the oncoming FIFA world cup in 2010. After 2010, R&D expenditure seems to have plateaued, and is remaining constant.

Figure 6: Number of listed JSE firms spending on R&D



Source: McGregor BFA Research Domain

It is also worth noting the number of JSE listed firms that have engaged in R&D expenditure since 1994. Figure 6 clearly shows an upward trend in the number of firms initiating R&D within their firm, providing a better breeding ground for South African R&D as a whole.

DST 2007 – Innovation Towards a Knowledge-based Economy: Ten Year Plan for South Africa (2008-2018)

In 2007, the DST put forth a plan to help ensure that South Africa becomes a knowledge-based economy over the period of 2008-2018, whereby innovation and growth are more or less exclusively determined by the level and availability of knowledge. The plan suggests that economic growth can be generated in South Africa if four key elements are focused on (DST, 2007). These elements include human capital development, research and development, associated infrastructure to ensure knowledge exploration and generation, and 'enablers' to

address the gap between research results and their socio-economic outcomes (Hart et al., 2013).

The primary focus of the 2008–2018 ten-year plan is to work towards addressing five grand challenge areas (DST 2007, p.6):

1. 'Farmer to Pharma' value chain strengthening, which emphasises the desire for South Africa to become a world leader in the biotechnology and pharmaceutical industry by exploiting the country's indigenous and natural resources.
2. Space science and technology development by increasing innovations in the space sciences and the satellite industry, with related improvements in earth observations, communication, engineering and navigation.
3. Ensuring a secure, renewable, clean, affordable and consistent energy supply to reduce reliance on fossil fuels and to access new markets including the 'hydrogen economy'.
4. Contributing towards global climate change through monitoring, scenario development and prediction of changes in Africa and the Southern Ocean.
5. Gaining a greater understanding of human and social dynamics by becoming a social sciences 'knowledge hub' in Africa and contributing to understanding the global shifts in social dynamics.

As stated by Hart et al. (2013) it is readily apparent that this plan is largely top-down in both its approach and its intentions. Given the five challenge areas it is clear that there has been no consultation or prioritization with citizens outside of the formal National System of Innovation (NSI) and that any consultation within seems to have been extremely selective. Furthermore, it is easily observable that this plan has been heavily influenced by the Global Grand Challenges (Gault, 2010), which includes climate change, health, security and the constraints related to conventional energy sources. While these are important avenues for South Africa to explore, the question must be raised, "are these the vital challenges that need to be overcome in order to ensure and increase the social and economic development of South Africa and the majority of its people?".

Box 2: South African Innovation Survey (2008)

In the period of 2005-2007, the DST commissioned the 'Centre for Science, Technology and Innovation Indicators' to undertake a series of national innovation surveys. This box will focus on some of the key findings presented by the final survey report.

An initial stratified random sample of 4000 enterprises with appropriate weights for the mining, manufacturing and services sectors was obtained from the official business register of Statistics South Africa (Moses et al., 2012). Once cleaned, the dataset was comprised of 2836 enterprises, which were weighted to statistically represent a total population of 22849 enterprises.

From the South African Innovation Survey of 2008, a total of 65.4% of enterprises were engaged in innovation activities, while the remaining 34.6% reported no innovation behaviours. Successful innovations (where innovative products were introduced to the market or innovative processes were implemented within the enterprise) were recorded by 27.2% of enterprises. Successful innovators consisted of product only innovators (8.9%), process only innovators (10.3%) and innovators with both product and process innovations (7.9%) (Moses et al., 2012). Enterprises spent approximately 1.7% of their turnover on innovation activities in 2007, with the bulk of this innovation expenditure being dedicated to the acquisition of machinery, equipment, and software.

Of the total innovative enterprises, 4.4% of these indicated that their innovations were new to both the market and the world; while 23.1% indicated that their innovation was new to the market and to South Africa. The survey relied on respondents to self-report their findings, as a result, classifications of innovation as "world first", or "first in South African history" were not given much weight, and were largely ignored.

Innovation provides South African enterprises with a large effect on their bottom line. The bulk of enterprise turnover (85%) was attributed to marginally modified or unchanged products, while 'new-to-the-market' innovations accounted for 8.5% of turnover; leaving innovations that were new to the firm to provide the final 6.5% of turnover (Moses et al., 2012).

DST 2012 – Ministerial Review Committee on the STI Landscape in South Africa

In 2010, the then Minister of Science and Technology, Naledi Pandor, set up a committee of scientists to review the science, technology and innovation landscape in South Africa. This Ministerial Review Committee (Minrec) was tasked to consider the state of the South African NSI in light of the following:

- Its readiness to meet the needs of the country in the medium to long term;
- The extent to which SA is making optimal use of its current strengths;
- The degree to which SA is positioned so that it can respond rapidly and significantly to changing global contexts (Hart et al., 2013).

The Minrec was also tasked with identifying what was required from the state and other various stakeholders to ensure that increasing investment in innovation would eventually result in a strong and sustainable knowledge-based economy that would be capable of advancing core national objectives of economic growth, employment and job creation, and improved health (Hart et al. 2013). Following this process, the Minrec was to make recommendations on the future structure and governance of the NSI, the roles and responsibilities of the various actors, the roles and responsibilities of the DST and its relationship with other government departments (Hart et al. 2013). Comprised of two stages, the final Ministerial Review Report was completed in March 2012. This report went on to note that the following challenges exist within the NSI (Hart et al. 2013, p.27):

- R&D activities, where these still exist, are separately coordinated by line departments and remain highly fragmented, often duplicated and contradictory.
- There needs to be a movement away from formal conventional design and engineering R&D to encourage innovation within public sector service delivery systems, as these systems are equally important and require urgent attention.
- Although noting the problem with primary and secondary education, the emphasis remains on education needs to better equip school leavers and improve tertiary and post-graduate qualifications. Highly skilled individuals remain important.
- Knowledge infrastructure must be maintained and increased to ensure that the various components of the NSI are adequately resourced and capitalized to ensure optimal development, availability and use of knowledge.
- Generally the quantity and nature of the resource flows in the NSI are both inadequate and distorted.
- The NSI must be an internationally open system with in-flows and out-flows of people, skills, resources, etc.
- The capacity of the NSI must improve to ensure that it is a learning organization that responds to signals both within the system, as well as the wider environment.
- Current exclusionary practices and silo mentality further weaken the system overall and political will is required to ensure improved coordination.
- Improved systems of oversight and analysis are required. In this regard, the report considers improved monitoring and feedback with regard to qualitative and quantitative science, technology and innovation indicators, as well as the need for oversight to ensure correct purposes and modalities are adopted.

The Minrec then went on to make 41 recommendations to fill the challenges and gaps within the NSI, these recommendations fell within five core areas (Hart et al. 2013, p.27-28):

1. Governance of the NSI, including the restructuring and redefining of roles and responsibilities.
2. Ensuring the enabling environment for innovation in the private and social sectors, including the opening up of the innovation system to foreign engagement and employment.
3. The enhancement of human capital and knowledge infrastructure.
4. Monitoring and evaluation of the system as a whole to overcome the limited contributions of simple innovation surveys.
5. Financing the NSI.

"Since 1994, and the abandonment of the peculiar needs of apartheid and the end of the country's isolation, South Africa's innovation and research policies have been significantly modernized and have entered the international mainstream. The government has developed a more holistic view of science and technology by centralizing responsibility in the DST. National needs and strategy have been openly debated both in government and through a foresight process. Priority has been explicitly given to innovation, rather than expansion of traditional, researcher-directed university research, though major projects in fundamental research continue to be important" (OECD, 2007).While the final Minrec report notes some significant changes from earlier reviews and attempts to promote the initial intentions of the White Paper of 1996, the underpinning ideology still appears to adequately address the need to incorporate the larger share of South African society, who are marginalized (Hart et al., 2013).

Box 3: IPAP

South Africa's industrial policy is governed by the *Industrial Policy Action Plan (IPAP)*. Successive iterations of the document are brought out year-on-year, hoping to ensure that policy is well aligned, and current; with the first iteration of the document being released in August 2007. What this document lays out, is a strategic development strategy in which the industrial policies of South Africa can be bolstered, and used to contribute to South Africa's quest for the New Growth Path. IPAP is part of the vision of the New Development Plan[4], and is predicated on the need to bring about significant structural change to the South African economy.

The successive iterations of IPAP set out transversal and sector specific programmes, and key action plans, with time-bound milestones and the identification of the lead and supporting agencies responsible. This has been a useful tool for strengthening intra-governmental integration and coordination. Furthermore, the structure of IPAP has allowed for the strengthening and deepening or government, parliamentary and public oversight, and accountability for the targets and milestones that IPAP presents.

Due to the ever-changing nature of IPAP, it is not possible to accurately summarize all the goals that were hoped to be achieved – it is therefore far more useful to consider the main objectives of South African industrial policy[5]. These objectives are comprised of the following: 1) The diversification beyond traditional commodities and non-tradable services, requiring the promotion of increased value addition. 2) The long-term intensification of South Africa's industrialization process and movement towards a knowledge economy. 3) The promotion of a more labour-absorbing industrialization path. 4) The promotion of a broader-based industrialization path characterized by the increased participation of historically disadvantaged

[4] However, ASGISA (Accelerated and Shared Growth Initiative for South Africa) was the first macroeconomic policy plan to put industrial policy firmly on South Africa's policy agenda.
[5] Goals that IPAP hopes to help achieve.

peopled and the marginalized regions in the mainstream of the economy. 5) Contributing to the industrial development of the African continent. In order to achieve these objectives, IPAP has targeted 13 widely different sectors[6] in which it hopes it can create policy to meet the aforementioned objectives.

However, no policy plan is free from constraints, and IPAP is not an exception to this rule. IPAP is implemented against the backdrop of external and domestic shocks, compounded by wide-ranging structural challenges which continue to be an impediment to industrial developments. These constraints include (but are not limited to): The slow recovery and continued vulnerability of the global economy; the speeding up of infrastructure investment given the protracted slowdown in public and private fixed investment expenditure; the monopolistic provision and pricing of key inputs into manufacturing; and a weak skills system, which does not adequately respond to the needs of productive sectors.

As a whole, IPAP has shown moderate successes, but it has also failed in areas upon which it promised to deliver. More time will be required before a true measure of the success of IPAP can be gauged.

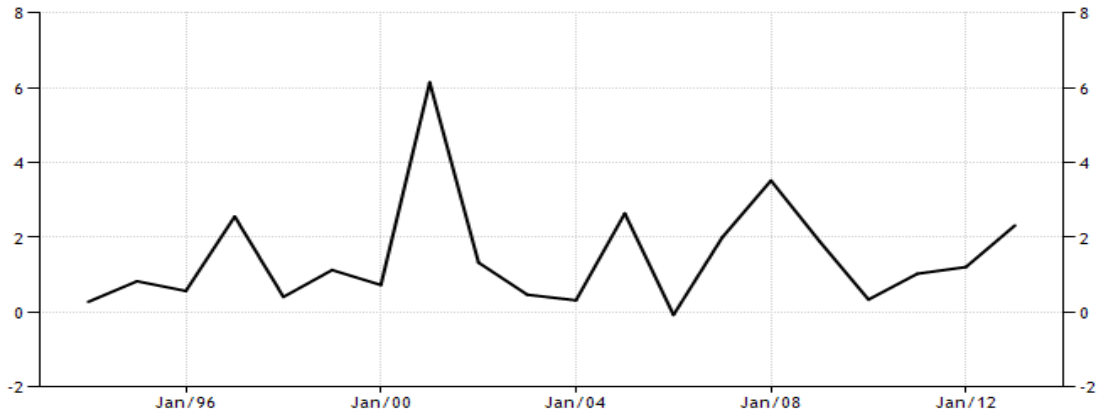
[6] These 13 sectors fall primarily under the classification of either, "manufacturing", "primary production/manufacturing nexus", and "services".

Box 4: FDI Regulation in South Africa

Attracting FDI has long been a primary goal of post-apartheid government in South Africa. After being isolated and barred from a large degree of international dealings during the apartheid era, the South African government was acutely aware of the need to bolster the county's image, and make South Africa appear to be a country worth investing in – this would only be achieved by creating an investment climate that was liberal and open. These efforts were underpinned within South Africa's 1996 'Growth, Employment and Redistribution' (GEAR) strategy, which aimed for a broad liberalization of the economy.

South Africa has been relatively unsuccessful in attracting FDI, being on average lower than comparable developing countries. FDI inflows to South Africa have been around 1.5% of GDP in the first decade of democracy while later peaks were mainly driven by large ad-hoc investments in the financial and communications sector (figure 7). Other possible explanations include the lack of skilled workers; poor transport infrastructure, high levels of crime which may deter investment, and inefficient spatial development plans that were inherited from the apartheid regime.

Figure 7: Net Foreign Direct Investment inflows (% of GDP) 1994 – 2014



Source: Tradingeconomics, 2014
Note: Foreign direct investment; net inflows (% of GDP), are the net inflows of investment to

acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments.

Due to the lackluster results of the liberal approach to FDI, a significant transition has been sparked in South Africa, whereby there is a push towards an FDI regime that gives primacy to extracting the maximum domestic benefits from each investment. This change in regime shows a change in the perception of the benefit of FDI in South Africa – Initially FDI was seen as beneficial itself, whereas now FDI is only seen as beneficial when it achieves certain policy goals. These goals include (but are not limited to) reducing unemployment, creating inclusive growth, and accelerating progress; all of which are key components of South Africa's National Development Plan (NDP).

Coinciding with this shift in mindset towards FDI, the government is in the process of cancelling or allowing the expiration of various bilateral trade agreements (BITS) that were accrued during the excessively liberal phase, just after the end of apartheid. These BITS are to instead be replace by a single domestic investment regime that will offer various protections for investors, while allowing the country to institute policies to address economic inequality and meet domestic policy objectives.

According to Wood & Wentworth (2014), "While considered rational by many, the government's greater focus on maximizing the domestic benefits of FDI, including implementing local and black economic empowerment partnerships, as well as local content agreements, does complicate the structuring of FDI transactions. Historically, most FDI into South Africa has come in the form of mergers and acquisitions (M&As), where the local firm is mostly equipped to comply with these requirements. Greenfields investment, which has been persistently weak into South Africa, would likely be more complicated – albeit much more

desirable."

Moving beyond the core FDI regulation, a number of incentive schemes do exist within South Africa. The Enterprise Investment Programme (EIP) provided a cash grant of up to 30% for qualifying assets – this programme began in 2008 and was subsequently done away with in 2014. As it currently stands, the EIP has now been tied in with the Manufacturing Investment Programme (MIP) – this conjoined programme is utilized to stimulate investment, including the accelerated depreciation on investment assets; graduated tax rates applicable to small enterprises; and tax incentives applicable to research and development capital expenditure (DTI, 2011); but beyond this there are few options for large tax-holidays or lower tax rates (Wood & Wentworth, 2014). More recently, feasibility studies have been conducted for the establishment of Special Economic Zones (SEZs) in all of South Africa's nine provinces. These SEZs, which were implemented in 2007, promise a significant corporate tax reduction and duty exclusions for all firms aiming to produce within these zones.

As it currently stands, there is no way to measure the impact on the regime change that has been implemented. More time will be required before any meaningful insights can be garnered.

Box 5: Education & Vocational Training Policies in South Africa

Since the fall of apartheid in 1994, South Africa's new government has continually emphasized the role education and training must play in order for South Africa to reach a competitive position in the global, knowledge-based economy. From the Reconstruction and Development Programme (RDP) of 1994, to current South Africa, government has continually stated that sustained economic growth is a necessary condition for South Africa's continued transformation, and a precursor to that, is education and training.

Consequently, the key measures identified in accelerating education and training growth in South Africa can be summed up as follows (OECD 2008, p.240):

- Achieving high levels of literacy and numeracy;
- Increasing high school graduates with mathematics and science;
- Upgrading career guidance programmes;
- Upgrading Further Education and Training (FET) colleges;
- Revamping Adult Basic Education Training (ABET) programmes on the basis of the models developed in other countries.

With regard to skill needs, the following areas have been identified, and related (continuously updating) objectives have been set (OECD 2008, p.241):

- Increase the number of engineers graduating from higher education. Measures should be put in place to ensure that graduates register as engineers;
- Increase the number of trained artisans per year. This objective should also be achieved through a better articulation of the various pathways (apprenticeships, learnerships, and the new vocational qualifications at FET colleges);
- Improve the competitiveness of the tourism sector though the development of programmes to deal systematically with skills gaps;

- Strengthen town and regional planning capacities through the definition of the required competencies, of professional registration and continuing professional development.

The key principles with regards to skills development requirements are aligned with the National Skills Development Act (1998), and the National Skills Development Strategy.

Further Education and Training (FET)

Upper secondary education in South Africa is provided through the Further Education and Training (FET) system, and covers the period of post-compulsory schooling, namely after grade 9, up to pre-higher education learning (OECD, 2008).It includes both the three year academic programme in schools and the provision of vocational education and training through FET colleges, which are the result of the rationalization of the system.

The levels of qualifications provided in accordance with the National Qualifications Framework (NQF) are 2, 3, and 4. The NQF system replaced the previous NATED system, which was primarily theory-based school curricula, which was set up in 1935 to meet the needs of the labour forces of the South African harbours and railways. “Qualifications and standards registered on the NQF were described in terms of the learning outcomes that the qualifying learner was expected to have demonstrated” (SAQA, 2000, p. 10). There were 12 National Standards Bodies made up of employers, trade unionists, government officials, professional bodies and education and training providers which recommended the standards to be registered. Sector Education and Training Authorities (SETAs) were then responsible for ensuring the quality of the standards and qualifications (OECD, 2008).

The post-Apartheid FET system was established with Further Education and Training Act of 1998 with the objective of regulating all learning and training programmes leading to qualifications from level 2 to level 4 of the National Qualifications Framework, as contemplated in the South African Qualifications Authority Act, 1995. The levels referred to above are general education and below higher education (OECD, 2008).

In 2007, a provincial FET colleges system was designed and it is governed by a new act, the 'FET Colleges Act (2006)', which replaces the 1998 act. The primary aim of the reform was to develop the skills needed for economic growth, and to reduce poverty and unemployment. In 2007, approximately 400 000 students were enrolled at FET colleges, this number had increased to 670 455 in 2013 (DHET, 2013).

The National Sector Plan for FET colleges identifies 6 broad objectives:

1. Creating a nationally coordinated FET system with a unique identity;
2. Broadening student access and participation and improving achievement;
3. Entrenching quality and excellence;
4. Promoting institutional autonomy, responsiveness and relevance;
5. Encouraging diversity and differentiation;
6. Monitoring systemic and institutional performance and fostering public accountability.

The National Certificate (Vocational)[7] is offered in eleven economic sectors, and clustered to be covered by the FET system in accordance with the classification of priority skills areas, as follows:

1. Civil engineering and building construction
2. Electrical infrastructure construction
3. Engineering and related design
4. Finance, economics and accounting
5. Hospitality
6. Information technology and computer science
7. Management
8. Marketing

[7] Equivalent to a completion of grade 12.

9. Office administration
10. Primary agriculture
11. Tourism

The split between theory and practice is 60:40 and the practical training is mainly based on simulation carried out in workshops that are located in the colleges.

Focus Schools

The focus schools are innovative initiatives aimed at providing access to excellence in various educational fields and to contribute to the development of skills aligned to key growth sectors within the provincial economy. Twenty eight secondary schools, serving historically marginalized communities, were converted into focus schools during a period of three years from 2005 to 2008, in the fields of: arts and culture; business, commerce and management; and engineering and technology (OECD, 2008).

Continued Training

The National Qualifications Framework (NQF) was adopted in South Africa in 1995 in order to promote an egalitarian educational system. In accordance with the NQF's objectives, skills and knowledge are measured at the end of the learning or training period against agreed upon standards. The NQF is managed by the South African Qualification Authority, which is comprised of a board of 16 members that have been appointed by the Ministers of Labour and Education.

In order to further regulate qualifications, 25 SETAS were established in 2000.
The SETA/NQF model of quality assurance is based on decentralized assessment, without examinations, whereby individual institutions are accredited to offer specific qualifications that have been registered with the NQF. Each SETA has its own requirements for the accreditation of

providers within its sector, which have to design their own learning programme against the qualifications, on the basis of the learning outcomes and assessment standards that are in the registered qualifications.

Abbreviations

ABET	Adult Basic Education Training
AMERU	African Microeconomic Research Unit
ANC	African National Congress
ASGISA	Accelerated and Shared Growth Initiative for South Africa
DACST	Department of Arts, Culture, Science and Technology
DHET	Department of Higher Education and Training
DoE	Department of Education
DST	Department of Science and Technology
EIP	Enterprise Investment Programme
FDI	Foreign Direct Investment
FEST	Foundation for Education, Science and Technology
FET	Further Education and Training
GEAR	Growth, Employment and Redistribution
IPAP	Industrial Policy Action Plan
JSE	Johannesburg Stock Exchange
Mincrec	Ministerial Review Committee
NDP	National Development Plan
NIS	National Innovation System
NQF	National Qualifications Framework
NRF	National Research Foundation
NSI	National System of Innovation
OECD	Organisation for Economic Co-operation and Development
PRI	Public Research Institute
R&D	Research and Development
RDP	Reconstruction and Development Programme

S&T	Science and Technology
SETA	Sector Education and Training Authorities
SEZ	Special Economic Zone
STI	Science, Technology, and Innovation

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