The **Council for Geoscience** was developed as a rebranding of the old Geological Survey, and the ARC was formed as a merger of various Department of Agriculture research institutes. The logic of their formation, perhaps conducted in some haste in the twilight years of apartheid, suggests that re-thinking may be overdue. The larger issue of food security has been taken care of; widespread poverty and inequality call for quite different responses by public research organisations.

The **NRF** currently carries the responsibility for the so-called **national facilities**, although there is an inherent conflict of interest between running this group of unique and expensive entities and the primary agency functions of the foundation – the real logic of the arrangement has never been entirely clear. The national facilities are indeed starting to spin off into other agencies as the contradiction of their NRF placement becomes ever more apparent and problematic (NRF 2011). The national facilities actually constitute a distributed, research-performing 'science council', and the question has to be asked why they are still run by an essentially specialised grant-making organisation. Thus the South African Nuclear Energy Corporation (NECSA) could take over the iThemba Laboratory for Accelerator-based Science (iThemba LABS), the new Space Agency the observatories, and the Department of Environmental Affairs the National Zoological Gardens.

A second and major reason for a serious re-think of the science councils is the problem of an inadequate coherent cross-system policy, ineffective coordination of their activities, and disparate funding models. This has arisen from the problematic implementation of the **New Strategic Management Model (NSMM)** in 2004 (see the Phase One part of this Report for details) which effectively fragmented the science council system into a few core DST-run entities and a majority of sectoral entities reporting to, and funded by, specified line departments; the NSMM (vainly, as it turned out) sought, by sharpening a number of policy definitions, to emphasise the cross-cutting role of the DST in setting common governance standards and quality assurance mechanisms in place for each science, engineering and technology institution (SETI), irrespective of its location in the system, and making some preliminary provisions for 'market failure' or incapacity on the part of line departments. These provisions were intended to blunt the impact on national coordination of moving government R&D organisations to their sectoral departments. Unfortunately, it meant that science councils which had received top attention in the DST moved to situations in their new organisational locations where they did not receive priority attention.

A critically significant part of the NSMM document described the nature of the partnerships-to-be between the DST and other departments in sector-specific S&T. Among other things, the document notes: "In the case of sector-specific science, the function of DST would be to develop interventions in the case of market failure, under-subscription or where there are technology gaps of a strategic nature. Examples here include those areas where sector departments are not ready to drive the necessary sector-specific technology programmes due to capacity deficiencies." The DST was also to assist in the case of national priority programmes with best practice advice on S&T aspects, including developing financial instruments for this purpose. The question was really, however, whether a 'consultant' role for the DST was really adequate in cases of departmental incapacity or incoherence, and whether it was feasible to expect the DST to intervene in the case of a failed stewardship of a sector-specific SETI.

The need for a common mechanism for planning and budget development for the science council system is further exemplified by the current prevalence of **duplication of focus areas in the science councils**, where, for example, the volume of health research performed in the CSIR, the

HSRC and the ARC probably much exceeds that performed by the MRC. (The agency function of the MRC, the last to remain outside the NRF, apart from the rather differently conceptualised Water Research Commission, is by now a virtual step-child of that organisation, with a minority share of the baseline budget as well as of the extensive administrative machinery. The question should be asked whether this is this sensible.) Another matter that deserves attention in this context is the reportedly **low expenditure of many line departments on Science and Technology** Activities (STAs), which suggests that problems encountered in service delivery or policy implementation are not being innovatively addressed. This is hardly good practice in a knowledge economy.

There are further signs of disquiet that suggest that a new social contract must be formed between what might better be termed the research and innovation system, and society. Starting with the August 2005 call of Cabinet for evidence of the benefits of spending public funds on R&D, to the scepticism expressed in meetings of the Parliamentary Portfolio Committee on Science and Technology, there is a mood that demands change and value for money, with S&T being held to account. Poverty appears to be intractable, and economic growth stuck. 'Show us the benefits' is now a serial question.

The foregoing comments serve as context for introducing the Ministerial Review Committee's assessment of the 2007 OECD review of South Africa's innovation policy in the Phase Two part of this Report. The review strongly challenged the DST's conception of the system of innovation, claiming that its **"mental models of how the innovation system operates [are] over-focused on the role of the state"** (OECD 2007: 5), and that this should be changed, with firms being placed more centrally to policy considerations. [This view is unsurprising in that it represents OECD orthodoxy.] Even so, it resonates with the DST stance; despite contrary evidence from the National R&D Surveys, the DST steadfastly maintains that the private sector is failing to join government in supporting national objectives, thereby justifying its own activist approach.

To bridge this gap requires measures that (i) strengthen the incentives for firms to become involved in innovation that will serve national objectives; (ii) build links between universities/science councils and industry; and (iii) build absorptive and technological capacity in industry at all levels.

The OECD Review (see also the Phase One sections of this Report) also recognised positive aspects – the mere fact of innovation system survival, the availability of system information, departmental leadership, and the high industry expenditure on R&D.

The OECD Review then offered a number of recommendations: policy intervention should only arise from market and systemic failure; the need for action to address inequalities; a commitment of government to openness, participation and transparency; and the need to build critical mass. Other recommendations covered the need for a mechanism for high-level decision-making, shifting from supply-side to demand-side interventions, from the selection of technologies to identifying 'sectors' in which innovation would be implemented; the review of negative consequences of immigration policy; and new roles for the Industrial Development Corporation (IDC). A review of higher education research funding was also called for in order to provide

"stronger incentives for, and greater selectivity in resource allocation to, high quality work", while arguing that measures for "ring-fenced funding are needed to foster the emergence of newcomers to the competition" (OECD 2007: 14). It was noted that small and medium enterprises (SMEs) deserve special support measures.

It is important to note that **business appears to have an equal misunderstanding, if not mistrust, of the government role.** Among the nine country studies conducted for the Committee (Kahn 2011a), none shows such lack of alignment as in South Africa between the major private sector players, and the public components of the innovation system.

The DST's response to the OECD's recommendations has been measured, and has included the establishment of a NACI-CHE sub-committee on human resource development, and a change to the NACI Act to allow for the appointment of an independent CEO.

Despite the recommendations of many external reviews – the reviews of NACI in 2003 and 2008, and the system-wide reviews of 1998 and 2006 – it is the view of the Committee that there is considerable institutional congruence between the pre- and post-1994 innovation systems, with attendant problems of focus, accountability, autonomy, fragmentation and inadequate performance measurement and evaluation. To a large extent, the public component of the innovation system continued in its previous areas of niche expertise, the major exception being the **impressive expansion of infectious diseases research**, and this in spite of, not because of, government policy. International networks and the availability of donor funding were, and are, crucial in allowing this to take place. Various recommendations for changes in system governance have not come to fruition.

The Committee acknowledges the many positive achievements of the DST, including South Africa's ability to effect large projects such as the Southern African Large Telescope (SALT) and MeerKAT, and the world class bid to host the Square Kilometre Array. Other noteworthy interventions are the South African Research Chairs Initiative, the university Centres of Excellence and Centres of Competence, the achievements in genomics and early humanoid research and South Africa's participation in many international scientific projects. The Committee also recognises the achievements of the private sector in effecting innovations and pursuing new market opportunities.

The **DST is essentially a policy department**, and oversees transfer payments to the statutory bodies for which it has responsibility, while major responsibility for grant-making is the role of NRF, WRC and MRC. What has emerged over time is a change in the activities of the DST, in that the department is also taking on the role of research activist, if not experimenter, perhaps addressing perceived market failure within the public sector. This gives rise to the question of whether a policy department should be so engaged, or whether this is the province of the science councils or other organs of state.

It would be reasonable to describe the current innovation system as decentralised, in that there is no high-level coordinating mechanism in place. The fact that until 2009 the responsible Minister

was not selected from the ruling party, together with the position of the Ministry of Science and Technology in the hierarchy of government ministries, almost certainly compounded the absence of such a coordinating mechanism. Seen from the perspective of government, funding mechanisms appear to constitute the principal steering devices that have been deployed; others are the promotion of employment equity and preferential procurement. No fundamental shifts are in evidence.

The key concerns of the Committee may be summarised as follows:

- An uncoordinated approach in various parts of the system to resourcing innovation-related activities, with the failure to attain critical mass in any strategic direction
- The slow growth of innovation-related skills in all sectors of the system
- Mission creep and loss of capacity in public research organisations as well as the growing obsolescence of parts of the knowledge infrastructure
- An inadequate base for evidence-based decision-making, and in many cases weak accountability for the expenditure of public funds
- The need to leverage existing innovation potential more effectively, and to grow the national innovative disposition more broadly.

3.4 Emergent Policy

The next matter for consideration is the advocacy of the New Growth Path to institute a developmental state. The developmental state agenda notwithstanding, the Committee is concerned that the New Growth Path document (EDD 2010) says little about innovation, R&D and technology, instead being content, with one exception, to repeat the indicators of the Ten-Year Innovation Plan. This is insufficient to build a prosperous state whatever its design may be, and would position South Africa outside mainstream thought on the importance of innovation (see for example, OECD 2005a, 2010). The Committee also notes that it is a major contention of the Ten-Year Plan that, "To build a knowledge-based economy positioned between developed and developing countries, South Africa will need to increase its PhD production rate by a factor of about five over the next 10–20 years" (DST 2008b: 25), hence the target that 3000 PhDs in science, engineering and technology will graduate annually by the year 2018.

There is a serious problem of mismatch between the intentions of the New Growth Path, the Ten-Year Innovation Plan and the Twelve Outcomes of government and their associated Delivery Agreements. Delivery Agreement 5 nullifies the DST's PhD target by setting a much lower rate of production. Output 5 calls for 1350 PhD graduates by 2014 along with the provision of 100 postdoctoral fellowships. The figure of 1350 may be compared with the HEMIS 2009 figure of 1380 doctoral graduates, while the 100 postdoctoral fellows are far below the 627 recorded in the official 2008/09 National R&D Survey. Where the undercount for the postdoctoral fellows may have arisen through error, that derived from HEMIS does not. **Delivery Agreement 5, if implemented, would amount to a slow strangulation of the research side of the innovation system. The goal of reaching the target for GERD as a percentage of GDP of 1.5% will be unattainable.**

The **Industrial Policy Implementation Plan 2 (IPAP2)** is more specific on the role of innovation, asserting that the state should operate at three levels (the dti 2011: 76):

- Leveraging industrial development through state support for the commercialisation of new technology innovations; including those arising out of research and development at state institutions such as the CSIR
- Consolidation of existing commercial opportunities from research work previously carried out, but which has not been fully commercialised, and with respect to technologies that can be acquired in order to upscale production capabilities in defined sectors where opportunities exist
- A much clearer alignment between demand-side skills needs and training programmes and the deployment and operationalisation of new technology and industrial processes.

For reasons unknown, the CSIR, the largest science council, gains the central role IPAP2, and no other science councils are mentioned. Despite the observed potential for employment creation in agriculture, mining and pharmaceuticals, there is silence regarding the ARC, Mintek, MRC, HSRC and Council for Geoscience. Their acronyms do not even occur in the IPAP list of abbreviations although the SABS does. The mistrust and misunderstanding between government and the private sector has already been alluded to. Here one finds a lack of understanding on the part of the Economic Development Department (EDD) and the Department of Trade and Industry regarding potential actors within the state itself.

How then should the innovation system be brought to bear upon the economic and social needs of the country? The next step is to look at how **other countries** have approached the issue of governance of their innovation systems.

3.5 Comparative Perspectives

Nine country innovation systems were studied with respect to the mechanisms employed for prioritisation and agenda-setting, their institutional make-up, framework conditions, and modes of policy learning.

The countries span a diversity of history, economic structure and national polities, especially with regard to regional autonomy. **Each innovation system is unique to itself while bearing superficial resemblance to others, since there are generic elements.** Central to this is the realisation that "... the benefits of countries' science, technology and innovation policies, including specific policy instruments, cannot be adequately assessed outside the specific context of the national innovation system for which they are designed" OECD (2005a: 7).

Among the countries studied, Australia, Norway and Brazil are three commodity exporting countries. The **Australian system** bears the closest superficial resemblance to South Africa. The Australian innovation system is larger, but its set of institutions is similar. What stands out is Australia's commitment to representative, transparent, high-level prioritisation and policy learning through institutionalised monitoring and evaluation, and foresight. This is embodied in

the expert-member **National Innovation Council** chaired by the Prime Minister, the Office of National Assessment, and the National Centre for Innovation Research. The responsible Ministry is a **combined Ministry of Innovation, Industry, Science and Research** (similar to the UK Department of Business Innovation and Science). A salutary lesson is the Commonwealth Scientific and Industrial Research Organisation's (CSIRO) long, costly and ultimately successful experience in enforcing its Wi-Fi patent rights. Where New Zealand has moved most strongly to push its public research organisations (PROs) to the market, invoking strict application of the client–contractor principle, Australia has retained its PROs and promoted the partnership scheme of the Cooperative Research Centres.

Public research organisations play a very small role in **Norway**, and unsurprisingly it is the **Minister of Research and Higher Education who chairs the Cabinet committee** responsible for prioritisation and coordination. Norway has lower than average innovation indicators, but high growth. Three important features are its culture of administrative fairness, statutory evaluation studies and institutionalised strategic intelligence (through NIFU-STEP, the Nordic Institute for Studies in Innovation, Research and Education - Centre for Innovation Research). The relatively weak coordinating authority in the figure of the Minister has endured because of the culture of fairness in Norway, but there is also recognition of fragmentation and weakness in addressing demand-side needs. The relative lack of coordination in Norway is the result of "... the lack of a national arena for setting consensual priorities" (OECD 2008: 155). Norway has also raised state revenues for R&D through taxes on resource rents.

Brazil, by virtue of size, is in a class of its own, showing how a federal system of innovation can function in practice alongside a strong commitment to building state-level regional systems of innovation. This is possible since the Brazilian states are empowered to raise taxes that may then be deployed towards innovation support through **state-level innovation funds**, for example, FAPESP (the Foundation for Research Support of the State of São Paulo). At federal level, there are a number of practices and instruments that may be adapted to the South African situation: administrative transparency, the CV database Plataforma Lattes, the Innovation Fund (FINEP), the resource levy-supported sectoral funds and the incubator movement. The arms-length **Center for Strategic Studies and Management Science, Technology and Innovation (CGEE)** plays an important role in supporting policy learning.

Malaysia stands somewhere between commodity producer and high-technology factory producing items under licence for export. With its Bumiputera affirmative action policy, Malaysia presents the chance to observe how such a policy plays out over time. Malaysia succeeded in the export market through the exploitation of cheap labour, authoritarian rule and government subsidy. It now faces stagnation since its universities and research base have not been sufficiently developed. The country experiences brain drain, in part driven by quota policies. Whilst STI information is centralised in the **Ministry of Science, Technology and Innovation,** doubts have been expressed as to the validity of some of this work.

Finland, Korea, Austria, Sweden and Belgium are export-led economies. **Finland** has a high-level stakeholder-based steering committee, the **Research and Innovation Council.** While a recent external evaluation was critical of Finland's present willingness to adapt, the response to the 1987 OECD review was exemplary for its engagement, and may well have empowered Finnish policy-makers to respond to the crisis of the collapse of their trading relationship with the USSR post

1992. The modus operandi of TEKES (the **Finnish Funding Agency for Technology and Innovation**) is worth noting: the TEKES board, together with the major stakeholders, determines the thematic programmes; roll-out is through a mix of grants and loans, without equity stakes or a share of resultant intellectual property. TEKES claims this has had positive effects – companies have increased their commitment to R&D, strengthened university–industry links and international collaboration. TEKES' major successes include Nokia, software firm Rovio, and dairy processor Valio with its low-lactose products. Finland, like Brazil and South Africa, shows wide regional disparities.

South Korea's experience between 1910 and 1945 resonates with South Africa's history of discrimination. The Korean response was different, since Korea is highly authoritarian, and is not open for emulation with the exception of one aspect – education. The high accord and expectation given to educators is an essential ingredient of Korean success. Korea also functions with a very **high-level innovation council** and makes extensive use of foresight. The particular style of governance is uniquely Korean, reflecting the country's deep culture as well as the power of the family-owned *chaebol* conglomerates and their closeness to government.

In the early years of Korean industrialisation, R&D was state driven. It is important to note that Kim (1997) questions how much publicly funded R&D was actually transferred, let alone commercialised. What was important was the role of state research laboratories in deepening the skills base.

Perhaps the most important learning from Korea and Finland is that education matters, and that skilful location of universities, based on government–industry–community participation can catalyse regional and industrial development. Brazil's recent experience in attracting foreign-funded R&D centres is a confirmation of the importance of having a critical mass of engineers and researchers.

Belgium and Austria are both small open economies. They exhibit a diversity of governance forms with strong regional dimensions. Both have evaluation mechanisms in place, but these show limited efficacy. Belgium's CV database is worth noting, as is the fluid employment regime that characterises Imec at Leuven. Austria leads the way in extending state incentives to start-ups in their 'before profit' phase, in other words, a direct subsidy for R&D.

Sweden offers the paradox of high R&D expenditure with lower than expected outcomes. Sweden, like Finland, made a rapid shift from a resource-based to a knowledge-based economy. It also has deep education traditions and a small public research sector. Direction of the innovation system is at a lower ministerial level, and has come somewhat late in the day. Like South Africa, Swedish companies appear to prosper more internationally than locally. The implication is that companies know best where to invest and take risk, and presently that is less at home and more abroad.

Evaluation has high priority in most of the nine countries, with Korea, Malaysia and Brazil perhaps making least use of this. A number of the countries have institutionalised STI information

systems: MASTIC in Malaysia, Belspo in Belgium and NIFU-STEP in Norway perform valuable work. In a number of countries, foresight is also institutionalised.

All of the nine countries show **interest in promoting industry–science relations**. The OECD (2005a) argues that the **main value of science to industry is the provision of skills, followed by new knowledge, new technologies, new methods and equipment prototypes**. Transfer involves recruitment, networking and the capture of codified information by means of open publications or restricted contract work. Occasional spin-outs involve the migration of staff and tacit knowledge into new companies. Industry–science links involve signalling between the research and industrial systems about what the important problems and the potential solutions are, thereby improving the alignment between the activities of the research system and societal needs.

The last issues to be considered are **intellectual property rights** and the importance of patents as indicators of market potential. Little mention is made in policy documents of the position of the state with respect to ownership of IP resulting from the use of public funds. The governments of Finland, Canada, Korea and the United States forego ownership of IP resulting from publicly funded R&D. The experience in the United States since the Bayh-Dole Act is that firms have often shied away from working with universities out of concern that their intellectual property would be jeopardised. For companies to invest in R&D is risky; actions on the part of government that increase that risk should be a matter of last resort. As Edquist (2009) argues "... for public intervention to be motivated in a market economy, (1) private actors and markets must fail to achieve the objectives formulated (i.e. a problem must exist), and (2) public actors must have the ability to solve or mitigate the problem".

Korea and Finland point to the **important role of crisis** in re-orientation. Apartheid South Africa met the crisis of international isolation with 'Total Strategy'. Chile, faced with a crisis of stagnation, decided to move up the agriculture value chain by improving its wines, producing out-of-season fruit and vegetables for Northern markets, and embarking on aquaculture (focusing on salmon). Finland moved into high-technology exports. Such demand signals are an essential focusing device for the system of innovation.

These pointers will be woven into the recommendations to follow below.

3.6 Towards a Research and Innovation System?

The National Planning Commission has declared poverty to be the major crisis facing the country. This is a view with which the Committee associates itself.

Poverty is multi-faceted, so that electrifying an informal settlement (a technology solution) in the wrong place (a political legacy) barely impacts the drivers of poverty. Electrification plus apartheid planning is still apartheid. Such service delivery shortfalls reflect deep political and system failure, rooted in South Africa's legacy and structures, rather than resulting from a poverty of technology.

If the innovation system is to adopt the war on poverty as its major mission, then the system actors must (i) draw on their core competences and (ii) construct additional mandates. This melds legacy and vision, and conjures the image of two-headed Greek god, **Janus, who looks both back and forward**. The war on poverty is the 'Janus Mission' for the emergent research and innovation system The Janus Mission will be the game-changer.

It is important to clarify the reference to the research and innovation system. Through numerous interactions with parties both inside and outside government, the Committee is persuaded that **the concept of the national system of innovation has failed to gain adherents beyond the Department of Science and Technology**. There are many reasons that may explain this lack of traction: the position of the Ministry of Science and Technology in the hierarchy of government departments; fear and distrust of science and technology engendered during apartheid exclusion; lack of appreciation of the long-term value of S&T; trade union hostility to the 'creative destruction' of new technologies. To this may be added the persistence of the research-led linear model of innovation, a misconception perpetuated in the media stereotype of the white-coated scientist (usually a white male) bringing some new wonder object out of the laboratory. It is time for a real change. The distinction must be highlighted: **research may lead to innovation, but it is not innovation.** This is more than a semantic distinction.

To affect this shift, the Committee proposes major changes in system governance. It is useful therefore to reiterate what is expected with respect to the governance of the research and innovation system:

- **Agreed mechanisms for prioritisation and agenda setting**
- **Ensuring an enabling environment for innovation of appropriate policy and regulations, including protection of IPR and provision of direct and indirect incentive schemes**
- **Provision of knowledge infrastructure and promotion of human resource development, including mobility**
- **Mechanisms to promote knowledge transfer and exchange, including dissemination, networking and internationalisation**
- **Exercise of oversight, and the accountability of those entrusted with implementation**
- **Policy learning, resting upon monitoring, measurement and evaluation, for review and synoptic purposes.**

Most important is the overall purpose of the research and innovation system. The system makes use of scarce resources and must account for its choices (doing the right thing) and implementation (doing the thing right). The interdependence among the different parts of the innovation system means that piecemeal efforts to improve its performance are not effective on their own. The higher education system cannot expand to meet development needs if the schools fail to educate children properly. They cannot grow by importing and training foreign nationals if immigration policies force those foreign nationals to leave South Africa once they are trained. Companies cannot increase their R&D effort if the universities do not do research and postgraduate education in fields relevant to them, and they may struggle to innovate in the absence of technical services such as metrology. Compared with peer countries, what is singularly

lacking in South Africa is the ability to define and implement mutually consistent policies across different parts of government that enable the development of the national system of innovation and therefore economic growth and development. To do this, **South Africa needs a body for high-level coordination, prioritisation and agenda-setting in the research and innovation system.**

The Committee therefore offers a set of recommendations designed to achieve a governance architecture that is fit for purpose. In so doing the Committee rejects the adage that 'restructuring is an admission of lack of strategy'. The Committee's carefully considered opinion is that restructuring cannot wait; that the inherited structures must be shifted decisively; and that all affected parties are urged to embrace the advocated changes. The Committee argues for a new research and innovation system in which the social sciences, humanities, natural sciences and engineering work in harmony. The change is to be promoted through a high-level consensus-seeking body.

3.7 The Department of Science and Technology

Despite the shortcomings of the NSI, the Committee regards the **public recognition of the DST as a 'good government department'** to be well-deserved. Pioneering initiatives and successes have included:

- The launch of the Innovation Fund and Biotechnology Regional Innovation Centres;
- The setting up of National Centres of (Research) Excellence and the more recently introduced Centres of Competence, as well as the South African Research Chairs Initiative (SARChI)
- A very successful programme of international liaison for research exchanges, collaboration and the general enhancement of available resources
- The currently aggregating and further evolving major components of the National Space Programme
- The key departmental contributions in the Industrial Policy Action Plan, such as the tax incentive scheme for company R&D, the setting up of TIA, NIPMO and university technology transfer offices, and support towards the costs of patenting
- The operation of a spectrum of schemes to enhance R&D cooperation between business and higher education
- Fostering the growth of the Academy of Science of South Africa (ASSAf)
- Many on-going interventions in the technical and knowledge-using capacitation of small and medium firms (through technology stations) and other enterprises featuring prominently in the Minister's current performance agreement with the President.

Balanced against these achievements are the reservations expressed by the OECD review panel five years ago about the functioning of the NSI as a society-wide system, which is largely congruent with the assessment of the current situation in the present review:

- There is still **no common understanding of the NSI** and its purposes across government departments and beyond, and there is uneven support for it, even where it appears to be understood.

- The New Strategic Management Model (NSMM), established in 2004, emphasised a cross-cutting role for the DST in setting common governance standards and quality assurance mechanisms in place for each SETI. In the case of sector-specific science councils, the function of the DST would be to develop interventions in the case of market failure, under-subscription or where there were technology gaps of a strategic nature. The NSMM provided for sector-specific research agencies to remain in the domain of their respective line departments (the Medical Research Council [MRC] with the Department of Health, the Agricultural Research Council [ARC] with the Department of Agriculture, Forestry and Fisheries etc. The **DST, largely as a result of the NSMM organisational model set up in 2004, has not been in a position to create a coherent, truly systemic policy framework to promote and coordinate the NSI**, and has been obliged instead to throw its energies into activities that it seems to have undertaken in the manner of a 'line department', rather than as a system-wide facilitator.

- **The trust placed in voluntary inter-departmental cooperation across the system has not, perhaps predictably, been vindicated.** For example, even a very promising and well-formulated collaboration agreement between the DST and the Department of Higher Education and Training (DHET), already drafted in August 2010, had not been signed by the beginning of 2012, while the Knowledge Economy Forum activities and structures initiated by the DST in order to mobilise joint action across departments have petered away.

- Virtually no prospective NSI planning as envisaged in the White Paper has been possible (although the Committee appreciates that a **funding cluster on Research, Development and Innovation** has been adopted in the current Medium-Term Expenditure Framework), and the retrospective annual STA Report on government expenditure in these areas does not enjoy wide distribution or exposure.

- **NACI has been constrained** to 'advise' only in the same limited NSI domains in which the DST can operate.

- **Supply-side thinking remains pervasive** (with continued emphasis on the linear model of innovation), leading to a continuing poor response to market and social demand.

- There is still **too little systemic coherence and sense of common purpose between the private sector, government, higher education and civil society in NSI functioning in its broader sense** (including governance, decision-making and allocation) or in the agenda for national development.

The key performers of research, development and innovation are private-sector business and state-owned enterprises (SOEs), on the one hand, and public higher education institutions and science councils, on the other. A degree of systemic agenda-setting and prioritisation can be achieved in the private sector itself, especially if it is effectively drawn into the overall governance and delivery vehicles of the NSI, while SOEs are in principle directly amenable to systemic approaches and interventions designed to enhance innovation (see Section 2 of the Executive Summary: The enabling environment for innovation in the private and social sectors).

An example of enhanced systematisation would be **wider stakeholder participation in public-sector funding processes** than is currently the case, where for practical purposes only portions of water and energy research are informed in this way. The generally successful introduction in other countries of **sectoral funds**, administered by boards drawn from a variety of stakeholders, suggests that the benefits already generated by the existing public researcher industry incentive schemes could be extended if some public R&D funds were granted by sectoral boards rather than by the traditional panels of the NRF (this would have to be 'new money', as the existing agency provision is wholly inadequate).

The **state** itself is potentially a powerful site of innovation, both in how it delivers on its mandate and how it forges common purposes with other social partners. **Civil society** also provides a platform for innovative initiatives and brokerage potential between social actors, while having only limited capacity to take innovation to scale.

The overall conception of the NSI must thus take the full range of social actors into account, and work to marshal their distinctive capacities towards addressing the socio-economic development imperatives of the era. These large and complex challenges will mostly not be resolved in the short term, but the means must be constructed now for systemic collaboration between the various sectors in the longer term.

3.8 Structure of the Public Sector National System of Innovation

The current structure of the public sector actors that contribute to the NSI was well described in the 2007 OECD Review, and in summary these operate at four levels:

i. High-level institutions statutorily mandated to provide policy advice to government on innovation, or innovation-related functions, including the National Advisory Council on Innovation (NACI), the Council on Higher Education (CHE) and the National Science and Technology Forum (NSTF)

ii. Government ministries and departments

iii. Research and innovation agencies, including the National Research Foundation and the Medical Research Council

iv. Research-performers, including universities and science councils.

The systemic challenge contained in the idea of the NSI is the need for these agencies, at their various levels, to achieve a **collective coherence in the complementarity of their functions**, and a coordinated impact that makes the best of the resources invested in these entities. The challenges of coherence and coordination run both vertically up and down the levels of authority in the system as well as horizontally between the agencies. As the evaluations provided by the OECD and numerous other reviews have suggested, and as this Committee has noted in its comments above, there is much that must still be done to optimise the functioning of the system.

In particular, a **greater clarification of roles** between various agencies is needed in order to sharpen mandates and rein in mission creep; greater effects can be achieved if the efforts of specialist capacities in addressing complex challenges are well coordinated; and the best-informed intelligence from all quarters of the system must be gathered in setting priorities and deploying resources. There is a need for stronger reciprocal channels of communication, including more strategically configured evaluations of the performance of the system and its constituent agencies.

The need for greater coherence and coordination has long been understood, and a variety of statutory and voluntary mechanisms have arisen to these ends. In addition to the organisations already noted above, and various government-driven efforts to achieve coherence across clusters of departments or across priority outcomes, there are numerous sectoral bodies such as **Higher Education South Africa (HESA**, for higher education institutions) and the **Committee of Heads of Organisations of Research and Technology (COHORT**, mainly for science councils). The contribution of these devices to the strengthening of the NSI varies, but there is little doubt that much more can be achieved than is presently the case.

3.9 Recommendations

In general terms, the Ministerial Review Committee recommends that **the clear and inspirational White Paper conception of the NSI be publicly re-endorsed by government as a potentially decisive driver of national economic and social development, indicating clearly that the NSI must be pervasive and truly systemic in its design and functioning, and that its functionality is core to any systematic national approach to creating jobs, addressing poverty and providing fulfilling life opportunities to all South Africa's people and communities.** What is needed more than ever is a high-level expert body that will offer guidance to the NSI as a whole, a role that neither the defunct MCOST nor NACI has been able to fulfil.

Recommendation 1: The Committee recommends the establishment of a compact (15–20 person) statutory National Council on Research and Innovation (NCRI) to carry out the task of prioritisation and agenda-setting for the NSI, oversight of the system and high-level monitoring of its evolution, outcomes and developmental impact. The Council should be chaired by the Deputy President to emphasise its seniority and its pervasive systemic functions across government and society. The Minister of Science and Technology should be Deputy Chair and Implementation Coordinator because of the key facilitation role of the Department of Science and Technology in the NSI as a whole. The membership of the NCRI should include the ministers from key departments, and influential figures from the private sector, higher education and civil society best positioned to advise on issues of development and innovation. The NCRI must ensure that optimal framework conditions prevail and that financial resources are adequate and must receive system-wide evaluations. It must act to build trust through promoting a culture of responsiveness and administrative fairness. The Council must be equipped to make the hard calls to meet demand and to create supply.

The Committee is of the opinion that failure to establish such a high-level steerage mechanism for the NSI will mean no coherent strategy and no real progress for many years to come. The 2008 review of NACI pointed out the urgent need for the creation of such a body; NACI itself, as currently constituted, is not equipped to perform its proposed roles.

A first task for the Council must be to map out the demands on the research and innovation system for the next decade, and then to advise on broad measures needed to galvanise system actors to these ends, including advising on the mix of public research organisations needed to take up system or market failure.

The Council would make recommendations on future Grand Challenges, major allocations, major equipment needs and new sources of funds. The Council should receive and comment upon all system-wide evaluations, as well as maintain a watching brief on large projects with annual budgets in excess of an amount to be determined by the DST from time to time.

The Council must ensure consistency of efforts to address the supply of high-level resources, from schooling and from further and higher education and training, from other sites of training and across government, the private sector and civil society as a whole. It would be expected to identify policy inconsistencies and recommend appropriate changes.

Recommendation 2: A unitary Research and Innovation Vote should be established, designed to extend beyond the original version that operated until 2005, to function as a macro-coordinating mechanism to ensure that the country's public researchers in all public research-performing institutions (i.e. both higher education institutions and science councils), are adequately supported to perform their work. The NCRI, in consultation with cognate advisory bodies, should provide the oversight of the broad size and shape of this allocation. The NCRI should not be responsible for making specific budget allocation decisions, however.

Particular attention needs to be given to the adequacy of public funds awarded to research performers throughout the system as grants (to higher education institutions) or budgets (to science councils). There has been clear recognition for some time (in successive NRF and MRC SETI reviews, for example) that the average amounts of funding made available in agency mode have been inadequate for their multiple purposes of generating new knowledge and human capital as well as innovations. The total amounts allocated by the NRF and MRC, as well as the incentive schemes for industry for public researcher collaboration, must accordingly be increased to about twice their current levels as soon as possible.

In this context, the Committee is of the opinion that **the public grant-making agency function should be consolidated within the NRF,** so that a common policy framework and better-coordinated delivery model can be built, incorporating and generalising the successful instruments of promotion (Centres of Excellence, Centres of Competence, Research Chairs and major equipment provision) that have been introduced with such significant impact in recent years. This would incidentally also facilitate re-considering the mandate of the MRC as a science council.

Recommendation 3: The present NACI should be transformed into a new statutory Office for Research and Innovation Policy (ORIP). This arms-length body should compile evidence regarding

both success and failure across the system in order to inform policy and planning by the NCRI and the DST, and associated policy nexus platforms. Among other things, ORIP should monitor the research investment climate, to determine and advise on any inhibiting factors and the performance of the system in responding to priority needs identified by the NCRI. The ORIP should, for example, be responsible for the **National R&D and Innovation Surveys**, and for **designing information and indicator systems, technology foresight and social fabric studies; and the development of a researcher database** (see Section 6 of the Phase Two report: Monitoring and evaluation, for details). ASSAf should work closely with the proposed ORIP to ensure that sound, multi-perspective, evidence-based reviews of key issues in the NSI are conducted.

Recommendation 4: The Ministry and Department of Science and Technology should henceforth primarily function as a pervasive, systemic formulator and coordinator of NSI-related policy and strategy, consistent with the decisions of the NCRI, allocating macro-resources, promoting system learning through the oversight of effective and integrated monitoring and evaluation, maximising international cooperation and resources, systemically overseeing public research organisations, and providing best-possible knowledge infrastructure (people, equipment and facilities, and cyber-infrastructure) within the public sector.

Recommendation 5: In order for the NSI to be systemic in the fullest sense, the Committee recommends that **the NSI needs at least three well-functioning 'core' policy nexuses, each structured through a written collaboration agreement spelling out how policy harmonisation and the coordination of implementation action plans would be continuously ensured:**

- **One focused on post-school education and training involving the Department of Higher Education and Training (DHET) and the DST**
- **One focused on business and enterprise development, involving at least the departments of Trade and Industry (the dti), the Economic Development (EDD), Public Enterprises (DPE) and the DST**
- **One focused on social development and social innovation, involving the DST and departments concerned with social and rural development, and the social security, health and education complex.**

The Committee states that failure to create well-functioning policy nexuses as described will very likely be associated with serious and continuing stasis at the very core of the NSI.

Recommendation 6: Because grant-making is not only a question of the amount of funding but also of its efficacy, **the Committee recommends the purposeful elaboration of a new, additional mode of public grant-making based on the principle of cooperatively allocated sectoral funds.** The priority sectors for such a mode would be identified by the NCRI from time to time (e.g. based on the Grand Challenges' of the TYIP). **Boards would be established, involving all NSI stakeholders,** to articulate the precise demands and to develop translational solutions. While in principle the funding could be drawn from the levies already raised against the depletion of some natural resources (minerals), as is done in Brazil and Norway, it would be easier to apply to this purpose some of the urgently required increase in total agency funding (see Recommendation 2).

The sectoral funds could address both technological and social innovation dimensions of a focus area; one of them could, for example, be a Social Innovation Fund (perhaps in partnership with private sector philanthropy) to address social innovation needs identified by the NCRI.

The new funds should be structured so that they constitute well-informed consultative forums, including industry and government actors, for the identification of sector-specific strategic priorities and the development of corresponding research and innovation agendas. Reports and recommendations from the funds should inform the deliberations of the NCRI, and vice versa, investing the funds with both systemic alignment and gravitas.

Recommendation 7: The present organisational model for government research (the DST-run science councils, the sectoral science councils and the in-house S&T technical service organisations) needs to be revised to permit coherent, integrated and optimised mandates to be designed in each case within common policy frameworks, so that strategically directed funding flows can be applied across all these significant components of, and contributors to, the NSI. **The Committee recommends that the NCRI should commission a review of the science councils and all other public research organisations (PRO)s, including, but not limited to the National Health Laboratory Service (NHLS), the scientific sections of museums, and Onderstepoort Biological Products.**

The review must enable Government to make hard choices. **It should review the reporting lines, missions, future functions and resource requirements of the science councils and PROs (including whether to terminate them, modify their mandates or establish new ones).** It should take careful account of international practice and of variations in the role of such organisations over time and at different levels of development. The review should also consider how science councils, other SETIs and the private sector could become more fully involved in postgraduate supervision and human capital development generally.

The establishment principles and mandates of research-performing science councils should be redefined and used to review each of these organisations in a 'fitness of purpose' exercise, along with the periodic 'fitness for purpose' SETI reviews.

Efficiency, effectiveness and funding considerations would attend a decision to move into the science councils many of the scientific and technical services that are currently housed in government departments, which are likely to be both more functional and innovative if they were incorporated into a relevant science council or another body. This would also apply if most or all of the national facilities currently operated by the NRF were relocated to other bodies.

The science councils and public research organisations (PROs) would be asked to engage with the review by providing:

- An analysis of their offerings, broken down as essential services (including extension services), public goods research and client-oriented research, with associated revenue, outputs and impact
- A plan, including financial and staff requirements of how they would (i) address poverty and under-development, and (ii) simultaneously develop mechanisms to meet client demand and effect technology transfer.

If fully implemented, these seven recommendations will bring about the deep structural transformation needed to enable the research and innovation system to engage with the war on poverty, enhance competitiveness, build the human resource base and contribute to improved well-being.

SECTION 4: ENABLING ENVIRONMENT FOR INNOVATION IN THE PRIVATE AND SOCIAL SECTORS

4.1 Role of the Private Sector in Innovation

The terms of reference of the Review pose the question of "whether the country is making optimal use of its existing strengths and whether it is well positioned to respond rapidly to a changing global context and thus to meet the needs of the country in the coming ten to thirty years". This question applies to the public and private sectors of the system of innovation, separately and conjointly.

To answer the question, the discussion starts with the economy, then turns to what it does in terms of renewal, expansion and innovation.

South Africa has a market economy, in which entrepreneurs play the leading role. It is this open and vibrant economy that has brought South Africa into the G-20 and the BRIC club. The economy shows dynamism and innovativeness, the Rand is freely convertible and highly traded, and the JSE has a market capitalisation among the top 20 of the world, yet the economy appears to be trapped in a low growth trajectory. In the 1960s, GDP per capita in South Africa was higher than that of Mexico, Malaysia and Korea. They have since surged ahead, while South Africa has stalled.

The 2010–2011 Global Competitiveness Index (WEF 2010) provides more detail. South Africa is categorised as a **factor-driven economy**. Of the 139 countries measured, South Africa is ranked 54th, down from 45th the previous year. While South Africa is in 9th position for financial development, business sophistication is ranked 38th, innovation 44th, technological readiness 76th, labour market efficiency 97th and health and primary education 129th. This seems to be paradoxical – sophisticated financial systems alongside poor health and education outcomes. The cynic might retort that there is no paradox, and that this is an artefact of South Africa's previous and present inequalities. The indicators certainly raise interesting questions as South Africa aspires to becoming an innovation-driven economy. It is apposite to note that HSBC places South Africa at rank 30 in the year 2050, down two places from the current position.

The **composition of GDP** has shifted dramatically over the last half century. Currently GDP is made up of agriculture, forestry and fishing (2.7%), mining and quarrying (7.3%), manufacturing (18.6%), electricity, gas and water (2.3%), construction (2.4%) and services 66.7%. The main feature is the rise of manufacturing and the fall of the share of mining. As such, the economy resembles that of an OECD member state. It is services led, and agriculture at 2.7% plays a small role, although it employs 9% of the workforce.

The same shift is seen in the **composition of exports** (Edwards and Alves 2005), in which the value of manufactured goods has surpassed mining. In the 1970s, gold made up 60% of exports; by 2000 this was down to 29%. Nonetheless, South Africa's exports still comprise commodities to

a large extent, along with motor vehicles and components, none of which embody South African intellectual property. There is no IP in a gold ingot or ton of coal. The IP in a German coupé is owned in Stuttgart, not East London.

A relatively **small number of companies dominate the economy**, some with roots going back nearly two hundred years; others, especially in telecommunications, are naturally younger. Many 'local' companies are the successors of originally foreign-owned companies since acquired by local interests; Altron is a good example. In similar vein, South African transnational corporations (TNCs) acquire companies abroad. This is the nature of globalisation, with mergers and acquisitions in all directions, and some 'greenfield' investment too. The international expansion of South Africa's TNCs is mainly through acquisitions, as for example the case of SAB Miller buying up brewers from Patagonia to Perth. Australian BHP purchased South African Billiton; South African Old Mutual purchased Swedish Skandia. These are the dynamics of an open economy.

Foreign mergers and acquisitions are not enough, however. The domestic economy must expand and thereby create employment opportunities, and it is the private sector that must make this happen. So far this has not occurred.

What then is to be done? The simple answer is for South Africa to focus, build on what it has, and grow what it does not have.

According to Hobsbawm (1962) industrial revolutions require two things, the prospect of high profits and a monopoly position. Diamonds and gold powered South Africa's industrial revolution, and, with cheap labour, offered fabulous profits, thereby creating the mining houses. What did not happen was Hobsbawm's second stage, the emergence of a strong capital goods market. The plausible vision referred to in Section 3.1 above suggests what such a capital goods sector might look like.

The turning point came in the 1970s as 'peak gold' was reached. Today South Africa produces less than one quarter of that level. Fortunately, platinum ('white gold') has come to South Africa's rescue, and it now exceeds the export value of gold. The issue is that mining involves the wasting of an asset. Diversification of the economy did occur, but too much effort went into the fruitless quest of preserving white hegemony at any cost. The large space between mining and services has to be filled by yet more productive activity. The 1990 turning point saw globalisation without industrial deepening, except for automotives and a few other niche players.

Figure 2 illustrates how this **industrial deepening** might come about. It is an adaptation of the well-known illustration of Finland's diversification from growing pine trees to becoming a leader in pulp and paper and associated machinery (Routti 2007; Kahn 2007).

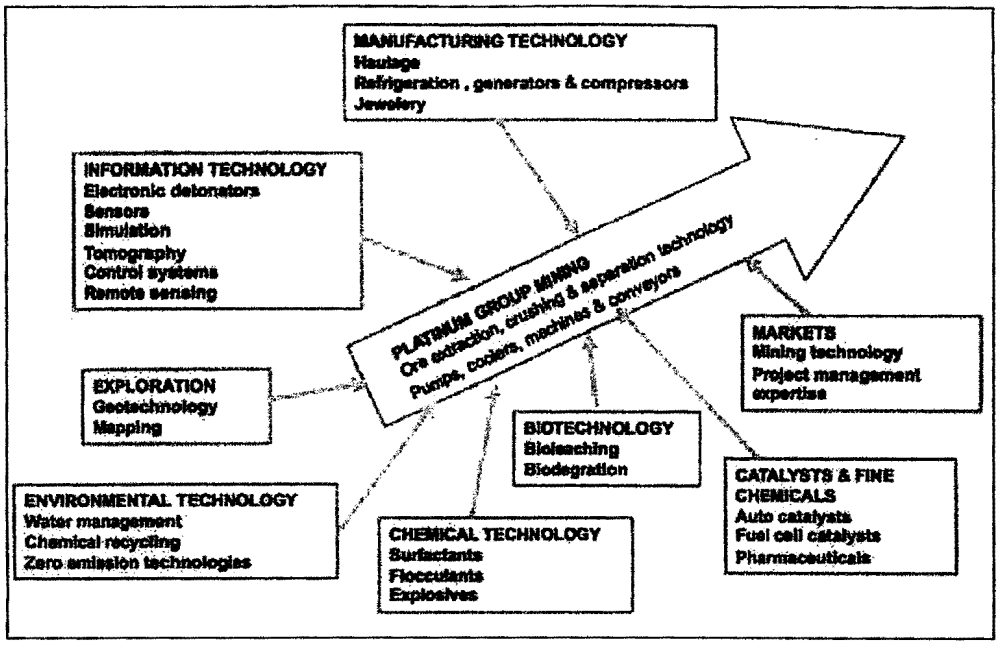

Figure 2: Securing competitiveness in the platinum group mining sector

This diagram makes the case that **diversification** is not only possible, but that it has already happened. Electronic detonators were a spill-over from defence R&D and the expertise in catalysts that started with Sasol's desire to break the US monopoly on the supply of iron catalysts. Bioleaching of minerals was a Gencor technology. That company no longer exists, and BHP Billiton is a leader in the field. Though few in number, South Africa holds patents in virtually every box in Figure 2 and has expertise in the others. Further horizontal diversification is desirable, possible but constrained.

At the same time, **infrastructural weaknesses** have compromised the real potential of mining exports and employment creation.

The reasons for the constraints on diversification are complex and disputed. It is agreed, however, that there are risks in the actions of starting a business, introducing new product lines and re-organisation. Factors that increase that risk may induce those with excess capital to seek opportunities with lower risk and higher returns elsewhere. This is the essence of free markets.

Innovation entails the introduction of new or significantly improved goods or services, or processes into a market or organisation. That is the standard definition for business, and is relevant to this discussion. Innovation activities are diverse and include the search for information, bringing in new skills, reverse engineering, design, R&D, training and protecting intellectual property.

The private sector is the most important source of finance for, and performer of, R&D; it is a key strategic partner for government to engage with in promoting R&D investment in the

country. The private sector consists of local businesses, including small, medium and large enterprises, foreign-owned companies in South Africa and other foreign R&D-intensive companies that invest in South Africa in a variety of other ways.

Government has little direct control over the private sector in respect of self-driven R&D but plays a critical role in creating favourable framework conditions for product and process innovation, as well as 'steering the ship' to support mainstream policies and attain national objectives. Government obviously exerts much more influence over state-owned enterprises, several of which are major performers of R&D, both here and elsewhere, which accounts for the 20% of total business R&D expenditure sourced from government. This is mainly sourced from government; increasing R&D in this sector is therefore relatively simple if the will to do so is present.

It stands to reason that factors that increase the risks associated with innovation may impede its introduction. The adage should be remembered that 'necessity is the mother of invention'. For necessity some might substitute the word 'crisis.' Above all, South Africa's historical record shows a people that can innovate 'out of a bind'.

Two sources of evidence serve to inform the thinking about private sector innovation in South Africa, and placed together they constitute another paradox. The first and most commonly used evidence is the award of **patents at the United States Patent and Trademark Office (USPTO)**; the second is softer and arises from what is known as the **Innovation Survey** (OECD 2005c).

Put concisely, South Africa's patenting intensity has remained static over three decades, but is showing signs of revival with 91, 93 and 116 US patents in 2008, 2009 and 2010 respectively. Other countries such as Brazil and Norway that are also commodity exporters show a much faster rise in patenting levels. South Africa is lagging behind. It is some consolation to recognise that South Africa has a historic depth of patenting in technologies such as catalysis, ore separation and transportation, and electrical switching.

According to the official Innovation Surveys for 2002–2004 and 2005–2007, the proportion of South African companies claiming to have introduced innovations is among the three highest of the 60 or so countries that carry out such surveys. It is paradoxical that South African companies innovate, but do not patent; they innovate, but this does not translate into new jobs.

Part of the reason lies in the **types of innovations** that are introduced, which are mainly incremental and adaptive. In this, South Africa is similar to many other countries, including Denmark. Korea, in its industrialisation over the period 1963–1987, was awarded only 343 USPTO patents and largely engaged in imitation and reverse engineering; over the same period, the South African tally was 1744. This is the historic depth. The low levels of patenting activity arise from the fields in which South Africa is at the technological frontier, and in which it is necessary to register patents. Many of South Africa's high-technology exports are in the military domain where patenting is avoided in order to protect trade secrets. For medium-high technology such as

automotive products, South Africa is an original equipment manufacturer (OEM), which involves no local patents.

To this picture must be added other evidence from the Innovation Surveys. As in other countries, South Africa companies get their ideas for innovation mainly from other companies. Suppliers make changes that impact on the manufacturer; customers demand something new; the competition nibbles at market share. To innovate is to survive and prosper.

In the schema of innovation systems, the private sector, universities and public research organisations synergise toward innovation. The issue is where public research organisations feature in the complex activity of innovation.

As noted above, the prime sources of innovation for companies are other companies. Companies will collaborate with outside entities if it makes sense in terms of risk, financial reward and protection of their intellectual property. As in other countries, South African companies attribute much lower importance to universities and public research organisations as sources of information for innovation. A concern is that there has been a decline in the perceived importance to innovation of universities and public research organisations over the period 2004 to 2007. The universities, science councils and other public research organisations remain the primary sources of the highly skilled that bring to business new ideas and competences in the use of advanced scientific equipment.

Generally speaking, according to the definition of innovation, universities and public research organisations are not in the business of innovation. Universities are essentially in the business of teaching and research, while the public research organisations perform essential services and conduct applied research. Innovation should not be confused with research. Without universities, companies would be starved of the highly skilled and the new ideas that they bring.

There are two important exceptions to this characterisation of public research organisations, namely to those working in agriculture and health. In both cases they are also major sources of innovation. South Africa is 13th in the world (2.6% of the total) for the registration of plant varieties, an achievement involving the private sector, universities and the ARC. This goes a long way to explaining the country's food security, and why South Africa is a successful exporter of agricultural products. There is a sectoral system of innovation in agriculture.

Two further aspects of the relationship between the private sector and higher education are important. The first is that by world norms, the R454 million of **local private sector funding of research in the universities** was among the highest in the world at 10.8%. (If foreign private sector funding were added, the figure would be considerably above the world norm.) Moreover, roughly half of the R454 million flows as a result of THRIP. The second is that the private sector, locally and globally, has high regard for the leading research universities, hence the inclusion of the Universities of Cape Town, the Witwatersrand and KwaZulu-Natal in the international league tables.

National Treasury, the dti, the Harvard Group, and others have sought to understand what is holding South Africa back and then to craft policy for the economy to break out of its constraints. The dti's Industrial Policy Action Plan and EDD's New Growth Path represent the government's response to this. DST for its part has sought to revitalise the innovation system through the Ten-Year Innovation Plan.

According to Harvard academics Hausmann and Klinger (2006), South Africa's export predicament is central to the argument that for South Africa to grow, it must export. Their paper concludes, "A lagging process of structural transformation is part of the explanation for stagnant exports per capita. **Slow structural transformation in South Africa is found to be a consequence of the peripheral nature of South Africa's productive capabilities.**" The paper notes that South Africa is an outlier among comparator countries, but has strengths in four sectors in which existing technological capability can be expanded to grow export markets, namely agriculture, machinery and equipment, chemicals and pharmaceuticals. It is because of the structure of the economy that South Africa's innovative activity remains incremental, and, as measured by patents the country is lagging.

Three expert contributions were commissioned to inform this section.

Segal (2011) provided a case study on the generation of intellectual property by examining 'dry cooling' power station technology. Eskom is a world leader in this area, but patenting does not protect the IP as "it is not in the culture of the electricity supply industry, perhaps particularly in the power utilities themselves, to think proactively and certainly protectively about management of its intellectual property. This attitude is inevitably reinforced by the fact of so many utilities internationally being publicly owned monopolies that typically do not compete with one another" (Segal 2011: 9). Eskom has a great deal of know-how, but no associated product to export in this case.

Kaplan (2011) addressed industrial policy, noting that the inputs to innovation[5] appear to have been accompanied by stagnation or low growth in outputs, which points to inefficiency. Since the system is thus sub-optimal, **"the first-order policy priority should be improving the efficiency of the system rather than expending more resources"**. He goes on to argue that there is no correspondence between the dti/EDD industrial policies and the technology and innovation policy of the DST, and then offers two suggestions that echo with the Harvard advice: firstly, that attention should be given to working with existing technological competences and migrating these into new areas of production rather than trying to emulate the world leaders at the technology frontier; and secondly, that South Africa should invest in sectors that exhibit a "high ratio of training and innovation per increase in unit of output".

It is the social impact of innovation that Marcelle (2011: 4) seeks to address since, "The biggest challenges facing countries in the developing world include poor health services, lack of affordable housing, environmental sustainability, energy, poverty, urban management, and a range of other issues that affect quality of life." This implies a different focus for R&D efforts, since in her view local "R&D aimed at producing technological breakthroughs at the technology frontier is almost negligible" (ibid 4). Her assessment (ibid 5) is that, "**The average South African**

[5] Business expenditure on R&D in 2008 Rand almost doubled over the period 2001/02 to 2008/09.

firm does not have active learning as a distributed networking process in which firms learn through interaction within a highly differentiated network including strategic alliances and collaborating competitors."

These three inputs share a common theme of how companies go about learning, adapt to the environment and formulate appropriate strategies.

The list of plausible areas for export growth suggested by Hausmann and Klinger (2006) is considered one by one, seeking evidence for strength and alignment with industrial and innovation policy, namely: agriculture, machinery and equipment, chemicals and pharmaceuticals.

Evidence of strength in **agricultural development** has already been mentioned, citing prestige in plant cultivars. This is matched with research across related fields (plant science, ecology, environmental science) that make up some 20% of South Africa's total scientific output. Agriculture is the theme of the 'Farmer to Pharma' Grand Challenges of the Ten-Year Innovation Plan (TYIP).

In the **machinery and equipment** sector, there are pockets of expertise in mechanical engineering and mechatronics in the universities (and universities of technology) that extend into the private sector through the Denel group and heavy engineering works on the East Rand, and include companies such as Bell Engineering and Defy (Segal 2011). In the period 2000–2004, South Africa was ranked 13th in the patent class for power conveyors (Pouris 2009), an activity involving mechanical and electrical engineering. There is also expertise in Eskom, Transnet, the CSIR and ARC. However, South Africa has dropped in the rankings and is now ranked 18th for Power Conveyors. Heavy equipment is a field that South Africa could enter, given the will, as sketched out in the thirty-year scenario (see Section 3.1 above) South Africa has the steel and the energy, and the expertise can be grown. A decision is needed in this regard.

The evolution of Bell Engineering and Defy may be noted in passing. Both companies found it necessary to enter into technology-sharing agreements with foreign partners. Bell Engineering shares technology development with 31.6% shareholder John Deere of the US but remains based in South Africa, while Defy has left Franke Holdings of Switzerland and is now owned by Arcelik of Turkey, the third largest white goods manufacturer in Europe. Bell Engineering and Defy began as small family concerns, which is nothing new. Pick n Pay and Bidvest also started small, and became large. While there is a vast literature on macro-economics and labour economics, there is a huge gap in the knowledge of how small and micro enterprises emerge and prosper. One may look with admiration at the two hundred company case studies assembled under Kim (1997) that provided a basis for understanding the shift in Korea from imitation to innovation. That approach is certainly worth copying in South Africa.

Interestingly, if by equipment is meant **electrical equipment**, then South Africa is already a niche player, exemplified by UEC, Reunert, Circuit Breaker Industries, Tellumat, the former Omnipless (now Cobham), the Denel group and others, many of which use know-how arising from defence-

related research spill-overs. These are all world-class companies, some of whose technologies are patented, and some not. Over the period 2000–2004, South Africa was ranked 18th in the patent class Communication: Electrical. These companies contribute to South Africa's small volume of high-technology exports. It should be noted, however, that over the period 2006–2010, South Africa slipped to 24th rank in Communication: Electrical alongside Norway.[6] It is the residual expertise in the Telemetry Cluster of Innovation that makes the Space Science and Technology Grand Challenge an interesting possibility. Whether this should be a Grand Challenge priority is another matter.

Most of the South African patents at USPTO have been awarded to Sasol, essentially in Chemical Engineering and related fields. Sasol increasingly also holds patents in other countries where it is involved in production; its patent share is ranked at number 4 in the world. Sasol maintains its own large laboratories and links closely with local universities. Where Sasol identifies expertise abroad, as in Scotland, it also makes R&D investments, but its strength lies in home-based R&D. Chemicals are already an export product.

South Africa has strengths in **pharmaceuticals** in companies such as Aspen, Adcock-Ingram and Cipla, but is currently not involved in drug discovery. Over the period 2000–2004, South Africa was ranked 22nd in the patent class Drug, Bio-affecting and Body Treating Compositions. The related scientific fields of biochemistry, biotechnology, pharmacology, microbiology and virology make up some 15% of scientific publications. It must be recognised that **drug discovery** requires massive investments and a great deal of patience. It should also be taken into consideration that South Africa has slipped in the Drug patent class ranking to number 34, below Cuba. Taking these considerations into account, South Africa's prospects become somewhat dimmer.

Pharmaceuticals may feature in both IPAP and the TYIP, but there are issues to be addressed, including bureaucratic hurdles and possibly hostile regulators. An example is found in the section of the TYIP that confuses foreign direct investment and clinical trials. By definition these are different things. To exclude clinical trials from South Africa would be an error of judgement, since professionally managed clinical trials (as they are in South Africa) are a source of learning both for South Africa and for foreign companies and essential to proving efficacy. Exclusion would be short sighted, and it would cripple the South African pharmaceutical industry to restrict foreign company clinical trials. Openness is essential to success in pharmaceuticals, including the possibility of South Africa conducting clinical trials in foreign countries if it wishes to become a global player in this field.

The background role played by public research organisations, especially the science councils and universities is integral to the above discussion, as explicated in the discussion of the governance of the NSI.

If the arguments made in Section 3 for the revision of the **mandate of science councils are accepted, these organisations would variably be special purpose vehicles of government, or of a**

[6] http://www.uspto.gov/web/offices/ac/ido/oeip/taf/tecstc/clstc_gd.htm

sector or sectors of government, designed and funded to perform operational R&D directly linked to government functions and especially service delivery, as well as R&D that is not easily or optimally done at HEIs.(whether for reasons of justified secrecy; or continuing linkage to an indefinitely required scientific/technical public service; or based on a unique facility in terms of cost and scale; or simply, and probably temporarily, to supply a skills-set that no HEI [yet] possesses; or for other valid reasons). They would essentially conduct R&D for the private sector only on the client–contractor principle, and at full cost recovery.

The discussion of the areas where South Africa has technology strength, at least as evidenced in the awarding of US patents, shows that South Africa is a small player. Elsewhere in this review, the South African innovation system was compared with that of Norway in terms of size and scientific productivity. The same holds for the above-noted patenting activity, with the exception of Fischer-Tropsch catalysis where South Africa is strong in relative terms – on par with France and ahead of Germany, where the technology began ninety years ago. Norway, despite its oil and gas reserves, is not involved in Fischer-Tropsch technology.

An important aspect of the environment for innovation is the **regulatory framework for intellectual property rights**. As noted earlier, local companies innovate, but do not patent. It is necessary to understand this behaviour. The Committee' therefore approached patent attorneys in order to gauge the suitability of the intellectual property regime and received the following responses, in summary:

- Over-enthusiasm on the part of patent applicants often confuses know-how with invention; these are quite different things.
- Patenting in the US is costly and only makes sense for those that intend to sell in that market.
- South Africa's non-examining patent regime is advantageous in speeding up IP protection.
- The patenting side of the Companies and Intellectual Properties Commission (CIPC) is functioning satisfactorily (in part because patent attorneys have close working relations with CIPC.)
- The Technology Innovation Agency has taken too long to become operationalised and has thus introduced further delays and uncertainties for beneficiaries.

The regulatory environment, although well intended (involving clinical trials, field trials and bio-prospecting) is increasingly burdensome for its users.

There has now been a significant change in the status of patents in respect of exchange control. The Oilwell (Pty) Ltd v Protec International Ltd judgement of March 2011 no longer views patents as 'capital' whose movement is subject to section 10(c) of the Exchange Control Act. Uncertainty remains, however, since there are indications of a desire on the part of government to effect greater rather than less control over national intangibles and resource assets.

It is a matter of concern that the European Patent office will no longer capture South African patent data manually. The installation of a state-of-the-art electronic database for patent management at CIPC is thus a critical issue for the dti, and by implication, the DST.

The message is that being internationally competitive extends to all facets of the innovation system, requiring high-quality staff, and institutions and regulations that enable, rather than hinder. The work of Kaplan (2011) and Pouris (2009), as well as evidence submitted to the Parliamentary Portfolio Committee on Science and Technology, give rise to concerns that the present **IP law and other regulation of research** are counter-productive. While it is too early to assess the impact of the Intellectual Property from Publicly-funded Research Act (Act No. 51 of 2008), the delays inherent in the new NIPMO suggest that there may be more problems in the future.

Moreover, there are signs that local and foreign companies may, as occurred in the United States after the Bayh-Dole Act, limit their cooperation with universities especially where sensitive IP is concerned. Even the attempt to segment ownership of IP through full-cost payment may push companies to outsource their R&D to other private providers rather than to universities.

The submission from **Business Leadership South Africa (BLSA)** received in Phase One of the review argues for an active role for the state in science and technology, but expresses concern that there is an over-emphasis on 'big science' at the expense of interventions that could make a difference to business, notably to address the lack of venture capital and 'angel funding'. In the view of the BLSA, this leads to the migration of "many top people and companies to countries where the governments provide well-structured incentives". BLSA also believes that, "In many respects, the roles and functions of DST are relatively unknown and the key role players are simply not visible", while otherwise sound incentive programmes appear not to address the needs of industry, and the implementation agencies are not user-friendly.

While the Committee does not necessarily endorse each and every sentiment reported herein, it is clear that there is a serious disconnect, and the Committee hastens to add that it is a systemic disconnect, with deep roots and many drivers.

The Committee reiterates **the importance of synergy between the two pillars of government that enable the entire system of research and innovation, namely the DST and DHET on the one hand, and the dti on the other.**

The mechanisms that a number of countries use to achieve this are combinations of steering and selection agencies (e.g. TEKES in Finland and FINEP in Brazil) with **'sectoral' or 'industrial' innovation funds**. The Committee considers the introduction of such funds as an essential way of bridging the industry–science gap, and **shifting the emphasis from supply-side science towards demand-led innovation**. These new Industrial Research and Innovation Funds should be structured so that they constitute well-informed consultative forums – including industry and government actors – for the development of sector-specific strategic priorities for research and innovation. Reports and recommendations from the funds should inform the deliberations of the

National Council on Research and Innovation (NCRI), and vice versa. This linkage to the peak authority should invest these funds with both systemic alignment and systemic gravitas.

4.1.1 An Open National System of Innovation

A fundamental quality required in the enabling environment for innovation is the openness and permeability of the system. The capacity for learning, adaptation and novelty depends on the **free flow of talent and ideas within and across organisations, national systems and globally**. This has implications for the mobility of talented people, the availability of knowledge and lessons from elsewhere, and the freedom for new insights to arise across and between fields. Both **immigration policies** and **intellectual property regimes** need to be judiciously calculated to enable systemic openness for planned and fortuitous chemistries of innovation. Allowing foreigners to apply on equal terms for vacant posts in South African research institutions, business and industry acts as a competitive stimulus and a bench-marking tool in the system; it also permits the country to enlarge the pools in areas of talent shortfalls and to introduce fresh ideas into the relatively small and introspective research community. The legal framework and regulatory regimen for work permits and visas must be simplified and rendered as user-friendly as possible. The proposal of the National Planning Commission that foreign doctoral graduates be granted work permits for up to seven years reflects the kind of new thinking that is urgently needed.

The NSI requires active measures that will **promote collaboration across boundaries** within the national system and more broadly across the globe. This should include arrangements for the optimal utilisation of research infrastructure and the promotion of a culture of sharing and support for access to research facilities, including encouraging reciprocal access to equipment held by the private sector and state-owned enterprises.

International collaboration and linkages are indispensable components of healthy knowledge transfer and exchange. The DST, often using the NRF as its agent, has done a sterling job in promoting and managing cooperation schemes with selected countries in a variety of formats. A particularly significant achievement has been to make South Africa one of the principal beneficiaries of the European Union Framework Programmes. Less effective, perhaps, has been the use of the International Council for Science (ICSU) to leverage resources for the development of the individual disciplines represented by ICSU.

In this context, the benefits from **South Africa's involvement in the African Union's S&T activities**, including those related to the New Partnership for Africa's Development (NEPAD), have so far been less obvious, with some success stories (e.g. the African Science and Technology Indicators Initiative) and a number of less dynamic activities. They remain an essential part of the way in which the NSI can harness outside elements and create value for all participants.

4.1.2 An Enabling Public Sector

The **state-owned business enterprises** (SOEs) account for a substantial segment of business R&D conducted in the country. Government can obviously exert a reasonable measure of policy control over innovation in state-owned enterprises, several of which are major performers of

R&D, both here and elsewhere, and account for the 20% of total business R&D expenditure that is sourced from government. State-owned enterprises also have considerable potential for energising innovation through their large-scale procurement activity and through international linkages; they are also extensively involved in technology transfer, with attendant opportunities for local adaptive innovation. The Industrial Development Corporation (IDC) and the Public Investment Corporation (PIC) are additional, potentially important levers for innovation.

An innovative public service stimulates innovative business enterprise and can energise the entire NSI. Examples of dramatic improvements in the public service efficiency include:

- The ease with which passports and ID books are now issued and renewed
- The massive transformation of the tax-collection system introduced by e-filing
- Much-simplified, online employer and worker registrations and payments by the Unemployment Insurance Fund.

These are examples of how government through **innovative service delivery** can create not only a sense of future possibilities, but can also develop processes that are core to business activity and make investment wheels more workable. This is vital for both established and emergent enterprises. There is, of course, still a great deal to be done in the many areas of public service delivery that must underpin a well-functioning NSI, especially in regard to the regulatory and science-technology services operated in line departments responsible for health, agriculture, the environment, police, etc.

The Committee noted the recent formation of the TIA, and that the agency has not yet had time to establish a track record of performance. However, the Committee observed that the strategy for the constitution of TIA involved the inclusion of a number of pre-existing agencies and wondered about the fit between the capabilities provided by these residual bodies and the role that TIA should play in the future. Given the insight into the current and future NSI generated during the Ministerial Review process and the role TIA should play into the future, the Committee believes that TIA should benefit from formative evaluation sooner rather than later to ensure that the mandate and powers accorded to TIA are appropriate for the planned future trajectory of the NSI, and that TIA is appropriately equipped with the skills and capability to fulfil this role.

4.1.3 Recommendations

Recommendation 8: Systematic efforts should be made to bring industry and government closer together, and to strengthen the response of the system to demand signals from business and industry, on the one hand, and social spheres, on the other. The effective participation of the private sector should be structured into all levels of the system, including participation in the NCRI; strong establishment of the skills bases; encouraging reciprocal access to equipment held by the private sector and state-owned enterprises; and a repertoire of policy instruments within the respective three proposed nexuses of (i) the DST and DHET (focusing on higher education), (ii) the DST, dti, EDD and DPE (focusing on industry and business in general) and (iii) the DST with the various departments whose portfolios have implications for social development and social innovation, and the linkage of social security measures with education, health, etc. These should be directed to the sustainable development of the economy through

efforts to promote competitiveness, the establishment of firms and job creation, and poverty reduction (see Recommendation 5).

It is clear that a 'one size fits all' approach to company support will be ineffective. A diversified approach is required that caters for size and sectoral distinctions. Small companies generally cannot access incentives in the same way that large firms do. Technopolis, the UK innovation policy consultancy, has developed a schema (Figure 3) that assists in understanding the varying needs and capacities of firms according to their research and technological capability.

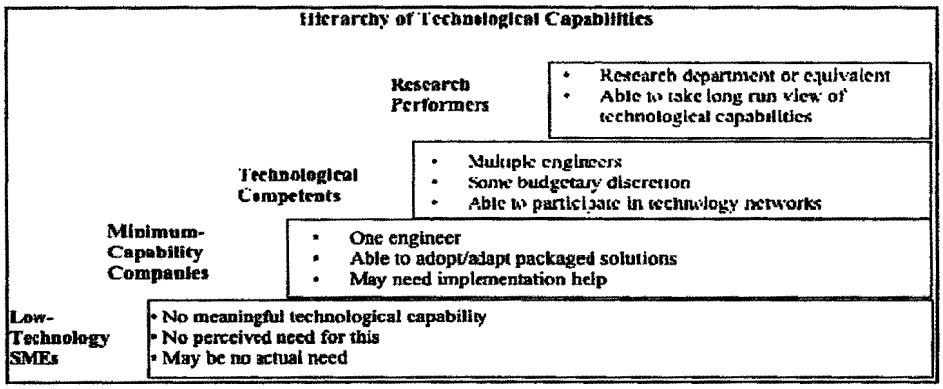

Figure 3: Firms' characteristics and technological capabilities (Arnold 2011)

The essential message of this hierarchy of technological capabilities is that companies do not operate on a level playing field. SMEs lack the in-house skills to access incentives, even where they are aware of these. To overcome this, Austria, for example, makes its tax incentives available to start-ups before they show a profit. Other countries have adopted technology voucher schemes to provide assistance to small firms that lack in-house technology expertise. As these firms develop capacity, they can then benefit from incubators and more sophisticated support.

This implies that there should be sufficient well-informed and skilled intermediaries available in public sector agencies to facilitate transitions to more sophisticated levels of capability. However, Kaplan (2011) notes, "The DST has very few staff with any knowledge of business."

This situation mirrors the dti's IPAP, which, apart from mentioning the CSIR, shows limited understanding of the importance of the science component of the research and innovation system.

Recommendation 9: Government departments that form the key pillars of the research and innovation system and must draw to their ranks staff with direct experience of the business, civil and research environments so as to enable cross-sectoral collaboration and to boost the absorptive capacity of organisations for reciprocal learning and adaptation. A concerted effort must be made to bridge the knowledge transfer gap between local companies (big and small) and public-sector researchers and administrators, in order to ensure that the nation's considerable intellectual resources are utilised to a much greater extent. These capacities should become the subject of deliberate skills-building and case-study research to boost South Africa's collaborative abilities across all sectors within the NSI.

Internationalisation has seen the volume of scientific production rise somewhat, despite a hiatus in the number of full-time equivalent researchers. However, South Africa's ability to generate new technologies has not grown apace, as measured by US patent awards. South Africa is in grave danger of falling even further behind, and the HSBC's prediction of South Africa's future at rank 30 begins to take on predictive rather than speculative form.

It has been noted that the economy and the innovation system are open, yet South Africa has singularly failed to attract international research centres in manufacturing industry, and with the exception of the Meraka Institute, in ICT as well. This diagnosis is supported by Kaplan (2011), who notes the absence of multinational corporations establishing large R&D centres in South Africa, as well as low levels of patent co-invention.

The summary report of the Harvard Group made the case that when it came to employment creation, it was not a question of high-technology skills versus labour-intensive technologies. Instead, the lack of high-level skills retarded the growth of employment in the economy at all levels.

There really is no debate that **skilled human resources** are critical. Kaplan (2011) advances the case by arguing that the choice of sectors for investment should be informed by the extent to which increased output will be associated with an increase in innovation and training. The Committee's recommendations on human resource development are outlined in Section 5 of the Phase Two report: Human capital and knowledge infrastructure.

South Africa is failing to attract know-how and expertise. The reasons advanced for this hiatus in 'R&D FDI' include the regulatory environment as well as perceptions concerning the availability of skilled staff. There are claims that South Africa does in fact have a very large corpus of engineers who are otherwise employed in management roles, and could well be induced to move back to engineering, given the opportunity. This may be a myth, but it is necessary to test it. To be internationally competitive, it is necessary to draw in new technological skills by all means possible.

These various shortfalls in the framework conditions and knowledge transfer environment lead to the following recommendation.

Recommendation 10: The research investment climate must be improved through a review of present and further possible incentive schemes for their accessibility, simplicity and effectiveness, with broadening as required. These measures should include:

- The Technology and Human Resources for Industry **(THRIP)** industry–public researchers linkage programme should be expanded further, to a target of double its present level.
- The excellent and thorough reporting system of the Support Programme for Innovation in Industry **(SPII)** should be adopted in other schemes (and perhaps in all public grant-

making above a threshold level of award, together with the requirement of beneficiaries to participate fully in the annual National R&D Survey.

- Additional, specially tailored **grants and concessions** are required by small- and medium-sized enterprises to enable them to access advanced scientific and technological expertise.
- The regulatory environment for **research permits** should be streamlined to remove obstacles and speed up approvals, thereby reducing the need for burdensome appeals.
- Regulations and the approval processes for **foreign researchers** should be streamlined to speed up the issuing of work permits. Consideration could be given to including **special treatment of R&D inputs** of goods sourced under the local procurement mechanism.
- Overall, more imaginative and flexible sources of **public capital support for innovation** activities should be devised, including but not limited to low-cost loans, replacement of loans by grants, renunciation of state equity components, access to publicly owned buildings and land at zero cost, etc.
- The government system of **company support and incentivisation** should thus embrace a diversified approach that caters to size and sectoral distinctions; small companies generally cannot access incentives in the same way that large firms do, and different categories of firms, with different technological capabilities and potential for transitions to enhanced innovation capacity, should have tailor-made schemes. This implies that a sufficient number of well-informed and skilled intermediaries are available in government departments and their agencies to facilitate such transitions.
- **Industry–public researcher links** may be further strengthened through improved tax concessions on company grants, scholarships and bursaries deployed in public sector research institutions. Interfaces and the mobility of skills should be maintained between national disciplinary associations and related business sectors; research institutions and their funders should deliberately build groups that begin to bear some of the characteristics of the R&D divisions of companies.

Recommendation 11: The Technology Innovation Agency (TIA) should immediately be externally reviewed in terms of 'fitness for purpose', aimed mainly at promoting its success as a pivotal new element in the NSI. The National Intellectual Property Management Office (NIPMO) should likewise be formatively reviewed after a further period of initial functioning.

Recommendation 12: Immigration policies and **intellectual property regimes** need to enable the openness of the NSI.

4.1.4 Further Comments and Considerations

The selection of the four areas of agriculture, machinery and equipment, chemicals and pharmaceuticals (which Hausmann and Klinger [2006] suggested would offer export potential) even if accepted, is too broad to serve as a focusing device. The Committee has therefore recommended the establishment of the National Council on Research and Innovation, along with the Industrial Research and Innovation Funds, where the more detailed work of specifying demand, ensuring supply, and allocating resources will be articulated (see previous chapter).

The OECD review, like many others before and since, drew attention to the dire condition of the **informal economy and the unemployed**. The Committee endorses that concern, noting that private sector innovation has a long way to go in more proactively introducing life-changing innovations into communities. The generally positive impact of mobile telephony has been noted. The 'please call me' cell phone function is a South African innovation. The efficiency with which the poor recycle materials has been observed. South Africa is good at distributing alcohol to the remotest areas, but less effective at distributing genuine necessities. Frugal innovation, and innovations that target the needs of the less wealthy consumer, are leading challenge for the South African business sector.

On a positive note, the OECD review observes that, "There exists a nucleus of technologically strong, innovation-performing business enterprises, and that this base appears to be broadening. R&D expenditure by business enterprises[7] has been rising in recent years and constitutes a larger fraction of total R&D than in most other economies with similar levels of per capita GDP or similar R&D/GDP ratios. Moreover, corporate R&D seems unusually locally connected – for instance, business funding accounts for a larger share of university R&D than in many other countries" (OECD 2007: 5).

The Committee is also positive about the future role of the private sector in the innovation system. What is needed, however, is a clear commitment from government to invest actively in building people and eliminating blockages, some of which are ideological rather than technical, or ethical. The Committee believes that there are stronger convergent than divergent interests in the respective agendas of the public and private spheres in South Africa, and that it is a priority for the South African NSI in the future to find the means to share and advance these purposes together. The goal should be a positive research and investment climate, built on a strengthened commitment to shared futures.

4.2 Social Innovation and Sustainability

The Committee's consideration of **'social innovation'**, or **'innovation for development'**, has as its starting point the pre-eminent national priorities related to poverty and joblessness that have been identified by government. As noted earlier in this report, the founding conception of the NSI was that of a system that would serve the full spectrum of developmental imperatives faced by the country. These challenges have been cogently and urgently outlined in the National Planning Commission's Diagnostic Report (NPC 2011), which acknowledges the dangerous persistence of "widespread poverty and extreme inequality".

The idea of social innovation is a broad one, necessarily embracing a wide range of activities. Wikipedia notes that it "refers to new strategies, concepts, ideas and organisations that meet social needs of all kinds – from working conditions and education to community development and health – and that extend and strengthen civil society". The Committee believes, however, that the

[7] The business sector funds 45% of formal R&D and performs 58% of it. These proportions demonstrate that South Africa has an important platform of industrial R&D competence upon which to build – although it could be argued that the share of business is high because of constraints (especially people and money) that limit the state's ability to invest in human capital for innovation and research, both via the knowledge infrastructure and in more direct partnership with industry.

imperatives of the South African context require that the pre-eminent focus should be on "any **appropriate technologies or interventions that can address the challenges of poor communities**" (Petersen 2011: 2), and this has been used as a means of structuring the discussion in this section.

Invoking the notion of 'social innovation' in relation to 'poverty' might be interpreted as using special modalities, set apart, to treat an issue that all other parts of the NSI can then ignore, as if the phenomenon of poverty, and the communities who experience this condition, stand separate from the rest of the economy, and can be treated as such. This is obviously not the case. As already argued, and as will be shown below, the NSI must be considered as a full-spectrum endeavour with implications for all quarters of the society and economy. All systemic choices carry social consequences. Poverty and inequality are as much a matter for concern in well-established sectors of industry as they are in community-level initiatives. Activities that could be categorised as social innovation simply represent one sub-set of strategies through which the NSI as a whole addresses the developmental priorities of society.

Although distinctions are often made between formal/informal, first/second, rural/urban, or commercial/subsistence economies, or between townships and suburbs, these categories in fact mask a more complex and subtle set of dynamics that characterise how South Africans (especially poorer South Africans) sustain their livelihoods, and how they are located spatially in the economic geography. These complexities do not reduce in any way the urgency of the social and economic crisis that South Africa faces, but they do require that an understanding that addressing the crisis requires complex and multiple strategies undertaken at every level of enterprise, and that the responsibility is shared among all actors in society.

The responsibility can no longer be seen as government's alone but as a collective one, embracing all role-players, including the private sector, civil society and poor communities themselves. Equally, the responsibility for achieving appropriate levels of employment cannot be confined to the 'formal' economy alone. Social innovation should thus be seen as a fundamental component of a sustainable society and economy, integrally continuous with other priority areas for innovation in the South African system. Although there is a distributed responsibility for these social purposes, there is a vital role to be fulfilled by government in constituting the social innovation dimensions of the broader NSI in a systemic fashion, and in orchestrating the contributions of the various social partners.

4.2.1 Defining Social Innovation

The idea of social innovation is relatively recent in international and local literature, and generally speaking refers to **changing social and economic practices so as to improve the life chances of poorer sectors of society in the context of sustainable livelihoods into the future.** There is much enthusiasm and advocacy to be found, but very much less in terms of research and analysis of how 'innovation for development' is to be undertaken, especially in the South African context.

At the heart of the idea is a foundational shift in thinking about how development in poorer communities should be approached. Cousins (2011) notes that constraining approaches to development include "the idea that the periphery (townships, informal settlements, communal

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