

### **Recommendations Related to Knowledge Infrastructure**

**Recommendation 23:** To address the growth targeted by government in national R&D (GERD) in relation to GDP, driven to a very significant extent by increased public sector investment, the Committee recommends that the existing infrastructure needs not only to be expanded in a commensurate manner, but restructured in terms of its elements to ensure a higher degree of effectiveness and efficiency in its deployment.

**Recommendation 24:** To this end, there is a strong case for the establishment and step-wise roll-out of an Infrastructure Roadmap for South Africa, probably best driven by the new NSI governance structures proposed in this report.

**Recommendation 25:** An appropriately constituted National Advisory Panel on Cyber-infrastructure, reporting to the proposed National Council for Research and Innovation (NCRI), would be a suitable body to deal with cyber-infrastructure at strategic and policy levels, including fast broadband, and to draw up a roadmap for integrated implementation over time.

**Recommendation 26:** The extent and status of the knowledge infrastructure in the private sector and state-owned enterprises (SOEs) should be surveyed, and the linkages evaluated between this highly R&D-active sector and the universities and science councils.

**Recommendation 27:** The DST-subsidised, free-online, fully indexed e-publication platform, SciELO-South Africa, set up by the Academy of Science of South Africa (ASSAf) in order to render a large part of the content of South Africa's scholarly journals visible worldwide, should be expanded and sustained.

**Recommendation 28:** The subsidised national licensing of e-access to high-impact, international core commercial journals should be effected following the release of the current ASSAf advisory study on this topic.

## SECTION 4: MONITORING AND EVALUATION

### Assessment

The notion of the NSI that was introduced in the 1996 White Paper on Science and Technology was intended to be fundamentally transformative in its purpose, a renewal intended to reach all dimensions of business, scientific and socio-economic activity. The achievement of intended change is difficult and may take time. Knowing what is happening depends on the availability of top-quality information, the ability to access and interpret it, and the capacity to use the information to achieve adaptation in performance.

Progress in improving the functioning of the NSI is currently still hampered by the absence of an assigned responsibility for ensuring the availability, collation, maintenance (and even analysis) of the science, technology and innovation indicators, both quantitative and qualitative, needed for monitoring and evaluation, and for planning and management of the NSI as a whole. Although evidence is available from a number of sources for some dimensions of discrete activity in the system, there is no comprehensive synopsis available, even in conception, that reflects the need to 'see' the system in its totality, and to assess how it might fulfil its contribution to national development.

There are some useful windows into selected parts of the system. For example, the annual National Surveys of Research and Experimental Development (usually known as the National R&D Surveys), provide reliable data on R&D expenditure in different sectors, the human resources deployed and overall major funding flows within and from outside the country. The surveys, performed on contract by the HSRC through its Centre for Science, Technology and Innovation Indicators (CeSTII), have rightly become part of the working language of all NSI participants. It should be noted, however, that many indicators are not fully 'unpacked' in the published survey reports, nor are they sufficiently meta-analysed to yield their true worth. The DST has commissioned the Human Sciences Research Council (HSRC) to do a study of indicators appropriate to the aspiration of a knowledge economy; the proposals should be widely discussed among stakeholders and well-evaluated before adoption.

The South African Innovation Surveys, also conducted by CeSTII, provide vital and intriguing insight into business sector innovation, and point to important continuing trends, such as the relatively high innovative activity in firms, but at the same time (and following international trends) the surprisingly low propensity for the acquisition of knowledge from higher education and research councils, as already noted in Section 2 of the Executive Summary: The enabling environment for innovation in the private and social sectors. Similarly, the surveys reveal that investment in innovation is constrained by a lack of funds, while at the same time only a small proportion of innovating companies are accessing, or are able to access, public funds for these purposes. There is, however, no sense of what further research and intervention might have been directed at these phenomena between the surveys and thus what might have been learnt about the operation of the system, especially the interaction between the key players reflected in the data. Provision for sustained research into the dynamics of the system is lacking, and the Innovation Survey can therefore not adequately inform policy steerage.

The annual Science and Technology Activities (STA) Report, retrospectively compiled by the DST, expands on NSI-related publicly funded expenditure, mostly directly by government departments, presenting data under the headings of education and training, services and innovation. The report suffers from methodological problems that have thus far not been amenable to correction despite serious effort, and also fails sufficiently to 'unpack' the data provided or adequately to meta-analyse them in policy terms. Moreover, the report does not make provision to compare the science and technology activities against the originally prospective budgets of the participating departments, in accountability mode.

The DHET compiles an increasingly informative and detailed annual report on the accredited research outputs of higher education institutions, in numbers of actually graduated research postgraduates (masters and doctoral) and peer-reviewed publications in scholarly journals, books and conference proceedings, most recently also categorised by scholarly field. Knowledge of the relevant policy is required to understand the numbers, as publication output units are not equal to the numbers of actual papers because of the fractionation of authorship by institutional affiliation and the denial of credit to authors who are not working at public higher education institutions in South Africa. A further issue is the use of a single, rather low 'quality threshold' for accreditation of any particular output, above which the quality of all publications is assumed to be the same.

The Higher Education Information Management System (HEMIS) is a valuable source of information about this sector, as are the comparable databases maintained by the NRF in regard to its grantees. Neither of these databases is easy to access or user friendly.

The Research Information Management System (RIMS) is only partially in place, facing implementation issues in part caused by prior commitments made by a number of institutions to other installed enterprise resource management systems.

The requirement for key performance indicators in the annual reports of science councils has induced them to make public many more output indicators than in the past. Very few, if any, summative compilations of the combined science council production of patents, publications and research student graduations have been done to the Committee's knowledge. For higher education institutions, the Council on Higher Education (CHE), for example, publishes an annual summative review of some of the outputs.

A number of scholars distributed among various institutions have begun to map the publication performance of the country's researchers, mainly using the widely known, well-developed and readily mined databases of the Thomson-Reuters Web of Knowledge (WoK) journal citation reports. While the fact that the indexed databases are selective makes this a rigorous bibliographic tool (based on the concept of a core literature, in which 80% of the significant information is supposed to appear in only 20% of all published journals), the bias in favour of advanced countries and English-language journals operates to the disadvantage of journals published in other regions, especially emerging or developing countries (the company has recently expanded the indexes through the addition of about 1500 regional journals, resulting in South Africa's share rising three-fold to about 70 indexed journal titles). SA Knowledgebase is a

private bibliographic and demographic database that seeks to capture all accredited publications produced from South African addresses, with a substantial capacity for demographic analysis, comprehensive field-specific studies, and institutional-specific analyses. It is important that bibliographic studies emanating locally should fully contextualise their observations in the 'real world' of the research and innovation system, something which has not always been the case.

The country's comparative performance in the WoK indexes is variable, with a static figure of just over 0.3% of total authorships in recent years. Collaboration has increased markedly, judged by data on author addresses, and the field-specific citation rates are sometimes higher than, and sometimes lower than, the world averages.

Monitoring information on social innovation is available, but from disparate sources. Intriguing survey information is available in the regular editions of Trialogue's *CSI Handbook* (the most recent 13<sup>th</sup> edition reflects 2009/10 activity), which among other things confirms the diverse effect of the very considerable R5.4 billion in annual corporate social investment (CSI) expenditure, distributed across twelve development focus areas analysed in the report. The handbook points to increasing incidences of working partnerships between corporates and non-profit and public sector collaborators, and increasing determination for CSI investment to be aligned with stakeholder interests. The information provided in this resource, however, is a reflection of private sector funding of development projects, and provides little insight into the levels and destinations of social innovation funding made available through the philanthropic community.

Equally valuable insight into social development activity can be obtained from other NGO sources. The Impumelelo Social Innovations Centre, for example, has rich information about particular projects (or portfolios of projects in some cases), often assembled into regional maps of innovation activity. These 'innovation landscapes' have potentially powerful value for the planning and brokerage of collaborative approaches to larger innovation priorities, and provide a model for how this information (with its detailed case-study material) could be made available through a more comprehensive centre for innovation system intelligence.

A different level of evidence-gathering and analysis is represented by the steadily increasing capacity of ASSAf to produce independent, multi-perspective, consensus reports on key issues affecting the NSI and the nation more broadly. This is an essential activity in terms of policy development, complementary to the quantitative analysis based on indicators and other proxies.

Even so, while there is a surfeit of data, there is a dearth of information, and it is evident that no entity in the NSI currently has the following capacities:

- **System-mapping:** What innovation activity is occurring across the various sectors, with a particular interest in those areas of activity currently under-reflected in existing measures? Private sector activity and formal R&D are best represented at present, although as yet inadequately understood. Innovative reforms in the public sector are more difficult to track, although several existing avenues provide rich windows into this activity. Much more elusive are the wide variety of innovations and adaptations in

communities, both urban and rural, that arise spontaneously or are supported by non-profit organisation (NPO) or CSI activity.

- **System-analysis:** What do is known about the state of the enabling conditions that the Committee believes are required to release the innovative potential within the system, and how are the various actors in the system responding to these conditions? What can be learnt about how bottlenecks and constraints work to limit this potential, and how incentives are able to release it? How robust are existing theories about system dynamics, and about South Africa's contextual specificities?
- **System-building:** What intelligence can be made available to inform and equip each of the system-building measures noted earlier in this section? In addition, periodic capability reviews of key agencies in the NSI should be commissioned, and progress in fulfilling recommendations needs to be monitored.
- **System-steerage:** What measures are best advised to produce deliberate, desired system effects? National goals of sustainable, labour-absorptive growth and poverty alleviation require that policy and investment decisions prompt adaptive behaviour. How can the evaluation capacity best guide these planning decisions? System-steering work involves at least three levels of activity, including those producing projections (such as foresight exercises and scenario-building techniques), those informing policies (both *ex ante* and *ex post* impact-assessment studies) and those informing programmes (contextual and project-specific intelligence geared to optimise a particular intervention).
- **System-evaluation:** What trends are discernible, and what is the impact of the investments in innovative and adaptive behaviour? There is wide acknowledgement of the difficulties associated with estimating systemic impact accumulating over a period of sustained investment in targeted measures, especially in elusive quality-of-life measures. The monitoring and evaluation (M&E) capacity must enable the derivation of compelling indicators and analytically powerful qualitative insights. Ultimately, the capacity is required to assemble a synoptic view of emergent patterns across the system, and the relationships that might be at work among them.
- **System-learning:** One of the founding conceptions of the system is that it is an interactive, relational system of mutually reinforcing learning and adaptation. One of the functions of the monitoring and evaluation (M&E) capacity is to provide a knowledge base and a communicative nexus for cognitive exchange and accumulation within the system, both within sectors and across them. This has to be done deliberately and inclusively, so as to draw on local and distributed knowledges arising from the sites of innovative activity, and to ensure the widest possible distribution of the questions, the debates and the insights that must inform the growing vitality of the system.
- **System-foresight:** The extensive investment made in Research and Technology Foresight in 1998 has not been followed up with further exercises of this kind.

## Recommendations

**Recommendation 29:** The intention behind the proposal for the establishment of an Office for Research and Innovation Policy (ORIP) (see Recommendation 3) is to establish a centralised facility to serve as a repository of evaluation information on the NSI, and an expert site for its distillation and distribution to inform strategy and steerage at the highest levels and more broadly.

Secondly, the agency should encourage good-practice evaluation much more widely in the system than is presently the case. The strength of a complex, relational and multi-actor NSI will arise from strong M&E capacity distributed through every part of the system, where all sites of practice are making decisions based on astute localised insight. This distributed, localised knowledge needs also to be assembled centrally to inform system-wide strategic views, both for state steerage and to inform thinking throughout the system. Part of galvanising the system towards a number of national priorities is the need to keep all the players informed about what is happening, what is working and what is not. Sustaining shared commitment over time depends on the capacity for collective learning, and the ability to become a learning society.

**Recommendation 30:** The Committee recommends that the mandate of the proposed Office for Research and Innovation Policy (ORIP) must include systematic monitoring and evaluation for the entire NSI, as outlined above. The approach should be based on the different elements outlined above, namely system-mapping, analysis, building, steerage, evaluation, learning and foresight. This would include:

- Provision of the research and intelligence needed for the functioning of the proposed National Council on Research and Innovation, from which ORIP would receive its strategic mandate and its systemic authority.
- Provision of the research and intelligence needed for the policy-making and regulatory functioning of the DST and the proposed three policy-incubating nexuses focused respectively on higher education, the business sphere and social innovation (see Recommendation 5).
- Design the range of instruments and methodologies needed to fulfil the systemic functions outlined above, and contract and outsource those that ORIP cannot practically undertake itself. Among other things, consideration should be given to the future location of the Centre for Science, Technology and Innovation Indicators (CeSTII), support for and cooperation with CREST's SA Knowledgebase, and functional linkages with the Higher Education Information Management System (HEMIS) and the intended Research Information Management System (RIMS).
- Oversight of the follow-through on review reports of public research organisations and other NSI-related institutions.
- Oversight of a policy that all major research, development and innovation projects attracting significant levels of state funding (above an amount to be determined by the DST from time to time) should be subject to statutory evaluation, the results of which should be publicly available through ORIP.
- Maintenance of a system whereby publicly funded databases relevant to the national R&D system make their data available to ORIP (and thus to the public) through appropriate data access protocols.
- Extraction of the optimal meta-analytic value from all NSI-related surveys, evaluations and indicator studies in order to inform the strategies and purposes of the NSI.

**Recommendation 31:** The Committee recommends that the role of the Academy of Science of South Africa (ASSAf) should be strengthened and broadened to provide independent evidence-based advice on key issues relevant to the NSI. These might come in various formats such as

commentaries on policies or draft legislation; full consensus studies; facilitated forum-type conferences and workshops; and other thorough investigations.

**Recommendation 32:** A thorough investigation of data collection and interpretation related to the NSI is urgently needed. Particular considerations in this regard include:

- The NCRI and national government priorities relating to social development and social innovation must be included within the range of instruments and indicators deployed by ORIP. In addition, ORIP should seek to recruit NGOs and company corporate social responsibility directors in a sustainable network of information-gathering and analysis.
- The Committee recommends that an annual summative review of the outputs of all the science councils and other public research or S&T-based technical service organisations be considered. The annual summative CHE review of higher education should include the key indicators selected by ORIP for monitoring and evaluation of the system as a whole. The annual report on higher education research outputs produced by the DHET should be expanded after detailed consultation among stakeholders, and made public.
- The accuracy of the official figures for the technology balance of payments should be subjected to scrutiny.

**Recommendation 33:** The annual Science and Technology Activities (STA) Report compiled by the DST should be linked to the new prospective research, innovation and development cluster budget for the year in question, to enhance accountability and to provide a valuable complement to the National R&D Survey for the same year. This should be associated with a greater degree of linkage in that survey to contexts and policy outcomes.

**Recommendation 34:** Ten years after the most extensive exercise of its kind in this country, attention must again be given to foresight studies, as well as carefully designed social fabric studies as a basis for effective social innovation.

## SECTION 5: FINANCING THE NATIONAL SYSTEM OF INNOVATION

### Assessment

At a high level, the Committee believes that the NSI in South Africa is now generally in stasis, heavily stabilised and constrained within itself, and can be only be moved to a different state by investments aimed at the country becoming a knowledge economy. The means by which the system is resourced thus become critical levers for the steerage of the system, and for its general vitality.

The biggest constraints are the stuttering pipeline of trained and knowledgeable people, at all levels; the inadequate investment in the research teams that do exist; not keeping up with infrastructure requirements; and failing to incentivise private investment in innovation, both within and from outside the country. Financing of the system must henceforth be driven in a new and more purposeful manner.

South Africa has maintained a steady growth in R&D expenditure over the past decade, with GERD growing in current prices from about R4 billion in 1997/98, to about R21 billion in 2008/09. The ratio of GERD as a percentage of GDP has also expanded over this period, indicating the growing role of R&D within the economy. From 2007/08, however, there was a decline in GERD as a percentage of GDP for the second year in succession, from 0.93% in 2007/08 to 0.92% in 2008/09. The 1% target remains elusive.

The Committee applauds and supports the government's intention to increase the R&D intensity (GERD) of the country to the ambitious target of 1.5% of GDP within a few years; this target is obviously dependent on the actual growth of GDP over this time. It is important that the investment is well planned and concerted in nature, based on a thorough understanding of the causes of the inertia.

Comparison of the 2008–2009 data with those for 2007–2008 shows an increase in total 'real' spend of only 1.3%, while the total number of researchers and R&D personnel has generally been static, and actually fell when expressed as a percentage of the total employment in the country, to only 1.4 researchers per 1000 persons employed.

The higher education institutions (HEIs) need to increase the volume of high-quality human capital generation (in the form of greater numbers of well-trained honours, masters and doctoral graduates as well as postdoctoral fellows, drawn from the talent of the whole population) as well as that of research outputs (like high-impact peer-reviewed articles and scholarly books), commercially exploitable patents and potential innovations generally. Many of the required concerted interventions are outlined in Section 3 of the Executive Summary: Human capital and knowledge infrastructure; some of these will require expenditure of funds held by HEIs or granted them by government agencies and/or business.



The Committee also recommends the re-organising of a much better-resourced external government agency system to focus primarily on the purposeful and adequate resourcing of the well-performing, multiple-output research groups, while providing considerably increased overall support for such groups, appropriately designed in terms of operational, capital and human resource provision, at various levels.

In the science council sector, the question of 'new target' resourcing flows depends largely on what the individual and grouped mandates of these government-owned organisations should be in future. The competitive advantage arising from the marked systemic economies of scale, the multiple beneficial outputs of HEI-based R&D, the constant entry of talented newcomers, the richness of the multiple-discipline environment, and the independence of the general mind-set, makes a strong general case for HEIs undertaking a very large percentage of the total national R&D that is not performed within business enterprises.

There would be funding implications associated with a decision to move into the science councils some of the scientific and technical services that are currently housed in government departments, or to relocate most or all of the national facilities currently operated by the NRF to other bodies.

Private business and industry, the most important source of finance for, and performer of R&D in the NSI, is a key strategic partner for government to engage with in promoting R&D investment in the country. It is deeply disturbing that business- and industry-funded R&D in the public sector has fallen over the period 2001/02 to 2008/09; while transfers to universities have doubled, engagement with the science councils fell by two-thirds.

Government obviously exerts much more control over 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 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.

An important strategic instrument is the so-called triple helix between government/science councils, HEIs and business/industry; quadruple helix formation takes place when civil society also becomes directly involved. The Committee regards it as extremely important that every effort is made to ensure the smooth initiation and sustainable operation of such complex partnerships so that the decline in business/industry funding in the public sector can be reversed. There is a particular need for seamless funding arrangements in multi-helix innovation strategies, along innovation chains and over time in each enterprise. Stimulation of this activity will assist in increasing the proportion of 'applied' and 'experimental development' research performed at HEIs, promoting the overall uptake of cutting-edge information and innovation by business.

The current stable of incentive schemes run by the dti and TIA/DST is investing about R600 million of government money in innovation projects in business/industry, most of it actually spent in HEIs

and science councils. The tax benefit for business R&D activity that meets set criteria is being taken up increasingly despite administrative problems. The tax expenditure or tax revenue forgone due to the R&D tax incentives is estimated to be just over R1 billion for the period 2005/06 to 2008/09. The DST estimates an amount of R632 million for the year 2009/10 (DST 2011: 7d).

Venture capital for innovation is actually readily available in South Africa, but the total amount invested is very small; it appears that certain tax and exchange control regulations impair the ability of fund managers to create value.

The role of foreign firms in the South African economy has increased considerably in the last decade, with foreign direct investment (FDI) rising from 1% of GDP in 2003 to about 4% in 2009. Regrettably, most of the investment is in equity purchases or share portfolios rather than in innovative industry. Everything possible must be done for South Africa to become the preferred destination on the African continent for R&D-related foreign direct investment.

The country also has a widening balance of payments; domestic demand should increasingly be met through domestic capacity, as a matter of some urgency.

The Committee believes that the creation of a knowledge economy in South Africa will require in respect of the business sector much higher R&D expenditure by business/industry, probably as much as 50% more than at present; a greater degree of partnership between business/industry and HEIs and science councils, representing the outsourcing rather than the performance of part or all of the R&D concerned, preferably in well-regulated and well-facilitated triple- or quadruple-helix arrangements; expansion of the incentive schemes offered by the dti and TIA/DST, both in total amounts applied and in the range of enterprises serviced in this way; assisting more purposely the realisation of innovative capacity in small and medium-sized businesses; enhancing the national capacity to transfer and adapt new technologies as much as the capacity to create new ones; facilitating and optimising through appropriate legislation, regulation and administrative practice the potential of local firms to recruit high-level staff from other countries, and to maximise their impact; energetically promoting foreign direct investment so that multinational companies carry out globally applicable R&D in this country rather than elsewhere; mobilising the skills of business to enhance social innovation and improved service delivery in the public sector; and expanding the venture capital industry as well as the application of corporate social investment in achieving innovation in various different ways.

The so-called government sector of the annual R&D survey is a rather heterogeneous but potentially highly significant component of the NSI.

A matter that deserves attention is the reportedly low spend of many central line departments of government on R&D, which suggests that problems encountered in service delivery or policy implementation are not being innovatively addressed. The government departments concerned are prime candidates for a much-expanded programme of steered and assisted social innovation. The financing of these newly focused activities would depend on the organisational

arrangements, the wide participation of sponsoring and/or partnering companies, the interplay between different levels of government, and the way in which the developmental state is re-envisioned by government in the next few years.

### **Recommendations Related to Financing the NSI**

**Recommendation 35:** Public resourcing of R&D conducted at HEIs should be significantly increased, with a focus on the best-performing, multiple-output research groups, the extension of the system of Research Chairs and Centres of Excellence to Research Institutes, and the provision of improved infrastructure. Furthermore, consideration should be given to the subsidisation of national licences for high-impact commercial journals and the free-online e-publishing platform, SciELO-South Africa, for high-quality local journals.

**Recommendation 36:** The public funding of the science councils should be adjusted to match their newly formulated individual and collective mandates.

**Recommendation 37:** Business/industry should be encouraged and incentivised to increase its R&D expenditure, probably as much as 50% more than at present, through much more pervasive triple and quadruple helix formation with government/science councils and the HEIs, and involving extensive outsourcing of the R&D required for business innovation.

**Recommendation 38:** The incentive schemes offered by the dti and TIA/DST should be expanded, both in the total amounts applied and in the range of enterprises serviced in this way, with a special focus on the realisation of innovative capacity in small and medium-sized businesses.

**Recommendation 39:** Everything possible must be done for South Africa to become the preferred destination on the African continent for R&D-related foreign direct investment (FDI).

**Recommendation 40:** The potential of local firms, HEIs and science councils to recruit high-level staff from other countries should be facilitated and optimised through appropriate legislation, regulation and administrative practice.

**Recommendation 41:** Measures should be devised to encourage government departments to improve service delivery through research, development and innovation, including the effective use of the annual survey of government expenditure on science and technology activities, to draw up prospective expenditure plans annually for such activities.

## CONCLUSION

Awareness of the social dimensions in all technological activity has informed the Committee's deliberations. The Committee believes that technology impacts on peoples' lives both positively and negatively; people in turn shape the uses and development of technology in similar ways.

It is the considered view of the Ministerial Review Committee that the research and innovation system is key to a better life for all. To this end, considerable renewal of South Africa's knowledge base (in all its forms) is needed, with attendant fiscal implications at a time of fierce competition for resources. The justification for investing in a resurgent NSI is that this should ultimately deepen the impact of human and budgetary resources. Research and innovation have previously delivered in response to the demands of the day. The imperative now is to lay the foundations of a new contract between the research and innovation system and society at large. The new contract is predicated upon a participatory articulation of economic and social needs, and their fulfilment through innovation activities. As such, the research and innovation system needs to be advanced as a values-driven and deeply embedded part of society, championed by compelling and inclusive leadership.

## PHASE ONE: THE CONTEMPORARY NSI LANDSCAPE

### SECTION 1: CONTEXT OF THE OECD REVIEW, AS REFLECTED IN PREVIOUS POLICY AND REVIEW DOCUMENTS

#### 1.1 Preamble

This overview is developed to outline the policy ambitions, and some of the systemic measures, proposed since 1996 to advance a **National System of Innovation (NSI)** for South Africa. This overview is based on a desktop review of the **principal policy documents** and **review reports** that the Ministerial Review Committee has been able to access. The material noted in this section is **necessarily selective**, intended best to provide a sketch of the priorities and debates that constituted the discursive context for the OECD study, many of which remain continuing preoccupations for those concerned with the future success and vitality of the NSI.

Innovation is the capacity to generate, acquire and apply knowledge to advance economic and social purposes. It includes both the search for frontier technologies driven by research and development (R&D), as well as the forms of learning and adaptation that might be market led or socially driven. Innovation is fundamentally uncertain, highly contextual and path dependent, but it is at the heart of moving the country from its present mix of resource- and efficiency-driven economic activity to one that is driven by the generation and application of knowledge. It is about doing new things in new ways.

The **Department of Science and Technology (DST)** and its predecessor department (the Department of Arts, Culture, Science and Technology – DACST) over the last decade and a half have been placed at the centre of the government's adoption of the National System of Innovation model as a framework to make innovation a key driver of economic growth and improvement of the quality of life of all citizens.

The idea of a **National System of Innovation (NSI)** rests on the importance of linkages and interactions among organisations and institutions in the creation of knowledge, its transfer and the development of innovations. There are technological and non-technological forms of innovation, involving changes in production, products and processes.

The main actors in an NSI are business (mostly private sector but some state-owned), government research laboratories and universities. Business innovations either improve efficiencies in production and/or generate products that enter the national and global markets. Government research laboratories and universities conduct research and develop skills, sometimes in partnership with business. They also contribute to policy development and improvements in public service delivery.

Government plays many roles in the NSI: by setting framework conditions, providing infrastructure as services and utilities, promoting human resource development, as well as 'business' innovator (e.g. through state-owned enterprises), and research performer (e.g. through the science councils).

'Deliberate' framework conditions that shape a system of innovation include policies and regulations for skills supply and immigration law, foreign exchange regulations, tax incentives, the regime for state loan finance, equity stakes and grants, and the protection of intellectual property. Framework conditions enable firms to invest in innovation and to promote the flow of information, and they encourage the circulation of skilled people. 'External' framework conditions are those imposed by the increasingly globalised operating environment.

The South African government has taken a number of measures to establish institutions, governance systems, resourcing initiatives and general framework conditions intended to create a supportive environment for innovation. This has arisen from several strategic initiatives aimed at giving effect to the intentions of the NSI. These include the White Paper on Science and Technology (1996), the National Research and Technology Foresight Study (1997–1999), the National Research and Development Strategy (2002), and the New Strategic Management Model for South Africa's S&T system (2004), with its Policy on Governance Standards for Science, Engineering, Technology and Innovation Institutions (SETIs) and framework for the development of a National Science and Technology Expenditure Plan.

At key points since 1996, a number of review exercises have been conducted. The evolving policy framework was (and still is) intended as the basis by which leadership, coordination and cooperation could be achieved over a wide and highly diverse set of actors engaged in innovation, either through research and development or in other ways. Arising from the original 1996 White Paper on Science and Technology, it was anticipated that the NSI would have a pervasively positive influence on economic and social development in the country.

The theme of this section will be the framework conditions in which leadership and coordination might be provided for the NSI (or indeed frustrated), as well as the ability of innovation to act as a key driver of national development. The analysis provided in this report concerns itself mostly with the system-wide arrangements advocated in succeeding policy and review documents, the degree to which implementation has been achieved, and the extent to which these measures have had the intended effect. In particular, therefore, the report focuses on the governance structures, the institutional architecture and the resourcing patterns associated with this complex and ambitious endeavour. It is these issues, then, that act as the organising criteria for the narrative that follows. Although this account is necessarily skeletal, we have sought to provide sufficient detail to illustrate the persistent issues that have implications for the success or failure of the policy of placing innovation at the heart of national economic and societal development.

## 1.2 1996 White Paper on Science and Technology

The founding document for the notion of an NSI is the 1996 White Paper on Science and Technology (DACST 1996). This remains the most complete description of the vision of a country

that uses innovation for economic competitiveness, national development and service delivery. It is worth noting this particular vision in some detail, since it sets in place the basis for the institutional and governance architecture for the South African system.

### *Purposes*

The 1996 White Paper responds to the global knowledge economy and competitive pressures on the South African economy due to global market forces. In this context it focuses on the need for **“increased coordination of innovation policies and strategies”** and a **“problem-solving, multi-disciplinary approach to innovation as a mechanism of growth and development”**. The NSI was intended to have a **“high measure of strategic and creative interaction amongst its constituent elements”**. The core vision was to **“harness the diverse aspects of S&T through the various institutions where they are developed, practised or utilised”**. A prime objective of the NSI was **“to enhance the rate and quality of technology transfer from the science, engineering and technology (SET) sector by the provision of quality human resources, effective hard technology transfer mechanisms, and the creation of more effective and efficient users of technology in the business and government sectors”**. Government R&D was meant to positively affect the **“quality of life of citizens in the areas of environmental sustainability, health care provision, meeting basic needs at community level, reducing the cost of infrastructure provision, and providing safety and security to all”**. It is important to note, as already indicated, that as a conceptual device, the NSI does not involve only R&D (or S&T) but that there is a range of sources of innovation. These creative (or reformative) activities are understood to be complex processes arising from both formal and planned initiatives as well as informal and fortuitous activities. In this conception, formal R&D stands as one (very important) part of the overall system of innovation.

The reasons given in the White Paper for adopting the NSI approach were:

- It affords an opportunity to think of means for the promotion of coherence and integration among national activities, two factors which have been sorely neglected in the South African S&T system of the past.
- It offers a means of identifying what needs to be done without automatically tying the necessary functions to any particular existing institution or organisation.
- It focuses attention on *innovation* – on doing new things in new ways – rather than simply on the production of knowledge.

This is not to say that innovation systems-thinking is a ‘one-size-fits-all’ specification. The concept should be understood as a constant ‘work in progress’ that has wide contemporary appeal in a rapidly changing world, that is still undergoing refinement in the light of that change combined with international experience and continuing analysis, and can create an inspiring model for an emerging nation.

### *Conception*

In summary, the White Paper conceptualises the NSI as a **“set of functioning institutions, organisations and policies which interact constructively in the pursuit of a common set of social and economic goals and objectives”**. Government has to see to it that these NSI components

are in place, that they interact, and that there is an agreed set of goals and objectives for a knowledge society/economy. In this regard, it allocates to itself the function of policy formulation and regulation, while public- and private-sector stakeholders would share in the other functions of finance-allocation, actual performance of R&D and innovation, infrastructure provision and human resource development.

### *Participants*

The White Paper provides a conceptualisation of which **stakeholders** might be included in the NSI. Government players include central policy departments (e.g. the Presidency, Treasury and some functions of DACST) and line departments (including Defence, Health, Education, Communications, Trade and Industry, Agriculture, Transport, etc.). Outside government were general agencies (e.g. the National Research Foundation), specialised domain agencies (e.g. the Water Research Commission), research-performing SETIs, state corporations, private business and industry, higher education institutions, and non-governmental organisations (NGOs). This provides a sweeping and inclusive vision of all knowledge-intensive participants contributing to the national aspirations set out in the White Paper.

### *Governance and institutions*

The White Paper goes on to describe the **institutions to be established** in order to promote the development of a well-functioning NSI. These were in essence to be a national Ministry and Department of Science and Technology (DST), a Ministers' Committee on Science and Technology (MCOST), a National Advisory Council on Innovation (NACI), a National Research Foundation (NRF), an Innovation Fund, and major national research facilities managed by government. The MCOST was to be composed of all Ministers whose portfolios encompassed a significant S&T component; it was to be the principal policy-coordinating and information-disseminating body for S&T matters across government.

NACI was charged with carrying out 'enquiries, studies and consultations' with respect to the functioning of the NSI, at the request of the Minister of Arts, Culture, Science and Technology. It was to be advisory rather than operational. The key, and very significant, structural aspect of the proposal for NACI was its placement within the DST, and its designation as being advisory only to the Minister of Arts, Culture, Science and Technology who, by means of MCOST, should coordinate government line departments and their associated SETIs and agencies in the NSI. NACI was duly established in 1998 as a statutory body with the Director-General of Arts, Culture, Science and Technology as its CEO.

### *Resourcing*

The White Paper specified that an annual 'Science Budget document' would be prepared from data drawn from departmental budgets, to reflect all government S&T expenditure, including all its agencies (and including, in particular, the support offered by the Department of Education to institutions in the higher education sector). Further, a policy of tax incentives for industry would be introduced to encourage R&D in the private sector, while the agency-type Innovation Fund was to encourage longer-term, large innovation projects in the higher education sector, SETIs, civil society and business. With these measures, the White Paper envisaged a



regime of resourcing that would coordinate government R&D activities and provide incentives for innovation more broadly.

### *Commentary*

The preceding summary of the 1996 White Paper has been deliberately selective in its extraction of the main ingredients of this landmark document. **What remains after 14 years of eventful follow-up is the impressive aspiration to generate and use knowledge cooperatively in order to develop the whole country as an innovative, creative and prosperous society.** The NSI is thus an assertion that systemic innovation of this ambitious kind requires forms of governance and coordination to achieve the wise and effective use of resources, and the optimum development and mobilisation of South Africa's talent pool.

Much of the subsequent history of the NSI has centred on the realisability of the assumptions made in the White Paper about the nature and capacity of units of government expected to participate cooperatively in the NSI, the relationship between the elements that 'steer' and those that are 'steered', the overall resourcing of the public S&T system amidst huge unmet developmental needs, and the onward march of the globalised operating environment.

Apart from the apparently short-lived inter-ministerial MCOST and the intrinsically 'hamstrung' design of NACI, the most critical structural issue in the NSI created by the White Paper was the setting up of a separate **Ministry and Department of Science and Technology** to achieve ambitious systemic national goals, mostly in other ministers' or departments' 'backyards'. This was likely to lead to frustration at the level of the Ministry and Department of S&T as it sought to lead NSI development mostly by energetic advocacy at the highest level (Cabinet and Ministerial cluster), or by default within its own circumscribed domain. It is true to say that no other line department of government (except perhaps the Department of Trade and Industry) has shown much visible interest in the NSI as a 'mental model' crucial to its own strategies and preoccupations – that has been left to the DST.

The following sections outline subsequent initiatives that have sought to bring further definition to the NSI, or to fine-tune some of its public sector constituents. These are arranged chronologically.

### **1.3 1998 system-wide reviews of public-sector SETIs**

Following the publication of the White Paper, a **cross-cutting review** of 11 different science, engineering and technology institutions (SETIs) was commissioned by MCOST, organised by the DST, and intended to take stock of the public R&D landscape in order to prepare the ground for policy development arising from the White Paper. It included separate individual reviews of each of these SETIs, as well as a review of the role of government in supporting S&T.

In spite of the ambitions and measures of the White Paper, the review found that the public sector institutions were still characterised by "poor interactions and networking", constituting "a

major weakness of the South African SET system". The most significant deficit was "between the SETIs and the higher education sector." As result, it was said, "nearly all ideas in the government SETIs were internally generated and most innovations were not pursued to their maximum potential". The review went as far as to state that these problems (which the review considered remediable) were greater than those posed by the overall inadequate funding levels. The review recommended that "provision should be made for system-wide independent oversight, evaluation and strategic advice to government", and that "numerous opportunities should be provided to facilitate linkages and interactions across disciplines, sectors and institutions", in order to "create a stimulating environment and an innovative climate throughout the entire system".

**NACI's mandate** was addressed in the system-wide review by recommending that it should focus on "advice to government on the development of its overall strategy, on the prioritisation of its activities, and on resource allocation to all SETIs". It is important to note that these were systemic recommendations relating to the whole government and the NSI, rather than being specific to the DST domain.

#### **1.4 1997–1999 National Research and Technology Foresight process**

The very participatory **National Research and Technology Foresight (NRTF)** exercise, which published its outputs in 1999, was intended to "put real content into the NSI and thereby develop a framework of goals within which our technology programmes can be shaped". The initiative differed from other NSI-related interventions in its detailed examination of the main sectors of the economy and society, and it produced carefully debated consensus recommendations that outlined a mix of medium- and long-term opportunities and obligations in relation to a twenty-year horizon.

The immense effort of the NRTF was not rewarded with take-up in line departments or even in the policy trajectories of the DST itself. The main legacy of the exercise (as in the case of the Green and White Papers before it) was the entrainment of a large number of potential participants in the national S&T policy-making and development agenda, some remaining engaged in a diversity of ways, and others becoming passive onlookers or active critics from the vantage of their main preoccupations.

#### **1.5 2002 National Research and Development Strategy**

The adoption by the Cabinet of the **National R&D Strategy (NRDS)** (DST 2002) seems to have been a response by the newly independent DST to government's concern that the NSI was not taking shape as expected. It focused on key perceived weaknesses of the NSI such as inadequate funding, lack of growth in numbers of high-level S&T personnel, apparently declining R&D in the private sector (although this was not in fact the case), the absence of a new policy framework for intellectual property, and general fragmentation of government S&T activity.

Of the initiatives proposed by the NRDS, the following four are significant for the purposes of this report, since they form part of the reiterated themes that have preoccupied innovation stakeholders since the White Paper, namely:

- i. The establishment of a **Foundation for Technological Innovation** to enhance coordinated agency activity in order to focus on closing the perceived 'innovation chasm'. This took nearly eight years to become a reality in the shape of the new **Technological Innovation Agency (TIA)**, established by statute in 2009.
- ii. The initiation of five major new **S&T Missions**, deliberately spread across areas in which the DST would have a reasonable degree of traction, namely:
  - Information technology involving a set of 'technology platforms'
  - Biotechnology
  - Technology for manufacturing
  - R&D in the natural resources sector
  - Technology for poverty reduction.
- iii. The Missions were ambitiously to function as organising principles for concerted cross-boundary collaboration in pursuit of common goals.
- iv. The NRDS sought a radical increase in skilled human capital for a **knowledge economy, and proposed strong and effective cooperation between the (then) Department of Education and the DST for this purpose**. The **South African Research Chairs Initiative (SARChI)** is seen by many as probably the main, and perhaps the only, significant outcome of this overall effort.
- v. Lastly, and very significantly, the NRDS sought to deal purposefully with the continuing structural and functional fragmentation of the S&T system. It proposed that the DST annually draw up a three-year **R&D Plan** for the whole country, dovetailing with government's Medium-Term Expenditure Framework (MTEF) and "capturing its key targets and investments". The R&D Plans would include the programmes of each line department of government, including the targets expected of parastatals and sector-specific SETIs. The accompanying national R&D budget, foresight inputs and risk assessments would also be provided by the DST, working together with the other departments and agencies. Each government department would set R&D goals for the institutions reporting to them, and allocate funds separately earmarked both for 'service R&D work' and for self-directed R&D. Each department's R&D Plan would be a component of the national R&D Plan prepared by the DST.

The NRDS recommended that all **sector-specific institutions** be placed in their sectoral line departments. It appears that this view was based on the notion that the other recommendations to reduce fragmentation would all be successfully implemented, with the DST able to exercise a coordinating role as the master integrating entity of the NSI.

The adoption of the NRDS by Cabinet, however, created a very challenging situation for the DST in the complex political environment of the country. In terms of the NRDS, the DST was intended to have the capacity to draw peer departments and multiple stakeholders together into a single national NSI, in the face of the inevitable impulse of these entities to operate autonomously.

A warning sign in the NRDS was its preoccupation with the public sector segment of the overall NSI, which was to become a key point made in the 2007 OECD review of the NSI, and by business commentators later (see Section 1.9 of the Phase One report).

## **1.6 2002 review of National Advisory Council on Innovation**

The 2002 review was the first review of the National Advisory Council on Innovation (NACI) since its inception in 1997. The review concluded that it was vitally important that the government should continue to seek and to receive well-researched advice on both policy and performance within the NSI, from a group of experienced and active people drawn from the many different areas within the system. It was felt that this need would best be met through the activities of a strengthened National Advisory Council on Innovation, which would continue to maintain an active dialogue with the Cabinet through the Minister of Science and Technology.

The main device suggested for strengthening NACI was to make it operationally independent of the DST, with a CEO who was not the Director-General of the Department, and to give it the freedom to work more widely within the NSI, despite the report-back channel being through the Minister of Science and Technology. The principal and most encompassing role of NACI was thought to be advising on policy matters in the domain of innovation, and the view was that it should not concern itself with the provision of technical advice on immediate and pressing issues. It was recommended that NACI should prepare a systemic review of the NSI every three to four years.

## **1.7 2004–2006: Implementing the new strategic management model for South Africa's S&T system, the policy on governance standards for SETIs, and the realisation of a National Science and Technology Expenditure Report/Plan**

The **New Strategic Management Model (NSMM)** was cast in precisely the same terms as the documents already discussed, but sought to sharpen the definitions and make some preliminary provision for 'market failure' or incapacity on the part of line departments in respect of their R&D functions and institutions within the NRDS conceptual framework, as already described.

The NSMM emphasised the **cross-cutting role of the DST in setting common governance standards and quality assurance mechanisms for each SETI**, irrespective of its location in the system. At the same time, however, the model reaffirmed the view that sectoral research agencies should remain within the domain of their respective line departments: thus the Medical Research Council (MRC), for example, was to remain in the domain of the Department of Health, and the Agricultural Research Council (ARC) in the domain of the Department of Agriculture, even though they both had considerable cross-cutting and overlapping activities. The Council for Scientific and Industrial Research (CSIR), by contrast, as a clear 'cross-cutter' was to be moved to

the purview of the DST, away from its previous reporting relationship to the Department Trade and Industry (the dti), as were the other cross-cutter agencies, the Human Sciences Research Council (HSRC) and the Africa Institute of South Africa (AISA). Uncontroversially, the National Research Foundation (NRF), housing also the Innovation Fund, remained in the sphere of the DST.

A critically significant part of the NSMM document described the nature of the ENVISAGED partnerships 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 that purpose.

The question is thus whether a 'consultant' role for the DST is really adequate in cases of departmental incapacity, and whether it is feasible to expect the DST to intervene in the case of a failed stewardship of a sector-specific SETI.

One of the residual centralisations of the NSMM was the assignment to the DST of the annual process of assembling **National Science and Technology Expenditure Reports**, to be used for the generation of a single **government S&T expenditure plan** covering and integrating all DST and sectoral R&D plans. This was intended to "guide the clusters and government as a whole on the deployment of resources ... while retaining absolute accountability in the relevant departments".

The expenditure reports collate expenditure in three different categories across the large number of government departments (23 of the 34 departments) with significant **Science and Technology Activities (STAs)**. The three categories are Scientific and Technological Innovation (STI, about 63%), Scientific and Technological Education and Training (STET, 20%) and Scientific and Technological Services (STS, 17%). National Treasury assists in compiling the reports by mining the relevant information from its annual Estimates of National Expenditure (ENE) in respect of the departments concerned, supplemented by questionnaire-derived information and direct consultations with departments. The Ministerial Review Committee had access to three successive National S&T Expenditure Reports, which appear to provide the beginnings of an informative cross-system view of government S&T expenditure. Closer inspection revealed, however, that the highly significant contribution to national STA of the Department of Education (now the Department of Higher Education and Training) was not reflected in the reports, while some high figures reflected in the reports were problematic (such as the more than R2 billion attributed to STET by the Department of Health, which represented a questionable set of data in that the large sums earmarked for education and training in academic hospitals were not spent exclusively, or even extensively, on activities that could be categorised as S&T). The generation of three successive annual National S&T Expenditure Reports has not, to the knowledge of the Committee, led to the generation of a National S&T Expenditure Plan.

All in all, the NSMM represented a major intervention in the public component of the NSI, providing clarity on certain definitions and mapping a perhaps optimistic view of the role of the DST in its limited, but now better-defined, domain by advising or cajoling its departmental peers into meeting the demanding requirements set for each of them in creating a well-functioning segment of the NSI.

### 1.8 Observations from SETI reviews up to 2007

A number of individual SETI reviews were conducted in the period preceding the OECD review. It is not the intention to present a summary of all of these other than to point out several insights that resonate with the themes already illustrated.

The 2005 SETI review of the NRF provided an example of the difficulties associated with blurred mandates, and the need for sharper differentiation of agency roles. The report drew attention to a widely held perception that the DST was increasingly performing agency functions that could, and should, have been assigned to the NRF or other agencies or SETIs. In some cases, "potential NRF grantees had applied directly to DST for funding because they thought they could get more". On another tack, and with respect to the relationship of the DST with the then Department of Education's (DoE's) Higher Education Branch, the review panel considered that **the greatest importance needed to be attached to harmonisation of the policies and practices of the DoE (advised by the Council on Higher Education – CHE) in relation to higher education institutions, on the one hand, and those of the DST and the NRF, on the other.** The review panel found little evidence that the DST (by itself or through the NRF) and the DoE (by itself or on the advice of the CHE) had addressed the obvious inter-dependencies between their policies and funding instruments. The NRF reviewers recommended the urgent achievement of a greater degree of complementarity between the DST and NRF Missions, on the one hand, and those of the DoE and the CHE/Higher Education Quality Committee (HEQC), on the other.

The 2001 SETI review of the MRC, by contrast, gave some attention to another dimension of systemic coherence, this time between sectoral agencies and their government line departments. The review report expressed concern about the MRC's relationship to the national Department of Health (DoH), noting that the department felt that "the Council should be more responsive to its needs, and pay more attention to translation of research to serve the country's needs".

### 1.9 Conclusion

In concluding this section, it becomes apparent that a powerful and compelling vision for an innovation-driven national economic and social development was articulated in the 1996 White Paper on Science and Technology. **This vision has unfortunately not been adopted widely enough in the range of government departments to achieve the intended pervasive impact.** Yet no argument has been advanced in the review reports referred to, nor in the interviews conducted by the Committee, that the vision is inappropriate; the concerns are about how to make the NSI work more powerfully and pervasively. Some initiatives (e.g. the NRTF and the NRDS) have sought to this end to deepen the NSI's definition and content, while others (notable the NSI reviews and the NSMM) have argued for modification to the architecture of the governance and implementation arrangements.

Emerging from this overview of the documents and processes are a number of concerns and questions that go to the heart of the country's capacity to organise and sustain a well-functioning and effective NSI. These are outlined below, and are intended to provide key questions for discussion in subsequent sections of this report.

- A persistent theme has been the **lack of effectiveness of the means that government has mobilised, especially those centred on the roles and powers of the DST and NACI as designated coordinators of an otherwise fragmented and diverse NSI**. We have seen some blurring of the boundaries between the functions of various important public sector agencies, while line-function sectoral agencies have maintained impermeable boundaries and operated quite autonomously in spite of declared policy intent. Consequently, there have been instances of duplication, dissipation or disruption of effort, and the loss of opportunities for powerful multi-agency collaboration to address complex needs. The fundamental question is whether the chosen model (together with modifications and enhancements, as noted above) is, in its fundamental architecture, the most appropriate one.
- Another recurring theme is the **absence of a clear focus in the DST on business as the largest NSI actor**, and the need to create optimal framework conditions for the whole NSI.
- The White Paper envisaged that the finances, infrastructure and human capital for the NSI would be generated jointly and cooperatively between the public and private sectors. To date, the question remains how the high-level goals and objectives of the whole system can best be arrived at, together with a **resourcing plan** (i.e. what resources will be needed, and where they will be sourced), in order to make the achievement of the goal of innovation-driven development a realistic proposition? To what extent have the measures that have been implemented succeeded in securing the resources needed for the system to serve its purposes?
- What measures are needed to **optimise the framework conditions** required for 'performing actors' in the NSI to link up responsively with one another to mutual benefit, so that resources (of all kinds) can be directed to the greatest effect?
- A number of initiatives have been undertaken that were intended to produce a **coordinating and enhancement effect**, including the MCOST, the NRDS, the NSMM, the Ministerial cluster model and, very recently, the Knowledge Economy Forum. What levels of success have these measures enjoyed, and what is to be learned from these about models of coordination appropriate for the South African context?
- Foundational to the notion of a national system of innovation is that the **'mental model'** is broadly shared among those that are intended to participate in it. Is this currently the case? Can we work further to clarify and deepen system-wide appreciation of the concept and its modalities?

- Given that **foresight exercises**, and their cohesive effect in achieving shared understandings and common purpose, are so central to the success of national innovation systems elsewhere, can we account for the seeming under-exploitation of South Africa's strong investment in 1997–1999 in such an exercise? How can this kind of work be institutionalised in the future, including at project level?
- A necessary **role for NACI of achieving a coherent and responsive** system is a powerful theme running throughout the discussions, and seems central to improving the governance architecture and system-level management of the NSI. How should NACI (or some successor device) be better structured, positioned and empowered to carry out the functions assigned to it?

These themes, emerging clearly in the pre-2007 formative years, will find expression again in the deliberations of the OECD Review, considered in the next section of this report, and will be persistent factors informing the deliberations of the Ministerial Review Committee.



## SECTION 2: CONCLUSIONS AND RECOMMENDATIONS OF THE 2007 OECD REVIEW

This section summarises in abbreviated form the observations and recommendations of the 2007 Review produced by the Organisation for Economic Co-operation and Development (OECD), *OECD Reviews of Innovation Policy: South Africa* (OECD 2007).

### 2.1 Challenges

The OECD was commissioned by the DST to conduct a **review of South Africa's innovation policy**. Published in 2007, the review constituted one of a series of highly reputable OECD country reviews of innovation policy, and was based on a **country self-assessment** prepared by NACI and an extensive series of interviews with stakeholders in the country's innovation system (NACI 2006).

**The Ministerial Review Committee set out to assess the validity and cogency of the findings and recommendations of the OECD Review in three contexts. The first and most direct was scrutiny of the evidence provided for them by the internationally experienced panel concerned; the second, comparison with the preceding self-assessment or background report; and the third, the opinions of respondents. Strikingly, no significant disagreement with the report was revealed in any of these ways. It was thus assumed that the Ministerial Review, in its first phase at least, did not need to launch an in-depth assessment of the OECD review report, which thus serves as a convenient and sound point of reference in the evolution of the South African NSI.**

**The standing of the OECD itself does not need to be interrogated; it is a highly appropriate and constructive external agency for the kind of review of the local NSI needed ten years after the release of the White Paper that signalled the adoption of innovation as a key driver of national development.**

The OECD Review noted that the context of the analysis was a society still in transition from a social economy sharply skewed along racial lines with deep disparities of poverty and wealth. The country faces the dual challenge of integrating its economy into a highly competitive global market while simultaneously providing employment opportunities that would mitigate the joblessness and poverty of a large proportion of the population.

The Review noted that post-1994 South Africa had inherited a relatively strong national S&T system, but one that had been structured to meet the needs of the previous social order. Although significant measures have been taken to restructure this system for the contemporary needs of the country, and the slowly improving, if uneven, performance of this system was noted, the NSI was perceived as still inadequate to address the urgent challenges that the country faces.

In particular, the NSI was characterised as **insufficiently supporting a transition from strong reliance on a resource- and commodity-based economy to one that is characterised by value-adding and knowledge-intensive activities**. Although some areas of the services sector are growing, the economy has yet to achieve the labour-absorption capacity it urgently needs. Equally, the NSI seems to be inadequate in its contribution to alleviating poverty and providing jobs. Indeed, the report notes that there may be little understanding of the role the NSI should play in addressing social imperatives.

Among the obstacles identified as impeding the functioning of the NSI is the **serious deficit in high-order skills**, particularly in the area of design, engineering, entrepreneurship and management (DEEM). This skills shortage is exacerbated by a global labour market that draws top talent towards the developed world. The second, and related, key obstacle is the deficit of university-based research and research training.

## 2.2 Findings

The OECD Review notes that South Africa's R&D-related assets include a strong, yet very limited, set of established higher education institutions, a good system of research councils and a nucleus of technologically-strong, innovation-performing business enterprises. The country has also introduced improved governance architecture, which includes a dedicated government department for science and technology (the DST), the National Research Foundation (NRF), and the National Advisory Council on Innovation (NACI). Initiatives such as the Technology and Human Resources for Industry Programme (THRIP) have been successful in promoting cooperation between universities and industry.

However, the policy landscape has many dimensions that warrant systematic attention, including:

- The **concept of a 'national system of innovation' has as yet gained limited currency**, both in the extent to which it is understood as something wider than traditional R&D activities and in the extent to which it has been fully absorbed into the strategies of key actors (including government departments and universities). The importance of R&D is well understood and supported, but there is far less understanding of the **notion of innovation** – in all its dimensions, including technical, economic and social. It is this latter understanding, and its potential to reach into all dimensions of society and the economy, that is a critical lever of development.
- Where there are far-sighted initiatives (often from the DST), these may find only limited effect in implementation. This may be due to the uneven commitment to the underlying notion of the NSI, the inevitable silo-effect of **organisational boundaries**, or simply a **shortage of skills**
- A **limited level of investment is spread too thinly** over a wide variety of disparate purposes and projects. There is insufficient identification of priorities, and inadequate capacity to marshal resources from different quarters to address these priorities at critical mass.
- The agencies that do exist (science councils, funding agencies, universities, etc.) may be **insufficiently differentiated**, with a consequent diffusion of roles and a weakened capacity to fulfil specialised roles needed for a sophisticated and responsive NSI.

- There seems to be only **limited horizontal coherence and integration** between agencies in the NSI, whether these are research and funding councils, or government departments. In particular, there is no Cabinet-level coordinating body to devise and monitor strategies for innovation at national level, and the resources needed for these. Although NACI sees its mandate as encouraging coherence (and no doubt enjoys success in various ways), its function is compromised by the fact that it reports to the DST and thus has no structural location that would afford it the authority needed for effective coordination.
- Similarly, there is **insufficient linkage between various levels of government**, with consequently weak integration between national, provincial and local levels.

## 2.3 Recommendations

The OECD Review concedes that its recommendations are selective and do not constitute a comprehensive formula for action. Instead they proceed from the review team's perceptions of priority areas, and from the features they believe to be factors supporting the success of national systems of innovation elsewhere. The recommendations include:

### *Widen system perspectives that help to shape innovation policy*

Such measures could include:

- Include the role of business more fully in the conception and coordination of the NSI
- Give greater recognition to a wider array of activities (than only traditional R&D) that do, or could, contribute to the NSI
- Encourage and support greater integration with the international innovation system, including the two-way flows of knowledge and skills, and the reciprocity between international and local policies and strategies
- Understand more clearly (through evidence-gathering where necessary) the demand side need for innovation, to enable greater responsiveness from supply-side measures.

### *Re-examine the major national innovation priorities and missions*

- Define the priorities for innovation increasingly in terms of sectors where innovation needs to find effect, rather than more narrowly in terms of particular technologies. For example, a comprehensive assessment of how the innovation strategy should address the structure of the economy, both in terms of its preoccupations (e.g. knowledge-driven rather than resource-dependent) and its reach (e.g. increasing inclusion of the so-called 'second economy')
- Strengthen the governance systems that would best enable the identification of such sectoral priorities.

### *Improve the governance structure of the innovation system*

- Establish a body at Cabinet level to provide a synoptic and holistic overview of strategies, policies, participants and resourcing. This body should be able to ensure the coordination of the innovation-related priorities, activities and resourcing of the various government departments

- Reposition the structural location of NACI to a Cabinet-level instrument of governance, with the mandate to achieve effective advice and coordination across government departments
- Strengthen the mechanisms and instruments to support the interfaces that prompt innovation and the production of skilled human resources
- Establish and monitor appropriate forms and levels of functional specialisation.

***Strengthen the human resource base for science, technology and innovation***

- Strengthen the pipeline of progression from school to university
- Address the conditions and impediments that limit the access and success of large numbers of students (especially black students) into the education system
- Create conditions to increase in the number, and the rate of completion, of postgraduate students
- Reform the cost structure for university studies, which inhibits access to the more costly fields of study
- Strengthen measures and investment to support the human resource development activities of business
- Put measures in place to enhance the international reticulation of skills, including a review of immigration policy.

***Improve the funding of university research***

- Further enhance the mechanisms designed to focus research attention on areas of social and economic priority
- Review the funding formula for university research subsidies to provide stronger incentives for high-quality research
- Provide carefully directed resources for the long-term project of building research capacity among historically disadvantaged individuals.

***Develop greater differentiation in public R&D and innovation support organisations, especially to the benefit of small and medium enterprises (SMEs)***

- Achieve greater acknowledgement of the diversity and diverse needs of SMEs
- Strengthen measures to support innovation in SMEs, including the provision of specialist organisations and resources
- Provide greater support for start-up enterprises, including government loans on favourable terms and with mitigated risk-sharing
- Provide the means to strengthen SMEs' access to the support that research and innovation organisations can provide
- Provide regional and cluster-based technology parks and innovation centres, sometimes associated with industrial parks.

The OECD Review represented a much-needed outside look, by seasoned professionals, at ten years of policy-making and implementation of the agenda set in motion by the 1996 White Paper on Science and Technology. The response of the various NSI actors to the OECD Review, especially that of the DST as 'coordinator' of the system, would be a good indication of the ability and willingness of the system to engage in critically informed policy learning.

### SECTION 3: RESPONSES OF SELECTED NSI ACTORS TO THE OECD REVIEW

This section is aimed at sketching the responses to the OECD Review and the resultant initiatives of selected players in the NSI, insofar as these could be gleaned from available documentation and interviews granted by key figures. The account cannot be considered as comprehensive, since this phase of the report has been based on a desk-top research exercise. [A more systematic empirical exercise would yield greater insight, and this was undertaken in Phase Two of the review.<sup>2</sup>]

In some cases, the responses of the agencies discussed in this section are based on their own reports of the measures they have undertaken related to the recommendations of the OECD review, while in other cases the responses are inferred from subsequent activity. While some material is self-reported, other material has been gleaned from the commentaries of other actors.

#### 3.1 Department of Science and Technology (DST)

The responses of the DST to the OECD Review have been derived partly from formal documentation (especially the Ten-Year Innovation Plan), partly from a newly formulated response document provided by the Director-General (DG) of Science and Technology, partly from informative briefings by the DG and other senior officials, partly from perusal of agendas and minutes of various inter-departmental cooperation bodies established by the DST and partners in government, and partly from perspectives provided more widely.

A senior official informed the Ministerial Review Committee that the DST's **Ten-Year Innovation Plan (TYIP)** (DST 2007), released in 2008, constituted the formal documentary response of the DST to the recommendations of the OECD Review, while the legislatively driven inauguration of the **Technology Innovation Agency (TIA)** addressed system architecture recommendations. The Committee learned of the production of a Cabinet Minute in relation to the OECD Review, which was not available because of the confidentiality surrounding such documents, but was said not to constitute a formal DST response to the report. A departmental six-page summary of **DST responses to the 2007 OECD Peer Review of the South African National System of Innovation** was subsequently received, which proved extremely useful in systematically addressing the DST response to the OECD recommendations.

The DST started working on the TYIP before the OECD Review exercise, and this might explain why the relationship between the two documents is somewhat tenuous and sometimes contradictory. Puzzlingly, no reference is made in the TYIP to the OECD Review, and a number of central recommendations seem not to be addressed in this document. **These include the need to bring the private sector more centrally into the NSI, meeting the infrastructure requirements of a knowledge economy, and (perhaps most importantly for a policy document) resolving the**

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<sup>2</sup>Additional perspectives on some organisations are included in Section 1 of the Phase One report, which provided an overview of the pre-2007 NSI.

**considerable systemic difficulties arising from the current governance and institutional architecture of the NSI.**

The TYIP, as originally disseminated, reads more as an elaborate 'vision statement' than a fully developed action plan. Nonetheless, the notion of the '**Grand Challenges**' has entered the discourse of the NSI community, especially the science councils. Consonant with the OECD Review's areas of focus, the TYIP characterises the priority pillars of the NSI as **human capital development, R&D, and knowledge infrastructure**. The '**Grand Challenges**' are to be spear-headed by the DST and will "offer tremendous opportunities for steering our resource-based economy towards a **knowledge-based economy**". Notably, the responsibility for addressing the Grand Challenges is necessarily spread across the operating domains of many government departments. Unlike the five new Missions of the 2002 National R&D strategy, most of which were more-or-less under the control of the DST itself, the '**Grand Challenges**' represent huge general priority areas of government such as energy generation, responses to global change, space, the bio-economy, and human and social dynamics. According to the TYIP, the measures available to the DST to fulfil this responsibility will include appropriate policy development, additional or reprioritised funding, coordinated planning and implementation, focused international collaboration, and public-private partnerships. A good example of a cross-sectoral project is the Space Agency, which requires collaboration across SETIs and government departments.

The failure to transform a key Mission of the 2002 NRDS, namely **Science and Technology for Poverty Reduction**, into a Grand Challenge is noteworthy, as it seems to fly directly in the face of the recommendation of the OECD review to **close the gap between the 'first' and the 'second' economy** in order to mobilise political commitment, and obtain advantageous benefits on both the supply and demand sides of the system.

The TYIP does not directly address the structural difficulties of achieving the Grand Challenge outcomes, occasioned by the **lack of systemic authority invested in the DST or NACI**. It also appears that these problems have increased rather than decreased during the period since 2007 when the OECD Review was published.

The DST from 2007 introduced a **Knowledge Economy Forum (KEF)** to consider progress towards the knowledge economy across broader government. The KEF has met only once a year, but its agendas and minutes reveal a determined if drawn-out attempt to provide information to sister departments about DST initiatives, to exchange perspectives, and to build a system of coordination and cooperation. The mandate of the KEF, as reflected in the terms of reference (as originally drafted in 2007), is to "strengthen the capacity of scientific and technological activities within government departments; choose research priorities that will have a direct impact on the reduction of poverty and the improvement of the quality of life of our people". It goes on to say that "the Forum will ensure that there are programmes to increase the rate and quality of innovation in South Africa and that there is expansion and intensification of initiatives relating to knowledge dissemination and sharing, as well as public understanding of science and technology knowledge".

The stated objectives of the KEF are:

- To develop a **network** through which government departments can share experiences, good practices in S&T policy and strategy development, and management to improve coordination of the sectors and services to the sector R&D community
- To provide a **platform** to discuss knowledge economy budget cluster policy priorities for funding and implementation for the benefit of all sectors
- To design and implement **policies** aimed at improving effective coordination and service delivery to sector R&D stakeholders
- To examine the **progress** that is being made in establishing the national S&T expenditure plan, **highlighting the barriers** that prevent its implementation and offering workable solutions
- To serve as a **resource** to policy-makers and decision-makers by providing road maps for higher growth in the S&T system and research sector
- To identify **key performance indicators** and discuss the performance of the NSI as whole, or focus on specific sub-systems, such as the National Agricultural Research System (NARS) or the National Health Research System
- To play an **advocacy** role for S&T policy within government and ensure continued recognition of the knowledge economy within the government cluster system and the National Treasury
- To ensure **effective implementation** of the governance framework, especially developing linkages between line-function departments and their science councils.

The impression created by the documentation surrounding the KEF between 2006 and 2009 is that the forum has sound terms of reference and that the attendant signing of memoranda of agreement (MoAs) between the DST and inter alia the departments of Trade and Industry, Minerals and Energy, Defence, Transport, Agriculture, Water Affairs, Environmental Affairs and Housing has been well-intentioned and well-conceived. (The departments of Health and Education are notably absent from the list). In each case, **cooperation frameworks** have been created on the basis of signed MoAs, and provision has been made for **joint coordination committees** drawn from the participating departments. In most cases, these committees have in fact met (but at best only on an annual basis) and sought to fulfil their assigned functions, with some successes (as described below). There have nevertheless been concerns within the forum about the long intervals between meetings, the absence of senior representatives, and the generally slow movement of the joint agendas; these concerns appear to be well justified.

The Ministerial Review Committee was told that despite the best efforts of the DST described above, the R&D activities in sectoral government departments in practice constitute a **highly fragmented system**, with both the risk and the reality of duplicated or contradictory efforts, and the erosion of attention to R&D generally within these sectors (see below). There were cases where, by contrast with the DST which said it gave "exemplary support" to its base of R&D institutions, other line departments provided inadequate sector planning and budgeting for research institutions under their respective mandates, and caused delays in the timeous appointment of boards, with concomitant governance risks. There were also concerns about the



maintenance of research equipment serving R&D initiatives as well as serving industry, and the erosion of scientific and technical professionals staffing R&D in these sectors.

Legislation has now been passed that revises the management of NACI by establishing a CEO position outside the DST staff structure. The extent to which the proposed change will permit NACI to function more effectively and transparently is not discernible at this stage, yet is a very important issue, and it is a pity that this necessary and symbolic step has not yet been visibly accompanied by attention to the mandate, scope of operations, and more systemic functioning of NACI.

The suggestion in the OECD Review to move away from heavy dependence on resources to knowledge-intensive production, and to close the gap between the first and second economies, has prompted the DST to develop the kind of sectoral focus originally expressed in the 1998–1999 National Foresight Exercise, “seeking to leverage off earlier investments where key industry capabilities had been developed”. The Technology Innovation Agency is designed to make a significant contribution across the private and public sectors in this way.

The DST has responded to the OECD Review’s identification of a perceived bias towards public sector institutions by “adopting the Innovation Survey as a core instrument for measuring industry performance”, and by committing itself to “working at industry sector level with the dti”. Both the Innovation Survey of 2005, covering the period 2002–2004, and the more recent Innovation Survey of 2008 (DST/HSRC 2009, 2011) revealed a very high degree of innovation in South African business enterprises, comparable with that of many OECD member states, much of it generated locally, and with a significant impact on profitability. The total spend on innovation was estimated at about 3% of total turnover. The overall favourable picture was marred by a **low level of public funding of business innovation activity** (aligned with the finding that funding of innovation was the main constraint encountered by business), a **low incidence of innovation-related information coming from universities (5%) and government research performers (3%)**, and a **low level of patent registration**. It is not clear whether the DST picked up these issues when the Innovation Surveys were released, and what was done to improve matters. Presumably, the ‘adoption’ of the Innovation Survey as a key tool capable of informing policy will be associated with more energetic and coordinated action in future.

It remains moot whether the ‘adoption of the Innovation Survey’ is really more than an opening move in a new approach to including business in the steering mechanisms of the NSI and attending comprehensively to the design of optimal framework conditions of the system. The rest of that agenda is not yet clear.

A number of measures are also currently under way under the DST’s own control or in partnership with other departments or organisations. The Ministerial Review Committee was briefed on projects aimed at addressing the following priority areas:

- **Poverty reduction and job creation:** Programmes supported by the DST that address poverty and the need for accelerated job creation include small-scale (pilot) initiatives to grow the bio-economy through agro-processing, aquaculture and agronomy, involving

partners in other public sector NSI agencies such as research councils and universities. Further measures are aimed at promoting sustainable human development, including access to clean water, affordable energy, innovative housing technologies and ICT connectivity. Projects are under way to provide educational support through the internet and social media. These initiatives are being pursued using modelling and risk-assessment technologies that are apparently becoming increasingly sophisticated. The Committee is in no position to assess the effectiveness or even the appropriateness of these projects, but the question arises whether the DST is achieving a proper balance between its policy-making, coordinating and implementation roles.

- **Technology and industry initiatives:** A number of ambitious programmes are currently in place, although (as noted by the DST) not yet sufficiently resourced and/or amenable to impact assessment. These include:
  - **Advanced Manufacturing Technology Strategy:** Value-adding in smart materials, electronics and production technologies)
  - **Advanced Metals Initiative:** Value-adding to natural resources in the four thrust areas of light metals, precious metals, speciality steels and new metals
  - **Biotechnology:** In human health, animal health, plant health and industrial applications)
  - **Information and Communication Technologies (ICT):** Key programmes in geomatics, wireless and mobile technologies, human language technology, and access technologies for people with disabilities. There is also a special programme on cyber-infrastructure that includes SANReN (the South African National Research Network) for advanced connectivity and the High Performance Computing Centre, and more recently, the space programme, with the launch of the satellite, SumbandilaSat.
  - **Science and Technology for Social Impact:** Sustainable livelihoods and sustainable human settlements, with second-economy targets in job creation and household-level benefits from alternative technology solutions for off-grid communities.
  - **Human Capital Development Strategy:** Currently being finalised (after much delay), with some instruments already being implemented (namely research chairs and centres of excellence).
  - **Human and Social Dynamics:** A broad strategy for this Grand Challenge is also being brought consultatively to final form, with implementation plans that use the policy and financial instruments already developed, notably research chairs, centres of excellence, special bursaries for postgraduate study, forums and collaborative programmes, etc. It is not clear whether the humanities will be positioned more favourably in the new approach than in the traditional 'handmaiden' role assigned to them in the NSI thus far.

Institutional instruments have been introduced for developing a 'critical mass' of capacity in what have been described as 'emerging research areas', such as investments in a number of nanotechnology platforms. At the other end of the spectrum, **Centres of Competence** have been established to drive efforts to develop industry-relevant products for commercialisation. The approach of the Centres of Competence is to operate at industry level, with various role-players contributing different competencies that allow South Africa to compete in global markets. The

availability of two contrasting modes of intervention in Centres of Excellence and Centres of Competence demonstrates an evolving ability to fit the investment to specific kinds of intervention.

The **New Strategic Management Model (NSMM)** for the public sector SETIs is being re-considered, because of significant failures in achieving its objectives, but no progress has been made to date, and considerable resistance is being encountered to the current piecemeal approach. The Committee was not provided with details of the new thinking in this area.

Efforts to achieve better vertical coordination between layers of government are focused on the development of a series of **Provincial Innovation Systems**, currently including Limpopo, Free State, Gauteng, North West, and Northern, Western and Eastern Cape provinces. In order to achieve sustained activity, **Provincial Innovation Forums** are being established, to bring together the leadership from industry, government and the research communities in the provinces. Science Parks are similarly intended to mobilise and energise industry through research partnerships. Advice from NACI was received on this important approach, but the extent to which that advice informed the present plans is not clear, and the Committee has not seen any agendas or minutes of Provincial Innovation Forum meetings, or details of early-stage outcomes. Any extension of these initiatives to the equally important local government level has not been evident so far.

In the context of the DST's response to the OECD recommendations, reference can again be made to the report compiled for **Business Leadership South Africa (BLSA 2010)**, to be described in Section 4 of the Phase One report: A business perspective on the role of the DST, which reflects the results of a survey aimed at tapping the perceptions of the business sector of the role of the DST in the post-OECD Review era. Business affirms the vital role that the DST should play in promoting the technological base needed for economic growth and competitiveness, and for job creation; given South Africa's context as a developing country, the intervention of the State is considered very necessary in this regard. There is a strong view, however, that the activities of the DST tend to be focused on the 'science' dimension of its mandate and rather less on the 'technology' dimension, especially the technologies and incentives that support industry and business. This is reflected in the low levels of awareness by the business sector of the current role played by the DST, and the **low business profile among senior DST executives**.

The report acknowledges the range of well-intentioned initiatives supported by the DST, but comments that these have yet to find full fruition. One example is the tax rebate on R&D investments which, as yet, has limitations that restrict access to potential benefits, curtailing its incentivising intentions. Furthermore, the lack of venture capital and 'angel funding' – as well as of incentives for technology-based industries – stand as barriers to growth, including for black-owned business. Comparative views suggest that successful provision in this regard by other comparable countries acts as a draw-card away from South Africa. It was felt that the relative lack of business-experienced personnel in the DST accounted for the way in which its activities tended to be skewed towards science, and the experience of business that the DST was 'user-unfriendly'.

The striking contrast between the self-assessment by the DST of its vigorous and positive response to the OECD Review, and the perceptions of many in the business community, suggests that the Ministerial Review Committee's initial study of the science, technology and innovation landscape will need considerable deepening in Phase Two of its work.

In summary, DST presented to the Committee its vision for the development in South Africa of a pervasive 'knowledge economy', building on and extending progress already made, and using a range of programmes that are believed to be generally consonant with the advice offered in the OECD Review. It is clear that a determined though seriously constrained attempt is being made to overcome the structural problem of inter-departmental coordination and the achievement of common strategic purpose through bilateral agreements and the creation of Provincial Innovation Forums in the provinces. Attention is also being given to the DST's role in helping to deliver on the priority areas of the government's Medium-Term Strategic Framework.

There appears to be much room, however, for a review of the DST's capacity to develop and support the infrastructure needed for vigorous science and innovation throughout the economy, and the best ways in which that capacity can and should be applied. Attending to the needs of the private sector appears to be a particular area of future re-focusing of the DST. Most critically, however, the over-riding issue of governance in the system needs to be addressed as a matter of urgency, because it is only through better governance arrangements that the DST can focus on its main role of advocacy and coordination of the provision, within government as a whole, of the optimal framework conditions for shaping the NSI.

### 3.2 National Research Foundation (NRF)

In responding to the OECD Review, the NRF has focused in particular on observations that the agency had become over-extended, and that its resource base had become too thinly spread across a wide range of activities, with the result that – among other things – critical scale was often not achieved. In response, the NRF has moved to rationalise the programmes under its control, including the Centres of Excellence, the Flagship Projects and the National Facility clusters. The challenge remains to balance investment between the foundation disciplines and areas of strategic focus (including priorities identified in the National R&D Strategy and the Grand Challenges).

Given the limited resourcing available to the NRF and the need for the agency to address simultaneously its mandate to **build research-capable human capacity**, support the advance of key fields of study and address priority areas of socio-economic development, the NRF has moved to sharpen the focus and methodologies for the allocation of funding. In addition to rationalising priority focus areas for investment, the NRF has deepened the competitive nature of funding decisions and strengthened the role of peer review in arriving at these decisions. These moves have, however, tested the availability of the expertise needed for the reviewing and adjudication protocols.

The NRF acknowledges that there is still only **limited understanding of what it means for the country to be internationally competitive within a global knowledge economy**. Better understanding is required of the collaboration needed between sectors and the scale of investment needed for an effective NSI. In particular, investment in higher education for the production of research-capable skills needs to be strengthened. There is a concern that some private sector investment in R&D is directed overseas when it could be performed locally, and efforts are needed to determine what would be necessary to make local R&D the best option available to the firms involved. A great deal of innovation, however, should not only be technologically driven in the traditional sense, but should also address social, political and environmental priorities, and these areas of focus are not adequately provided for.

At the level of government, there remain **insufficient levels of coordination between departments**, with a reluctance to participate in the competitive grant-making system. Role-diffusion in the responsibilities assumed by public-sector agencies in the NSI continues to be a problem. Tighter vertical differentiation is needed across the four-level distribution of functions seen as the optimal structure for public-sector NSIs, namely: (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; and (iv) research-performers, including universities and science councils. This differentiation should assist in identifying sectorally strategic priorities for resourcing, rather than just project-specific priorities, as is often the case. Currently, however, the role of the NRF spans perhaps three of these layers in that it provides advice, is a funding agency and also supports research-performing activities. This places further strain on its resource base and its capacity to fulfil what should be its primary function of being an autonomous research and innovation funding agency.

### **3.3 National Advisory Council on Innovation (NACI)**

Two review exercises of NACI were carried out in 2003 and 2008, each arriving at broadly similar conclusions and recommendations. The reports noted NACI's dependent relationship with the DST which had a number of counterproductive effects, including widespread perceptions of a lack of autonomy, limited capacity to influence national-level strategy and planning for the NSI, a relative lack of resourcing and the low profile of its work. Recommendations arising from these reports include:

- **NACI's role should be strengthened as an agency that informs and advises government at a national level on the strategy and planning for a truly national and coherent NSI.** Measures to this end should include the formation of a body or platform, ideally convened by the President, which directs and coordinates the activities of the various NSI stakeholders (departmental and sectoral) towards common strategic priorities.
- The Act mandating the existence, constitution and role of NACI should be amended to, among other things, install a permanent CEO for NACI in place of the DG of the DST, as is currently the case. Furthermore, the resourcing of NACI should be arranged to enable greater autonomy from the DST and an improved capacity to fulfil its mandate.
- NACI should arrange for **greater visibility** of its work in order to boost the profile and credibility of the agency, and its capacity to influence actors in the NSI.

- NACI should **include the private sector** more centrally in its membership and deliberations.

NACI's response to these recommendations provides for a number of measures. These are noted below, together with queries that the Ministerial Review Committee may wish to pursue:

- The formulation and implementation of a National Innovation Strategy which achieves coherence across innovation-related priorities of various government departments and public sector agencies
- The commissioning of a system-wide review to consider the horizontal and vertical coherence and alignment of NSI agencies
- The establishment of a NACI-CHE task team to address the human capital requirements of a NSI
- The creation of a task team to bring business into innovation policy
- Commissioning a study to map the national infrastructure needed for effective innovation
- Convening of a dti-DST working party to identify gaps in existing incentives for innovation.

Notably absent from the measures noted above are resolutions to address the matter of the **NACI Act** which constrains the independent and national-level function that the agency should play. Although NACI has specified in detail what these changes should be (see *NACI Response to the 2008 External Review*), this seems not to have been addressed except for the recent amendment to the NACI Act that has removed the designation of the Director-General of the DST as its CEO and has made this a full-time post. NACI notes that past and current Ministers have not been opposed to changes much more extensive than this one, and the current Minister awaits the advice of this Ministerial Review Process.

### 3.4 Council for Scientific and Industrial Research (CSIR)

The CSIR notes that the single most significant observation made about itself was that the CSIR does too many things, and its activities are thus somewhat fragmented. There is a need for greater capacity to be directed towards fewer activities, in an effort to achieve critical mass around selected strategic priorities. Although there has been a steady improvement in the quantity and quality of the CSIR's outputs (in the form of ISI publications, patents, etc.), the biggest problem continues to be the **breadth of its mandate**, in that the organisation can be called on to do anything that may be said to have 'technology' in its definition. The CSIR has been expected to respond to needs ranging from the highest levels of policy to very operational project implementation. As a consequence, the CSIR's work has **proliferated across a wide range of fragmented activities** and, given its finite resource base, has become over-committed. The CSIR is presented with a continuing flow of compelling projects, but has no adjudicating platform to decide on competing priorities: "We're very good at starting things, but hopeless at closing them down." Often the decisions made within the CSIR on the adoption or terminations of projects were informed by the contingencies of resourcing rather than strategic planning.

It seems that the **proliferated, fragmented and over-committed activities of the CSIR** are a reflection of, among other things, a larger systemic failure to provide coordination for the NSI.

### 3.5 Human Sciences Research Council (HSRC)

The HSRC sees itself as an integral constituent of the NSI, uniquely positioned to bring its skills base to bear on the **social and economic developmental challenges** confronting the country. The council's capacity for basic, strategic and applied research in the human sciences informs, among other things, the formulation, implementation, monitoring and evaluation of policy. This legislatively mandated responsibility for carrying out **evaluations of government programmes** of action inevitably involves reflections on the achievements of other government departments.

The research agenda of the HSRC is directly guided by **national development priorities**, as well as the **Millennium Development Goals (MDGs)**. As an illustration of the council's contribution to the social preoccupations of the NSI, its current research programme includes Democracy, Governance and Service Delivery; Economic Performance and Development; Education and Skills Development; HIV/AIDS; Sexually Transmitted Diseases and TB; Human and Social Development; and Population Health, Health Systems and Innovation. The absence of the humanities in this broad agenda is noteworthy, and reflects what has been called the '**handmaiden role**' of **social science** in supporting the efforts of the natural sciences, engineering and business in the NSI.

While the HSRC pursues strongly structured programmes of research, including large-scale cross-sectional and longitudinal studies, the organisation nevertheless strives to be alert to the possibilities of unanticipated developments and the need to respond swiftly when these occur. The HSRC's research-based datasets are used extensively for further analysis by other organisations, illustrating the role of the council as an interactive constituent of the NSI. The HSRC also strives to contribute explicitly to innovation-related purposes through advice on policy formulation, the development of assessment instruments and indicators and, importantly, research on innovation activities themselves. This is reflected in a number of studies focused on industry-university interactions aimed at the development of innovative technologies. Among other things, the HSRC produces the **annual National R&D Survey** and the **Innovation Survey**.

Currently, a large proportion of the HSRC's income is derived from competitive donor-funded or partner-funded projects, which tend towards shorter-term and contingent purposes, rather than enabling more powerfully dedicated attention to development priorities. Funding streams from the private sector are also constrained by the fact that social and human sciences research is explicitly excluded from the R&D tax incentive scheme. The HSRC further notes that the assumption that the national skills shortage is confined to the SET disciplines is misjudged, and that the social sciences are in similar need of top quality researchers.

In summary, the HSRC constitutes a focused resource, directed at the need for social, economic and political innovation; while the university sector has collectively a far greater skills and financial resource base in the human and social sciences, these resources are understandably (and necessarily) directed towards divergent and autonomous research priorities, of which the humanities are a large and neglected part. There is clearly room, however, for some of these resources to be directed concertedly towards common purposes, and in longer time-frames. Insights emerging from the Ministerial Review Committee's discussion with the HSRC raise again the need for tighter governance over the differentiation and specialisations of the research councils, coordination across agencies and sectors, as well as the need for improved and longer-term funding to be directed towards key innovation priorities.

### 3.6 Conclusion

The commentaries above confirm that many of the **observations made by the OECD Review speak to real and enduring issues running through the NSI**. It is also clear that these issues are not to be taken lightly, since they threaten the notion that innovation can be made a prime driver of the development of the nation, nor will these persistent issues be amenable to perfunctory measures. Many of them are bigger than the agencies that wrestle with them, and require concerted political will at the highest levels, together with strongly determined efforts to effect to the vision. There can be no doubt about the support, in good faith, for the concept of the NSI and its promise; yet there is an underestimation of what it will take to make it happen, examples from elsewhere notwithstanding.

The theoretical basis of a national system of innovation has undergone refinement over the years as increasing numbers of examples have become available for analysis. It is important that each country that has adopted the idea keeps up with the best thinking and experience in the field, and the intervention of some of the best of these in conducting the OECD country review of South Africa in 2007 is in some ways an input of considerable consequence. **The Ministerial Review Committee has learnt a number of things from the OECD Review that it believes should be foregrounded in the Committee's advice to the Minister:**

- **Business enterprise should be placed at the heart of an innovation system.**
- **Innovation activities should be seen as involving more than R&D, so that design and engineering activities, and innovations in pervasive public service delivery systems, are also seen as legitimate and mutually supportive parts of an NSI.**
- **An NSI must be an internationally open system, with two-way inputs of all kinds, including skilled people.**
- **Demand-pull innovative approaches should be given as much attention as supply-push approaches.**

**Of all the issues becoming visible from the narratives given above, the most pressing matters concern the need for strengthened and coordinated governance at the highest level (including the recognition and elaboration of best-practice in terms of the key insights listed above), dramatically improved resourcing to critical mass directed at a limited number of priority areas, urgent measures to address the broad range of skills needed for the vitality of the system, and the much greater involvement of business in the NSI policy arena.**



#### SECTION 4: A BUSINESS PERSPECTIVE ON THE ROLE OF THE DEPARTMENT OF SCIENCE AND TECHNOLOGY

At the request of the Ministerial Review Committee, **Business Leadership South Africa (BLSA)** provided a commentary – based on a necessarily limited survey of private sector experiences and perceptions – on the role DST had played in using its resources (financial, regulatory and otherwise) to advance the role and interests of the sector, not least by promoting an innovation mind-set among the business community and other actors in the economy.

Although the commentary makes only one passing mention of the NSI, it nevertheless asserts that the state should play a very active role in terms of advocacy, support and resourcing to promote a technology-rich economy and society. It argues, for example, for stronger collaboration between state, industry and higher education. However, given all the international evidence (confirmed by the OECD review) that it is business at the firm level that is critical to innovation (just as it is the private sector that is the engine for economic growth), the BLSA report expresses its clear disappointment that the state has tended to encourage investment in big science (e.g. the Square Kilometre Array – SKA) rather than forms of technology that would strongly support the private sector from the point of view of short-term economic growth, more access to global markets and positively impacting on export revenue. **It is global best practice for the state to engage with business to identify areas where the greatest assistance could be leveraged by the state and to create funding mechanisms to enhance the acceptance of new technologies within the industrial sector.**

For example, there are many areas in the manufacturing, electronics and telecommunications sectors where South Africa needs bolstering to leverage its local market so that it can be more competitive. One of the greatest successes was the large-scale interaction between automotive industries, research establishments and universities which gave birth to the **Automotive Industry Development Programme (AIDP)**. Through facilitated workshops, it was possible to identify the real needs of the automotive industry and in particular what local South African manufacturers could do to enhance their share of the automotive industry from a component point of view. From this intervention, a number of initiatives were identified and various research projects were executed, including collaborative programmes with international research agencies such as the Fraunhofer Society. In order to do this, the state would have to change its stance from providing funding for so-called 'blue skies' research to 'hard-nosed' implementation programmes, in which the state would work together with the private sector to establish specialist facilities and programmes to provide such support.

Business is strongly of the view, therefore, that innovation and technology are fundamental for economic growth, competitiveness and job creation. The organisations that drive the economy (both large firms and SMEs) would benefit from a **top-level coordinated approach** that marshals the resources of the economy to collective benefit, not least through cooperative programmes. Given South Africa's developing country context, the intervention of the state is very necessary in this regard, but the state must intervene from a position of **deep understanding of firms' behaviours and needs in the innovation and technology realm.**