National Research Foundation – Quo Vadis?

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Executive Summary

As formulated in the question of the title of this document, this is not a strategy planning document. Instead it is a first attempt within an iterative process at contextualising policy choices and options within the regime of R&D / S&T policies and practices. We have tried to table for debate, the following obvious dichotomies currently facing us, viz.

1. that of national S&T policies largely developed in 'the North' being "superimposed" on an emergent / developing economy;

2. that of a divergent national R&D strategy (perhaps system instead of strategy because the NR&DS emphasises poverty alleviation as one of the strategic goals) from core strategic national goals of, for instance, poverty alleviation;

3. that of a national agency with an encompassing mandate, yet faced with severe capacity and funding constraints to meet the above;

4. that of national S&T agency with line function responsibilities to the Ministry of S&T, whereas its core activities are with individuals and institutions within the domain of higher education – whose main funding, programmes, processes and policies are largely provided and driven by another line function Ministry, viz. that of National Education.

What may be the reasons for raising these (well-known) dichotomies here?
The National Research Foundation as a whole is engaged in complex, concurrent processes either requiring or receiving attention. It should be noted that there are different levels of prioritisation and / or urgency regarding the many issues being dealt with or to be dealt with during the next months. The following comes to mind:

- The NRF Board priority issues including, for instance, its relationship with the Ministry, S&T; its thoughts around "growing the NRF core budget; its engagement in strategic (S&T policy) matters; the status and locus of the National Research Facilities, e.g. the SA Space Agency deliberations. These issues, driven by the Board, are supported by the NRF Executive as and when deemed necessary.
- The (implicit) Plan of Action with regard to the NRF Institutional review of 2005 and the NRF Management Response, largely around the set of thirteen recommendations tabled during the review. These, mainly RISA-related matters, include, for instance, the DST – NRF relationship(s); a fund-raising strategy ("growing the budget"); a 'Focus on Africa' SP; (internal) human resources matters, e.g. implementation of the recommendations of the Organisational Culture report; streamlining of operational and IT-related matters, mainly GMSA-related; and "other" open issues such as SARCHi, SANAP, international and multi-lateral relations.
- The envisaged, CEO-driven strategic planning process for the new SP 2008 – 2012 – and beyond. Currently terms of reference, a project plan, time-frames, proposed submissions, events and visits are being formulated which will seek to address the full range of stakeholder and customer relations.

The business unit 'Systems & Policy Analysis and Strategy Advice' has been tasked with the last-mentioned issues under bullet three. Mindful of the fact that this has been deemed an iterative process "driven" by the priorities of the various levels of the organisation and those of its stakeholders and customers.

This document serves as an initial platform of orientation for rigorous internal debate. Comments to date have been received from individual – not all! – NRF Board and Executive members. Comments by the NRF – RISA management will be recorded at its annual breakaway.
A presentation of these (and other) comments will be given at the next NRF Executive Strategic workshop scheduled for May 2007.

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List of abbreviations

S&T	Science and Technology
NSI	National System of Innovation
DG	Director General
DST	Department of Science and Technology
NRF	National Research Foundation
NF	National Facilities
OECD	Organisation for Economic Cooperation and Development
CSD	Centre for Science Development
FRD	Foundation for Research Development
DACST	Department of Arts, Culture Science and Technology
MDGs	Millennium Development Goals

1 Purpose of the document

The purpose of this document is to outline key strategic policy issues in Sience and Technology (S&T) that have major impact on the performance of the NRF as an 'agency' / 'intermediary' within the National System of Innovation (NSI). The document attempts to delineate experiences and models from elsewhere in the world in regard to the implementation or realisation of a national system of innovation "superimposed" on an emergent economy in a country such as South Africa. It is our firmly held view that when the NSI was first mooted as a conceptal framework in green paper on S&T, although the conditionalities of a „developmental state" were set-out in the document, the crucial intra-governmental policy (practice) linkages were neglected.

2 Introduction

South Africa has, in the twelve years since 1994, embarked on a daunting *'Transformation Project'* which embraces virtually all aspects of the lives of its subject citizens.[1]

A revolutionary and globally "leading" Constitution has been negotiated, promulgated and inscribed in the lives of some 45 million South Africans. This constitution and the hundreds of pieces of legislation either rescinded or promulgated during the past ten years have, collectively, proscribed the major transformation of South African society.

But, what have been the results of these "transformative" initiatives? How have these concretised themselves in the public (and private) domains? How does one interpret, analyse and "introduce" (10 year) review findings into the respective (national) domains? More importantly,

[1] See the various "reviews of the state of the nation" after 10 years of democracy

how do these findings impact on key strategies such as *policy development and design … and, obviously, policy implementation?*

Most analysts agree that of all issues, the most pressing remain that of *poverty eradication, gross societal inequalities and disease.* A most recent study contends that, despite enormous state efforts at various policy and programme levels, these "issues" remain firmly embedded in what development economists term *structural injustice.* In their study, Seekings and Nattrass argue that the inherited *distributional regime* had "long served to privilege one section of the population while excluding others". They further argue that –

… the underlying bases of distribution remain fundamentally inegalitarian. The reason why extreme inequality has persisted after 1994 is, above all, that the distributional regime of the late apartheid period has been reformed (primarily through deracialisation) rather than transformed or rejected in favour of a more egalitarian one.[2]

A further factor exacerbating the "transformation project" is well known; that despite various BEE charters, for instance in the mining sector, the means of production and that of capital accumulation still largely vests in the coffers of white capital. Recalling a recent presentation of the Director General (DG) of the national Department of Science and Technology (DST), Dr Phil Mjwara, at the National Research Foundation (NRF) Board and Executive workshop, it is against the above described context that he outlined his primary concerns vis-à-vis the mandate, functions, roles and challenges of public bodies such as the NRF and the DST within the NSI.[3] Upon closer analysis of the presentation and subsequent discussions, several features evolve which, without any doubt, the NRF has to engage with should it wish to retain the appellation of *premier national S&T agency and its understanding as being an agent of change within the NSI*.

[2] Seekings, J. and N. Nattrass. 2006. *Class, Race, and Inequality in South Africa.* Scottsville: UKZN Press, page 6.
[3] Presentation delivered at the Mount Grace Country House Hotel, September 19, 2006.

Also inserted into this document, for intensive deliberation at all levels of the organisation, are conceptual frameworks, programmes and (best) practices of other national systems of innovation, including such systems as mentioned in the DG's presentation, viz. Finland, South Korea, etc. The reason for this is that the scope of Dr Mjwara's presentation is an indication that we cannot deliberate issues such as "growing the NRF budget" in isolation of the contiguous and complementary issues as tabled below (agenda-setting; policy coordination, etc).

First however, there is a need to reflect on the broader South African R&D context which, according to the DG:DST, include:

- the *strategic development of a knowledge economy* –
- situated within *the context of an (innovative) developing country (IDC) – "challenges" faced by South Africa – see the case study "Finland";*
- stakeholders and responses to determined *national strategies – and (the pathway of) consensus-building;*
- the *South African* and *SADC NSI challenges, i.e.,* complementarity of national and regional priorities?
- insertion of the DST's *"reasons for existence"* within the context described in the introductory paragraphs above

How does the NRF understand and interpret the above? What have been, currently are and / or should be the NRF responses? Its "reasons for existence"? A rationale could be the following:

Throughout the centuries, research has been of crucial importance for the formation of society. Research (and Innovation) is one of the key drivers for economic growth especially given the rapid acceleration of knowledge dependence of global economies. The world economy has become more dynamic, with knowledge production and use, and innovation and technology development becoming more important for economic growth and restructuring. Competitiveness is contingent upon rapid knowledge generation and rapid knowledge translation and

transfer. However, success in attaining a competitive position depends on the availability of a pool of highly qualified human resources, appropriate framework conditions and infrastructure supportive of the production, adoption and translation of high quality knowledge.

Economic competitiveness under the current global modalities has many dimensions, most importantly is technological change, which is perhaps the most significant source of structural change in an economy, because it enhances productivity and alters the mix of products, industries, etc. Another, which builds upon human capital, is knowledge. A more accurate perspective on national economic differences is not a focus on differences in resource endowment or differences in the rate of growth of capital or labour. It is the growth and accumulation of useful knowledge and the transformation of knowledge into final output via technological innovation, upon which the performance of the capitalist economy ultimately depends[4].

The NSI approach offers a coherent and practical way of strengthening the link between research and societal benefit. The NSI approach seeks to enhance goal alignment among stakeholders and promote the enactment of mutually reinforcing and coherent policies and legislations. This then translates into complementary programming (policy instruments) and efficacy in the division of labour among the various stakeholders (government departments, policy and implementation, different agencies, etc) in terms of R&D and innovation support and other key activities critical to competitiveness. The challenging part is attuning and coordination of research and innovation policies that are scattered over various actors in the innovation system within the public administration. Therefore governance structures have to be responsive and relevant so as to mediate the inherent differences in rationales within the prevailing division of labour in the public administration system. Creating a Ministry of Research, as has been suggested in other systems, will create a new set of challenges which are

[4] Innovation Policies in South Korea and Taiwan, *Soren Eriksson*, Vinnova Analysis, 2005

arguably more dire than the current ones (The Ministry will risk being considered a competition to other ministries tasked with the so called "bread and butter" responsibilities as opposed to R&D and Innovation being seen as providing solutions to addressing the "bread and butter" issues). This is but one factor and challenge we have to face in South Africa.

Building a functional system of innovation is, without a doubt, a daunting but necessary task and requires political manoeuvring or political support at the highest level. Since the NSI approach emphasizes policy learning, unlearning and re-learning at various levels in the system as priorities change, it is important that feedback loops at every level are built into the governance structure of the system. The agencies are or should be expected to be "closer to the ground" and therefore have an important role to play in terms of policy learning and unearthing bottlenecks (i.e. inadequate funding, fragmentation caused by divergent policies or different funding instruments) that hinder optimal functioning and development of the system. At a systems level this translates to a need for intelligence gathering capability at all levels in the system. This intelligence capability is linked to various aspects in the system i.e. agenda setting, etc which are discussed below in the relevant sections.

This "science intelligence" applied to the SA NSI reveals that, upon cursory examination, there has been a subtle but discernible "correction" (policy learning), viz. that *if the major investments into technological innovation for economic growth are to succeed*, this has to be preceded (or concurrently accompanied) by the *requisite investments in human capital development – focussed, targeted and directed*. The latter is evident in the range of human capital programmes launched and funded by the DST over the last three years[5]. A study of developments in South Korea of the past 20 years should serve as a possible example for our interventions despite the fact that South Africa's scientific "base" in 1994

[5] Examples are the Centres of Excellence, the SARCHi, Post-doctoral Fellowships in specific disciplines and programmes, the Regional (SADC) Scholaship Scheme and various bursary and scholarship schemes attached to programmes of the National Research & Development Strategy, e.g. in Astronomy.

was much more sophisticated than that of South Korea in the early 1980's when their national R&D plans were first introduced.[6]

It is in such a context that the NRF would make an argument and motivate for the ca. R 620 million human capital funding (cornerstone interventions)[7] requested over two financial years. The adoption of the "*Ph.D. as a driver"* motto for achieving the NRF core missions and objectives is laudable, but must be carefully motivated, structured and form a key intervention for the core national, strategic R&D programmes. *The argument would include undertaking a major overhaul of the current values of the various post-graduate bursaries and scholarships, and fellowships*.[8] Analyses of the current system by both internal and external parties indicate that such a major revision would certainly contribute to retaining prospective candidates within the national research system and also contribute to a significant rise in "demand".

Of particular significance here would be our arguments then – and now – that in order to adjust and increase NRF bursary, scholarship and fellowship values to effectively retain post-graduates and post-doctoral candidates within the higher education research and national science systems, *the NRF required an amount effectively doubling its baseline (core) allocation at this time, from R 293 mill. to R 586 mill.* It is common cause that NRF values have not kept pace with, amongst others, *inflation-related increases, increases in cost-of-living expenses, and increases in tuition fees.* The NRF has not been alone in this regard. The NSAF, various student representative bodies such as SASCO *and* the academic

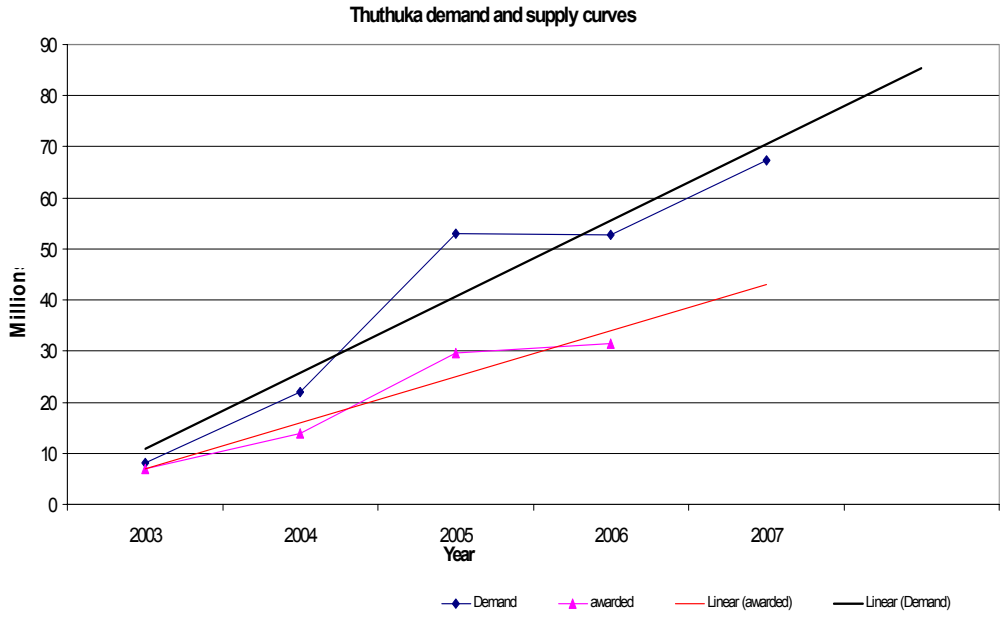
[6] Korea's National Innovation System and Science and Technology Policy, Deok Yim, Science and Technology Policy Institute, South Korea 2005.
[7] Details are to be found in the NRF MTEF Submission of August 2006 attached under Appendix 2B
[8] Refer to the draft study undertaken within ICD for specific institutional and regional details.

community at large have all alerted government to this malaise.[9] This situation is particularly exacerbated at post-graduate level where domestic expectations of financial contributions after a first degree are high particularly among prospective black candidates. Each year the NRF experiences cancellations of scholarships by very promising students precisely for the above-mentioned reasons.[10]

An anticipated significant increase is true of, for instance, the *Thuthuka* programme where partner higher education institutions – which have to fund two-thirds of the total costs of this staff development programme – have constantly indicated a need for a generous increase in the overall annual NRF allocation and budget of this very successful programme – see figure below for current 'demand' and 'supply' where current demand outstrips supply by in excess of R 20 million. In realising such an increase across *all* human capital programmes to the baseline (core) funding of the NRF, the National Research Facilities, too, would be enabled in making significant contributions to human capital development *throughout the system* within their respective areas of expertise and as outlined in their respective strategic plans.

[9] Several articles in the most recent edition of ***Campus Times, Summer 2006 – an insert of the M&G of 03 November 2006 –*** make reference to this. Trevor Wills, executive dean of students at UKZN, acknowledged that there is a problem at every tertiary institution of a growing number of students that are not accepted (or admitted to exams – our insertion) owing to insufficient funding.

[10] A draft report entitled **A Review of the NRF Scholarship Values vs. the Cost of South African Universities** is currently being studied within the institution in order to further strengthen our case for significant increases in this regard. Apart from a careful analysis of data from all higher education institutions in the country, selected interviews were also conducted on a regional basis with administration services at these institutions.



3 Key elements of an NSI

3.1 Agenda-setting institutions and practices

One of the key tasks of good governance within a science system is to ensure effective prioritization and agenda setting for innovation policy. This also entails creating a platform where a discourse on the state of the system and possible strategic options and priorities available to launch the system into a new growth trajectory can be effected[11]. The optimal functioning of the system is highly dependent on availability of intelligence and therefore intelligence gathering capabilities are a critical component of governance or rather governance capabilities. These include evaluations, foresight studies and more general kinds of policy studies[12]. Information and analyses are required for bottleneck analysis.

[11] Governance of Innovation Systems Vol 1, OECD, 2005

[12] In this regard it is crucial, therefore, that the NRF Board and Executive are well prepared to engage in the deliberations on the findings of the OECD Review of the SA NSI – scheduled for February 2007.

Previous studies of science systems, especialy those of OECD affiliate countries, revealed a weak correlation/link between strategic intelligence and agenda setting and prioritisation initiatives within those systems[13]. However, there seems to be concerted efforts on the part of most countries to rectify this structural deficiency. Recent evidence suggests that in other science systems, especially those of developed economies, strategic research areas are almost always linked to areas of economic comparative advantage i.e. selecting areas with high growth potential that have horizontal impacts across the economy – create critical mass, scale and specialisation.

Many countries have recently attempted to adapt their policy making to achieve better take-up of a more horizontal innovation policy with a view to greater coherence. Two broad tendencies emerge:

1. Some governments have initiated broader *framework policies* to create a better and more comprehensive agenda for innovation policy. In some cases, these framework policies attempt to establish a new industrial policy that gives innovation policy a specific role. In other cases, they are more closely linked to a general policy for sustainable development. In both cases, there is the issue of policy hierarchy and the determination of the rationale that is to serve as the lead principle. There also emerges a tension between policy paradigms so that framework policies collide with the embedded principles of autonomous, single policy ministries.

   Examples here include:
   New Zealand's Growth and Innovation Framework
   American Competitive Initiative
   Canadian Innovation Strategy
   Malaysian S&T Policy for the 21st Century

[13] Research and Innovation Governance in Eight Countries, *Patries Boekholt et.al.*, Technopolis, 2003

2. Other governments have refocused on their *science, technology and innovation-related institutions*. Korea, for example, has elevated the Minister of Science and Technology to the level of deputy prime minister. Science and technology policy councils or various "innovation platforms" are being introduced or re-examined with a view to creating a broader and more focused innovation policy agenda. The experience of Finland is relevant here: its long-standing Science and Technology Policy Council has been of the utmost importance in creating a legitimate environment for STI priorities, but its consensus orientation makes it unable to deal effectively with the need to redirect innovation policy. It is all the more difficult as Finnish innovation policy has been defined and understood as technology policy.

   Examples here include:

   Finland – Science and Technology Policy Council of Finland (Chaired by the Prime Minister) of which our counterpart body, the National Academy of Finland, is a member.

   Denmark – Ministry of Research (Coordinates research across all government departments) and is advised by the Danish Council for Research Policy

   Netherlands – Advisory Council for Science and Technology Policy

   United Kingdom – Council for Science and Technology and the Chief Scientific Advisor (has access to the Prime Minister). The role of the Chief Scientific Advisor focuses on science-related policy issues than on horizontal research and innovation policy coordination.

   New Zealand – Ministry of Research Science and Technology provides policy advice to government

Canada – Advisory Council on Science and Technology

United States – Presidential Council of Advisors on Science and Technology (chaired by the President of the US) in conjunction with interagency National Science and Technology Council of which our counterpart body, the NSF, is a member.

It is important however to recognize the path dependency of the development trajectories of the various systems. It has been argued that policy making "is driven less by anticipation of its uncertain consequences and preferences … than by a logic of appropriateness reflected in the structure of rules and conceptions of identities. Social choices are shaped, mediated and channeled by institutional arrangements. Policy making, in this context, implies matching institutions, behaviours and contexts in ways that take time and have multiple, path-dependent equilibria, thus amenable to timely interventions to affect the meander of history and to deliberate efforts to improve institutional adaptability[14].

The underlying theme is that history counts. Many governments may be using yesterday's institutions to meet tomorrow's problems. Policy priorities are often deeply rooted in political-economic systems and often go unchallenged. This may lead to policy lock-in situations with biases and allocations that may cause governments to forego options for structural accommodation[15]. Therefore it is important that the process to reach research priorities should be as inclusive as possible although driven a government level as the following quote from the Research Council of Norway suggest – "the selection of priorities will be formulated at a superior level; instead of political powers identifying specific programmes, the government intends to define priorities more closely in dialogue with research communities, society and the private sector"[16].

[14] Governance of Innovation Systems Vol 1, OECD, 2005
[15] ibid
[16] Commitment to Research, *Norwegian Ministry of Education and Research,* Report No. 20 (2004 – 2005)

3.2 Co-ordination practices

There has been a marked shift in the understanding of the innovation process. The understanding of the linkages between economic developments, innovation and technological change has increased. Innovation Policy is no longer the purview of S&T institutions but creates a more generic policy agenda requiring broader cross-ministerial attention. The first generation of innovation policies viewed innovation as resulting from a linear process – basic science leads to applied research which causes innovation and wealth creation[17]. This view was not adequate because the role of the marketplace in the innovation process had not been elucidated. This led to "market pull" models of innovation. The argument between push and pull models was laid to rest in the 70s with the emergence of a view stressing the importance of coupling between science, technology and the marketplace or between opportunity and need. Innovation processes then do not start at a particular place (basic science or the marketplace) but can be prompted by changes anywhere. Innovation can only be successful when there is congruence between knowledge and need.

This paved the way for the emergence of second generation innovation policies which are based on the concept of a National Innovation System comprising of three main pillars which are deemed critical to the process of innovation i.e. Industrial system, Higher Education and Research system, and Political system[18]. An illustrative diagram of a generic national system of innovation is given in figure 1 below.

[17] Reflections on devolving funding in vote RS&T in New Zealand, *Eric Arnold*, Technopolis, 2005
[18] Evaluation of the Research Council of Norway*, Eric Arnold et.al.*, Technopolis, 2001

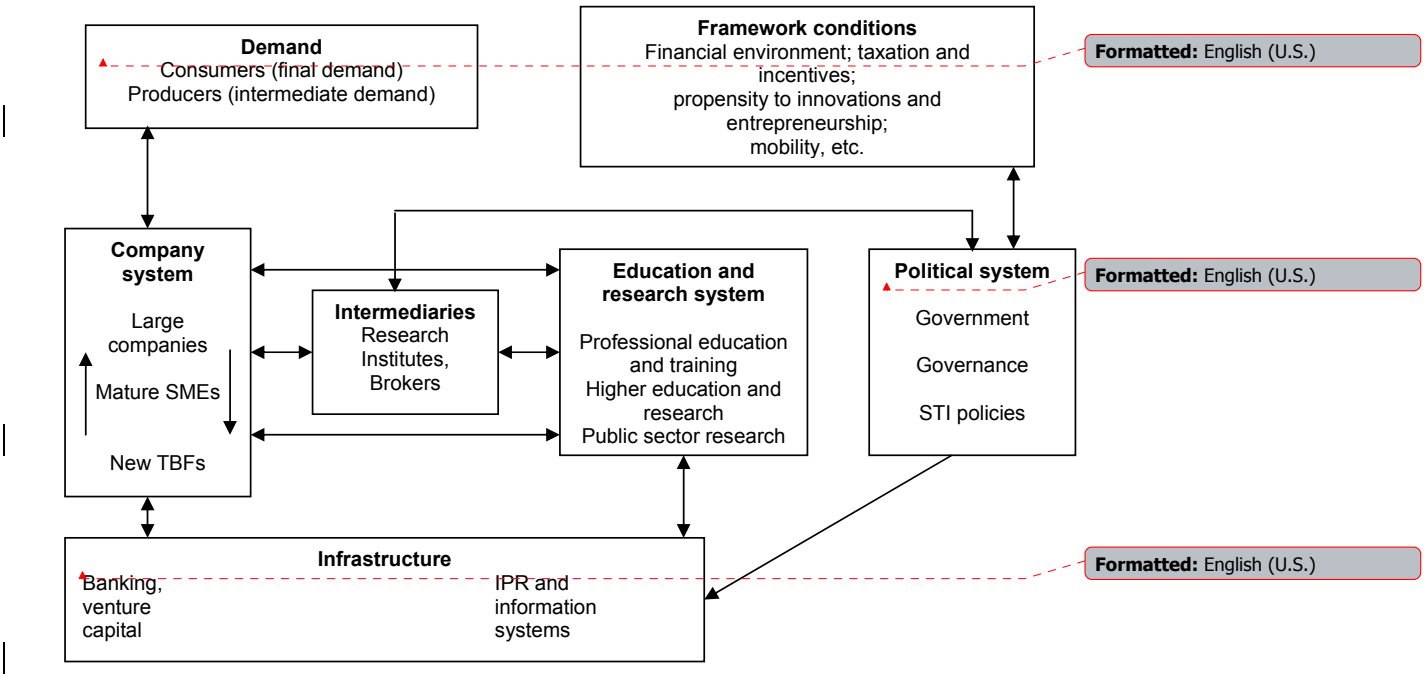


Figure 1 A generic national innovation system
Source: Arnold and Kuhlman (2001).

The NSI approach is normative in so far as emphasizing the importance of institutional linkages and networks, and policy coordination and harmonization as being crucial to the health of the system (linkages do not necessarily imply that the system's behavior can be predicted). Innovation is realized through a triple helix of industry-university-government (as opposed to the three hump model where the three institutional types have distinct and separate roles[19]) relations where the each of the three pillars can assume the role of the other – emergence of the concept of entrepreneurial university or "multiversity"[20]. This approach nonetheless still left the responsibility of innovation policy with the S&T institutions.

The third generation innovation policies involve a broader focus and are underpinned by an understanding that innovation is not a purely

[19] Research and Innovation Governance in Eight Countries, *Patries Boekholt et.al.*, Technopolis, 2003
[20] The new visible hand – an assisted linear model of science and innovation policy, *Henry Etzkowitz*, Science and Public policy, June 2006

technological phenomenon but encompassed both technological and non-technological changes that bear on economic and social development. Innovators are affected by incentive systems and regulations that have various sources and rationales. In a sense innovation is stimulated across a number of governmental or policy areas. Therefore strategic actions are needed to induce a coherent policy framework for dynamic innovators and structural change[21]. Coordination is required across government ministries (Horizontal coordination) and within ministries (Vertical coordination)

Governments are not omniscient and the sector-based division of labour between ministries exacerbates the complexity of creating horizontal coordination beyond the sector-based paradigm.

- Co-ordination is closely linked to agenda setting. When governments can formulate strategic, long-term policies and visions that set a clear and legitimate direction for priority setting, co-ordination is more effective. When they do not, more co-ordination has to take place through discrete, lower-level activities like communication tools, consultation and arbitration.

- As many governments assume that ministerial practices may not respond to rising pressures for co-ordination, a trend towards "agencification" has developed. Thus, governments retain the basic policy-making structure while inducing decentralisation, accountability and flexibility at the agency level. They believe co-ordination is most effective at the level of implementation, with agencies best equipped to develop co-ordinated action with innovators.

Denmark and Finland appear to use budgets more strongly as a coordinating mechanism though in different ways. Denmark coordinates by making a single ministry responsible for research and

[21] Governance of Innovation Systems Vol 1, OECD, 2005

innovation policy. Finland superimposes a high-level national council, where key ministers can effectively negotiate about budgets.

The US also uses budgeting more strongly to steer the system – "In general the Administration favours Federal R&D investment that:

- *Maximizes the efficiency and effectiveness of the S&T enterprise…*
- *Support high-leverage basic research to spur technological innovation, economic competitiveness and new job growth…*

Agencies that receive funding for interagency activities should be prepared to produce among others an interagency implementation plan"[22]*(two points here – Efficient deployment and interagency collaboration and co-programming."*

Budgetary co-ordination appears weak in Canada, Ireland and Netherlands.

Coordination mechanisms tend to be specific focusing on those actors who need to be coordinated rather than using a broad general purpose forum such as a standing committee. Such mechanisms tend to fall into four categories viz.

- *Cross-ministry/agency programmes*
- *Interagency cooperation agreements*
- *Ad hoc coordination*
- *Use of planning processes and procedures that require coordination*

An alternative to coordination would be to build bigger institutions with wider responsibilities e.g. Research Council of Norway or Denmark – single ministry responsible for Research and Innovation, and the recently constituted Danish Agency for Science, Technology and Innovation.

As governments attempt to respond to greater external and internal complexity and dynamism, policy co-ordination becomes the main means

[22] Memo to Heads of Executive Departments and Agencies, Offices of Science and Technology Policy and Management and Budget, June 2006.

of achieving greater coherence. As the MONIT[23] work reveals, there are difficulties:

- Co-ordination mechanisms may be static and short-term rather dynamic, particularly when there is significant institutional fragmentation and short-term considerations dominate agenda setting. Co-ordination may simply concern annual budget-related decisions and be decentralised to implementing institutions. This does not lead to long-term or strategic policy priorities.

- Designing co-ordination mechanisms takes time and financial support. A sense of urgency is necessary if efforts to co-ordinate policy are to affect policy governance. Without a sense of urgency, co-ordinating arrangements may fail and the system may build up resistance against subsequent attempts.

- Co-ordination across policy domains: People are more decisive than structures but structures support people. Well-functioning co-ordinating activities require personal leadership and commitment, and policy makers should ensure supportive structures for co-ordination activities that rely on persons.

- Because different mechanisms are typically needed at different levels, arrangements that function well at ministerial level may be less relevant for lower levels. The need for different mechanisms for different types of policy issues, brought out in the study of sustainable development, seems to substantiate this. Moreover, successful co-ordination on one level sometimes reduces the need for investing in co-ordination on another.
- As for the innovation system, it is necessary to identify strong and weak links. With appropriate analysis of co-ordination failures, targeted coordination arrangements may be easier to design and implement.

[23] Monitoring and Implementing National Innovation Policies – project initiated by the OECD in 1995 with the aim of finding ways to redirect innovation policy in OECD countries, taking into account new insights into the innovation process emerging at the time from innovation research.

3.3 Policy integration

A comprehensive innovation policy *spanning ministerial boundaries* must have coherence, and policies should be mutually supportive. Governments should therefore attempt to ensure that policies and their instruments are aligned and reinforce each other. However, certain issues embedded in policy or governance systems may make this integration difficult[24] which, include, amongst others:

- Lack of understanding of innovation policy in other policy domains undermines communication in the co-ordination process.
- Strong traditions, in particular in the science policy domain, create segmented "belief systems".
- Dynamic coupling of problems, policy proposals and politics resulting in policy often takes place in the context of specific windows of opportunity.
- Specific sectoral policies may be defined in ways that define others as rivals.
- Strong political leadership is necessary to create common visions and a legitimate basis for joint agendas.
- Stakeholders differ. S&T policy focuses on economic competitiveness and its most relevant stakeholders are the business and research communities. Their preferences and judgements may be different from those of stakeholders in other areas.
- Drivers of policy formulation differ. For example, environment and sustainable development policies are traditionally driven by international agreements and global problems, whereas innovation policy in most countries is very much driven by national concerns. S&T policies traditionally aim at increasing national competitiveness and wealth, whereas sustainable development policy is concerned

[24] Governance of Innovation Systems Vol 1, OECD, 2005

with improving international governance for tackling global problems. It follows that S&T policy needs to be more alert to international developments and sustainable development policies will have to tackle national challenges.

- Policy measures differ. Sustainable development and environmental policies mainly use regulatory and fiscal measures, often based on international agreements, with strict, set targets and rules regarding actions. In addition, they often rely on standards, voluntary agreements and information sharing. In contrast, the main innovation policy measure is resource allocation for R&D, and regulatory and fiscal instruments have a much smaller role.

Resources for actions differ. Political power is ultimately linked to control of money. Typically, sustainable development and environmental policies have very few resources for actions, while S&T policies control the state budget for R&D allocations. This difference may hamper efforts to design joint actions that require some reallocation of resources.

In concluding this background document, we thought it necessary to once again raise the matter of the "agency as an agent of change" as we believe that this will become crucial in the deliberations with the DST, DoE and other national departments. The presentation by the DG: DST was a necessary and sympathetic "view from outside" of the NRF. This should be very useful in the planned interactions over the coming months.[25]

3.4 The 'Agency' as an agent of change

Different countries place the boundary between basic research funding, R&D or innovation funding involving industry and wider business development at different places. Norway (Research Council of Norway) and more recently Denmark (the recently constituted Danish Agency for

[25] The business unit has compiled a set of documents related to the key issues and areas raised here. These will be made available along with a brief executive summary of each document.

Research, Technology and Innovation) have attempted the radical step of putting innovation and research funding into the same agency. There seems to be aggregation and disaggregation in other science systems in pursuit of integration. Modern Innovation theory suggests close linking of the three functions alluded to above but the practicalities of integrating the breadth of functions requires astuteness in the design of "umbrella" agencies[26]. The question of boundaries and design of agencies has profound implications for agenda setting and integration functions.

However, experience in other systems suggests that there is a tendency by government departments, in an "umbrella" agency and multi-principal agency setup, to micromanage the agencies through excessive earmarking. Whilst it is desirable that governments should retain long-term policy competence, they should afford agencies sufficient flexibility to ensure coherent and timely implementation of programmes and policies. Micromanagement of agencies is counterproductive if the goal is to achieve coherent governance[27]. The central question in the design of agencies or aggregation exercises should be the extent to which coordination and coherence is promoted and enhanced.

The above alludes to important and strategic roles that agencies have to fulfill over and above being seen as just implementing agencies. The NSI approach emphasizes learning, unlearning and re-learning. National Innovation systems are a complex and dynamic combinations of institutions that support learning processes and technological accumulation, and are therefore intelligence intensive. A general strategic intelligence framework for an NSI is depicted in the diagram below.

[26] Research and Innovation Governance in Eight Countries, *Patries Boekhot et.al.*, 2003
[27] Governance of Innovation Systems, OECD, 2005

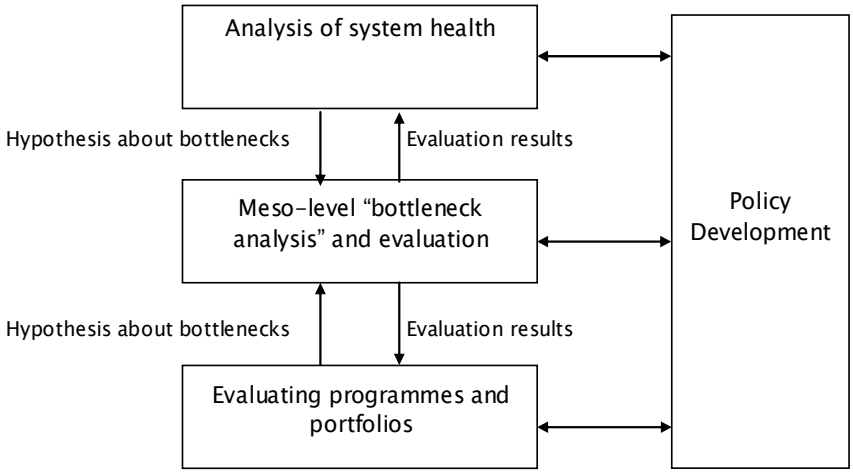


Figure 2 Strategic intelligence for research and innovation policy in a systems world (Source: Reflections on devolving funding in vote RS&T in New Zealand, *Eric Arnold*, Technopolis, 2005)

Although the governance of innovation systems inherently resides with government ministries but largely relies on intelligence resident in the various institutions that make up the system. Although it is the state's key role to undertake bottleneck analysis – continuously identify and rectify structural impeferctions. However, the state cannot on its own optimise or manage the complexity of an NSI. Therefore the agencies, as well as other stakeholders, are crucial for policy making in terms of identifying bottlenecks, identifying funding needs, etc, and escalating those into the policy making processes. Modern research councils and innovation agencies tackle both the "bottleneck analysis" and to some degree act as change agents in a NSI. For instance, the Research Council of Norway provides policy advice to the Ministry of Education and Research.

The following are some of roles that agencies as change agents are expected to fulfill:

- Providing funding instruments in line of national priorities
- Identifying bottlenecks for policy actions
- Identifying funding requirements and new priorities
- Coordinating the instruments in their control
- Seek cross-sectoral coordination with other agencies through co-programming and co-funding

3.5 Funding of the science system

The main elements in the innovation system are Knowledge, Money and People. The main activities are knowledge creation, transferring and utilization in the market. Therefore actors within a NSI interact with each other and exchange knowledge, financial and human resources[28]. If this is taken as conventional wisdom, then a lack of one element will result in suboptimal performance of the whole system[29].

The human capital is the critical element which facilitates knowledge creation, which is the main currency of exchange within an innovation system[30]. However, building the human capital requires time and financial resources. Unfortunately investments in R&D and human capital are typically treated as annual expenditures even though they represent investments with long payback times[31]. However, there seems to be universal acceptance of the fact that investment in R&D is critical for future competitiveness. Scientific advances and technological change are important drivers of economic restructuring and growth. The ability to create, distribute and exploit knowledge has become a major source of competitive advantage, wealth creation and improvement in the quality of life[32]. Many governments are increasing their investment in R&D in

[28] Korea's National Innovation System and the Science Technology Policy, *Deok Yim*, Science and Technology Policy Institute, South Korea, 2005
[29] Ibid
[30] Ibid
[31] Governance of Innovation Systems Vol 1, OECD, 2005
[32] Science, Technology and Innovation in the new economy, OECD Policy Brief, 2000

pursuit of desirable economic and other social outcomes i.e. improved defence systems, disease control and treatment, poverty alleviation, etc.

The investment in R&D as a percentage of GDP is a proxy for future economic competitiveness of a country (this does not imply that increasing R&D investments will on its own lead to economic prosperity if issues such as policy coherence and coordination are ignored. The so-called "Swedish paradox" is well documented; that despite huge increases in R&D investments, the Swedish National System of Innovation has shown weak long-term competitiveness in terms of innovation, economic growth and job creation[33]. This suggests the presence of structural impediments which stifles knowledge diffusion and translation).

Most of the countries have set targets for R&D spend as a percentage of GDP. However structural threats within the Innovation system may necessitate more robust investment decisions. The decline in US R&D personnel, changing patenting patterns, etc, spurred the US government to commit to doubling the spend on basic research by 2015. In a true systems approach the American Competitiveness Initiatives (2006) tackles what have been identified in a previous study (Sustaining the Nation's Innovation Ecosystem, 2003) as system bottleneck i.e. declining R&D intensity, declining R&D personnel, declining interest in Science, Technology, Engineering and Mathematics among US students. The initiative addresses all these issues in a systematic manner dealing with the root cause and providing incentives throughout the "value chain". The ultimate goal of the initiative is to reclaim and maintain the US preeminence in R&D and innovation[34]. Again in a true systems approach the US federal government will put up 22% of the required among and unlocks further business R&D through tax incentives to make up the other 78%. This is important given the fact that business accounts for a significant portion of R&D spend in all countries that have a viable innovation system.

[33] The Swedish National Innovation System 1970 – 2003, Vinnova, 2004
[34] American Competitiveness Initiative, OSTP, 2006

Other countries have at some point in the development trajectories of their innovation systems made these extraordinary investments beyond the logic of the budgeting process increments. The Korea (South) government spend on R&D (as a percentage of GDP) has been increasing by on average 0.11% every two years and currently stands at 3,5%. This is a significant commitment to R&D[35].

As we know from the annual R&D surveys, South Africa, too, has embarked on increasing its public and private R&D spend to currently 0,87% of GDP with a target of 1% of GDP by 2008. This is quite significant, given that GDP has grown to about US $ 540 billion (PPP) currently – and is on an upward trajectory. And, given this positive development of the past few years which is largely due to the pro-active interventions of the DST with National Treasury, we have yet to engage the publicly-funded national science system of a more effective process of allocation across the system as we have set out in the various sections of this document.

4 The NRF context

Against the introductory backdrop and context, and focussing on an aspect of the national science system, the National Research Foundation [NRF] views its 'agency' function and that of 'custodianship' of the national research facilities [NF] as that of an agent of change within the broader remit of the above-mentioned 'Transformation Project'[36].

Indeed, its vision states the following:

[35] Korea's National Innovation System and the Science Technology Policy, *Deok Yim*, Science and Technology Policy Institute, Korea, 2005

[36] Although the 'agent of change' / 'change agent' concept is severally utilised within the organisation, it is our considered opinion that there is little ***common understanding and practice*** of this concept within a transforming society or corpus. This would require intensive engagement during the envisaged strategic planning process in order to gain clarity, direction and motivation in terms of concerted efforts ***across the organization and across the national science system.*** So, too, the notion of the "***working within a matrix".***

The NRF aims for a prosperous South Africa and African continent steeped in a knowledge culture, free of widespread diseases and poverty, and proud contributors to the well-being of humanity.

However, as evidenced in the 2005 *Institutional Review of the NRF* (and most likely, too, in the recently completed OECD Review of NSI of South Africa)[37] the findings and recommendations tabled reveal several key and strategic threats and failings in the realisation of the above cited vision. It is worthwhile noting here that upon reflection on the findings and recommendations of the System-wide Review of 1998 and the reviews of the Centre for Science Development (CSD) and the Foundation for Research Development (FRD) in 1999, that although there have been improvements at some levels, both within the NSI and in the NRF, there are several recommendations of the latter reviews which more than resonate with those of the latest findings. Of cardinal importance then and now have been the crucial issues of 'funding', of prioritisation and that of the relationships between the DST (then DACST) and the NRF! It is largely for the latter reasons that this document deviates somewhat from the original brief. For, if the focus remains only on that of funding, i.e. out of the larger NSI and stakeholder context, the NRF may well declare itself redundant. However, given the NRF Board's undertaking to engage primarily with strategic issues as pertaining to the NRF, it may be appropriate to apprise and acquaint ourselves with national systems of innovation elsewhere. Despite the variety noted there, core principles emerge which we consider of importance as guidelines for engagement not only with the DST, but with all relevant stakeholders engaged in the national Transformation Project.

5 Growing the NRF core budget in a sustainable manner

[37] Upon recent enquiry, we have been informed that an initial draft report should be available by mid-February 2007 and that this would be made available to the NRF by NACI.

Knowledge production and use, and innovation and technology development have become important for economic growth and competitiveness. A functional and prolific knowledge production infrastructure is a necessary precursor to innovation and the resultant economic growth. World-wide, nations have increasingly come to the realisation that to remain competitive and thrive in a highly competitive global economy they have to invest more resources into science and technology attracting the highest-skilled people and the companies which have the potential to innovate and to turn innovation into commercial opportunity[38]. This is what the United Kingdom (UK) government terms *"the new prosperity"*[39].

The increasing competitive intensity in the knowledge production space and the resultant speed of knowledge production requires foresight, decisiveness and, *sustained investment in the knowledge infrastructure* if innovation, economic competitiveness and the improvement in the lives of the citizens are to be attained. The increasing polyvalence of knowledge production is driving many changes not least the way the knowledge infrastructure is configured and rapid policy learning. New knowledge combinations not perceived possible or likely a decade ago, are now possible and emerging fast. Scientific developments in one field enable progress in another scientific field. Over the years providing ample scope for cutting-edge research ideas and new knowledge to emerge from the science base has provided huge benefit to business and society – for example, the study of upper atmosphere physics revealed the existence of the Ozone Hole, and research into the biology of a soil-dwelling nematode worm led to genome sequencing and proof of principle that sparked the human genome project[40]. South Africa must continue to make space for the

[38] Testimony of Dr. William Jeffrey Director National Institute of Standards and Technology Technology Administration U.S. Department of Commerce before the Committee on Commerce, Science and Transportation Subcommittee on Technology, Innovation, and Competitiveness United States Senate "Importance of Basic Research to United States' Competitiveness" March 29, 2006
[39] Science & innovation investment framework 2004 -2014, DTI, UK Government
[40] Ibid.

most talented researchers to follow their own initiative in pushing the boundaries of knowledge.

In addition to response to market failure, governments fund research for the following reasons:

- For cultural and historic reasons
- In order to promote socio-economic development
- To provide a basis for evidence-based policy making

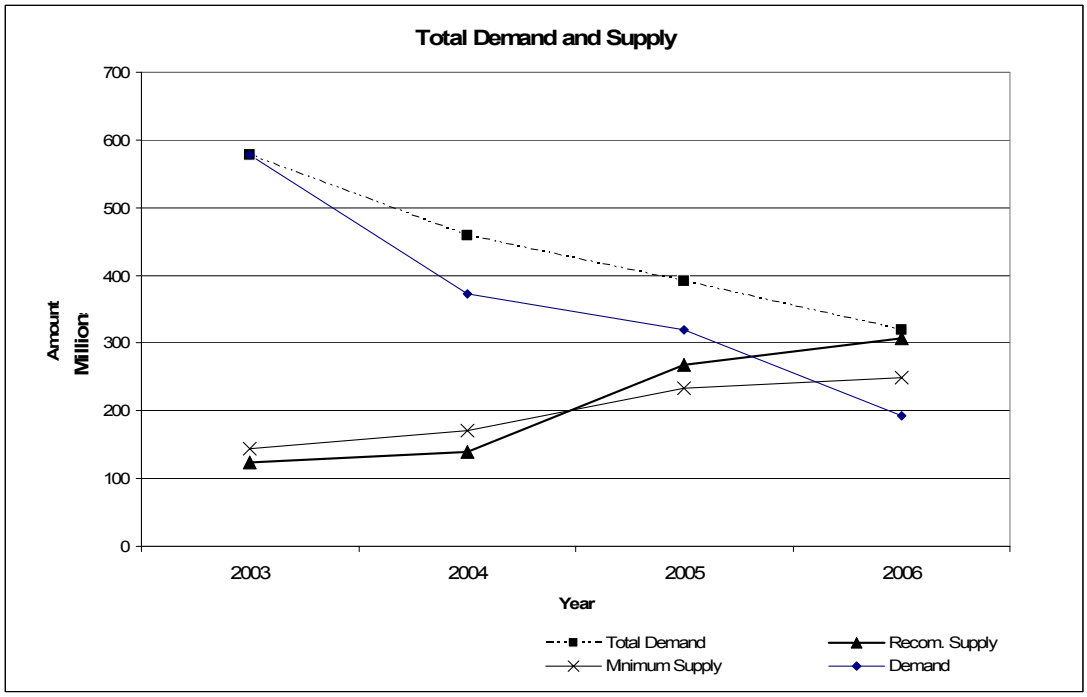
Often research thought of as belonging to one of the categories turns out also to belong to one or both of the other. However, states seem to place emphasis on the second and third bullet as drivers for investment decisions in R&D. The US has significantly increased its funding directed at basic R&D in the last four years (2006/7 budget – increase of 50% from 2004 funding base) and the US congress has committed to double the basic R&D budget by 2010. The main drivers for this seem to be concerns about the decline of US competitiveness in knowledge production and innovation[41]. The American Competitiveness Initiative (June 2006) seeks to address the "how" part and boldly announces major funding increases for basic science. The US increase in funding for knowledge production and focus on the "how" have consequently addressed the related component aspect of human capital. It is impossible to talk about increase in knowledge production without a related increase in skilled labour or human capital. Given South Africa's (grossly inadequate) human capital base, it is crucial that the available human capital is optimally utilized to generate knowledge in keeping with its macro-policies, as well as engaging in and funding targeted human capital development research programmes.

Against the above scenario, it critical to ask: *what is the state of NRF core funding? What is the nature of "demand" across the*

[41] Sustaining the nation's innovation ecosystem, PCAST, US, 2004

programmes currently supported by NRF grants? And, to what extent and measure do these programmes match the above-mentioned modalities?

The following is a representation of 'demand' vs. 'supply' over the past four years. Some data has yet to be verified once more, but by and large the downward trend of demand as shown here is significant.

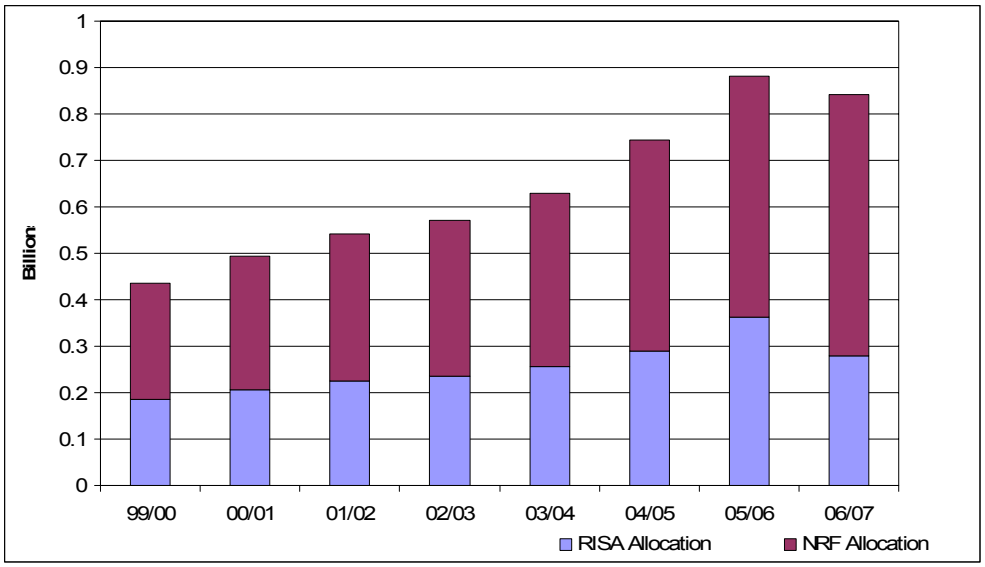


- *Total Demand is defined as the rand value of all applications considered for funding (excluding applications rejected during the initial screening phases). The total demand takes into account previous cycle allocations or awards.*
- *Demand is defined as the rand value of applications submitted in a particular year. Again this includes only applications considered for funding (peer-reviewed and/or considered by a panel).*

- *Recommended Supply refers to the funding levels recommended by the panels (includes previous cycle/round allocations – the recommended funding levels are in addition to that which the NRF has committed).*
- *The Actual Supply refers to the NRF's actual allocation in a given year in addition to the commitments already made in the previous cycle or round.*

The downward trend in the total demand (and demand) is not surprising given the multi-year funding mode that the NRF adopted in 2003 and in line with similar research support and funding agencies. Given the limited pool of researchers in the country, those that have received funding for multiple years would at least be "out of the system" until the funding period expires. Another explanation might be that fewer researchers are applying for NRF funding. The reasons may be manifold but the grant sizes vis-à-vis the "effort" might be one of the reasons. As the NRF review highlighted re clarification or rather clear demarcation or delineation of responsibilities between the NRF and DST, as the DST is perceived to be encroaching on NRF responsibilities in terms of its funding activities, and in terms of offering "higher grant" values compared to the NRF (competition as opposed to co-opetition). There is definitely a discernible albeit understandable reduction in the number of applications considered. However, this does not detract from the serious message that the graph conveys. Evidently, given the reduction in demand (rand value) and the effect of multi-year funding, coupled to modest core budget increases, there is less and less "new" funding available for new applications. This is untenable given the NRF's position as one of the premier funding agencies in the country.
Of note, too, is the fact that for 2006 there is a convergence of ‚total demand' and ‚recommended supply'. Figures for 2007, as soon as all panel have sat, will be of interest as we suspect that ‚demand' will once again outstrip ‚supply' as the next round of three year applications makes its impact felt.

The following bar graph depicts the the total NRF and (in blue) the RISA allocations since 1999. Figures for 2005 and 2006 are being collated for insertion. All figures are from the annual audited statements and reports.



Equally important towards the "new prosperity" mentioned above is funding basic research while maintaining a balance between directed ('top-down') and responsive ('bottom-up') research. The latter, which in a sense would be a policy decision that would need to be taken within the South African context, should continue to form the larger part, and through permissive management and funding of the science base ensure that the world-beating ideas of tomorrow can arise and flourish, generating some of the 'disruptive technologies of the future' for South Africa's development. The serendipitous nature of new major inventions dictates that all fields should at least be adequately funded.

Basic research is fundamental to the capacity to bring forth new knowledge. It facilitates the emergence of new ideas, and is essential to modern society's ability to identify, define and solve the often complex technological and cultural problems that arise. Basic research plays a vital role in building cultural values, and often provides the basis for ethical considerations that are pivotal to a society's identity and understanding of itself. At the same time, it represents preparedness, and provides a knowledge base that may prove crucial to solving problems that have yet to be discovered. Many view adequate basic research as an absolute necessity for promoting the innovative powers required to create a viable framework for trade and industry as well as society at large. (Research Council of Norway – Division for Science)

Notwithstanding, a proportion of top-down direction of activity is a necessary and prudent management tool to meet both strategic requirements for business development and public policy goals that cannot be left entirely to the market in research ideas, and to build critical mass in key areas of research, i.e. Centres of Excellence, Research Chairs, etc, as are currently being rolled out in South Africa. Thus, to deliver the best from *this balanced model of research funding requires flexibility in modes of funding to seize opportunities or meet new challenges early.* Consequently, South Africa's research funding system should continue to allow space for fundamental basic research, complemented by strategic priority programmes and incentives for researchers to work on projects focused on application. This will only be effective should, for instance, the DST and the NRF pro-actively embark on enhancing the NSI through what is termed co-programming and co-funding as described below.[42]

[42] See section 7, last bullet below.

6 The research granting marketplace – the contemporary context

The agencification is a phenomenon that gained momentum after the Second World War, where a powerful demonstration of the power of science systematically harnessed for the state's benefit was provided. The prevailing understanding then was that, scientists, if left to do research would eventually produce outcomes that would have societal benefits. However, resources were allocated based on scientific rather than social criteria. The contestation was that science was neutral and it is society that could put the outcomes of science to good or bad use. The state provided patronage by delegating its responsibilities to science councils which were largely captured by the scientific community itself. However, post 1970 the social contract between science and society began to show strain largely due to the potentially deleterious consequences of some scientific outcomes e.g. development of atomic bombs. As the Cold War receded, states became more interested in promoting technology for competitiveness. As a result, over the past 30 years or so, there has been a shift away from the idea that scientists should be supported as autonomous truth-seekers and towards an idea that they should orient their work rather more towards social and economic objectives. In effect, the social contract with the research community has changed and researchers are now held more accountable than in the 50s and 60s. This signalled the re-emergence of the dichotomy between "basic" and "applied" research. We will not go into detail about the challenges to the practicality of this nomenclature.

The NRF, as other agencies world-wide, finds itself having to mediate this dichotomy. However, funding basic research is not the only role of agencies. Agencies are also required to:

- Contribute to human resource capacity development
- Advocate for the maintenance of the knowledge infrastructure (physical)

- Promote technological developments
- Perform bottle-neck analysis – identifying and analyzing research and innovation policy needs
- Co-lead the reconfiguration of national knowledge production assets
- Contribute to the internationalisation of the research endeavour – with special reference to Africa in the case of the NRF

In addition to the roles described above, the NRF, similar to the Research Council of Norway, manages the National Research Facilities and is also responsible for the implementation of international bilateral and multi-lateral programmes largely funded by the Norwegian Ministry of Foreign Affairs. Collectively, the points delineated above indicate the crucial role that agencies are supposed to play, viz. that of "an agent of change". The central question therefore is to what extent the NRF has effectively discharged its responsibility as an agent of change in terms of, amongst others,:

- Identifying and motivating for funding for new research areas
- Responded to national policy imperatives i.e. MDGs, in terms of its programming – see again the presentation by the DG: DST
- Appropriate balance between basic and applied research
- Developing human resource capacity in line with national imperatives i.e. redress and equity

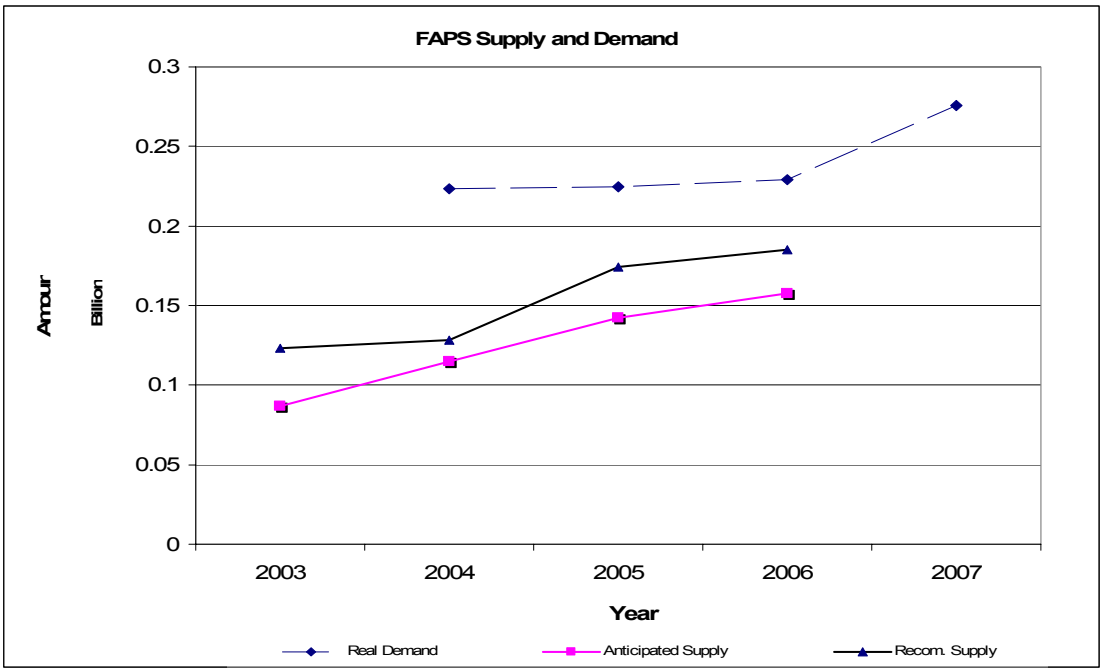
The current organisation of the Focus Area Programmes (FAP) has to a large extent attempted to do the above, but has been severely hamstrung by factors such as:

- the small size of the grants in order to "spread" the annual allocation over several knowledge areas
- the totally inadequate and unattractive values of the grant-holder linked bursaries and scholarships – with no provision for the exchange of post-graduate students within international research cooperation programmes

- the limitations placed on, for instance, running costs which have remained stagnant despite inflation-related and product price increases
- the inadequate annual allocation towards the national equipment programme which, for instance, limits the number of students gaining access to state-of-the-art equipment at the higher education institutions
- the virtual absence of adequate funding to assist researchers in the publication of their research outputs in internationally accredited journals, and increasingly open access journals for instance[43], and
- Virtually no support for scientific and professional associations in the Social Sciences and Humanities disciplines

And, as stated elsewhere, that although the demand within the FAP has usually been higher than the supply, we have also noticed that several higher education institutions have encouraged their top academics to apply elsewhere for adequate grant-funding, e.g. to the US Foundations' Consortium in South Africa, or to the DST directly. Although not as yet adequately analysed, the multi-year funding cycle introduced at the NRF in 2003, has also had an enormous effect on "new funds" entering the FA programmes as the annual MTEF allocation has, in the first place, to be awarded against committed funds made in the previous year. The following figure provides information on the relations between "real demand" (all applications), "recommended supply" (panel approved applications) and "awarded supply" (the annual allocation made).

[43] The recent study done by ASSaf confirms this.



Given the demand for research funding and the need to grow our human resource base, it is quite evident that the NRF requires increased funding to enable it to adequately deliver on its mandate. The challenge of replenishing and to create diversity within our research population calls upon us to take bold and ambitious steps in building our human resources for the future. The NRF's clarion call, PhD as a driver, is testimony to the growing concerns that probably we have been using yesterday's paradigms to resolve today and future challenges. What we can do today depends very much on what we did yesterday and what we learned in the process.

There is a need to learn from other more successful systems to avoid the meander of history. However, our approach to developing our system should be grounded on a clear understanding of the South African context which is unique, in terms of, amongst others, its historical context and resultant challenges. It becomes important given our resource constraints to ensure that there is optimal coordination and

synergy within our system. The NSI approach emphasizes the importance of linkages and the need to optimize these for the system to grow. The Swedish paradox is testimony to lack of proper linkages and lack of coordination within the system. The question then arises as to whose responsibility it is to build linkages. The structure of our NSI places the DST at the forefront of policy coordination. However, we have been faced with a situation where the sub-system which we have to influence falls outside of the mandate and scope of our parent department's ambit of influence. Nonetheless, we are required to make an impact on that sub-system.

Of course, there are a myriad of actions we can take to resolve this dichotomy. Some of the actions can include co-programming and/or clear demarcation of research areas which we can fund in relation to other funders within the system. Some can include involving other government departments in the R&D system through, amongst others, bidding to handle their R&D funding activities i.e. the DOA's proposed R&D fund. In that way, we may be able to avoid duplication and create synergies and optimal deployment of scarce resources.