

The System-wide Review of Public Sector Science, Engineering and Technology Institutions

A Report Submitted to the
Department of Arts, Culture,
Science and Technology
of the Government of South Africa
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Table of Contents

[Executive Summary](#)

[Summary of Principal Recommendations](#)

[Introduction](#)

[Part 1 Principles, Guidelines and Recommendations](#)

1. [An Overview of the Public Research System](#)
2. [Independence and Alignment, Transparency and Accountability](#)
3. [Planning, Monitoring and Evaluation](#)
4. [Funding Levels and Modalities](#)
5. [Leadership and Strategic Management](#)
6. [Transformation and Human Resources](#)
7. [Interaction, Integration and Cooperation](#)
8. [Commercialisation](#)
9. [Internationalisation and Strategic Alliances](#)
10. [Recommendations for Restructuring](#)

[Part 2 Commentaries on the Panel Reports](#)

1. [The Africa Institute of South Africa \(AISA\)](#)
2. [The Agricultural Research Council \(ARC\)](#)
3. [The Atomic Energy Corporation \(AEC\)](#)
4. [Council for Geoscience \(CGS\)](#)
5. [CSIR](#)
6. [The Human Sciences Research Council \(HSRC\)](#)
7. [MINTEK](#)
8. [The Medical Research Council, \(MRC\)](#)

9. [The South African Bureau of Standards \(SABS\)](#)
10. [The South African Weather Bureau \(SAWB\)](#)
11. [The National Research Foundation and the Agency Function](#)
12. [National Facilities](#)

[Appendix 1 Membership of the System-Wide Review Panel](#)

[Appendix II Examples of Potential Key Performance Indicators](#)

Summary of Principal Recommendations

....on Independence and Alignment, Transparency and Accountability

1. Government should improve the efficiency and effectiveness of its in-house SET activities by organising them within legal structures which permit flexibility of operation while safeguarding the use of public resources and providing for necessary measures of performance. Such conditions are usually best provided for by undertaking those activities within a statutory body with suitably designed objectives and responsibilities, or within a Section 21 Company operating under the Companies Act.
2. The Boards of the SETIs covered in this review
 - should take all steps necessary to make public the decisions which they take in response to the recommendations contained in this report, and in the supporting Panel Reports.
 - should play a key role in defining strategic directions for the institution in their charge and should make those directions public;
 - should direct the CEO of the SETI involved within a broad strategic direction given by government. To facilitate this, there should be regular and structured conversations between Boards and Line Ministries to enable clear expression of State priorities
3. SETI Board members, whilst appointed as individuals, are expected to provide sectoral expertise to Board deliberations and should also take responsibility for improving linkages between SETIs and their respective sectors.
4. In order to ensure accountability and good practice, the King Commission's recommendations on Good Corporate Governance should be adopted by all public SETIs.
5. The transparency of the activities of SETIs to the scrutiny of the larger SET community in South Africa, including the SETI's intended clients, should be improved by the judicious use of advisory panels. Given the need in some cases to protect the industrial confidentiality of some of the work undertaken, individual SETIs should publish, and invite comment on, the terms of

reference which they would intend to use as a framework for the operation of individual advisory bodies.

6. All SETIs should adopt a system of key performance indicators, discussed later in this report, in order to facilitate accountability.
7. DACST should initiate discussions with the Central Statistical Service, and with other interested parties, in order to address the problems of availability of data, even on SET activities within government. An internationally-accepted basis for such work exists in the Frascati and Oslo Manuals which have been developed and published by OECD

....on Planning, Monitoring and Evaluation

8. *Key performance indicators should be established throughout the publicly funded research system of South Africa. They should become an integral part of the management and monitoring processes within each SETI as well as at line department level;*
9. *Internal reporting and monitoring systems need to be complemented by regular reviews which should be conducted by an expert panel or scientific advisory board on regularly-scheduled basis;*
10. *At greater intervals, external evaluations of appropriate clusters of SETIs and/or relevant research areas should be conducted under the auspices of the newly-established NACI in order to provide government with independent advice on the future development of individual SETIs and relevant research areas as well as on strategic issues related to the South African system of innovation as a whole*

....on Funding Levels and Modalities

11. *At a minimum, in the short term, government should seek to maintain current levels of SET expenditure (although more efficiently distributed and utilised – see below). In the medium term, macro-economic and fiscal conditions permitting, government should seek to increase SET expenditure in different economic sectors to levels proportionately commensurate with those of competitive nations.*
12. *All parliamentary core and competitive grant funding for the SETIs should be delivered via the Science Vote.*
13. *DACST, with the support of NACI, should*
 - *expand and refine the classification of funding modalities used by government and should specify which modalities are appropriate for funding the differing institutional functions performed by SETIs as a basis for resource allocation among the SETIs by the state.*
 - *adjust relative funding levels between the SETIs from year to year (within the medium term expenditure framework) according to mutually-agreed criteria; These criteria should be related to an assessment of the relative mix of core public purpose functions or activities (such as public interest research, technology development and diffusion, human resource development and core research infrastructure) versus the limits of, or potential for, private funding from the sale of contract research, services, and products (including Intellectual property).*

- *seek agreement from the inter-ministerial committee on SET on the selected criteria , publish the criteria and then operationalise them through transparent and consistent application.*
 - *develop an appropriate funding mechanism for declared National Facilities which strikes a viable balance between providing secure infrastructural support for the operators of the facility and funding/empowering users (including the staff of the National Facility) to gain access to the facility on the basis of merit and relevance.*
14. SETIs with potentially close links with key economic sectors (such as CSIR, MINTEK and ARC) should be required to generate higher proportions of their income from external contracts and from sales of Intellectual Property than those such as the Weather Bureau in which much of the activity is oriented towards the production of public goods. *Such external contracts would include any contracts funded by the Innovation Fund.*
 15. *DACST should work towards presenting an enlarged view of expenditure on SET and innovation within the NSI and should start developing integrated and coherent criteria and mechanisms for guiding allocations among the different components of the SET system. In particular, a review of the S&T research component of funding for the Higher Education Sector should be undertaken to optimise application of funds earmarked by the Department of Education for this purpose.*
 16. Government should increase substantially the proportion of funding for SETIs and other participants in the SET system which is channelled through competitive mechanisms and programmes such as the Innovation Fund, THRIP, SPII and the agency funds of the NRF. These initiatives should incorporate explicit conditionalities which encourage cooperation across disciplines, institutions and sectors.
 17. Rules for participation in these competitive funds will differ, but they should be transparent and should encourage a level playing field. The management of these funds should be separate from the line Ministry through whose budgets the funds pass so as to facilitate objective monitoring and evaluation. This is mostly the practice at present (THRIP is managed by FRD on behalf of DTI; SPII is managed by IDC on behalf of DTI; Agency funds are managed by NRF on behalf of DACST). A similar separation should apply to the Innovation Fund once it begins to grow.
 18. All options for the long-term management of the Innovation Fund, including the contracting out of that management task, should be explored. In particular, the management system chosen should be capable of managing the growth of the Fund to a level which is considerably larger than today's. This will require capacity to manage an increasing degree of complexity in a Fund which should become a principal governmentally-provided source of funding of innovative activities. The growth in the volume of funds managed by the Innovation Fund will need to be accompanied by the fostering of a culture of R&D cooperation among stakeholders from diverse sectors, institutions and disciplines, all of it carried out in the context of the potential application of the results.
 19. New approaches should be explored for establishing virtual facilities through networking and cooperation between institutions, and these should be supported by earmarked funds for defined purposes for a fixed term.

20. The NRF should begin an early round of conversations with NSI actors and stakeholders to help inform thinking about how to use their budget in ways that best support national policy priorities and the NSI.
21. DACST with the Department of Finance, in consultation with the SETIs, should develop guidelines for SETIs which set out conditions under which SETIs can engage in the accumulation of financial reserves *and should provide guidelines for judicious investment in physical and human capital to sustain an institutional capacity for innovation and technology diffusion. The accumulation of surpluses through good performance should not unduly prejudice ongoing state support, provided surpluses are invested according to the above guidelines.*
22. DACST with the Department of Finance should explore workable incentive mechanisms to encourage the private sector to invest more in R&D.

....on Leadership and Strategic Management

23. *In the short to medium term, in cases of SETIs facing the need for substantial change, transformation teams should be appointed in order to assist with the transition towards dynamic leadership and improved strategic management;*
24. *Internal and external courses should be developed and offered on a regular basis to inculcate new research or management paradigms into the organizational cultures of SETIs undergoing change, and some fora for exchange of experiences with other SETIs that have traversed the transformation path will be of value.*
25. Managers have to spend time understanding employee needs, and aligning them to the broader organisational strategy and values. Delegation and empowerment have to be embodied because they can lead to employee excitement, and not just satisfaction;
26. Key Performance Indicators have to be set, checked for relevance regularly, and the process of measurement should be continuous. Wherever possible, these should be benchmarked against global players in the same fields. Some clusters of SETIs should be encouraged to set up common KPIs ;
27. Restructuring of staffing within some SETIs is needed in order to increase the ratio of researchers to support staff in research intensive institutions;
28. SETIs should perform regular internal/external audits on themselves, and involve clients and cooperative partners;
29. Regular training/seminars have to be conducted through internal and external means so as to avoid being insular, and regular updates on international trends have to be sourced

....on Transformation and Human Resources

30. *A strategic approach to human resources management should be implemented as a matter of urgency to ensure effective resource utilisation and relevance of HR to business objectives and goals.*
31. *Each SETI should make expanded use of professional skills in the management of organizational change.*
32. *A coordinated human resource development strategy among the SETIs and should be implemented. In particular, in the area of redress and equity, SETIs as a group, with the assistance of their human resource executives, should set*

for themselves a series of key performance indicators to allow for assessment of the rate of progress towards targets which they should establish for themselves.

33. *In pursuing their human resource goals, the SETIs should expand their programs of cooperation with institutions of higher learning, in particular to offer increasing opportunities for black people and women to receive training in the sciences, engineering and technology and to acquire the specialised skills needed by particular SETIs.*
34. *A transformation of corporate culture and practice - to respond to the need for competitiveness, innovation and survival in the economy of the new South Africa - should be implemented in most of the SETIs. Such transformations should also address the need for new leadership where the leadership now in place is not deemed capable of carrying through further programs of far-reaching change.*
35. *Implementation of HR systems is essential to ensure effective performance, remuneration for skills retention and proper management and sharing of knowledge, information and ideas.*
36. SETIs should seek to emulate international best practice in the management of knowledge-based institutions.

....on Interaction, Integration and Cooperation

37. Greater cooperation across disciplines, institutions and sectors should be encouraged through agency and competitive grant mechanisms earmarking funds for cooperative R&D and/or allocating higher values for such cooperation in their evaluation of funding proposals.
38. SETIs, private business, and, higher education institutions - the source of highly trained people,- should be relinked, as a matter of urgency, by a variety of systematic efforts including
 - a. more regular dialogue between DoE and DACST at every level, including ministerial,
 - b. stepped-up support to existing interactive mechanisms such as the Innovation Fund and THRIP, and
 - c. launching a series of alignment-achieving conversations among universities, SETIs and private business about NSI-wide human resource training and development gaps.[The National Science & Technology Forum could play an important role in *as the facilitator of such conversations.*]
39. DACST, the executive teams of publicly-funded SETIs, and SETI transformation teams (where recommended for specific organizations) should initiate a series of wide-ranging, cross-disciplinary, informal but expertly-facilitated conversations which would include private sector leaders, public policy makers, and practitioners of social innovation as well, to
 - a. re-establish or create interactive links and
 - b. share ideas about critical cross-disciplinary, national projects embodying science and technological innovation. The aim should not be prescription, but rather stimulating organizational and system-wide learning which can lead, of its own accord, to a variety of innovative,

cooperative projects--or pull people into existing ones about which they are unaware.

40. "Degree of interactivity" should become one of the key indicators for (post and ante) assessment of publicly-sponsored science and technology projects which purport to involve extramural research or research undertaken through networks of capacity.
41. Publicly-funded SETIs should be encouraged to utilise the work of social scientists, where feasible, and to tap into networks of social science capacity at the (radically transformed) HSRC, the universities, the organizations of civil society to inform their work in innovation.
42. Improved knowledge of Africa should be incorporated into the business strategies and research agendas of all publicly-funded SETIs, particularly those participating in SADC, trade initiatives and other cooperative activities in the rest of Africa.
43. SETIs should be encouraged by their Boards and executives to regard the communities of the majority in South Africa as an environment for learning and a source of ideas, not just problems, with respect to innovation. The process and results of the indigenous knowledge audit should be utilised by SETIs in this regard, and the new SETI-small user interface organisms such as the new Manufacturing Advisory Centres (being established by a partnership involving CSIR) should receive all due support in this new direction.
44. SETIs should undertake studies of their own organizational cultures and of the way that they learn (or fail to do so) as organizations, to inform all of the changes in institutional design, to provide for more strategic management of human resources, and to put in place the transformation and changed research paradigms recommended by this Review. Outside expertise should be sought for this work wherever internal capacity is weak or absent.

....on Commercialisation

45. As governments and funding agencies throughout the world are experimenting with a wide variety of different approaches to commercialisation as well as privatisation, government should explore the validity and appropriateness of innovative schemes successfully implemented elsewhere, and adapt them according to the needs of South Africa.
46. Public SETIs should develop a Code of Conduct which deals with their relationship with the private sector. This should be developed in cooperation with the private sector and include:
 - Commercialisation policy
 - Intellectual property rights
 - Conditions of service provision
 - Service pricing policy
47. A detailed examination of the activities of the SETIs should be undertaken in order to identify routine activities that could be transferred to the private sector.
48. A detailed assessment of the metrology activities of SABS should be undertaken in order to establish the viability and cost savings of alternative provision such that a private sector company could be contracted to lease the

- major assets entailed and provide metrology services to the government under a long-term contract.
49. Utilising outside experts, government should undertake a regular review of all S&T activities located within government in order to ensure that funding levels for these activities are commensurate with the minimum level of capacity required to fulfil necessary governmental requirements.
 50. Government should review regulations and acts in order to ensure that there are no unnecessary impediments or disincentives to the establishment and operation of S&T institutions within the private sector under appropriate forms of joint ownership
 51. SETIs should be required to charge customers on the basis of full cost recovery. Where customers benefit from earlier publicly funded strategic research, this should normally be reflected in the charge.
 52. With competition policy currently under review, the possible role of the competition authorities and regulations in restraining unfair competition emanating from publicly funded SETIs should be investigated.
 53. Government should develop a set of incentives in order to encourage SETIs to meet the needs of less well-resourced customers.
 54. Government should undertake a review of the factors that currently impede the transfer of S&T outputs to smaller and poorly-resourced consumers, over a wide field but more particularly in the productive sectors of industry, agriculture and mining. Once these impediments have been identified, design incentives for SETIs and develop policies to ensure a far more equitable flow of S&T outputs.
 55. SETIs aligned to the productive sectors of the economy should develop an incentive framework to encourage employees to engage their technical knowledge in the formation of new businesses. These SETIs, in collaboration with other organisations, should organise the requisite training and facilitate contact between the employee and venture capital organisation
 56. *DACST should commission a study of the steps which would need to be taken to implement a policy on potential roles for SETIs in the establishment of new ventures.*

...on Internationalisation and Strategic Alliances

57. *As soon as the NRF is established, it should become engaged in creating additional opportunities for international exchanges, collaborative projects and institutional links with the best possible partners in the world.*
58. SETIs should take advantage of their research capabilities and expand their international activities, especially in areas that are of great strategic importance to South African industry.
59. *Priority-setting and subsequent focusing of research activities should be promoted in SETIs as well as in higher education institutions to ensure that internationally visible centres of excellence are established which will attract some of the best foreign researchers in the respective field to the institution as well as open up new opportunities for international collaboration.*
60. Because of the fact that large-scale facilities are increasingly established on a multilateral or international basis, it is the prime responsibility of government to ensure that in relevant areas the respective South African researchers are granted access to these facilities.

61. In order to attract research-intensive industries to South Africa, government should develop appropriate taxation strategies.
62. SETIs should benchmark their research and other activities against some of the best internationally, taking cognisance of the different environments.

...on Restructuring

63. In the light of its broad mandate, NACI's agenda should focus on two broad classes of issue
 1. The provision of advice to government on the development of its overall strategy, on the prioritisation of its activities, and on resource allocation to all SETIs; and
 2. Periodic evaluation of SETIs, as well as the assessment of proposals for new facilities and institutions. The development of exit strategies for outdated facilities, institutions or major projects should also be an important activity.
64. A review of current legislation should be undertaken to ensure that similar statutes, standards and procedures are applied to all SETIs.
65. The Water Research Commission (WRC), National Institute for Virology (NIV), National Sea Fisheries Research Institute (NSFRI), Antarctic research programme, National Botanical Institute (NBI) and other relevant entities and programmes should be formally recognised as public SETIs which make an important contribution to the NSI. This does not necessarily imply structural changes – merely the application of effective coordination and cooperation as well as monitoring, assessment, and evaluation mechanisms.
66. Greater emphasis should be placed on the public understanding of SET – especially at school level and vis-a-vis the public at large
67. Where the current management of any SETI is unable to adequately or timeously transform the SETI from within, government should establish, in consultation with the relevant Boards, dedicated, professional, external transformation teams to manage the major transformation of individual SETIs as detailed in this report. In particular, in these cases, the appointment of a new CEO as part of the transformation process may be critical to ensuring a smooth transition.
68. In order to establish any required transformation team, DACST, acting as the Secretariat for the Ministers' Committee for Science and Technology, should consult with the Minister and the Chair of the Board of the SETI involved, and they should jointly reach consensus on the composition of the transformation team.

Further to these system-wide recommendations, the following recommendations are made in order to facilitate the transition processes which several individual SETIs are currently confronting:

AEC

64. Government should clarify the mandate, purpose, function and structure of the Atomic Energy Corporation. It is recommended that the AEC be split into two separate organizations (with a carefully planned transition):

- the core mandate of the AEC should be redefined to deal mainly with Decommissioning & Decontamination of closed nuclear facilities, radioactive waste management and operation of the SAFARI reactor, this latter possibility being subject to government decision with respect to the likelihood of SAFARI being capable of being operated financially at a break-even level. The reporting of this transformed AEC to DME should be reviewed in the context of its new mandate.
 - A new public corporation, should be established to contribute to national wealth through the development and exploitation of those core technological competencies and capabilities of the AEC which can be shown to have realistic commercial potential. Government should appoint a transformation team to assist it with this task.
70. The transformation team should be responsible, in particular, for evaluating the commercial potential of the current AEC activities in fluorine chemistry and radiation science and technology, and for preparing and implementing plans to commercialise and privatise into a new company those activities which have genuine market potential.
71. It is inappropriate to channel all government funding for the AEC through the DME. It is inappropriate to channel all government funding for the AEC through the DME. Technology support funds (phased down over a specified period in the transition to commercialisation) could be sought from other government technology support programmes such as the Innovation Fund. Remaining nuclear waste management and D&D functions could be funded through the ordinary budgets of either DME or the Department of Environmental Affairs and Tourism.

ARC

72. A transformation team should be appointed to assist the Minister of Agriculture and the Board of ARC in bringing about a change in senior management, a change in research philosophy, a change in program structure, and any necessary changes in internal organisation to transform ARC into a modern agricultural research organisation capable of responding to the needs of both commercial and resource poor farmers.

HSRC

73. A concerted effort to address the needs of South Africa will involve the restructuring of the mandate, and staff of the HSRC in order to make it more attuned to major contemporary issues.
74. *To tackle such challenges, the HSRC would need to have a staff which represents the cultural diversity of the country and which possesses modern research skills. The future HSRC should primarily operate as a manager, supporter and organiser of research and secondarily as a performer of research. Its could render great service by creating, supporting and guiding networks of researchers in HEIs and in NGOs who would undertake multi-year programs of research on key issues.*
75. A transformation team should be appointed to assist the Minister of Arts, Culture, Science and Technology and the Board of HSRC in bringing about, a

change in research philosophy and in research staff, a change in program structure, and any necessary changes in internal organisation to transform HSRC into a modern social science research organisation capable of responding to the needs of South Africa

AISA

76. As a result of the conclusions of this review, the Africa Institute of SA should be de-registered as a Section 21 company and its infrastructure and resources transferred into a new institution focusing on the study of change in contemporary Africa. To facilitate the formation of this new institution, a process should be initiated immediately involving eminent scholars and leading policy analysts to prepare a concept for the role and function of the new institute and appropriate modes for its operation, as well as to provide input into the definition of the complimentary research programme described below:
77. Earmarked funds should be provided by the National Research Foundation for a research programme specifically designed to stimulate research on cultural, economic and technological change in Africa in order to develop new research capacities within South Africa's higher education institutions.

MRC

78. *The MRC should be required by government to meet the following criteria in order to make it transparently evident that its resource allocations between its own research and its agency funding activities do not constitute a conflict of interest. The criteria are that:*
 - *all in-house research be financed via the same competitive process which allocates resources to research groups in other institutions; while MRC already subjects its in-house activities to review by externally chaired panels, it will be important to ensure that such panels have fully internalised the ENHR orientation into their work.*
 - *the process by which MRC allocates its budget between support of competitive funding and support of in-house operations, (which would include all of the overhead costs associated with maintaining an in-house research staff) and the annual results of such allocations should be transparent;*
 - *the Board of MRC should clearly delimit the areas of research which they believe should be performed in-house, and should encourage and be sensitive to public debate on their decisions.*

SABS

79. A professional team should be appointed to manage the transformation of SABS which, within the existing framework of SABS, should establish two clearly separate entities. The first would be a government-funded standards setting institution and the second would be an organisation responsible for accreditation, certification and the provision of laboratory services, all operated on a commercial basis. The basis for this change is clearly articulated in the relevant Panel Report

80. Beyond these structural changes which are required to meet international practice for standards bodies, internal operating changes are needed to modernise management systems and processes. Financial management systems in the SABS should be reviewed and upgraded in the context of the new structure. In addition, a fundamental change management process is required in human resource practices, policies and targets.

NRF

81. The establishment of the new national funding agency is a logical and necessary step in the further development of the South African research base. In view of the challenges provided by the process of establishing a new institution and, at the same time, integrating the existing FRD and CSD, it will be necessary to put into place a highly skilled transition team comprised of the present leadership of the two organizations and high-quality outside change management expertise, particularly in organizational development and strategic human resource management.

NATIONAL FACILITIES

82. *Legislation should be enacted to facilitate the designation and operation of National Facilities. The act should specify the criteria for selecting national facilities, the performance criteria which would need to be met to retain that status, and the funding regime which would apply both to meeting the infrastructure and operating costs of the facilities and to the financing of the use of the facilities by interested parties.*

SAWB

83. The SAWB should become a statutory body by following the process steps set out in Part 2 of this report.

Introduction

In September of 1996, the Government of South Africa published a White Paper on Science and Technology, "*Preparing for the 21st Century*", which committed government to attaining excellence in the use of science and technology in 'maintaining cutting edge global competitiveness and addressing the urgent needs of those of our citizens who are less able to assert themselves in the market'. It went on to argue in favour of promoting both creativity and innovation, widely defined, throughout the South African economy and looked to the country's 'national system of innovation' as a means through which the country would seek 'to create, acquire, diffuse and put into practice new knowledge that will help the country and its people achieve their individual and collective goals'. The goals which the White Paper set were those of promoting competitiveness and employment creation, enhancing the quality of life, developing human resources, working towards environmental sustainability, and promoting an information society.

The International Environment

The White Paper was written in the light of international acknowledgement of the significant role played by technical change in the promotion of economic growth and social development in today's highly competitive world. Present understanding of the role of technical change in economic growth has led governments around the world to invest in the promotion of technology diffusion - to maintain a high average level of technical competence throughout an economy - and in the promotion of technical innovation both to maintain the competitive position of leading firms in both domestic and international markets and to seek effective and efficient means of solving problems.

Such strategies are complex and involve difficult decisions since much technical change displaces poorly-trained workers while creating new employment opportunities for those privileged with access to higher levels of education and training. With the increasingly open markets of today, the luxury of opting out of these global trends is fast disappearing and so all governments are under pressure to create the conditions under which the average level of training of the entire workforce is continuously increasing and where firms are encouraged to take the risk of innovating in order to stay competitive. Public investment programs also are coming under increasing scrutiny to ensure that tax-payers are obtaining value for money, and hence the use of technology to enhance productivity is as important in the public as in private sector.

With this as a backdrop, governments around the world are seeking

- to create an economic policy environment which encourages investment in technological change;
- to identify means of sharing the risks and rewards of successful technological innovation;
- to take steps to overcome market failures in the provision of the underpinnings of knowledge necessary for technological innovation and diffusion; and
- to recognise the special needs of small, resource poor enterprises in the era of more open market competition.

Recent actions in South Africa

Since the publication of the White Paper on SET, significant changes have already been introduced in both the governance structure for SET and in the important areas of support to research and human resource development. An Act to establish a National Advisory Council on Innovation has been promulgated, and the processes leading to the appointment of the first set of members are underway. A second Bill, to establish a National Research Foundation, is now before Parliament. DACST has introduced, at a pilot scale, an Innovation Fund and has introduced an element of competition into the process of allocation of the 'Science Vote'. Earlier initiatives - principally the National Foresight Program and the SET Audit - have been pursued in a manner which continues to stimulate wide participation. Finally, 1998 has been declared 'The Year of Science and Technology'.

The White Paper on S&T proposed that the Ministers' Committee for Science and Technology put in motion a fundamental investigation into the governance and management structures of government-funded science and technology performing institutions in order to establish how these institutions could be restructured or reconfigured to meet broad national goals. This report represents the culmination of that process of investigation.

The final stage of the 'fundamental investigation' initiated by the White Paper has been an attempt to identify generic issues to be found within government science, engineering and technology institutions (SETIs) as a necessary precursor to identifying specific needs for major restructuring or reconfiguration either of individual institutions or of the system of civil science and technology within government as a whole.

As an essential backdrop to the conclusions of this exercise, it is necessary to bear in mind three points:

1. that civil activities in science and technology within government represent only one part of South Africa's national system of innovation - there are many important organizations and institutions in the private sector, in the higher education sector and in defence, which were not part of this review;
2. that the support of activities in science and technology is only one activity of government, albeit an important one, and so any policies proposed should be consonant with many other policies, and in particular should be viewed in the light of the macro-economic strategy for Growth, Employment and Redistribution (GEAR); and
3. that policies for government activities in science and technology should reinforce, and in turn be reinforced by, other specific policies dealing with sectors as diverse as education, energy, water, environment, agriculture, defence industries and so forth.

The Policy context of GEAR

South Africa's macro-economic strategy sees government undertaking a series of initiatives

- in the areas of fiscal, monetary and exchange rate policies in order to improve economic performance generally and to improve the efficiency of operation of government in particular;
- in trade, industrial and small enterprise policies to stimulate international competitiveness and employment creation; and
- in social and sectoral policies, in particular in education, health and welfare, and housing and infrastructure, to meet some of the pressing needs of the disadvantaged majority.

One of the tasks of this review is to realign the activities in science and technology within government so that they can make significant contributions to the programs of

the GEAR strategy by making more effective use of the scarce resources available to meet government's commitments.

This review clearly understands government's need for fiscal discipline, one result of which will be considerable restraint in all areas of government spending, including spending on science, engineering and technology (SET), in the medium term. It is the underlying belief of this report that **resource constraints are not a barrier to implementation of its findings which are designed to lead to more efficient and effective use of public resources.** While the proposed transformations can be implemented within a framework of no growth in real resources and will result in a system with a greater capacity to make efficient, effective and economic use of future higher levels of resources, whether they come from public or private sources, it is already evident that additional resources could be usefully absorbed in areas relating to human resource development, to expanding international connections and, most particularly, to the expansion of the Innovation Fund.

The impact of other policy initiatives

As part of government's comprehensive re-evaluation of policies in all areas of public policy, many White Papers have been published or are in advanced stages of preparation. As argued in the S&T White Paper, 'one of the challenges of promoting technological innovation [is] toensure that government actions across all fields - in trade, education, labour laws, environmental protection- are taken in due consideration of how these actions will affect the climate of innovation' Equally it was recognised that the management of technical change - which is the result of technological innovation and technology diffusion - is a fundamental source of economic, and much social, development in today's world. In this light, there are expectations that the SET activities within the country should be able to make significant contributions in almost all fields of intervention, from manufacturing to agriculture, from health to housing.

Sectoral policy documents in areas such those on Water and Environment have acknowledged the role of SET in their particular areas, but at a general level. Equally, some forthcoming policies, such as those on Energy and on Minerals are also expected to demonstrate areas in which South Africa will need to promote innovation in order to achieve its goals. In other policies, such as that on Higher Education, a general framework for decision-making has been put forward, leaving open the recognised need to become more specific in the treatment of crucial areas such as training in mathematics, science and engineering.

In the specific recommendations which have been framed in this document, careful thought has been applied to ensure that the directions proposed are in support of policy directions already in place.

The focus of the review - the public research system

During 1997, the Ministers' Committee mandated the Department of Arts, Culture, Science and Technology (DACST) to initiate and manage a series of twelve separate evaluations, each to be carried out by a team of experts drawn both from South Africa and from the international community. Ten of the reviews dealt with existing

institutions (the Africa Institute of South Africa, The Agricultural Research Council, The Atomic Energy Corporation, The Council for Geosciences, CSIR, The Human Sciences Research Council, The Medical Research Council, MINTEK, The South African Bureau of Standards and The South African Weather Bureau .) In addition, a panel reviewed the "Agency Function" - the way in which government currently provides financing to the Higher Education Sector for the purposes of scientific research , technological development and the training of human resources, while a second additional group reviewed the need for a special policy to be put in place to cover the conditions under which South Africa might identify and support 'National Facilities' for research. In this document, the term "Panel Report" is used to refer to the output of these sectoral reviews.

It is important to recognise that the present review did **not** extend to detailed coverage of SET activities in the private sector, in Higher Education or in Defence.

The mandate given to the present review required that it look at the activities of eleven different institution which undertake a wide variety of functions and which received a total of slightly more than 1.7 billion rand of support via Parliamentary Grants in the present fiscal year 1997-98 . They will also earn a significant volume of external support whose value for this most recent year of operations is not yet known.

The current sectors or areas of interest of SETIs covered by the review are

| | |
|--------------------------------------|---|
| The Africa Institute of South Africa | Foreign Relations; the understanding of economic and social change in Africa; data collection and policy analysis concerning African countries. |
| The Agricultural Research Council | Commercial agriculture, environmental questions relating to sustainability |
| The Atomic Energy Corporation | Nuclear waste management; decontamination and decommissioning of nuclear facilities; nuclear regulatory activities; production of chemicals and radio isotopes; Technology transfer and commercialisation. |
| The Council for Geosciences | National and regional geo-mapping; support to the mining industry and to urban and regional planning; |
| CSIR | Manufacturing industry, the minerals processing industry, housing, environment and water, aeronautics and defence, textiles, information technology, mining industry, the food processing industry. Technology development, transfer and application. |
| The Human Sciences Research Council | Infrastructure support to, and undertaking of, large scale research in the social sciences; psychological testing; development of survey methodologies |
| The Medical | The health of individuals and populations; health services |

| | |
|---|--|
| Research Council | environmental research. Support to the health care industry, including the pharmaceutical industry. |
| MINTEK | Support to the mineral processing and mining industries. |
| The South African Bureau of Standards | Establishment of standards for all industrial sectors; accreditation and certification activities related to these standards; provision of testing facilities and services |
| The South African Weather Bureau | Provision of meteorological services to the public, and to specific sectors; research on climate change; some development of scientific instruments. |
| The future National Research Foundation | Support of research and human resource development, principally in the higher education sector. |
| The Current National Facilities | Provision of large and expensive research facilities for use by multiple users; currently in the areas of nuclear physics, radiation therapy, and optical and radioastronomy |

During the review, it was apparent that consideration of any major gaps in the system of SETIs could only be dealt with in the light of structural changes emanating from this study and of conclusions which should emerge from the ongoing Foresight activity. It should therefore be part of DACST's longer-term agenda to commission further work on topics such as the organisation of South African activities in emerging fields such as biotechnology once implementation of the findings of this review is well under way and once the results of the Foresight exercise are known and have been discussed.

The Structure of the Report.

This Report is divided into two main parts:

First, there is presented an analysis of nine, broad areas of system-wide concern. These areas are:

1. A Framework for the Public Research System
2. Independence and Alignment, Transparency and Accountability.
3. Planning, Monitoring and Evaluation
4. Funding
5. Leadership and Strategic Management.
6. Transformation and Human Resources
7. Interaction , Integration and Cooperation.
8. Commercialisation
9. Internationalisation and Strategic Alliances.

Each of these elements of the report encompasses four topics:

- an overview of the problems of the existing system of governmental SETIs, based on the findings of the twelve panels and supplemented by our own discussions with senior representatives of the SETIs reviewed, with Ministers and senior officials of related departments, and with some informed observers of the scene;
- a statement of general principles which we believe to be generally valid and usefully applicable in South Africa today, and which are drawn from the collective knowledge and professional experience of the members of the group undertaking this work;
- a set of guidelines for formulating specific responses to the weaknesses and deficiencies which we have identified; and
- a set of specific recommendations which we believe should be implemented in order to achieve the restructuring or reconfiguration of either individual institutions or of the set of institutions as a whole, which was the central responsibility set out in the mandate of this review.

This first part of the report concludes with a set of recommendations dealing with the necessary restructuring of several of the SETIs reviewed.

Second, there are brief summaries of the findings of this exercise with respect to each individual SETI which has been reviewed. If Ministers accept the overall findings of this review, then the Boards of the individual SETIs should be charged with implementation of the more detailed suggestions contained in this part of the Report. Furthermore, again if Ministers agree, Boards should be charged with implementing such other suggestions contained within individual Panel Reports as are consonant with the findings of this present exercise.

Part 1: Principles, Guidelines and Recommendations

At the threshold of the 21st century governments around the world are faced with many challenges. Effective response to industrial and social change, energy security and sustainable development, the increasing globalisation of markets as well as the emergence of new and the convergence of existing technologies all call for a strategic approach.

How well a national system of innovation is performing, depends in complex ways on the financial resources available, the quality of the human resources involved, the degree of constructive cooperation, interaction and integration among participants, on the creativity of people throughout the system and on the transfer of their ideas into marketable goods and services or into social practice.

1. An Overview of the Public Research System

According to the recently completed National Research and Technology Audit, South Africa has a well-developed and sophisticated SET infrastructure that has an estimated capital value of some R15 billion, including private sector S&T assets. This

infrastructure provides the support base to many technology-dependent sectors of the South African economy. The infrastructure is however ageing and contains inappropriate elements which absorb valuable resources that could be better used elsewhere. Investment in developing the infrastructure is static to declining, and, in some quarters, concerns have been expressed that South Africa is in danger of weakening its support of industries in fields subject to rapid technological change, and hence of weakening its market position, internationally.

The system of Public Sector SETIs have developed over many years into a sophisticated and comprehensive system that, in some but by no means all fields, has a fairly-good track record in producing internationally-competitive technological innovations. As such it has potential to contribute to the sustainable development of the South African economy and society. The current portfolio of SETIs does, however, include inconsistencies in structure, size, management, operational practices and performance. Moreover, across this portfolio, SETIs are often hampered by research paradigms and basic underlying assumptions which have not kept pace with critical changes in the South African and international environments, as subsequent sections will highlight.

From a financial resource perspective, much past attention has been paid to the governmental allocation referred to as the "Science Vote". This is the annual government allocation, via Parliamentary Grant, to the so-called Science Councils - The Agricultural Research Council, (ARC) , The Council for Geosciences (CGS) , CSIR, The Foundation for Research Development (FRD) The Human Sciences Research Council (HSRC), The Medical Research Council (MRC), MINTEK, and The South African Bureau of Standards (SABS). Data for the value of the Science Vote are displayed in Table 1.

[Note: These data do not cover all public funded SETI's some of which were not subject to this review - e.g. the National Sea Fisheries Research Institute].

Table 1

| SCIENCE VOTE ALLOCATIONS 92/93 TO 98/99, In Millions of Current Rand | | | | | | | |
|---|-------|-------|-------|-------|-------|-------|-------|
| | 92/93 | 93/94 | 94/95 | 95/96 | 96/97 | 97/98 | 98/99 |
| ARC | 224.0 | 215.3 | 236.0 | 291.3 | 318.4 | 316.2 | 284.0 |
| MRC | 42.7 | 43.0 | 48.1 | 50.1 | 57.9 | 66.2 | 76.4 |
| CGS | 31.5 | 38.5 | 43.9 | 46.0 | 50.6 | 64.6 | 66.8 |
| MINTEK | 51.3 | 62.1 | 59.9 | 62.8 | 73.0 | 82.9 | 83.1 |
| CSIR | 198.6 | 234.2 | 223.5 | 247.0 | 266.8 | 316.3 | 313.5 |
| SABS | 33.8 | 37.4 | 40.0 | 44.0 | 46.3 | 67.0 | 75.0 |
| HSRC | 67.4 | 74.8 | 80.9 | 84.9 | 87.6 | 89.7 | 93.2 |
| FRD | 62.2 | 72.5 | 85.4 | 87.2 | 86.3 | 106.2 | 145.9 |
| NAC | 29.4 | 33.9 | 36.8 | 37.9 | 37.7 | 41.0 | 44.0 |
| SAAO | 5.2 | 7.2 | 7.2 | 7.5 | 9.2 | 10.1 | 11.8 |
| HRAO | 2.5 | 3.6 | 3.7 | 3.8 | 4.7 | 5.1 | 6.0 |

| | | | | | | | |
|-------|-------|-------|-------|-------|--------|--------|--------|
| | | | | | | | |
| TOTAL | 748.6 | 822.5 | 865.4 | 962.5 | 1038.5 | 1165.3 | 1199.7 |

Other Allocations relevant to the present review

| | | | | | | | |
|---------------------------|--|--|-------|-------|-------|-------|------|
| | | | | | | | |
| AISA | | | 2.8 | 2.9 | 2.9 | 3.1 | |
| AEC | | | 509.7 | 489.2 | 356.1 | 473.8 | |
| SAWB | | | 43.7 | 43.0 | 49.6 | 55.3 | |
| Innovation Fund | | | | | 10.0 | 10.0 | 30.0 |
| Year of SET | | | | | | | 8.0 |
| International Cooperation | | | | | | | 8.0 |

As will be discussed later, the availability of statistical data on SET activities in South Africa is not good, even concerning expenditures by government.

The funds allocated via the Parliamentary Grants made to these bodies are applied to a variety of functions including research and development, the financing of research training, the conduct of extensive surveys, the provision of technical services and the support of government regulations. All of these activities are important and valid in their own right, but they are different in nature and, as will be argued below, they should not all be financed on the same basis. The lack of utility of the past practice of attempting to treat all of the SETIs on the same basis springs from the fact that each member of that set was responsible for a program of activities made up of quite different mixtures of these various functions. As an extreme example, none of the functions undertaken by the FRD are undertaken by SABS, and only the training function of SABS is comparable (even in a limited way) to that undertaken by FRD.

The allocation of funds provided by Parliamentary Grant is only one component of the income used by the SETIs to finance their programs of work. Sources of external income, including contracts for research and development from both public and private sector sources, revenues from the sale of technical services, or from the licensing of intellectual property are to be found, to a greater or lesser degree, in the overall budgets of these institutions. Data provided by DACST show in Table 2 the distribution of income for eight of the institutions during fiscal year 1996-97.

Table 2

| | Own income (%)* | State grant (%) |
|--------|-----------------|-----------------|
| SABS | 77.7 | 22.3 |
| CSIR | 52.0 | 48.0 |
| MRC | 23.9 | 76.1 |
| MINTEK | 22.7 | 77.3 |
| HSRC | 18.0 | 82.0 |
| ARC | 17.2 | 82.8 |

| | | |
|-----|------|------|
| CGS | 16.7 | 83.3 |
|-----|------|------|

** Excludes minimal income from interest on cash reserves and rental*

Perhaps the most significant change introduced into the financing of public-sector SETIs since publication of the White Paper on S&T has been the pilot introduction of the Innovation Fund. According to the White Paper,

"The principal objectives of the initiation of the Innovation Fund are:

- to permit a reallocation of resources from the historical patterns of government science towards the key issues of competitiveness, quality of life, environmental sustainability and harnessing information technology
- to increase the extent to which funds for the activities of government SETIs are obtained via competitive processes and
- to promote increased networking and cross-sectoral collaboration within South Africa's national system of innovation.

The Innovation Fund will initially obtain its income from reprioritisation of the science allocations across government."

In Fiscal 1998-99, the Innovation Fund will disburse some 30 million Rand, a total which could, and should, grow rapidly in future years by further, substantial, reallocations within the Science Vote. Equally, the Fund could grow via additions to the size of the science vote once macroeconomic conditions make such growth feasible. With growth will come the need to put in place an expanded and more sophisticated management system for the Fund.

Public sector performance

The system is characterised by poor interactions and networking which may be regarded as a major weakness in all sectors of the South African SET system. Whilst interaction has improved in certain aspects, it is still particularly poor between the SETIs and the Higher Education Sector. As a result, virtually all new ideas in government SETIs are internally generated. Where innovations are produced, the system is not particularly effective in exploiting their maximum potential. Whilst the relevance of commercialisation varies from entity to entity, it is clear that South Africa has not fully exploited its technological base. This is further manifest in generally poor marketing of capacity and services.

Apart from ongoing concerns related to the level of funding in some parts of the system, few feel that funding levels to the public research system are seriously inappropriate. Modalities and time frames of funding do however need revision. Funding sources such as grant funds, contract income and income from intellectual property need better definition and integration within a context of longer-term planning. The processes used to allocate parliamentary resources to the system are an improvement on previous practices, but they can still be improved.

Once funds have been allocated to components of the system, the manner in which they are deployed is highly variable. It is clear that potential exists for greater efficacy

in deployment. It is further apparent that the SET system is not yet well-aligned with the national priorities as outlined in the White Paper on S&T – especially those related to meeting basic needs.

Most SETIs have acquiesced to the need for transformation, but expectations are high and progress is slow. Human resource management is not generally seen as a key strategic component of the SET activities.

Principles

Each country needs to ensure that it has in place a set of institutions, organizations, and policies which give effect to the various functions required within its national system of innovation. Within a framework of national policy defined by government :

- **An overall government strategy should be developed which is fully aligned with medium and long-term national priorities, and for which appropriate levels of funding and regulatory support are provided by the state;**
- **Provision should be made for system-wide independent oversight, evaluation, and strategic advice to government;**
- **Each institution should be permitted to operate with freedom from administrative constraints which hinder activities of research or development, or demonstration activities within the boundaries of a clearly-defined mandate;**
- **Each SETI should have appropriate Governance and advisory structures in place to provide an effective framework of oversight and advice for management;**
- **Numerous opportunities should be provided to facilitate linkages and interactions across disciplines, sectors and institutions.**

The ultimate goal of all of the organizational arrangements embodied in these principles is to create a stimulating environment and an innovative climate throughout the entire system.

2. Independence and Alignment, Transparency and Accountability

Much attention world-wide has been paid to the questions surrounding how scientific research and technological development carried out within government can be best organised and managed in order to make that set of activities both creative **and** responsive to national social and economic priorities. By the late 1980s in South Africa, there had been recognised some of the adverse impacts on both efficiency and effectiveness of operating programs of science and technology under the extensive and detailed system of rules which has traditionally determined actions within South Africa's public service. The policy of 'Framework Autonomy' was one response to

this imperative but it was a response to only part of the question. It did not deal with the question of responsiveness to a national agenda.

Today, almost all of the SETIs examined have a degree of administrative freedom which permits them - if they are so inclined - to develop management systems which are geared to the promotion of efficiency and effectiveness. The CSIR is probably the most advanced example, but others, such as MINTEK and FRD, also have good management. However, we have observed little evidence to indicate that the ARC, for example, has seen the relative level of administrative autonomy granted to it as an invitation to promote efficiency and effectiveness, and certainly no evidence to see that it is committed to the agricultural policy agenda of the post-1994 government.

The case of the Council for Geosciences is instructive, in that the Ministry of Mineral and Energy believes that the quality of the support which it receives from the CGS has improved since the CGS was removed from the departmental structure and converted into a statutory body. This improved relationship is attributed to the clarity of expectations of the relationship which has been established under a memorandum of understanding negotiated between the Minister and the CGS, defining the public functions which CGS will perform in return for the Parliamentary Grant transferred to it via the Ministry's Budget.

Such an example reinforces the case currently being made in favour of removing the Weather Bureau from within the Department of Environment and granting it the status of a statutory body in order

- to avoid the significant costs which it incurs at present in order to comply with administrative rules which are not geared towards the promotion of efficiency and
- to remove the current strong disincentives which have effectively discouraged it from seeking to acquire external income which would be available to it under a more favourable administrative structure.

The provision of operational freedom to SETIs -in order to promote efficiency, effectiveness and creativity - needs to be seen in the context of the obligations of the SETIs to operate within their legislated mandates and to be both sensitive and responsive to government's objectives and priorities. The mechanisms which need to be put in place- because today they are largely absent from many of the SETIs - are mechanisms to ensure transparency of decision-making and accountability for the use of public funds.

As the system works today, there is only an ineffective systematic requirement for transparency of operations - for example there is no effective requirement that a SETI should be able to display, even to its own Board, the purposes for which all of its Parliamentary Grant is used.

With respect to accountability, there are two systems in place -

- the requirement that responsible Departments issue a "K-5" certificate to indicate the Department's agreement that all Transfer Funds have been used for the purposes set out in an agreed upon business plan; and

- the requirement that the SETI conform to the requirements of the Reporting by Public Entities Act, a measure of effectiveness and efficiency of the use of public funds required by the Auditor General.

The problem with the K-5 system is that most line Ministries have limited staff and competence to make assessments of sufficient depth to have this process constitute adequate public accountability; and the problem with the reporting of Public Entities Act is that the set of criteria used to judge performance are not well aligned to the kinds of activities undertaken in those SETIs which have heavy involvement in R&D.

Building a new system for public sector SETIs should be based in part, then, on four basic principles;

- **that the allocation of a high degree of operational independence to a governmental SETI brings with it a set of clear responsibilities with respect to the need for the SETI to be responsive to government policies and objectives;**
- **that clear and effective systems need to be in place to ensure transparency of planning, decision making, and implementation processes at all levels.**
- **that SETIs should operate in a system of accountability in which performance criteria are geared to what the SETIs actually do and in which government has an appropriate capacity to evaluate performance against those criteria**
- **that the obligations of transparency and accountability should be seen as being active rather than passive, requiring that SETIs take positive measures to inform interested parties, including the public at large, of their policies, programmes and performance.**

To facilitate implementation of these policies it will be necessary for clarity to be introduced into policy thinking concerning the dual role of government as a shareholder and as a customer. This clarity is needed most in the processes of funding the activities of research, a topic dealt with in Section 1. 4.

While there needs to be better accountability systems in use within government, there is an even larger need for improved accountability to the citizens of South Africa at large, to meet the standards implied by the fourth principle set out above. Past failures to accept the principles of transparency and accountability have only served to magnify the problems of misallocation of resources and to increase the levels of controversy surrounding many programs, including among those the activities and programs of the AEC.

So far, this discussion on transparency has been focused on individual SETIs. There is also a need at a higher level to provide clear information, and particularly data, on the SET system as a whole. At present, there is no process in place to provide reliable time-series of data, covering the financial and human resources allocated to activities of science and technology in the public and private sectors, which have been collected and analysed in a manner which will permit international comparisons. For the higher education sector, FRD publishes regularly its volume of "SA Science and Technology Indicators" and recently an attempt was made to provide a snapshot of all sectors via the SET Audit. These activities, taken together, are not a sufficient long-term

response to the issue, and it will be necessary to put in place a system to provide to policy-makers a consistent and reliable set of data on SET activities in South Africa. Such data should also be internationally comparable to the extent possible.

In many other countries, the government's statistical service conducts regular surveys of SET spending as a contribution to policy making. Government in South Africa needs to address the issue of how it will provide similar information in a reliable manner, both in order to underpin its own policy initiatives and to create the basis for more informed public debate on major issues.

Guidelines

The usual organisational form used to house activities of science, technology and engineering within the public sector should be one which permits those activities to be managed in an efficient, effective and economic manner. In most cases, such an organizational form should **not** be a part of a government departmental structure.

SETIs within this system should

- operate within boundaries defined in legislation or in some other suitable legally-binding instrument;
- be oriented to the achievement of the goals set out in the White Paper on SET and be responsive to statements of government policy;
- have delegated to them the authority to manage their resources (human, financial and physical) in ways which are flexible and responsive to national needs;
- operate on the principles of active transparency in decision-making and accountability for the attainment of performance targets;

The primary responsibility for the overall direction and operation of each SETI should be vested in its Board;

Recommendations:

...on Independence and Alignment, Transparency and Accountability

○ Government should improve the efficiency and effectiveness of its in-house SET activities by organising them within legal structures which permit flexibility of operation while safeguarding the use of public resources and providing for necessary measures of performance. Such conditions are usually best provided for by undertaking those activities within a statutory body with suitably designed objectives and responsibilities, or within a Section 21 Company operating under the Companies Act.

- *The Boards of the SETIs covered in this review*
- *should take all steps necessary to make public the decisions which they take in response to the recommendations contained in this report, and in the supporting Panel Reports.*

- *should play a key role in defining strategic directions for the institution in their charge and should make those directions public;*
- *should direct the CEO of the SETI involved within a broad strategic direction given by government. To facilitate this, there should be regular and structured conversations between Boards and Line Ministries to enable clear expression of State priorities*
- *SETI Board members, whilst appointed as individuals, are expected to provide sectoral expertise to Board deliberations and should also take responsibility for improving linkages between SETIs and their respective sectors.*
- *In order to ensure accountability and good practice, the King Commission's recommendations on Good Corporate Governance should be adopted by all public SETIs.*
- *The transparency of the activities of SETIs to the scrutiny of the larger SET community in South Africa, including the SETI's intended clients, should be improved by the judicious use of advisory panels. Given the need in some cases to protect the industrial confidentiality of some of the work undertaken, individual SETIs should publish, and invite comment on, the terms of reference which they would intend to use as a framework for the operation of individual advisory bodies.*
- *All SETIs should adopt a system of key performance indicators, discussed later in this report, in order to facilitate accountability.*
- *DACST should initiate discussions with the Central Statistical Service, and with other interested parties, in order to address the problems of availability of data, even on SET activities within government. An internationally-accepted basis for such work exists in the Frascati and Oslo Manuals which have been developed and published by OECD*

3. Planning, Monitoring and Evaluation

Analysis

For any research organisation as well as for a national system of innovation as a whole, quality assurance is of the utmost importance. In this respect, the publicly-financed SET system in South Africa so far has been operated primarily on the basis of fairly traditional, mainly input-related, administrative and auditing procedures. These have been designed to assure the adequacy and correctness of spending, and to provide project as well as programme-related systems of peer review. In recent years, several SETIs have begun to develop and implement their own set of performance indicators, benchmarking systems and procedures as well as new approaches to the overall planning and implementation of their SET activities. However, the reports of the respective review panels clearly demonstrate that even some of the most advanced SETIs, for example the CSIR, still reveal a number of shortcomings which require structural and operational redesign.

In what follows, we distinguish between two important processes - the first is the regular monitoring and assessment of programs to provide management with a basis for action and the second is the periodic and more far-reaching evaluation of programs or of clusters of programs designed to allow government to make any major adjustments which might be necessary. In the case of monitoring and assessment, we also distinguish between the strategic role of a SETI Board, whose concern has to be with the question of orientation of the work of the SETI, and the more tactical role of external advisory committees whose primary concern is the technical quality of work being undertaken.

Whilst, in the past, several SETIs had set up technical advisory bodies which apparently did not function well and subsequently were abolished, others, such as MINTEK, still have technical advisory committees. In other countries, this task of assessment is usually fulfilled by expert panels or advisory boards which address issues like quality, originality, relevance, prospects, efficiency, effectiveness, impacts, and human resource development. In addition, they also can serve as a link to researchers from within and outside South Africa, and thus help to open up opportunities for collaboration and strategic alliance. Individual SETI Boards should ensure that their SETI has in place an adequate system of external technical assessment which works on an agreed-upon schedule, which could be as frequent as every two-to-three years.

Apart from the demand for a more strategic approach to the monitoring and on-going assessment of SETI performance, there is clearly a need for setting up an adequate structure for external evaluations of clusters of SETIs or research areas at medium-term intervals. In this respect, it is encouraging to see that all SETIs welcomed the current review process, and have already started implementing several of the recommendations of the specific reviews.

We note that in various Panel Review Reports there was the clear impression created that some existing Boards, even after reconstitution, were not functioning well and had yet to grasp the difficult challenge of providing strategic direction to the SETI involved. It will be important that Boards also are accountable for their performance and this should be an important element of the periodic evaluations which we are proposing.

Principles

Planning, monitoring and evaluation of R&D are indispensable elements of any well-designed system of innovation. In order to make them become an integral part of the policy and decision making process:

- **the objectives and criteria for the respective R&D activities as well as for the monitoring and assessment and the evaluation processes should be defined as concretely as possible;**
- **an organisational framework is needed to underpin the credibility and fairness of the evaluation process and, at the same time, ensure that the results will be implemented in due course;**
- **evaluation results should be presented in such a way that they will help decision makers in setting appropriate priorities, and feedback**

mechanisms should be established which enhance a fruitful interaction among all parties involved.

- **a coherent approach to planning, monitoring, assessment and evaluation should be established which ensures that at all levels quantitative as well as qualitative methods and techniques are in place which facilitate the assessment of progress made and results achieved.**

While continuous monitoring and assessments by advisory boards lie within the remit of each organisation, the evaluation of SETI performance over a period of 5 to 7 years should be conducted in a framework which provides a high degree of independence from the organisations to be evaluated, but is sufficiently linked to policy and decision making at government level.

Guidelines

Performance indicators provide a valuable input into planning, monitoring, and evaluation processes. They should become an integral part of the management of SETI within each SETI, and are best developed in an interactive process between the researchers, executive managers, board members and clients. The agreed set of indicators should contain a sufficiently wide variety of data in order to cover the spectrum of expected outputs, outcomes, and impacts. Particular emphasis should be put on indicators of success in the area of knowledge diffusion and technology transfer as well as of human resource development.

Internal reporting and monitoring systems should be implemented by each SETI in order to provide the executive management and the respective boards with information, on a continuing basis, that enables them to have a good overview on the state of affairs throughout the SETI. These ongoing activities need to be complemented by a regularly-scheduled review which should be conducted by an expert panel or scientific advisory board made up of South African as well as foreign researchers. They should address issues like quality, originality, relevance, prospects, efficiency and effectiveness as well as human resource development, and give advice to the executive management and to the board in particular on the

- Prospects of the research area in which the division or institute is involved;
- Enhancement of the division's or institute's significance in the respective research area;
- Improvement of the potential for knowledge diffusion and technology transfer;
- Appropriate distribution of funding;
- Concentration or reconfiguration of relevant forces;
- Modifications in the personnel and/or organizational structures.
- Degree of coordination and cooperation with SET stakeholders.

At greater intervals, usually every 5 to 7 years, it is essential to have external evaluations of clusters of SETIs and/or relevant research areas. It is crucial to provide an organizational framework which secures the credibility and fairness of these evaluations. Internationally, such important evaluations are usually carried out under the auspices of a high-level advisory body. A logical choice in the case of South Africa would be the newly-established National Advisory Council on Innovation (NACI) which could be given the responsibility for developing an appropriate concept,

including methods and procedures, and for conducting the external evaluations. These evaluations should give an account of past achievements and particularly advise government on the

- Long-term prospects of the research area;
- Need for continuing or discontinuing the SET activities;
- Structure, scope and resources of the division or institute;
- Adequacy of mode of governance, and performance of the board;
- Appropriateness of research environment;
- Improvement of the potential for knowledge diffusion and technology transfer.
- Added value to the South African economy and society

Recommendations

In view of the principles and guidelines outlined above, and being attentive to the current situation in South Africa, the following recommendations are made:

Key performance indicators should be established throughout the publicly funded research system of South Africa. They should become an integral part of the management and monitoring processes within each SETI as well as at line department level; [Some potential key performance indicators are sketched out, in a preliminary fashion, in Appendix 2]

Internal reporting and monitoring systems need to be complemented by regular reviews which should be conducted by an expert panel or scientific advisory board on regularly-scheduled basis;

At greater intervals, external evaluations of appropriate clusters of SETIs and/or relevant research areas should be conducted under the auspices of the newly-established NACI in order to provide government with independent advice on the future development of individual SETIs and relevant research areas as well as on strategic issues related to the South African system of innovation as a whole.

4. Funding Levels and Modalities

The present system

Government spending on SET occurs through a number of channels, including

- parliamentary grants (including core and agency funds) to the statutory SETIs;
- line Ministry budgets for other SETIs (e.g. for the National Botanical Institute),
- special government programmes (such as SPII and THRIP),
- the research component of the funding formula for HEIs,
- contracts from government departments,
- parastatal research expenditure, and
- to a limited extent, through dedicated levies (e.g. for funding of the Water Research Commission).

There is at present no overall co-ordinating mechanism within government for budgeting and fiscal allocation for the SET system as a whole. The present situation could be improved by the displaying of all government's SET expenditures in a single annual document which might accompany the government's overall budgetary documentation.

The relationship between Government and statutory SETIs up to now has been defined by the system of Framework Autonomy adopted in 1987, which *inter alia* established a process for allocating State funding to SETIs referred to as the Science Vote and provided for individual SETI budgets to be transferred to the SETIs via the budgets of appropriate line departments.

DACST today plays a co-ordinating role in defining the relative levels of funding for the SETIs within the total "Science Vote" and has sensibly rejected fixed base-line funding because the historically-based incremental approach does not accommodate a mechanism for evaluation and reprioritisation of State SET expenditures.

Some of the current funding routes are being reviewed and the introduction of a multi-year expenditure framework, by the Departments of Finance and of State Expenditure is a positive development. However, there are limitations on the range of funding modalities being used for SET funding. For example, levies for the support of designated activities are not favoured by the Department of Finance which is concerned about fiscal integrity and the high ratio of taxation to GDP.

Funding of research in the Higher Education System (HES) is also being reviewed. The existing funding formula for HEIs links the research component (amongst other factors) to the number of students but there was no way of tracking whether this component is actually spent on research. This method of financing will be replaced by a block formula component and earmarked funding within a national planning and performance monitoring framework. However, there are no indications of how this will be coordinated with planning, funding and performance monitoring in the rest of the NSI, or with government spending on statutory SETIs.

In the latest round of allocations, SETIs were guaranteed 80% of their prior year's allocation, but the remainder was allocated competitively – some getting more (e.g. MRC) and others getting less (e.g. ARC). Apart from the ARC (whose share of the science vote has fallen from 30 to 23%), the relative shares of other SETIs have remained remarkably constant over the years with the CSIR getting about 25%, and the rest each getting between 4% and 8% of the vote. Most of the individual SETI reviews recommended continuation of current levels or, in a few cases, increases (particularly in the case of the MRC).

The relative proportion of income for SETIs from core parliamentary grants and contracts or sales to government and the private sector, varies considerably between SETIs. The percentage of contract income varies from nearly 78% for SABS, to about 17% for the CGS. (Data for fiscal 1996-97 are presented above in Table 2 of Section 1.1) There is potential for many of the SETIs to substantially increase their proportion of contract income without prejudicing basic investment in research infrastructure or knowledge generation.

It is also generally acknowledged that R&D expenditure by the private sector is inadequate and that there is a need for incentives to increase investments in SET by this sector. The Department of Finance's objective is to reduce the general level of company tax and is concerned that any special tax incentives will reduce its ability to do so. It is also cautious and concerned about low levels of compliance and abuse, where it is often difficult to discern measurable impacts from such initiatives. Government recognises the importance of technical change in economic development. It wishes to see enhancements in productivity and competitiveness, but also job creation. It is also confronted by major and often competing demands for investment in social and physical infrastructure, including increasing needs from the Provinces. Incentive schemes and expenditure on SET have to be carefully justified and their benefits demonstrated. The White Paper on S&T and DACST through its programmes are beginning to build a culture where attention is being given to these issues.

DACST is introducing a new Finance and Reporting System (FRS) for the statutory SETIs to ensure that core state funds will still be allocated to SETIs in terms of their mandated core responsibilities and that much greater account will be taken of alignment with overall NSI goals and performance. The most profound shift in funding philosophy lies in acceptance of the view that funding sources will be multiple and that an increasing proportion will come from competitive sources such as contract income, or through the competitive grant mechanism of the newly introduced Innovation Fund, with an implied decline in the proportion of funding delivered via core grants. The new FRS also envisages a role for NACI in advising on relative allocations among SETIs.

Of primary concern to this review is the performance of the system now in place to allocate the science vote and to introduce the increased levels of competition into that process as suggested in the White Paper on S&T.

Principles, Guidelines and Recommendations

Innovation in science and technology, together with knowledge and technology diffusion, promote technical change which in turn is a vital contributor to economic development and prosperity. In this light, government expenditures on SET should be seen as an important component of infrastructural investment, which can enhance competitiveness while also enabling more efficient delivery of public goods.

The imperatives of GEAR deficit reduction targets constrain the total government funding envelope for SET in South Africa. Nevertheless, GEAR growth targets imply improved competitiveness, and redistribution goals imply job creation and improved social delivery. Technical innovation and diffusion can lay the basis for their achievement.

At a minimum, in the short term, government should seek to maintain current levels of SET expenditure (although more efficiently distributed and utilised – see below). In the medium term, macro-economic and fiscal conditions permitting, government should seek to increase SET expenditure in different economic sectors to levels proportionately commensurate with those of competitive nations.

The appropriate state funding modality should be determined by the nature of the function/ activity it is intended to resource and should be guided by an understanding of public purpose and public capacity.

The relative state grant funding levels between SETIs should be determined through a transparent process utilising agreed criteria

The principal SETI functions/activities which the state might fund, and the appropriate corresponding modality of funding are:

- *Public interest knowledge and information dissemination* activities which should be funded via the parliamentary grant.
- Necessary *core research infrastructure* in SETIs which cannot be funded through external contract or service income should be funded via the parliamentary grant.
- *Human resource development*: Research capacity in HEIs should be funded via parliamentary grants, usually via the agency function, and sometimes via SETIs where they have additional human capacity requirements. The parliamentary grant might also support in-house human resource development programmes.
- *Pre-competitive research*, which might be undertaken within the SETI or might be contracted out, may be funded via core parliamentary grants or via competitive mechanisms such as the Innovation Fund. In all cases, some contribution from interested economic actors should be sought.
- *Public purpose technology development and diffusion* in strategically defined / prioritised areas where because of market failure or other reasons it is not undertaken privately should be funded via parliamentary grants, or more often through competitive mechanisms such as the Innovation fund.
- *Research, consultancy, services or products* in order to meet well-defined, short-term objectives of individual government departments should be funded via contracts financed through individual government departmental budgets.

In essence, government will support activities which are considered to be services which the State has a duty to provide, programmes in areas of public good, programmes addressing areas where entry barriers related to equipment and human resources are high and pre-competitive research.

The combination of funding modalities which will provide financing to individual SETIs will differ among different categories of SETIs. HEIs, Agency functions and National Facilities will obtain a higher proportion of core grants than statutory SETIs who will be required to seek increased contract and external income.

System wide recommendations:

All parliamentary core and competitive grant funding for the SETIs should be delivered via the Science Vote. DACST, with the support of NACI, should

- *expand and refine the classification of funding modalities used by government and should specify which modalities are appropriate for funding the differing institutional functions performed by SETIs as a basis for resource allocation among the SETIs by the state.*

- *adjust relative funding levels between the SETIs from year to year (within the medium term expenditure framework) according to mutually-agreed criteria; These criteria should be related to an assessment of the relative mix of core public purpose functions or activities (such as public interest research, technology development and diffusion, human resource development and core research infrastructure) versus the limits of, or potential for, private funding from the sale of contract research, services, and products (including Intellectual property).*
- *seek agreement from the inter-ministerial committee on SET on the selected criteria , publish the criteria and then operationalise them through transparent and consistent application.*
- *develop an appropriate funding mechanism for declared National Facilities which strikes a viable balance between providing secure infrastructural support for the operators of the facility and funding/empowering users (including the staff of the National Facility) to gain access to the facility on the basis of merit and relevance.*

SETIs with potentially close links with key economic sectors (such as CSIR, MINTEK and ARC) should be required to generate higher proportions of their income from external contracts and from sales of Intellectual Property than those such as the Weather Bureau in which much of the activity is oriented towards the production of public goods. Such external contracts would include any contracts funded by the Innovation Fund.

At present government co-ordinates the allocation of SET expenditure only within the science vote which does not include some significant SET activities of government. It would be more coherent and rational to co-ordinate major government expenditure on SET and integrate, at least, the research component of the government grant to HEIs into a regular reporting system.

DACST should work towards presenting an enlarged view of expenditure on SET and innovation within the NSI and should start developing integrated and coherent criteria and mechanisms for guiding allocations among the different components of the SET system. In particular, a review of the S&T research component of funding for the Higher Education Sector should be undertaken to optimise application of funds earmarked by the Department of Education for this purpose.

Efficiency and alignment of research programmes can be increased and trans-disciplinary and cooperative approaches can be encouraged through increasing competitive grant funding modalities coupled with appropriate conditionalities

System-wide:

Government should increase substantially the proportion of funding for SETIs and other participants in the SET system which is channelled through competitive mechanisms and programmes such as the Innovation Fund, THRIP, SPII and the agency funds of the NRF. These initiatives should incorporate explicit conditionalities which encourage cooperation across disciplines, institutions and sectors.

Rules for participation in these competitive funds will differ, but they should be transparent and should encourage a level playing field. The management of these funds should be separate from the line Ministry through whose budgets the funds pass so as to facilitate objective monitoring and evaluation. This is mostly the practice at present (THRIP is managed by FRD on behalf of DTI; SPII is managed by IDC on behalf of DTI; Agency funds are managed by NRF on behalf of DACST). A similar separation should apply to the Innovation Fund once it begins to grow.

All options for the long-term management of the Innovation Fund, including the contracting out of that management task, should be explored. In particular, the management system chosen should be capable of managing the growth of the Fund to a level which is considerably larger than today's. This will require capacity to manage an increasing degree of complexity in a Fund which should become a principal governmentally-provided source of funding of innovative activities. The growth in the volume of funds managed by the Innovation Fund will need to be accompanied by the fostering of a culture of R&D cooperation among stakeholders from diverse sectors, institutions and disciplines, all of it carried out in the context of the potential application of the results.

New approaches should be explored for establishing virtual facilities through networking and cooperation between institutions and these should be supported by earmarked funds for defined purposes for a fixed term.

Institution specific:

The NRF should begin an early round of conversations with NSI actors and stakeholders to help inform thinking about how to use their budget in ways that best support national policy priorities and the NSI.

SETIs should be permitted to generate investment income but this should be judiciously used to develop and sustain physical and human capacity for innovation.

Many SETIs have developed significant financial reserves which are, in turn, generating investment income; government, as shareholder, should provide clear guidelines on the strategic utilisation of these reserves.

DACST with the Department of Finance, in consultation with the SETIs, should develop guidelines for SETIs which set out conditions under which SETIs can engage in the accumulation of financial reserves and should provide guidelines for judicious investment in physical and human capital to sustain an institutional capacity for innovation and technology diffusion. The accumulation of surpluses through good performance should not unduly prejudice ongoing state support, provided surpluses are invested according to the above guidelines.

This review has focused on public financing of SET activities but this should not lead to neglect of the increasingly important role which should be played by private sector financing. The private sector can be a dynamic engine for innovation and incentives to increase private investment in R&D may be more efficient than direct government investment in those activities. Such incentives are increasingly international practice and South Africa has to compete in an environment of internationally mobile R&D

investments. As a consequence, government will have to develop greater sensitivity in its tax strategy.

DACST with the Department of Finance should explore workable incentive mechanisms to encourage the private sector to invest more in R&D.

5. Leadership and Strategic Management

Analysis of the Present Situation

Today's well-performing institutions of all kinds are dependent on the availability of two key inputs into their operations - dynamic leadership at the top of the organisation and a well-functioning system of strategic management which links goals and objectives to all of the key decisions made in day-to-day operations.

There was a great variation in the extent to which these inputs were to be found among the public-sector SETIs covered by this review. On one end of the spectrum, some SETIs are well-led and managed, while on the other there are management systems of the 1950s. Disappointingly, the negatives in the system outweigh the positives. A minority have grasped the significance and the change in the policy environment in which they are expected to operate, and have established long term goals and objectives to bring about the changes necessary to contribute to South Africa's development under significantly-altered conditions. The CSIR is the prime example of a SETI which is seeking to respond actively to the new circumstances. Others have not incorporated the need for responsiveness to government's objectives and plans, or the need to learn how to support SMMEs, or the opportunities presented for improved cooperation with other institutions in the national system of innovation (other SETIs, HES, private sector, and international players), or even global research trends as important in their strategies. Some claim it is government's lack of direction that impedes them, but others like CSIR have taken bold steps to react more constructively to their environments.

Most SETIs have not undergone fundamental change to respond either to market requirements or to new government requirements. Their marketing skills appear limited, yet they do not appear to recognise the urgency to alleviate the situation, despite the potential to increase their external and contract income.

- A few have organisational functions that are fully linked to their strategies, but the use of true strategic management in others remains limited.
- Some have management systems and structures that support performance management around Key Performance Indicators. Others instead are unable to identify such indicators, even for their own organizations.
- Some do not see Human Resources Management and Development as part of their strategic thrusts. They instead relegate this important function to little more than 'Personnel Management'. As a result, for many of the SETIs, their performance on equity and redress is low, and they have not used knowledge generated by the social sciences to contextualise their activities (e.g. to get an African perspective). They remain too reactive and very short term in perspective.
- Most of the SETIs show signs of having difficulty with maintenance of morale, and motivation (especially of Black people) and institutional drive.

Turnover, particularly among black professionals, is high but there is little systematic investigation into the causes of such turnover the extent to which institutional culture might be responsible, and the losses entailed by failing to realise the links between redress, innovation and quality of research

Strategic management and technical change

The lack of capacity for strategic management within some SETIs manifests itself also in a lack of appreciation of the complexities of the tasks of using science and technology as tools in the promotion of economic and social development. Although we believe that stimulating more technological innovation is important, an even more important contributor to economic development is technology diffusion - the spread and adoption of new techniques and processes in order to operate more effectively and efficiently. Countries that embrace technological change, and in which technological knowledge diffuses rapidly through the society, are the ones whose economies perform best. However, in some SETIs, little management attention appears to be devoted to technology diffusion.

In South Africa there are various structural problems which affect the willingness to embrace technological change and which need to be addressed in SETI strategies; among these is a pervasive fear that more technological change will simply act to exacerbate the already high levels of unemployment in the country. There is a clear need to address issues such as

- the identification of obstacles to embracing technological change within society and the economy;
- how can society and workplaces be reconfigured and reorganised to embrace technological change?
- how can new forms of work or community organisation be developed to share in any of the benefits and costs of change?

The SETIs have to embrace an understanding of these issues as strategic determinants of their impact to quality of life of South Africans. In their processes of strategic management, they need imaginative new inputs from the social sciences, something which some SETIs are incapable of generating today.

Principles and Guidelines

Leadership has to be sensitive to changes in the institution's environment, and has to ensure the establishment of an agreed set of long-term goals and objectives for each organisation, which are consonant with an articulated vision of the future. Only in this manner can organisations become dynamic and effective.

Leadership has to drive the Organisational Culture to be in line with the strategic goals, and to transform government SETIs into ' Learning Organisations'.

Today's organisational cultures are impacted upon by a myriad of institutional, national and international imperatives. It is no more enough to optimally position an organisation within existing markets, but rather the challenge is to cope with

uncertainty and develop foresight into future markets. This in turn needs the strategic building blocks that seek to build competencies to master future market needs.

Management structures and systems, job procedures and organisational politics all have to reflect the new values, norms and basic assumptions in which SETIs' institutional (i.e., organizational) cultures should be rooted. Strategy, systems and culture, have to be aligned in ways which lead them to mutually influence one another.

At institutional level, organisational structure, job procedures, practised values and norms, and organisational politics have to be aligned with the institutional strategy because they influence culture (and are in turn influenced by it).

SETI employees have to also continuously unlearn the past paradigms and learn further to develop future core competencies. This is best accomplished within organisations which place high value on both individual and organisational learning much of which also takes place in groups or teams.

A point which should not be overlooked is the need to create adequate internal business systems within SETIs, particularly in the area of information technology and management information systems. A strong case exists for each SETI to have an across-the-board IT capacity which will enhance effective information sharing. This is especially crucial for cross-organizational synergies and learning in an efficiently integrated innovation, research and training environment. Such systems, if effectively implemented, will improve performance in project management and help prioritise resource allocation and utilisation. There is adequate capacity within the SETIs to achieve this goal through cooperation

Strategic planning at the SETIs should include both vision and long-term business plans which integrate the management of human resources, finances, operations, information technology, and marketing or social diffusion. Planning has to ensure linkages of core competencies to strategy, and should be supported by modern systems and structures, and particularly by performance management around Key Performance Indicators at all levels within the institution.

SETIs have to ensure maintenance of employees' momentum, morale and motivation as a strategic tool, and should constantly stimulate both individual resourcefulness and the sharing of knowledge and information to promote a culture of innovation.

Momentum, morale and motivation are a result of conscious avoidance of over-managing and under-leading (i.e. control vs. direction). The newer management theory emphasizes the differences between strategies for control and strategies for commitment, when dealing with knowledge workers. Today's strategies are very much a function of the ability to meet employee/people's inner needs on a continuous basis. Strategic management recognises that it is not funding which fuels the journey to the future, but the emotional and intellectual energy, and the commitment, of every employee. In short, resourcefulness is more important than resources, which implies

that a deep sense of purpose, a shared dream and a seductive view of future opportunity should be maintained at all times.

Recommendations

Within large institutions, change can be necessary in several dimensions. It can be needed in organisational culture, research paradigms, and/or strategic management. In a single organisation any one of these change can be difficult to implement. The problem facing a number of SETIs is that they need to contend with a number of these changes simultaneously, which poses a major challenge for their current leadership. Even some of the CEOs who have taken their organisations through one level of transformation may be unable to take the process to the next level.

- *In the short to medium term, in cases of SETIs facing the need for substantial change, transformation teams should be appointed in order to assist with the transition towards dynamic leadership and improved strategic management;*
- *Internal and external courses should be developed and offered on a regular basis to inculcate new research or management paradigms into the organizational cultures of SETIs undergoing change, and some fora for exchange of experiences with other SETIs that have traversed the transformation path will be of value.*
- *Managers have to spend time understanding employee needs, and aligning them to the broader organisational strategy and values. Delegation and empowerment have to be embodied because they can lead to employee excitement, and not just satisfaction;*
- *Key Performance Indicators have to be set, checked for relevance regularly, and the process of measurement should be continuous. Wherever possible, these should be benchmarked against global players in the same fields. Some clusters of SETIs should be encouraged to set up common KPIs ;*
- *Restructuring of staffing within some SETIs is needed in order to increase the ratio of researchers to support staff in research intensive institutions;*
- *SETIs should perform regular internal/external audits on themselves, and involve clients and cooperative partners;*
- *Regular training/seminars have to be conducted through internal and external means so as to avoid being insular, and regular updates on international trends have to be sourced*

6. Transformation and Human Resources

The Management of Human Resources

Evidence is abundant, from Panel reports and from our discussions with senior executives from the SETIs under review, that those SETIs which are engaging in serious transformation are being handsomely rewarded as reflected in their overall

performance and stability. On the other hand, those which are slow to bring about real transformation are those which also lack a clearly-articulated strategic vision and, as such, are those likely to experience growing difficulty in an increasingly competitive environment. Some SETIs still exhibit a serious lack of grasp of the socio-political changes and transformation occurring in South Africa. Race and gender issues and the management of diversity are still not receiving urgent focus. It is in this context that intervention is necessary.

There is general agreement that accelerated human resources development will be essential if the vision and goals set out in the White Paper on Science and Technology and other government policy initiatives are to be achieved, but some SETIs give the impression that this is something which should happen in other institutions. This is an unrealistic stance: a strategic approach to managing HR within all of the present SETIs is needed - for their own good and for that of the country.

Key aspects which require urgent attention include:

- Formulation of HR strategic plans
- An HR development strategy
- A performance management system
- A measurable equity and redress plan and programme

Most of the SETIs have potential to make significant impact provided a willingness to transform is demonstrated. Strategic realignment is crucial to ensure relevance, focus and effective utilisation of scarce national resources in a South Africa which is intent on meeting the needs and expectations of a largely poor constituency and in a world of global competition which is intolerant of inefficiency and lack of innovation.

Technological advancement remains a key variable for competitiveness and survival in the global economy. The science, engineering and technology institutions, with their enormous base of national resources and capability, can make a significant contribution in enabling the country to compete and survive. However, the business strategies, structures, systems, vision, culture should be appropriately realigned in order to cope with complex and accelerating global transformation. There exists a strong case for business and social transformation.

Change and transformation are organisational imperatives for efficiency, effectiveness and competitiveness. Simply put, organisations should adapt or they die. Transformation can be successful if it addresses business needs and survival. The review of the wide system indicates a need for change at three levels, viz.

- Transformation at the heart or core of the business, i.e. the strategies, structures and systems
- Transformation around the core, i.e. the culture and values in the organisation
- A vision and strong leadership to ensure effective and successful implementation

Although all presidents of SETIs expressed commitment to the effective management of HR, and most SETIs appear to have some form of human resource plan in place, little evidence exists of a systematic, professional and disciplined approach to

implementation. A minority of the SETIs have formulated and are implementing clear human resource strategies in a context in which this strategy is fully integrated with other core business strategies. But without such integration, the majority of SETIs are showing that they are having difficulties in attempting to achieve the vision, goals and objectives embedded in the White Paper on Science and Technology and other human development policy initiatives, including those set out in the RDP and in GEAR.

Based on the views and comments of the SETI's presidents and other executives, it would appear that in three SETIs, - CSIR, MRC and AEC, - human resource management does enjoy a high priority as a strategic imperative. In these organisations, HR processes are driven with vision and passion by the board, president and senior management. Even in those good performers, however, increased efforts are needed to collaborate with universities and technikons in developing a cadre of well-trained people.

Equity and redress

All SETIs have some form of equity and redress programme. Some SETIs, in particular the MRC, CSIR, MINTEK and FRD, appear to have achieved significant progress in appointing, developing, mentoring and funding the training of black people and women. The MRC, CSIR, FRD and the HSRC have been successful in appointing more than one senior blacks and women to key positions.

The other SETIs seem to be focusing at professional or lower levels of management. While this is a start, it must be noted that a more concerted effort is required.

Equity in the sense of equal pay for equal work at similar levels was not explored due to confidentiality. In view of the new Labour Relations Act the SETIs are well-advised to look into this issue and ensure that any necessary corrective measures are implemented.

It is essential that realistic targets be set and programmes be implemented to achieve equity and redress. The SETIs must also develop a culture and value system which will help retain blacks and women in the business.

A simple focus on numbers without an effort to create real jobs with proper support and mentoring processes will not yield much success as evidenced by the statistics in most of the SETIs. It is imperative that the country and institutions should engage in serious transformation to ensure social and political stability. Simply exploring the reasons for poor performance in this area is not enough.

Work Place Democratisation

In South Africa, a profound socio-political change has been focused on the creation of a new culture and value-system in which the work of individuals is respected and collective ideas are actively sought in the work place. In this context, there is a need to encourage and develop new collective processes in the work place to enhance the creation of new ideas and to promote innovation.

Most SETIs acknowledge the need for the creation of a democratised work place. However, there appears to persist still an adversarial, conflict resolution approach to the subject. The development of an innovative management/union relationship is desirable and should be pursued.

It would appear that AEC has experienced the highest level of union activity and has achieved reasonable success under the very difficult circumstances of a prolonged period of staff reduction.

It would be useful if the concept of work place democratisation could be explored more vigorously by involving all employee structures in organisational strategic issues. After all, a strong, well-informed, well-trained employee representative structure can add valuable input to organisational effectiveness.

A number of SETIs did not appear to have a system of modern HR management which was sufficiently well-grounded to create a progressive shared-vision or an appropriate internal organizational culture for the SETI. There did not appear to be entrenched in their day-to-day operations an ethos which was either African in spirit or fundamentally aligned to broader transformational imperatives.

Principles

In any society, the capacity of an organisation to reflect the culture and value system within which it operates requires that its staff reflect the diversity of its population, and it is that culture and value system which, in turn, enables the organisation to perform effectively within that society.

Knowledge-based institutions need to master the art of organizational learning which embraces the promotion of open interaction , information sharing and the encouragement of new ideas and which is enabled by the establishment of team approaches and the use of flexible structures .

Modern, knowledge-based organizations operate best when creativity and reflection are encouraged and valued.

Organizations which cannot embrace change are highly vulnerable in a fast-evolving, globalised world; the capacity to manage change is therefore an essential ingredient of good human resource management.

Management of human resources within any organisation is a key strategic variable and underpins the capacity of the organisation to act.

Innovative institutions should strive to capture the ideas of all of their employees.

Transformation

The six principles set out above provide the essential underpinning for the process of transformation which is needed throughout the system of SETIs reviewed by this process.

Recommendations

- *A strategic approach to human resources management should be implemented as a matter of urgency to ensure effective resource utilisation and relevance of HR to business objectives and goals.*
- *Each SETI should make expanded use of professional skills in the management of organizational change.*
- *A coordinated human resource development strategy among the SETIs and should be implemented. In particular, in the area of redress and equity, SETIs as a group, with the assistance of their human resource executives, should set for themselves a series of key performance indicators to allow for assessment of the rate of progress towards targets which they should establish for themselves.*
- *In pursuing their human resource goals, the SETIs should expand their programs of cooperation with institutions of higher learning, in particular to offer increasing opportunities for black people and women to receive training in the sciences, engineering and technology and to acquire the specialised skills needed by particular SETIs.*
- *A transformation of corporate culture and practice - to respond to the need for competitiveness, innovation and survival in the economy of the new South Africa - should be implemented in most of the SETIs. Such transformations should also address the need for new leadership where the leadership now in place is not deemed capable of carrying through further programs of far-reaching change.*
- *Implementation of HR systems is essential to ensure effective performance, remuneration for skills retention and proper management and sharing of knowledge, information and ideas.*
- *SETIs should seek to emulate international best practice in the management of knowledge-based institutions.*

7. Interaction, Integration and Cooperation

An effective National System of Innovation implies improved interaction, integration and cooperation between and among disciplines, institutions and sectors. This section analyses existing problems in the system and proposes policies and measures which could improve the situation.

As South Africa reinserts itself into global S&T it has to be aware of important changes in international understanding of the way in which research is undertaken and knowledge generated. In the industrialised countries, it is increasingly acknowledged that

- knowledge is ever more produced in the context of its applications, and there are greater expectations that support of research will lead directly to economic and social benefits for the nation providing the support;
- there is an inescapable trend towards larger and more interdisciplinary teams working in more transdisciplinary research activities;
- there is a growing diversity of participating organizations to be found in today's research teams (there can be a blurring of project or program); and

- there is a continuing trend towards greater international linkages within research teams.

The past science system in South Africa was fragmented and lacked effective articulation, with the notable exception of the work done to support security and defence. That system understood that individual creativity is the genesis of innovation. But the notion that knowledge is socially produced and distributed as well, and that groups working together may also innovate, both within research institutions and in the broader society, is not yet widely recognized in the emerging NSI. As a result, support for linkages and learning-by-interaction among South African knowledge-based organizations—and the people who populate them-- is weak. The entire science system is still relatively closed, and linear models of research and development are prevalent. There is generally low community awareness of the role and activities of publicly-funded science. SETI accomplishments in producing new knowledge are still relatively unknown internationally. The local private sector is under-appreciative of the commercial potential of national research, and SETIs themselves are not fully aware of each other's strengths. Links between SETIs and education—whether tertiary or pre-tertiary-- are still alarmingly weak. Redress has not yet yielded requisite variety within SETIs to match the complexities of the rapidly transforming external environment. Personal relationships among actors—new and old, public and private—across the NSI are not widely leveraged into systematic knowledge partnerships and strategic alliances, and there is too little inter-institutional trust. Entrenched culture in most SETIs favours neither cross-disciplinary approaches nor intellectual partnership between the social and the natural sciences, and interdisciplinary science projects on major national imperatives have yet to be construed in exciting, engaging fashion. The SETIs of the past operated as closed communities, where little interchange of staffing occurred. This lack of mobility of people among institutions in the NSI is a continuing cause of concern.

Intramural research still predominates over extramural research or networks of research capacity in many publicly-funded SETIs, though that is gradually changing. At one end, SETI linkages to the rest of Africa, and internationally, are evolving or re-emerging. But at the other end, linkage of public SETIs to smaller-scale, less technically-sophisticated national users, clients and stakeholders--small-scale mining, small business, resource-poor farmers and so forth--is still in its infancy, and often the SETI-small client interface to help articulate demand for applied science and technology is missing. There is little awareness of the competitive edge that might eventually be afforded by developing--in conjunction with these newer users--the mechanisms for innovative design, packaging (with a South African "stamp"), and delivery of knowledge-intensive products, processes and services.

As a result of this combination of factors, people, information, ideas, knowledge, cultural values and financial backing do not flow dynamically through the system, and it is still too insular. Opportunities for dynamic learning, production of new knowledge and innovation are thus lost.

Innovation and social science inquiry

The past has been particularly unkind to the social sciences in South Africa. The previous regime did two things;

- it created a centralized institution which has never occupied a position in the mainstream of social research and which has been unable to conceptualize a broad vision for the substance of its work in the new South Africa and
- it withheld funding from active social scientists in the higher education system and in NGOs because of their alignment with the mass democratic movement.

That legacy has yet to be erased.

The Science and Technology White Paper affirms the role of the human sciences as a source of social innovation and of informed critique about the country's transformation and identifies an indispensable complementary role for the human sciences in technological innovation and diffusion, too, which may be less well-understood. The opportunities around this orientation which are neglected due to the current weak partnership between the natural and social sciences are many. For example, one of the most important social settings for the application of technology is at the point of production in industries where boosting quality, creatively combining "high-tech" tools and materials with "high-touch" workers' expertise, and other process innovations may prove key to achieving the Department of Trade and Industry's export and job growth targets, and the Department of Labour's Skills Development Strategy. Social science should inform these strategic changes in work relations as management and labour transform production, help identify the obstacles to embracing technological change in South Africa, and probe the possibilities for using local knowledge as the platform for implementation of innovation-based strategies.

While there are many opportunities to make creative and important contributions to understanding and bringing about change of many kinds in South Africa - including social, economic, and technological change – the essential linkages among social scientists themselves and between social scientists and other groups are sadly lacking. This surely must end.

Innovation and knowledge of Africa

Integrating African perspectives into SETIs can help create new research paradigms and mental maps, as well as enrich existing ones. There is also a critical need for all South Africans to enter a 21st century of increasing globalization empowered by a sense of the indigenous knowledge Africa has constructed, and the opportunities for innovation embodied in its human and natural resources. This is the necessary antidote to decades of wasteful marginalization of the majority of South Africans from science and technology, from knowledge work.

The reluctance or inability to see African societies as sources of knowledge and ideas should be countered by deeper knowledge of African cultures, communities, production systems, and technologies. The SETIs can do much more to investigate these phenomena, and to nourish their research programmes with better knowledge about Africa. Knowledge of Africa's cultures and indigenous technologies may also improve the way science and maths are transmitted in the education sector, helping ignite the fires of curiosity and thus increasing the pool of science students and practitioners.

Finally, the SETIs will have to link with other SADC countries if they are to embrace the African Renaissance. That participation will not be meaningful until they have contextualized African perspectives at home, and built knowledge of Africa into the drive for research excellence and competitiveness.

Principles

An effective National System of Innovation requires improved interactions between disciplines, institutions and sectors.

The NSI should be an open, interactive, learning system (with infra-structural and social backbone), and publicly-funded SETIs should become proactive, strategic managers of their own linkages.

Human sciences should become the intellectual partners of the natural sciences in production of new knowledge and in technological innovation, a vital source of information and advice for decision-makers, and a source of new knowledge and critical analysis for practitioners in social innovation.

A thorough knowledge of Africa should be built and deployed across the NSI as a building block of innovation, an essential part of the platform for new science research and teaching, and a complementary asset to cooperative initiatives in the rest of Africa.

Recommendations

Greater cooperation across disciplines, institutions and sectors should be encouraged through agency and competitive grant mechanisms earmarking funds for cooperative R&D and/or allocating higher values for such cooperation in their evaluation of funding proposals.

SETIs, private business, and, higher education institutions - the source of highly trained people,- should be relinked, as a matter of urgency, by a variety of systematic efforts including

- a. *more regular dialogue between DoE and DACST at every level, including ministerial,*
- b. *stepped-up support to existing interactive mechanisms such as the Innovation Fund and THRIP, and*
- c. *launching a series of alignment-achieving conversations among universities, SETIs and private business about NSI-wide human resource training and development gaps. [The National Science & Technology Forum could play an important role in as the facilitator of such conversations.]*

DACST, the executive teams of publicly-funded SETIs, and SETI transformation teams (where recommended for specific organizations) should initiate a series of wide-ranging, cross-disciplinary, informal but expertly-facilitated conversations which would include private sector leaders, public policy makers, and practitioners of social innovation as well, to

- a. *re-establish or create interactive links and*
- b. *share ideas about critical cross-disciplinary, national projects embodying science and technological innovation. The aim should not be prescription, but rather stimulating organizational and system-wide learning which can lead, of its own accord, to a variety of innovative, cooperative projects--or pull people into existing ones about which they are unaware.*

"Degree of interactivity" should become one of the key indicators for (post and ante) assessment of publicly-sponsored science and technology projects which purport to involve extramural research or research undertaken through networks of capacity.

Publicly-funded SETIs should be encouraged to utilise the work of social scientists, where feasible, and to tap into networks of social science capacity at the (radically transformed) HSRC, the universities, the organizations of civil society to inform their work in innovation.

Improved knowledge of Africa should be incorporated into the business strategies and research agendas of all publicly-funded SETIs, particularly those participating in SADC, trade initiatives and other cooperative activities in the rest of Africa.

SETIs should be encouraged by their Boards and executives to regard the communities of the majority in South Africa as an environment for learning and a source of ideas, not just problems, with respect to innovation. The process and results of the indigenous knowledge audit should be utilized by SETIs in this regard, and the new SETI-small user interface organisms such as the new Manufacturing Advisory Centres (being established by a partnership involving CSIR) should receive all due support in this new direction.

SETIs should undertake studies of their own organizational cultures and of the way that they learn (or fail to do so) as organizations, to inform all of the changes in institutional design, to provide for more strategic management of human resources, and to put in place the transformation and changed research paradigms recommended by this Review. Outside expertise should be sought for this work wherever internal capacity is weak or absent.

8. Commercialisation

Analysis of the Current Situation

Government has clearly signalled that it wishes most SETI's to generate increasing levels of external funding, primarily from the private sector, a move which means that individual SETIs need to develop internal policies to guide their business negotiations with potential industrial partners. In addition, Government also wishes to see the private sector assume full responsibility for those technological activities which are purely market related.

Most SETIs have clearly enunciated commercial goals and policies and a commercial culture permeates most organisations. Indeed, in some cases, there is some concern that short-term commercial objectives may have been accentuated at the expense of innovative strategic research (CSIR).

While performance has been uneven, most SETIs are engaging more forcefully with the market. SETIs are increasingly searching for industrial partners, improving the management of their intellectual property and marketing their services and their products more effectively.

As a consequence, for many SETIs market-derived income has been increasing steadily. In the context of generally declining governmental support via the parliamentary grant, the *relative* share of market income has even increased more significantly. By comparison with similar organisations located elsewhere, a number of South African SETIs are now more reliant on their market derived revenue.

These are encouraging developments. However, despite this generally favourable picture, a number of significant concerns vis-a-vis commercialisation emerged from the specialist Panel reports. *Inter alia* –

- The narrow customer base. A high proportion of market revenue is obtained from a few customers
- The reliance on the local market. A very small share of market revenue is secured internationally
- The reliance on government as customer. For some SETIs, much of their market revenue is derived from services rendered to government
- The predominance within a small local market. In many cases, SETIs already secure a very high share of the potential local market
- Some SETIs have inappropriate commercial policies. In particular, the management of intellectual property is frequently weak
- Some SETIs, by virtue of their location within government, have very little incentive to engage in commercialisation and very little experience or capacity to do so.

These features have some adverse implications.

- Where SETIs have a narrow customer base, SETI customers are often larger, well-established organisations which are, in the main, able to specify their technological requirements. Commercialisation, as currently practised, caters much less effectively for the needs of the smaller, less well-established organisations which have far less existent technological capability,
- SETIs which engage solely in the local market, are denied significant possibilities of international learning and possibilities of establishing consortia type arrangements with other international organisations.
- Where government is a captive customer, SETI will have less incentives to engage more aggressively with the market and customer derived learning may be limited.
- Where SETIs already dominate the local market, and more especially where the local market is static or growing only slowly, the ability to earn market revenues will, in the longer run, be severely constrained.
- Frequently SETIs undervalue their intellectual property and fail to optimise commercial returns
- SETIs producing outputs which have substantive commercial potential may be inappropriately housed within government. If they are to be re-located,

consideration will need to be given to enhancing their in-house commercial and marketing capabilities

Principles, Guidelines and Recommendations

In any market economy, government should see to it that commercial activities in S&T are primarily performed in the private sector, and that government activities which can support the private sector are conducted under sound business principles.

As governments and funding agencies throughout the world are experimenting with a wide variety of different approaches to commercialisation as well as privatisation, government should explore the validity and appropriateness of innovative schemes successfully implemented elsewhere, and adapt them according to the needs of South Africa.

Public SETIs should develop a Code of Conduct which deals with their relationship with the private sector. This should be developed in cooperation with the private sector and include:

- *Commercialisation policy*
- *Intellectual property rights*
- *Conditions of service provision*
- *Service pricing policy*

Government has a responsibility to see that it has in place a sound regime of regulatory policies to deal with business practices and intellectual property.

Good international practice in the management of intellectual property requires that parties to a transfer of technology, or to any form of joint technology development, act on the basis of a clear contract which specifies in detail how intellectual property will be treated within the arrangement.

Government should not undertake S&T activities where these can be more effectively provided outside of government.

Currently several SETIs provide a diverse range of products from routine testing and standardised services to complex research activities. Where products are routine and where government has no need to ensure privileged access, there will be a *prima facie* case for transferring such activities to the private sector.

A detailed examination of the activities of the SETIs should be undertaken in order to identify routine activities that could be transferred to the private sector.

In some cases, scale economies or other factors may constrain government to purchase services from a sole supplier. Where this does occur, (and particularly where government is both a very significant customer and the sole supplier of the service), government should investigate whether the operation could best be undertaken by the private sector under some form of contractual agreement (similar to the system of 'government-owned, contractor operated' facilities to be found in some countries such as the US and Canada). Such an approach avoids the creation of a permanent monopoly and affords government the opportunity to use its market-power

to contractually derive some of the benefits of any efficiency improvements. The metrology services of SABS is a possible example of a service which could be operated in this manner.

A detailed assessment of the metrology activities of SABS should be undertaken in order to establish the viability and cost savings of alternative provision such that a private sector company could be contracted to lease the major assets entailed and provide metrology services to the government under a long-term contract.

Complex research activities supported by government funding may generate core competencies which ultimately become commercially viable. Unless there are contrary specific and clearly defined public interests, such activities should, at the earliest opportunity, be transferred to the private sector. The fluorine based chemicals competency of the AEC currently represents an important exemplar and requires urgent action.

Where public provision of S&T capacity is considered necessary and effective, the level of government financial support should be limited to ensuring the fulfilment of statutory and other identified requirements.

This will require regular review of such activities to ensure that such capacities are indeed fully deployed in necessary public provision.

Utilising outside experts, government should undertake a regular review of all S&T activities located within government in order to ensure that funding levels for these activities are commensurate with the minimum level of capacity required to fulfill necessary governmental requirements.

Government should encourage and facilitate the formation of S&T institutions within the private sector

Internationally there is a growing trend for new S&T institutions closely aligned to particular industries or regions to develop. Often sponsored by industry or regional associations, these may take the form of companies which are limited by guarantee. The Sugar Research Institute is a significant example of a local research institution which is not in the public sector and which is very closely aligned with the needs of the sugar industry.

Government should review regulations and acts in order to ensure that there are no unnecessary impediments or disincentives to the establishment and operation of S&T institutions within the private sector under appropriate forms of joint ownership.

Government has a responsibility to ensure that public provision of S&T does not crowd-out private provision

Where SETIs are encouraged to market their outputs and at the same time they continue to receive public support and are not subject to taxation, there will always be a concern that this will constitute unfair competition and will result in lower levels of private provision.

SETIs should be required to charge customers on the basis of full cost recovery. Where customers benefit from earlier publicly funded strategic research, this should normally be reflected in the charge.

With competition policy currently under review, the possible role of the competition authorities and regulations in restraining unfair competition emanating from publicly funded SETIs should be investigated.

Government has a responsibility to ensure that the line of demarcation between the public sector activities of its organizations and the commercial activities of the private sector is clear.

The relationship with the private sector should be one of cooperation and not competition. Within the context of activities aimed at promoting competition, currently several SETIs provide a diverse range of products from routine testing and standardised services to complex research activities. In many of these cases the SETI is competing with the private sector as opposed to undertaking joint developments and providing complementary services. The relationship with the private sector is generally sub-optimal.

The outputs of the S&T system should serve a very broad range of consumers, including and more especially small and less well-resourced consumers.

Government should develop a set of incentives in order to encourage SETIs to meet the needs of less well-resourced customers.

Various modalities and combinations are possible. They include -

- earmarking competitive funds to projects and programmes that are directed at these consumers
- earmarking parliamentary grant funds to projects and programmes that are directed at these consumers
- developing a more extensive and effective system of extension services so as to limit the costs of technology transfer

Government should undertake a review of the factors that currently impede the transfer of S&T outputs to smaller and poorly-resourced consumers, over a wide field but more particularly in the productive sectors of industry, agriculture and mining. Once these impediments have been identified, design incentives for SETIs and develop policies to ensure a far more equitable flow of S&T outputs.

Government should encourage SETIs to create and support the development of new technology based small enterprises

In some SETIs, especially in those serving the needs of the directly productive economic sectors, employees have substantial technical knowledge, but lack the training, finance and the incentives necessary to commercialise this knowledge.

SETIs aligned to the productive sectors of the economy should develop an incentive framework to encourage employees to engage their technical knowledge in the

formation of new businesses. These SETIs, in collaboration with other organisations, should organise the requisite training and facilitate contact between the employee and sources of venture capital.

There are even further steps which could be authorised by government to stimulate the creation of new enterprises to commercialise technologies developed in the public sector. SETIs could be permitted to take minority equity positions in new enterprises based on the SETI's technology and could be allowed to retain earnings from such ventures, without penalty to their Parliamentary Grant, for reinvestment in further technology development. Such activity should only be undertaken once the Board of the SETI concerned has established clear and public guidelines to indicate

- the conditions under which the SETI would be permitted to make such an investment and
- the conditions which should lead the SETI to divest itself of its equity position.

DACST should commission a study of the steps which would need to be taken to implement a policy on potential roles for SETIs in the establishment of new ventures.

9. Internationalisation and Strategic Alliances

Analysis

South Africa's period of isolation forced most organisations within the public research system to become inward-looking, which unfortunately exacerbated a practice of lack of cooperation which marked government institutions in the pre-1994 era. The HES was also affected, but has been able to quickly realign.

Internationalisation and strategic alliances are therefore quite varying in the different SETIs. The practice ranges from non-existent to moderately active, and also differs markedly from one SETI to the next. For example, the active ones can be classified as those who provide services in areas where there are active international bodies (SABS, SAWB, CGS) or those who aspire to offer internationally-competitive technologies (CSIR, MINTEK). The service-oriented SETIs are strategically aligned around basic capabilities yet not all of them see foreign countries as an opportunity to provide and sell their services. The others are competing with some of their technologies and forming alliances, but doing it insufficiently and sometimes unwisely. (As the recent experience of the AEC demonstrates, however, an international alliance in and of itself is not a guarantee of success)

The SETIs involved in mining are beginning to take advantage of international openings because South Africa is well respected for its deep mining activities. In other fields, the time compression facility in CSIR is a good example of how strategic alliances can be packaged to fully benefit the country (through rapid prototyping, education, etc.). CSIR is also good at sourcing technology, developing it further, and thus creating a competitive edge that can be explored internationally. AEC is seeking to internationalise its fluorination technology, which could be a major opportunity.

Some of the SETIs have taken advantage of the opportunities in the rest of Africa. However, the potential has not been fully conceptualised and appreciated, because

most do not want to be seen as "Big Brothers", and some believe their resources will be stretched too far. The Department of Foreign Affairs views this differently, because they have been assured that South Africa's help will be appreciated. SETIs need to put a strategy in place that also addresses some of South Africa's neighbours' concerns.

So far, SETIs have not taken the initiative to assess existing bi-national agreements on science and technology cooperation so as to use them as stepping stones towards internationalisation. They also do not seem to realise that it may be important to be part of groups that go overseas on government missions, not just for making contacts with eminent research policy makers in other countries, but also for establishing relationships with high ranking decision makers from the respective private sectors. Good participation by SETIs in international missions can serve to assist the government in drafting implementable SET agreements.

Principles

The globalization of the world economy, the increasing international flow of capital combined with a growing transfer and diffusion of scientific and technological knowledge, and the participation of new competitors in international trade make it imperative for any system of innovation to link itself as effectively as possible to relevant research communities throughout the world.

This is a prerequisite for maintaining or enhancing a country's capacity to convert scientific breakthroughs and technological achievements into industrial and commercial successes. In order to facilitate international collaboration and provide opportunities for strategic alliances, it is important that:

- Bilateral, multilateral, and international agreements are used in such a way that new research opportunities are explored and exploited;
- Especially in the area of large scale facilities, the most cost-effective approach to securing access for the respective research community is taken;
- Funding schemes are in place which provide a sufficiently wide spectrum of opportunities for the best, and especially the young, researchers to get exposed to stimulating research environments in other countries.
- Last, but not least, any national system of innovation has to see to it that as many of its researchers as possible are considered to be among the leading experts in their field. International collaboration on a top-quality level will only be sustainable if it operates on the basis of mutual benefit to all participants.

Guidelines

In view of the fact that South Africa produces considerably less than 1% of world-wide scientific and technological outputs, it should enhance its ability to access the knowledge and know-how available in other countries. Therefore, every effort should be made in order to strengthen the research base in the country in such a way that it becomes increasingly attractive for foreign students and researchers to come to South Africa, and - *vice versa* - for higher education and research institutions in other countries to invite South Africans to cooperate with them. Given the scarcity of

resources, it will be necessary for SETIs as well as higher education institutions to focus their research activities on those areas where they can compete on an international level. The establishment of internationally-visible centres of excellence within existing institutions seems to be the most appropriate way of achieving this goal.

As experience in many countries shows, agreements on bi-, or multi-lateral scientific and technological cooperation on behalf of the research community as a whole are most successful when they being signed, implemented, and operated by the respective national funding agencies. As soon as the National Research Foundation (NRF) is established, it should take on the responsibility of maintaining and strengthening South Africa's links with the research communities in other countries. Due to the long period of apartheid which kept the South Africans isolated, especially from other researchers on its continent, emphasis should be put on establishing improving relationships inside Africa. Successful funding schemes previously operated by FRD and CSD should be expanded in order to provide additional opportunities for international exchanges. The NRF should also take on a leading role in coordinating and securing access to large-scale facilities in other parts of the world.

Given their state-of-the-art facilities and research strengths, SETIs clearly should be prepared to proactively commit themselves to the enhancement of international collaboration in strategically important areas. They should also be encouraged to compete for contract work in other countries, provided that full cost-recovery is ensured.

Recommendations

After having existed in an isolated environment for a long time, the further development of the South African system of innovation could be enhanced by implementation of the following recommendations:

- *As soon as the NRF is established, it should become engaged in creating additional opportunities for international exchanges, collaborative projects and institutional links with the best possible partners in the world.*
- *SETIs should take advantage of their research capabilities and expand their international activities, especially in areas that are of great strategic importance to South African industry.*
- *Priority-setting and subsequent focusing of research activities should be promoted in SETIs as well as in higher education institutions to ensure that internationally visible centres of excellence are established which will attract some of the best foreign researchers in the respective field to the institution as well as open up new opportunities for international collaboration.*
- *Because of the fact that large-scale facilities are increasingly established on a multilateral or international basis, it is the prime responsibility of government to ensure that in relevant areas the respective South African researchers are granted access to these facilities.*
- *In order to attract research-intensive industries to South Africa, government should develop appropriate taxation strategies.*
- *SETIs should benchmark their research and other activities against some of the best internationally, taking cognisance of the different environments.*

10. Recommendations for Restructuring

In the preceding sections of this review, we have presented system-wide proposals concerning the performance and orientation of all of the SETIs which have been subject to this review process. In Part 2 of our report we summarize our reactions to the specific recommendations of the twelve Panel Reports which were the key inputs to our work.

Out of all of this we have concluded that there is a need for major change in several of the organizations reviewed and we make the relevant recommendations here.

The system oversight role of the National Advisory Council on Innovation is clearly defined in the recently promulgated NACI Act. *In the light of its broad mandate, NACI's agenda should focus on two broad classes of issue*

1. *The provision of advice to government on the development of its overall strategy, on the prioritization of its activities, and on resource allocation to all SETIs; and*
2. *Periodic evaluation of SETIs, as well as the assessment of proposals for new facilities and institutions. The development of exit strategies for outdated facilities, institutions or major projects should also be an important activity.*

A review of current legislation should be undertaken to ensure that similar statutes, standards and procedures are applied to all SETIs.

The Water Research Commission (WRC), National Institute for Virology (NIV), National Sea Fisheries Research Institute (NSFRI), Antarctic research programme, National Botanical Institute (NBI) and other relevant entities and programmes should be formally recognized as public SETIs which make an important contribution to the NSI. This does not necessarily imply structural changes – merely the application of effective coordination and cooperation as well as monitoring, assessment, and evaluation mechanisms.

Greater emphasis should be placed on the public understanding of SET – especially at school level and vis-a-vis the public at large

All options for the long-term management of the Innovation Fund, including the contracting out of that management task, should be explored. In particular, the management system chosen should be capable of managing the growth of the Fund to a level which is considerably larger than today's. This will require capacity to manage an increasing degree of complexity in a Fund which should become a principal source of funding of innovative activities. The growth in the volume of funds managed by the Innovation Fund will need to be accompanied by the fostering of a culture of R&D cooperation among stakeholders from diverse sectors, institutions and disciplines, all of it carried out in the context of the potential application of the results.

Where the current management of any SETI is unable to adequately or timeously transform the SETI from within, government should establish, in consultation with the

relevant Boards, dedicated, professional, external transformation teams to manage the major transformation of individual SETIs as detailed in this report. In particular, in these cases, the appointment of a new CEO as part of the transformation process may be critical to ensuring a smooth transition. The needs for transformation teams are outlined below and detailed in Part 2.

In order to establish any required transformation team, DACST, acting as the Secretariat for the Ministers' Committee for Science and Technology, should consult with the Minister and the Chair of the Board of the SETI involved, and they should jointly reach consensus on the composition of the transformation team..

A transition team should not be an outside "directive" body issuing more recommendations at a distance; the work which will be needed could involve a hands-on presence for a year or more, helping make real transformation and change possible. The teams have to be small, operative, and competently skilled in strategic management, especially in human resource operations and, perhaps, financial management. Each team has to have 2 or 3 members from inside the SETI, too, and is likely to have to undertake baseline studies or analysis of such things as organizational culture and learning, HR policies and practices (including labour-management relations), current organizational design and internal structure, and relations between the SETI and its users-clients and other stakeholders in the NSI.

At the same time, it is critical for the executives of each SETI to get the appropriate level of training in strategic management, or, where they are more advanced, ongoing executive development, so that they can take on change leadership and management functions themselves. Where the CEO will be new, the change management team can almost serve as his/her special advisors, to restructure or reshape the SETI right from the beginning of the CEO's tenure in office.

Further to these system wide recommendations, the following recommendations are made in order to facilitate the transition processes which several individual SETIs are currently confronting:

AEC

Government should clarify the mandate, purpose, function and structure of the Atomic Energy Corporation. It is recommended that the AEC be split into two separate organizations (with a carefully planned transition):

- *the core mandate of the AEC should be redefined to deal mainly with Decommissioning & Decontamination of closed nuclear facilities, radioactive waste management and operation of the SAFARI reactor, this latter possibility being subject to government decision with respect to the likelihood of SAFARI being capable of being operated financially at a break-even level. The reporting of this transformed AEC to DME should be reviewed in the context of its new mandate..*
- *A new public corporation, should be established to contribute to national wealth through the development and exploitation of those core technological competencies and capabilities of the AEC which can be shown to have*

realistic commercial potential. Government should appoint a transformation team to assist it with this task.

The transformation team should be responsible, in particular, for evaluating the commercial potential of the current AEC activities in fluorine chemistry and radiation science and technology, and for preparing and implementing plans to commercialize and privatize into a new company those activities which have genuine market potential.

It is inappropriate to channel all government funding for the AEC through the DME. Technology support funds (phased down over a specified period in the transition to commercialisation) could be sought from other government technology support programmes such as the Innovation Fund. Remaining nuclear waste management and D&D functions could be funded through the ordinary budgets of either DME or the Department of Environment.

ARC

A transformation team should be appointed to assist the Minister of Agriculture and the Board of ARC in bringing about a change in senior management, a change in research philosophy, a change in program structure, and any necessary changes in internal organization to transform ARC into a modern agricultural research organization capable of responding to the needs of both commercial and resource poor farmers.

The Human Sciences and African Studies

The human sciences and African studies have important roles to play in the new South Africa. The two organizations today with mandates specifically addressing these areas, wholly or in part, are the HSRC and the Africa Institute] Neither, in its present form, is capable of making a contribution of the magnitude or scope required.

HSRC

A concerted effort to address the needs of South Africa will involve the restructuring of the mandate, management and staff of the HSRC in order to make it more attuned to major contemporary issues. . The White Paper on S&T underlined the challenges to be faced in contributing to understanding transformation in South Africa, or to understanding the impact of technological change in the country. There are also broader needs to understand the nature and direction of social, cultural, economic and political change within the country and there is a growing recognition of the need to better understand the content and potential importance of indigenous knowledge systems. To tackle such challenges, the HSRC would need to have a staff which represents the cultural diversity of the country and which possesses modern research skills. The future HSRC should primarily operate as a manager, supporter and organizer of research and secondarily as a performer of research. Its could render great service by creating, supporting and guiding networks of researchers in HEIs and in NGOs who would undertake multi-year programs of research on key issues.

A transformation team should be appointed to assist the Minister of Arts, Culture, Science and Technology and the Board of HSRC in bringing about a change in senior management, a change in research philosophy and in research staff, a change in program structure, and any necessary changes in internal organization to transform HSRC into a modern social science research organization capable of responding to the needs of South Africa

AISA

The present Africa Institute does not seem to be able to meet the challenges provided by the intellectual renaissance of post-apartheid South Africa, but in view of contemporary developments on the African continent, it is of strategic importance to South Africa that it has in place an institution which ideally should combine the interpretative and advisory capacity of a modern "think tank", and the advantages of an internationally-acknowledged institute for advanced study with close linkages to researchers in universities throughout the continent and throughout the world.

As a result of these conclusions, the Africa Institute of SA should be de-registered as a Section 21 company and its infrastructure and resources transferred into a new institution focusing on the study of change in contemporary Africa. To facilitate the formation of this new institution, a process should be initiated immediately involving eminent scholars and leading policy analysts to prepare a concept for the role and function of the new institute and appropriate modes for its operation, as well as to provide input into the definition of the complimentary research programme described below:

Earmarked funds should be provided by the National Research Foundation for a research programme specifically designed to stimulate research on cultural, economic and technological change in Africa in order to develop new research capacities within South Africa's higher education institutions.

MRC

The MRC should be required by government to meet the following criteria in order to make it transparently evident that its resource allocations between its own research and its agency funding activities do not constitute a conflict of interest. The criteria are that:

- all in-house research be financed via the same competitive process which allocates resources to research groups in other institutions; while MRC already subjects its in-house activities to review by externally chaired panels, it will be important to ensure that such panels have fully internalized the ENHR orientation into their work.*
- the process by which MRC allocates its budget between support of competitive funding and support of in-house operations, (which would include all of the overhead costs associated with maintaining an in-house research staff) and the annual results of such allocations should be transparent;*
- the Board of MRC should clearly delimit the areas of research which they believe should be performed in-house, and should encourage and be sensitive to public debate on their decisions.*

SABS

A professional team should be appointed to manage the transformation of SABS which, within the existing framework of SABS, should establish two clearly separate entities. The first would be a government-funded standards setting institution and the second would be an organization responsible for accreditation, certification and the provision of laboratory services, all operated on a commercial basis. The basis for this change is clearly articulated in the relevant Panel Report

Beyond these structural changes which are required to meet international practice for standards bodies, internal operating changes are needed to modernize management systems and processes. Financial management systems in the SABS should be reviewed and upgraded in the context of the new structure. In addition, a fundamental change management process is required in human resource practices, policies and targets.

NRF

The establishment of the new national funding agency is a logical and necessary step in the further development of the South African research base. In view of the challenges provided by the process of establishing a new institution and, at the same time, integrating the existing FRD and CSD, it will be necessary to put into place a highly skilled transition team comprised of the present leadership of the two organizations and high-quality outside change management expertise, particularly in organizational development and strategic human resource management.

NATIONAL FACILITIES

Legislation should be enacted to facilitate the designation and operation of National Facilities. The act should specify the criteria for selecting national facilities, the performance criteria which would need to be met to retain that status, and the funding regime which would apply both to meeting the infrastructure and operating costs of the facilities and to the financing of the use of the facilities by interested parties.

SAWB

The SAWB should become a statutory body by following the process steps set out in Part 2 of this report.

[Continue to 2 of 2](#)

The System-wide Review of Public Sector Science, Engineering and Technology Institutions

(continued)

Part : Commentaries on the Panel Reports

The system-wide review of public sector SETIs was based on twelve reports prepared by panels of international and South African experts in the fields of activity of the institutions under review. In this element of the overall review are presented brief commentaries on each of the twelve Panel Reports, highlighting what the system-wide review team identified as the issues on which most attention needs to be focused.

Each short section provides this commentary and repeats any specific recommendations made in Part 1 of this document which relate to the specific SETIs.

1. The Africa Institute of South Africa AISA

Assessment of Core Competencies and Strategic Management

Of the three competencies identified for the Africa Institute of South Africa, its review panel found that only one is done well: the institute collects, but does not effectively interpret or distribute information on contemporary African affairs. Though it is, by all accounts, an excellent specialised library-cum-documentation centre on Africa, AISA's interactions, particularly with other components of the emerging NSI and with South Africa's library and research communities, leave much to be desired. AISA still serves non-South African (and non-African) scholars as a research outlet more than it serves the national research community. AISA's treatment of data adds relatively little value in terms of research, interpretation and analysis, primarily because the Institute still looks at Africa from the "outside" and has a weak research capacity – the occasional good paper from its senior researcher notwithstanding. AISA provides some value in the form of information services to the Foreign Department and has organised conferences. It has built up its own databank of names and institutions of African scholars and Africanists with networking potential, though the possibilities of South Africa's tapping into already-existing networks of African knowledge-producers needs to be explored as well. AISA does some consulting to the private sector and to embassies, though its services are under-commercialised and its fees quite modest for corporate bodies. AISA has performed far below its potential in training post-graduate students and diplomats, or offering

competitive executive courses or seminars to business based on knowledge about African trends.

AISA's allocation of resources is inappropriate; in particular, too little is devoted to research. The organisation lacks strategic vision and management, and the strategic vision which may be emerging from Council seems not to have been effectively transmitted to management. Under a paternalistic management, AISA has enjoyed managerial autonomy without accountability, and the Institute's demonstrated (rather than stated) commitment to equity and redress is still low.

Alignment with the SI

The set of core competencies encapsulated by the rubric "African studies" has great potential alignment with the objectives of the NSI, and with national development objectives as enunciated by GEAR and the RDP. But the argument for continued public funding of these competencies needs to be more strongly stated, for the matter goes beyond the relocation of the AISA's library and database. For one thing, South Africa's growing links with SADC partners are a forceful argument for building knowledge of Africa as a complementary asset to trade initiatives and technical cooperation in many domains. There is also the critical need for all South Africans to enter a 21st century of increasing globalisation empowered by a sense of the indigenous knowledge this continent has constructed and the opportunities for innovation embodied in its resources. This is the necessary antidote to this century's wasteful marginalisation of the majority of South Africans from science and technology, from ideas and knowledge work.

Recommendations of the Expert Panel

The main recommendations of the expert panel for AISA consist of proposals for two critical turn-arounds:

(1) transformation of the institution's intellectual legacy, so that it is Africa-sensitive and Africa-literate, seeing the continent from within and South Africa's place in it; and (2) creation of management and governance structures which will imbue creative independence with quality control. These, it is argued, will be best accomplished by affiliating what is today AISA under the larger umbrella of one of the country's emerging regional consortia of higher education institutions, preferably to a consortium which has demonstrated potential for integrating African studies into other cross-disciplinary initiatives in a manner that strengthens HDIs. Such relocation would open up the route to higher-quality publishing, seminars and conferences, and give access to a pool of graduate students. AISA's interpretative research work and documentation could help feed curriculum development within the consortium, and its fellows might do some minimal teaching.

The transition occasioned by relocation, the double turn-around, and the institution of a more commercial approach with respect to some service products will require a strong change management team. DACST may wish to line up a small operative team with a suitable mix of internal AISA staff and external expertise, headed by a leader with dynamic new vision. This transition team should be drawn from business, international affairs and the social sciences, but organisational development and strategic human resource management skills will be paramount.

Recommendations of the System-wide Review

The system-wide review panel concluded that it would be wiser to go even further than proposed by the institutional review panel.

The present Africa Institute does not seem to be able to meet the challenges provided by the intellectual renaissance of post-apartheid South Africa, but in view of contemporary developments on the African continent, it is of strategic importance to South Africa that it has in place an institution which would address those developments and which ideally should combine the interpretative and advisory capacities of a modern "think tank", and the advantages of an internationally-acknowledged institute for advanced study, with close linkages to researchers in universities throughout the continent and throughout the world.

As a result of these conclusions, the Africa Institute of SA should be de-registered as a Section 21 company and its infrastructure and resources transferred into a new institution focusing on the study of change in contemporary Africa. To facilitate the formation of this new institution, a process should be initiated immediately involving eminent scholars and leading policy analysts to prepare a concept for the role and function of the new institute and appropriate modes for its operation, as well as to provide input into the definition of the complimentary research programme described below:

Earmarked funds should be provided by the National Research Foundation for a research programme specifically designed to stimulate research on cultural, economic and technological change in Africa in order to develop new research capacities within South Africa's higher education institutions.

2. The Agricultural Research Council ARC

Until 1992, research on agricultural production was carried out principally within the National Department of Agriculture whose mandate was to focus exclusively on the problems of white, primarily commercial, farmers operating within the narrowly-defined Republic of South Africa (a definition which did not include the so-called TBVC states or the semi-autonomous areas within South Africa.) Its program was one which focused on individual commodities and did not address any larger issues within an agricultural system. When the ARC was transformed into a statutory body, encompassing most of the staff and facilities which previously had been within the department, its mandate was extended, tacitly if not explicitly, to encompass all farmers in South Africa, including the resource poor farmers among the disadvantaged populations in the country. With the Constitutional and Government change of 1994, the mandate of the ARC to address that wider constituency became fully explicit.

The model for agricultural research which was transferred to ARC at its creation was one which was based on the application of the biological and related sciences to the problems of agricultural production in an environment in which access to inputs, such as fertilisers, pesticides and irrigation were taken as given. This approach gave rise to a simplistic notion of 'scale-neutral' technologies on which ARC planning appears to have been based. This model was operationalised within a set of extensive experimental farms and facilities within which research could be conducted under

controlled conditions. In effect, the model was one which had prevailed for many years in the industrialised world, but which even there was evolving rapidly. One important gap in the South African system was the virtually-total absence of any social science capacity within ARC.

Throughout its history, ARC has operated on the belief that the outputs of agricultural research were 'public goods' to be delivered, free of charge, to farmers. With commercial agriculture now contributing at a significant level both to GDP and to exports, South Africa needs to re-examine why only sugar producers make substantial and direct financial contributions to the financing of research.

Agricultural research does not exist in a vacuum, and so in most countries, research has close links with extension services which serve as conduits of information from research to farmers and as identifiers of pervasive problems from farmers back to research. In South Africa today, this extension function is within Provincial jurisdiction (where capacities to perform and actual performance vary widely). The relationships which ARC has been able to establish in most cases have not been strong and this has contributed to the difficulties which ARC has confronted in seeking to address the problems of the resource-poor and the disadvantaged.

Since 1994, the tentative attempts by ARC to incorporate the problems of resource-poor farmers into its research agenda have been, in fact, failures, with even the modest attempt to master the well-established methodologies of 'farming systems research' having been abandoned.

Since there is no evidence that ARC has ever considered the management of its human resources as a key strategic variable, it has not internally come to understand that the lack of transformation within its staff and its lack of good working relationships with social scientists have nullified any real hope of success of any attempt to understand and operationalise an effective approach to addressing the problems of resource-poor farmers.

Among the important deficiencies in ARC performance which have been identified are:

- the lack of any identifiable strategic vision or strategic management process which would allow the ARC to identify necessary changes in its operations and to implement those changes;
- weak linkages to sources of knowledge outside the ARC and a poor record of disseminating the results of its own research in the international literature.
- no evidence of understanding the limitations on the appropriate use of public funding with the result that a significant proportion of ARC funding is probably being used as a subsidy to commercial agriculture;
- no accountability to its clients or to government for the way it has utilised the considerable past investments in agricultural R&D;

- ARC's human resource policies and practices are out of touch with the country's political reality and with good management practices world-wide;
- Conflicting reports exist as to the quality and relevance of the outputs of ARC's current research program;

Among the principal changes needed are

- a transformation in ARC governance by, inter alia, clarification of the mandate of the Board and its supervisory function, at the strategic level, vis- -vis management; a renewal of senior management, and establishment of a new management team; (the transformation of the membership of the ARC Board was effected in 1997)
- an internal transformation of staff against a realistic timetable agreed to by the Board and by government, in order to provide the ARC with the capacity it does not now possess to deal with many of its potential partners and clients, and to give effect to a program of equity and redress;
- transformation of the internal management system, away from the practice of being 'capacity-driven' (i.e. concerned principally with the utilisation of existing financial, human and physical resources) to one which is performance driven, and concerned with outputs and outcomes of its activities.
- the establishment of a financial system which will provide clarity and transparency in the allocation of the Parliamentary Grant
- a greater program focus on resource poor farmers and attention to new areas - such as biotechnology and food processing - in new partnerships with other SETIs, institutions of higher learning, or private sector firms as appropriate;
- establishment of much closer linkages and joint activities with other performers of agricultural and agriculture-related research, in the higher education and private sectors and within other SETIs;
- establishment of closer ties with user groups in agriculture, and a revision of the basis of cost sharing for research activities with private entities.
- re-examination of the validity of the internal structure of ARC's activities - which are located in 16 institutes organised on the basis of commodities (such as grains), discipline (such as veterinary science) or research speciality (such as 'agrimetrics').
- adoption of a policy requiring that an increasing share of the ARC research budget should be acquired via open competition, as a means of enhancing quality.

Recommendations of the System-Wide Review

A transformation team should be appointed to assist the Minister of Agriculture and the Board of ARC in bringing about a change in senior management, a change in research philosophy, a change in program structure, and any necessary changes in internal organisation to transform ARC into a modern agricultural research organisation capable of responding to the needs of both commercial and resource poor farmers.

3. The Atomic Energy Corporation AEC

The primary historical mandate of the AEC was to meet the total nuclear energy service and R&D needs of South Africa. This mandate is no longer appropriate as it currently stands and today is poorly aligned with the objectives of the National System of Innovation.

The AEC's uranium conversion, enrichment and fabrication plants have been closed and its flagship R&D project on new enrichment technology (MLIS) has been terminated. The AEC is trying hard, against the odds, to operate in a highly variable environment in which minimal policy direction has been given by the government during a period of rapidly-declining public financial support. The Corporation has realised limited success in this endeavour, although the human resource management component of downsizing has been effective to date. The present parliamentary grant exceeds R350 million (55% of total income) and realises limited added value. The financial difficulties being experienced are compounded by the burden of debt repayment as result of historical investments in the nuclear programme.

The AEC defines their core competencies as: -

- Management of radiation and nuclear processes including nuclear waste disposal

The key facility behind this competency is the SAFARI reactor which the AEC and the White Paper on S&T had proposed as a National Facility. This option was rejected by the AEC Review Team as well as the National Facility review team. This world-class but ageing facility is under-utilised by the research community and is not commercially viable. All over the world these kinds of reactors are subsidised. Government has to decide whether it wishes to continue subsidising its operation and the production of isotopes or to shut it down and benefit from the subsidised operations from other countries (an approach taken by the UK which has closed all such reactors). This area is best described as a key capability rather than a core competency which is internationally competitive.

On the positive side, South Africa has real needs in waste management and in the decommissioning and decontamination of nuclear facilities and only the AEC has the competence to undertake these tasks.

- Fluorination Technology

This expertise developed as a result of the AEC's experience in the preparation of UF₆ as a feedstock for Uranium enrichment. It has created the platform for the development of a range of fluorine-based chemicals. This core competency is clearly

competitive in Africa. Whether it is competitive internationally has still to be demonstrated.

The set of two areas of core competencies are supported by a strong technological infrastructure which is under-utilised. The skills base is adequate but eroding rapidly and urgent action is required to minimise negative impacts on the national skills base.

Largely due to its insular history, the AEC has poor linkages with the HES, other SETIs and industry. Commercially motivated joint ventures are beginning to be explored in a more proactive fashion. While management have set up good strategic management tools, they have lacked the leadership and vision to shake off the historical mandate and to reconceive the AEC as a dynamic contributor to the NSI. Governance difficulties have been compounded by a lack adequate dialogue with the Department of Minerals and Energy.

The first steps in appropriate human resource policy have been taken, at least on paper. HR management is conceptually good but the negative environment created by significant reductions in staffing has made success elusive. Some work has been done in capacity building. Rapid downsizing and limited culture change has made equity and redress very difficult to address successfully.

Progress has been made in the area of commercialisation with some limited successes in the introduction of new products into new markets. However, positive cash flows and profits still have to be demonstrated. Unfortunately there is still a significant degree of subsidisation of commercial services from the parliamentary grant. Losses are the norm – in spite of optimistic profit projections. The AEC has not been able to successfully marry their R&D competencies to a realistic commercial assessment of prospective markets.

The fluorination initiatives have commercial potential if adequately positioned in the context of the chemical industry. AEC management feels that SAFARI could be operated at no cost to the State, i.e. as a break-even facility. Analysis by the Review team however showed this to be unlikely. The balance of the radiation facilities will always need state support to meet an important national need in nuclear waste management and related radiation services.

The analysis by the Review Panel, summarised above, reveals that the AEC has evolved into two essentially different operations or businesses, each requiring a completely different management ethos. In the radiation field, the AEC retains an obligation to clean up and manage radioactive wastes and the future of SAFARI hangs in the balance. The second challenge for transformation lies in the fluorine chemicals area which requires vigorous new management in order to test its commercial viability.

Recommendations of the System-wide review

Government should clarify the mandate, purpose, function and structure of the Atomic Energy Corporation. It is recommended that the AEC be split into two separate organizations (with a carefully planned transition):

- *the core mandate of the AEC should be redefined to deal mainly with Decommissioning & Decontamination of closed nuclear facilities, radioactive waste management and operation of the SAFARI reactor, this latter possibility being subject to government decision with respect to the likelihood of SAFARI being capable of being operated financially at a break-even level. The reporting of this transformed AEC to DME should be reviewed in the context of its new mandate.*
- *A new public corporation, should be established to contribute to national wealth through the development and exploitation of those core technological competencies and capabilities of the AEC which can be shown to have realistic commercial potential. Government should appoint a transformation team to assist it with this task.*

The transformation team should be responsible, in particular, for evaluating the commercial potential of the current AEC activities in fluorine chemistry and radiation science and technology, and for preparing and implementing plans to commercialise and privatise into a new company those activities which have genuine market potential.

It is inappropriate to channel all government funding for the AEC through the DME. It is inappropriate to channel all government funding for the AEC through the DME. Technology support funds (phased down over a specified period in the transition to commercialisation) could be sought from other government technology support programmes such as the Innovation Fund. Remaining nuclear waste management and D&D functions could be funded through the ordinary budgets of either DME or the Department of Environment.

4. Council for Geoscience CGS

The essential mandate of CGS is systematic generation and publication of earth-science information. Its core competency clusters are appropriately identified as fundamental earth science mapping and geological research and its applications. These clusters include the core competencies of regional geology, regional marine geology, regional metallogeny, environmental geology, regional geophysics and national seismic work. There is a recommendation to re-establish a competence in hydrogeology and a National Geochemical Analytical Facility.

The CGS provides important support to government (seismic monitoring, land-use and geological data, shore-line erosion, etc) and provides data to allow innovation in the mining, minerals and engineering sectors (mineral exploration, land and water use, etc). It is regarded as providing a core, pivotal and valued service in the pre-competitive domain. As a geological survey it is world class. It strives to maintain a systematic approach to mapping and associated research, consistency in approach and presentation of data, retention of data for later re-use and more interpretation, maintenance of a team of credible experts, unquestioned quality of output and timely provision of useful information. The CGS could be considered a National Facility mainly collating and providing systematic and routine information, rather than a traditional SET with expectations for a high content of research and innovation.

The mandate of the CGS is captured appropriately in the Geoscience Act No 100 of 1993, although some modification might be necessary if the CGS is to be reconfigured as a National Facility. In addition, government, through the Department of Minerals and Energy, has entered into a contract with CGS specifying which services it wishes it to provide. This contract needs updating and could also include more performance objectives and measures. A Board governs the CGS at arms-length from the Department. It could provide greater strategic direction and oversight of management.

The core government grant in 1997/8 is R65 million (80% of total budget). The core functions (pre-competitive research, including systematic mapping, and research capacity maintenance) are appropriately funded by government. The Parliamentary grant should also fund some basic geological research. The statutory work could be funded through a relatively stable, multi-year contract with DME. Other work for government would be in the form of ad-hoc contracts. There is potential to grow contract research and commercial income through the sale of information and services.

Areas for change include

- **Management.** Management of CGS has been characterised as "low-key" and the CGS comprises a number of almost semi-autonomous and weakly directed groups. Strategic management systems are not evident and leadership and vision are too wrapped up in the personalised philosophy of the Director. No succession planning is evident. A strengthened leadership team will be required to complete the transformation of CGS.
- **Work Program** The work programme needs to be restructured to clearly reflect its strategic nature, and multi-disciplinarity in programme and project management could be enhanced. Suggested benchmarks for management of performance within the work program are: publication output, level of commercial activity, relative costs and pricing, outputs delivered on time and within budget, demographic profile of staff and independent end-user review.
- **Human Resource Management:** Human resource systems are mostly limited to traditional personnel administration and HR policy has not been integrated strategically with the core business of the CGS. Little progress has been made in equity and redress.
- **Interaction with universities :** Interaction with universities has declined. There is a concern that insufficient geoscience graduates are being produced These two problems could be tackled through improved access by research students, cadetships and post-doctoral fellowships. An acknowledgement that CGS serves as a National Facility would imply much greater attention given to user access to facilities and data.
- **Information Dissemination** Management of two museums provides opportunities for more wide-spread information dissemination to schools and the public. Linkages with

stakeholders and potential clients needs to be stronger (not only with industry but also government departments and also the provinces). Stakeholders complain that information is not always timeously produced and is not always easily accessible. There is a lack of adequate dissemination or publicity of CGS's work and the public affairs and outreach activities should be upgraded. There is also much potential for activity in Africa, which is beginning to be realised. CGS plays an important role in SADC.

- **External Advice:** The CGS's Technical Advisory Committee needs to be reactivated and liaison meeting should be held with key customer groups.
- **Support to small-scale mining:** Greater support could be given to government's small-scale mining initiatives.
- **Commercialisation Policy:** CGS needs a consistent and transparent commercialisation policy. Contract research should not be subsidised by the parliamentary grant. It should be financed commercially through a pricing policy which involves full cost recovery and which is market-oriented. A commercialisation tax was proposed which could be recycled to the State for further financing of the NSI but this idea has not been analysed in detail Commercial contract activity is an effective mechanism for knowledge and IP transfer.
- **Foreign versus domestic focus** There needs to be a clear rationale established, by the CGS Board, for determination of an appropriate balance between work done in South Africa and abroad. This balance should take into consideration the need to respond to domestically-identified needs and the opportunities for South African firms to participate in mining activities elsewhere on the continent. Most foreign marketing is done individually by the director which is an unsustainable position. The Marketing function needs to be better structured.

Recommendations of the System-wide review

The system-wide recommendations directed to SETIs as a group are all applicable to the CGS.

5. CSIR

The CSIR encompasses nine SET divisions which are designed to conduct research and development, and thus to provide scientific and technological solutions in order to support sustainable development and economic growth in the context of the South African system of innovation. According to the review panel the CSIR's core competencies reside in technology, namely materials, manufacturing and information technologies, and in outstanding management skills exemplified by their development of a world-class system for the analysis, distribution and content of financial resources, and for its exemplary human resource development programme. CSIR has shown a real commitment to transformation. Its leadership is considered to be mission-focused, visionary, dedicated, energetic, of high technical ability and people-

oriented. The national priorities for SET, as spelt out in the S&T White Paper are systematically and operationally incorporated into the determination of all CSIR research programmes and activities.

Despite this overall very favourable outcome of the review there are aspects of performance left which offer room and opportunities for improvement:

- A reconfiguration of CSIR's SET portfolio is recommended in order to phase out less mission-relevant activities and thus to release funds for developing significant new competencies in advanced manufacturing, especially in areas like computer simulation and virtual reality, and in some areas of information technology;
- In addition, the transfer of metrology facilities at CSIR (and associated budgets) to the SABS should be investigated.
- The divisions should focus their activities more towards innovative longer-term research projects directed towards enabling technologies on the basis of which industry can develop internationally-competitive products and services;
- Although the CSIR's management is fully aware of the need to exploit the market potential of its SET activities, incentives, training and other support for its research staff to become more entrepreneurial are still lacking;
- Within the range of its SET portfolio, the CSIR should establish itself as the leading link between the higher education institutions and the private sector in order to mobilise the respective talents available in South Africa as effectively as possible towards the objective of the national system of innovation;
- The CSIR should develop a comprehensive approach to establishing and maintaining international alliances in order to link its division more effectively to internationally renowned centres of excellence;
- In order to provide the South African system of innovation with a larger number of well-trained, excellent junior researchers, the CSIR should offer more opportunities for post-doctoral fellows to pass through its laboratories, and subsequently move on to the private sector as well as to other publicly financed institutions.
- The CSIR has well developed systems to ascertain customer requirements and levels of satisfaction. However, there is a need to engage at a much earlier stage with customers and potential customers in defining the priorities and directions of strategic research. Technical advisory committees could play an important role in this process.

All in all, the CSIR is one of the major assets of the South African system of innovation. Due to its strengths in applied SET it seems to be prepared to apply for larger parts of its budget on a competitive basis. If larger parts of the current Parliamentary Grants were to be transferred to relevant areas of the Innovations Fund,

the CSIR should be able to perform well on the basis of 30-35% core funding. In the long run, the CSIR should also be able to earn a considerable share of its overall budget from IPR income. However, this gradual shift of funding sources towards a larger share of competitively-earned income will be limited by the size of the domestic market until such time as the private sector recognises its need to invest more heavily in the promotion of technical change. CSIR should also be encouraged to expand its search for international funding for its activities and to participate where possible in international consortia which will give South Africa access to what is going on elsewhere in the world. Continued parliamentary grant allocation will be necessary in order not to harm the CSIR's impressive research base.

Recommendations of the System-wide review

- *The system-wide recommendations directed to SETIs as a group are all applicable to the CSIR.*
- *The location of coal research and of the National Metrology Laboratory in CSIR need to be examined with respect to Mintek and SABS respectively.*

6. The Human Sciences Research Council HSRC

While the individual review of the HSRC as a publicly-funded institution identified three core competencies—social research and coordination, data and information management, and assessment and testing—only this last meets the test of potential competitive advantage. Other organizations in the public and private sectors have relevant databases, and might easily emulate HSRC's capability in information management. HSRC's extensive infrastructure can indeed provide significant support to large-scale research. But its own mainly in-house research performance has not been marked by excellence, and other components of the wider National Innovation System, including universities, conduct much relevant social science research. HSRC's staff devoted to research—as opposed to support functions-- has been shrinking. HSRC's linkages with some critical stakeholders (higher education institutions, social service practitioners and others) has been weak, and it has lacked a multidisciplinary, strategic approach. This Council has yet to overcome the legacy of its past when, in the view of many South Africans, its intellectual work was employed in the justification of the apartheid project. As a result, HSRC's social science capability has not been widely deployed within the National Innovation System to mediate technological change, not even in opportunities so apparent as the Department of Trade and Industry's initiatives to radically restructure South African industry. Nor has the organisation's research noticeably influenced social innovation by practitioners in the new South Africa, significantly strengthened the research capacity of HDIs, brought new knowledge to the attention of decision-makers, or diffused influential insight about major social problems into the wider society. Thus HSRC's performance with respect to the role defined for human sciences in the White Paper on S&T is still inadequate, and the potentially powerful alignment of a cluster of competencies with the strategic objectives of the NSI has not been realised.

The HSRC is doing some of the right things but could be repositioned to do others differently, both to its own advantage and that of the total system. Recent or

impending strides in the direction of developing the research capacity of black staff, the appointment of new top level researchers with a different profile, provision for visiting scholars, and the involvement of outside researchers in assessment of proposal and publications quality are quite welcome, but should now be decisively reinforced—.

Social transformation and economic growth in South Africa may yield a rising need for development of the kind of psychological and educational testing tools in which the HSRC has found a unique niche, and with whose users it maintains good links. Maintaining competence and achieving excellence in tool development will depend in no small part on the organisation's being able to provide the kind of cultural insight and capability in South African languages that foreign competitors, especially--who are already beginning to erode HSRC's market--will not easily be able to provide. But at present the HSRC is itself deficient in these dimensions of human science research excellence.

HSRC's current management structure and system of governance are appropriate. Leadership has made some progress in effecting change and has provided a framework for directing the organisation. However the connection between this framework and the addressing of concrete issues in society is not clear. Despite an elaborate computerised project management system, research performance is not systematically measured or linked to strategy, and research project quality control is sub-optimal. The organisation's new human resource management plan has not yet yielded sufficient intake or mentoring of researchers from historically disadvantaged groups, though the majority of South Africa's black university graduates still receive their degrees in the humanities and social sciences. Only redress can close HSRC's gaps in cultural insight and language skills.

Management has shied away from taking confident, creative steps to reduce excessive support staff, thus perpetuating the imbalance in allocation of the Parliamentary grant between research, and administrative and overhead costs. Commercialisation strategies have not included competing aggressively for international or local competitive research funds in human science-related projects and programmes. HSRC's test business generates income but even here, in what it does best, the organisation faces growing competition.

Government has already decided to change HSRC's dual mandate of conducting and funding research by transferring the agency function. Now HSRC should begin to actively explore flexible, network-type institutional models which capitalise on the organisation's inherent competence to put into place and manage large, multidisciplinary projects.

- HSRC should retain just as much of a lean but excellent in-house research capacity as would (a) maintain the technical and professional integrity of its project management; (b) allow its participation as one of several partners in the conduct of selective, major-impact research projects; and (c) provide a "home base" to boundary-crossing social scientists working in flexible, creative arrangements across the National Innovation System and beyond it.

- Reconfigured as a smaller but smarter organisation, HSRC should then explore mechanisms to offer influential public policy and social innovation practitioners space to "think and catch up" on the latest developments in the field of social sciences, thereby diffusing practitioner knowledge to the more academic researchers flowing through the HSRC.
- In addition, the HSRC should explore the establishment of linkages with potential private sector partners to achieve better sales and distribution of its products in testing and assessment.
- These parallel changes in mandate, design and competence deployment would constitute a turnaround for the HSRC and would entail the organisation moving rapidly to implement its new framework.. A special turnaround team, with both internal and outside specialist membership, should oversee the toughest stages of the transition. Paramount in the skills set of this team to manage radical change should be organizational development and the strategic management of human resources. Among the turnaround team's first tasks will be to systematically reconnect HSRC to public policy-making, advocacy and leadership circles, in a series of facilitated conversations which should lead to the best structuring of the new design and functions recommended above.

Recommendations of the System-wide review

A concerted effort to address these needs [identified above and in Part 1 of this report] will involve the restructuring of the mandate and staff of the HSRC in order to make it more attuned to major contemporary issues. To tackle such challenges, the HSRC would need to have a staff which represents the cultural diversity of the country and which possesses modern research skills. The future HSRC should primarily operate as a manager, supporter and organiser of research and secondarily as a performer of research. Its could render great service by creating, supporting and guiding networks of researchers in HEIs and in NGOs who would undertake multi-year programs of research on key issues.

A transformation team should be appointed to assist the Minister of Arts, Culture, Science and Technology and the Board of HSRC in bringing about, a change in research philosophy and in research staff, a change in program structure, and any necessary changes in internal organisation to transform HSRC into a modern social science research organisation capable of responding to the needs of South Africa

7. MI TE

MINTEK has a well defined mission which is "to serve the national interest through high-calibre research, development and technology transfer that promotes mineral technology, and fosters the establishment and expansion of small, medium and large industries in the field of minerals and products derived therefrom." It provides an essential repository of technological expertise that leads to innovation within a well-defined industrial sector which in turn contributes significantly to export earnings and

which has huge potential for value-added in terms of minerals beneficiation, processing and downstream products.

MINTEK's core competencies of mineral and metallurgical technology, including ore processing, are internationally respected. They have produced nearly 40 patents since 1990 but, while they have a number of successful applications in industrial practice of processes, techniques and equipment developed in MINTEK, it has often taken a long time to win acceptance from local industry. The Review recommended an increase in scientific and technological expertise in respect of environmental issues facing the metallurgical sector.

The Mandate of MINTEK is expressed adequately in the Mineral Technology Act No 30 of 1989 and accountability and transparency is required through the Reporting by Public Entities Act No 93 1992. The Board governs MINTEK at arms-length from government and plays a vital role in establishing the strategic direction of MINTEK and oversight of an operating business plan. This should be regularly reviewed, taking into account the White Paper on Science and Technology and other policy initiatives in the National System of Innovation. The Board has an audit committee, but it is inappropriate that the president is currently a member of that committee.

MINTEK is resourced from a core grant from the "Science Vote" via the Department of Minerals and Energy (R 73 million), from contract research and from the sale of intellectual property. These latter two sources combined yield only 22.7% of MINTEK's budget which is low in comparison, for example, with the CSIR's 52%. Nevertheless, in fairness it must be stated that about half of CSIR's contract income derives from Government departments, whereas MINTEK's is almost entirely derived from private sector sources.

The Review recommended the following use of funding streams.

- The core parliamentary grant should be used for strategic basic research generating knowledge that precedes application-oriented process and technology development, education and skills development, and the development and maintenance of supporting information and knowledge systems.
- The Parliamentary grant supplemented by contract income could also be used for research related to longer term projects where industry is not yet committed to full buy-in.
- Service work for outside clients, transfer of intellectual property, commissioned R&D, and all international work should be fully covered by commercial revenue. There would seem to be much room for increased contract income, at least to levels commensurate with the CSIR. There is also scope for sourcing a higher proportion of state grant funding from the Innovation Fund.

MINTEK has in place adequate systems to ensure the maintenance of high-quality standards. Its planning and internal progress reporting systems are centralised, easily accessible and provide the necessary information electronically. However, MINTEK should set measurable performance targets for technology uptake by industry, for

inventions and patents and for technical reports and publications. MINTEK's research and technology processes should be benchmarked against outstanding international institutions and it should employ benefit:cost analysis as a tool to assist in the evaluation of projects.

MINTEK has strong, confident management who have put in place good strategic management practices, however management should be restructured by the removal of two layers and some positions and by the redesignation of titles in accordance with modern management practice.

Management have a commitment to equity and redress and policies are in place. However there is much room for improvement with attention given to the retention of black scientists and engineers. MINTEK wish to collaborate with other SETIs in developing common approaches to the recruitment and training of black staff. MINTEK has an impressive commitment to education and training with support schemes for schools, technikons, universities and also in-house training.

MINTEK has good linkages with universities and has a far-sighted programme of bursars and university support. It is estimated that one in five metallurgists in South Africa have passed through MINTEK. There should be greater cooperation and joint programmes with the other "SETIs", in particular CGS, and the CSIR's Miningtek and Mattek. The anomalous position of coal preparation research in Mattek will have to be addressed. There is some concern from industrial clients that MINTEK's maintenance of strategic basic research and the retention of necessary skills is being threatened.

MINTEK should continue to provide technical support to the small-scale mining sector. It should also expand its services and technologies to the sub-region with support from SADC member states, the South African government and international development agencies.

MINTEK has given a great deal of thought to commercialisation. It is a strong drive in the organisation and they have learned from experience over the years, although there is some conflict and misunderstandings regarding its position on intellectual property rights. There is a need to communicate more flexibility on this issue. The key to success in the future is strategic partnerships and alliances, and early involvement of potential clients so that the innovation process is less linear and more interactively dynamic.

Recommendations of the System-wide review

The system-wide recommendations directed to SETIs as a group are all applicable to MINTEK.

8. The Medical Research Council, MRC

The MRC was established to contribute to improvement of health in South Africa through research, and came into being when this mandate was interpreted - as in other countries - as requiring a biomedical approach to the combating of disease and injury. In the early 1990's there emerged, internationally, a concern for the identification of

what was referred to as 'Essential National Health Research' (ENHR) priorities. The ENHR approach was premised on a broader view of health, which encompassed a range of issues relating to the social conditions in which health was either enhanced or damaged, and concern for the operations of health systems within which interventions were organised and delivered. This new perspective was adopted by the Ministry of Health and the MRC has engaged itself in the complex task of redefining its program structure and priorities to embrace this new approach.

There is much which is positive about MRC's performance:

- MRC acts as a performer of increasingly focused research needed to operate in an ENHR context and also provides an agency function for much, but not all, health related research;
- it provides extensive support in increasingly-well constructed modes to capacity building.;
- it maintains good to international levels of performance in most of what it does and what it funds;
- in particular, it has good capabilities in the bio-medical area, but is in the learning stages with respect to how to integrate a wider social perspective into planning, financing and conducting research on broader health issues;
- of all of the SETIs covered in this review, it has the closest operational linkages to the priorities and programs of the Ministry to which it is attached;
- the management of MRC appears to be efficient as well as effective and MRC enjoys a good international reputation;
- by embracing the ENHR approach, MRC has equipped itself with a broad tool with which to align its research with national priorities which have been systematically identified; in addition, this approach leads naturally to the use of performance indicators which are tied to the outcomes of investments in research. One caveat is important here: while MRC's plans and strategies have been quickly realigned, that is not to say that all of its resources have similarly been reallocated. The Board of MRC needs to ensure that meaningful levels of support are reallocated to areas such as health systems research, technology development, community-based epidemiology and cross-sectoral studies. Such a move would be consonant with the advice of the review panel both with respect to the substantive focus of the research needed in South Africa and with respect to the shift of resources away from in-house MRC activities towards research performed in other institutions which have successfully expanded their programs to include the newer, non-bio-medical orientations.
- its strategy appears to be well articulated, but MRC needs to implement its own strategy more vigorously. In particular the Council needs to have a more open vision of potential contributions to the Health Sector by other institutions and other areas of research. A consistent decline in the proportion of MRC-funded research which is performed in-house would

be one indicator that the necessary strategic orientation was being implemented. The comment by the Panel which reviewed MRC concerning the effective breakdown of MRC's internal evaluation of its own programs is one which should lead to swift remedial action by the MRC Board.

- its human resource policies and practices, including those relating to equity and redress are among the most effective which we have seen among the SETIs reviewed. MRC is also conscious of the fact that it needs to continue its emphasis on the transformation of the body of researchers which it supports, given the increasingly social view of health which it has espoused.
- MRC has attracted foreign funding, from both public and private sources and should be encouraged to continue with this practice; it may be capable of attracting significant levels of foreign funding, if it manages current programs well.

Against this positive backdrop, MRC has been resistant to all proposals that would see a formal separation of all of its in-house research functions from its agency function of providing grant support to research in institutions of higher education. This is in sharp contrast to the attitudes throughout the rest of the scientific community in South Africa. If it is to be permitted to maintain this position, then it should be required by government to meet carefully-defined criteria in order to make it transparently evident that its resource allocations do not constitute a conflict of interest.

Since the new National Research Foundation will be empowered to finance research relating to health, the two SETIs should arrange cross appointments to grant review panels and be open to joint financing of activities when this is in the national interest. This latter approach will be particularly important in the financing of larger groups whose research may span activities from the fundamental to the more applied. The continued existence of two agencies funding health related research should not be permitted to allow good proposals to fall between the programs of the two bodies.

MRC will need to improve its capacity for interacting with the social science community - the approach of appointing social scientists to the MRC staff is a necessary condition for bridging existing gaps, but it is not a sufficient condition.

MRC will increasingly be called upon to engage in joint research activities with other SETIs - for example in areas of human nutrition, in which its biomedical skills will need to be integrated within programs which draw on skills in the social sciences, in agriculture and related to food processing.

Recommendations of the System-wide review

The MRC should be required by government to meet the following criteria in order to make it transparently evident that its resource allocations between its own research and its agency funding activities do not constitute a conflict of interest. The criteria are that:

- *all in-house research be financed via the same competitive process which allocates resources to research groups in other institutions. (While MRC already subjects its in-house activities to review by externally chaired panels, it will be important to ensure that such panels have fully internalised the ENHR orientation into their work.).*
- *the process by which MRC allocates its budget between support of competitive funding and support of in-house operations, (which would include all of the overhead costs associated with maintaining an in-house research staff) and the annual results of such allocations should be transparent;*
- *the Board of MRC should clearly delimit the areas of research which they believe should be performed in-house, and should encourage and be sensitive to public debate on their decisions.*

9. The South African Bureau of Standards SA S

SABS' general mandate is in the development, implementation, regulation and maintenance of standards in the country. The maintenance is achieved through the accreditation of institutions, and the certification and testing of products and processes. SABS activities are standards development, accreditation, certification services, laboratory services, trade metrology, and specialised training in the private sector. It is internationally recognised in all of them, and offers a necessary national competence in areas of public responsibility (in trade, safety, etc). The individual activities do not offer individual core competencies in that they can be emulated, but serve taken together they constitute a cluster of core competence.

The current accreditation activity should be transferred to SANAS to ensure impartiality, since institutions once accredited then become competitors of SABS in the task of product or process certification. The present level of accreditation activity contributes insignificantly to SABS' income.

SABS has adequate technical capacity and infrastructure to support its core activities in the medium term. However, they need to embody the strategic need for succession planning if these are to be sustained.

Strategic Management is totally stifled by the bureaucratic nature and the technical intensity of the organisation. This is probably amplified by the fact that the president of the organisation is normally a technical person who comes up the ranks, and HR and Finance are also headed by a technical person who comes up the ranks. As a consequence, the organisation has failed to grasp the strategic importance of HR, Finance, and the capacity to provide visionary (not technical) leadership from the president and his team. The organisation seems to be operating only in today's time frame with little regard (if their results are the yardstick) for the environment they are operating in. In short, SABS will need to inject some visionary leadership into its structures, and adopt (urgently) the structures recommended by the peer review. These structures will in turn improve their financial systems greatly (which point the peer review raised as a major concern), and clearly focus management on which strategies will be necessary and prevalent in the long term.

The necessity to strengthen SABS' performance in the field of Information Technology does not seem to be a current strategic preoccupation of management. This issue becomes even more serious given that the standards world depends on speed of publishing, and that IT standards and certification will in future present a growing opportunity for service delivery.

SABS execute their technical mandate well, but need to infuse a private sector mindset into all members of staff in order to significantly improve their external income. Their marketing seems too technical and not well directed at the broad population. They will need to start marketing differently if they are to reach most potential clients, and the structure recommended by the review panel will help in this regard.

SABS will need to establish linkages with the Higher Education Sector, a move which could assist the organisation in regionalising some of its activities. If the HDIs can be encouraged to become partners, this would go a long way to SABS tap the skills base of the disadvantaged community which is a necessary step in programs of equity and redress. By better linking with the HES, SABS could also serve as a conduit for capacity building in the country.

SABS is neglecting several current opportunities to expand its client base in areas such as:

- the supply of Quality Management Systems that have been identified as totally lacking in some of the SETIs and government line departments ; certification of parastatals is a major opportunity.
- opportunities in SADC. SABS participates extensively in SADC committees, but does not seem to consider it an opportunity because they view other member countries as having inadequate capacity (i.e. they are unable to turn this problem/threat into an opportunity).
- the provision of standards services to SMMEs.

SABS may need to be more-fully commercialised in the medium term, leaving only the standards development and regulatory functions as National Services fully funded by government. The current funding level will be adequate if NETFA can be classified a National Facility, and if Trade Metrology is fully funded by government.

SABS internal fund allocation was inappropriate because of the discipline-based structure, but should improve once the proposed reorganisation is implemented.

Recommendations of the system-wide review

A professional team should be appointed to manage the transformation of SABS which, within the existing framework of SABS, should establish two clearly separate entities. The first would be a government-funded standards writing institution and the second would be an organisation responsible for accreditation, certification and the provision of laboratory services, all operated on a commercial basis. The basis for this change is clearly articulated in the relevant Panel Report

Beyond these structural changes which are required to meet international practice for standards bodies, internal operating changes are needed to modernise management systems and processes. Financial management systems in the SABS should be reviewed and upgraded in the context of the new structure. In addition, a fundamental change management process is required in human resource practices, policies and targets.

A detailed assessment of the metrology activities of SABS should be undertaken in order to establish the viability and cost savings of alternative provision such that a private sector company could be contracted to lease the major assets entailed and provide metrology services to the government under a long-term contract.

10. The South African Weather Bureau SAW

SAWB is currently a departmental scientific activity of the Department of the Environment which is charged with provision of meteorological services, both to the general public (a public good) and to specialised interests (via value-added services). In addition, it carries out a modest program of research. The quality of its services is held in high regard, both nationally and internationally.

It faces a significant set of administrative problems due to its location within a department of government, a location which renders it subject to administrative rules, such as those relating to tendering for major equipment, which impose added costs and delays on the functioning of the Bureau.

Within its present position, SAWB has not developed a financial system which permits appropriate commercial costing of its activities, and so there is no current basis upon which to establish a defensible cost-recovery policy for its value-added services to clients such as the aviation industry. There has been an active disincentive which has limited the Bureau's interest in expanding the range of such services which it might offer: the Department of State Expenditure insists that any revenues generated by the Bureau be treated as general revenue for the State, not as income for the Bureau, while offering no compensation to the Bureau for costs involved in delivering services. As a consequence, the cost to the treasury of operating a meteorological service is unnecessarily inflated due to the impact of administrative rules and the decision on income generation.

The Bureau management have an adequate grasp of the importance of the supply of trained human resources as a strategic factor in its work and have put in place sound policies. Good capacity building systems are in place - but they are not used enough and could yield better results if expanded. There is an acknowledged need to do better in equity and redress.

Among the areas within SAWB which require attention are:

- definition of an overall commercialisation strategy is required; in particular some mechanism, such as a levy on aviation fuel, to recover costs from the aviation sector is essential;

- costing systems need to be completely redesigned to permit commercial operation; there is scope to increase external revenue as a share of overall budget;
- strategies to cope with increasing costs of foreign inputs into routine operations of the weather service; failure to resolve this issue would lead to a progressive deterioration of the services, both public and private, provided by the Bureau;
- linkages with the higher education sector, both for purposes of research and for human capacity development. Present linkages with both universities and Technikons should be expanded. There are good capacity building systems in place - but they are not used enough
- linkages with the private sector in areas of some Bureau competence (such as the development of low-cost instrumentation) are weak and need to be built up. The needed relationship is currently impeded by the Bureau's position within a line department.
- actual performance in equity and redress. - there are mechanisms in place for training which should be used for a more vigorous attack on this problem.

Many of the problems currently faced by the Bureau could be tackled with much more effect if it was granted status as a statutory body under legislation similar to that used for other SETIs such as the Council for Geosciences.

The principal steps needed to bring about this change of status, as articulated by the review Panel, include:

- provision of a Parliamentary Grant to cover the core activities will need to be the major component of the SAWB budget in order meet the statutory obligations of offering the public part of its services;
- preparation of enabling legislation, to define core activities, to identify Government's role in the funding and supply of core services, and to ensure compliance with international obligations, including adherence to the principle of the free exchange of data and products produced as part of the core service,.
- design and establishment of a Board of the new body, appropriately constituted to include members of the community, stakeholders, business people, professional scientists in the field and other experts.
- the establishment of expert task teams to plan for the transition and to train Bureau personnel;
- commissioning of further work to establish in detail what public service activities fall into the core activities for which an annual Parliamentary grant should be given.
- provision of professional advice from outside experts to assist the Weather Bureau as it prepares to commercialise its value-

- added services to identified interest groups, on a more sophisticated cost recovery basis than has been possible to date;
- preparation of a business plan for the Weather Bureau to guide its entry into the market for business-oriented projects within its technical and practical ability to sustain, in ways which will be compatible with the continued, efficient and effective execution of its public-service responsibilities.
- the design and implementation of a comprehensive programme to educate all Weather Bureau staff on their obligations and responsibilities in the new statutory body

With respect to the research program of the Bureau, it should be eligible to compete for funding on the same basis as other SETIs.

Given the nature of the extensive array of data gathering facilities operated by the weather bureau, and the unique collections of current and historical data maintained within its data bases, careful thought should be given to the possibility that some defined parts of it might be declared to be a 'National Facility', to which outside researchers would have a right of access under defined conditions, provided that such a designation would not impair its capacity to offer its core public services.

Recommendations of the system-wide review

The SAWB should become a statutory body by following the process steps set out [above].

11. The National Research Foundation and the Agency Function

The agency functions currently conducted separately by the Foundation for Research Development and the CSD of the Human Sciences Research Council are set to be amalgamated under the proposed National Research Foundation. The draft bill now rests for final decision-making with Parliament, where the new Agency's mission and modalities will take final form as legislation. The NRF's role is already presaged by the Science and Technology White Paper, and the Agency Function review team made numerous helpful specific recommendations about the formation of the NRF. Prominent among these are the recommendation to use the NRF as a strong lever for interaction and linkages in the research enterprise, and the recommendation that NRF enter into urgent discussions with the DoE to achieve greater complementarity in light of the recommendations of the White Paper on Higher Education and of DoE's preponderant role in financing university research. Thus the System-wide Review Panel, will not comment on the past performance of FRD and the CSD, or on the details of an Agency structure which has yet to emerge in final form. Instead, this Review highlights areas of strategic concern with respect to the new entity, and makes some recommendations designed to minimise those concerns.

The NRF will be an important player within the NSI, particularly with regard to helping to galvanise investment in human capital NSI-wide—a position somewhat different from the organisation-bound concerns of individual SETIs and of private knowledge-based enterprises. It has an opportunity to use the results of the Science

and Technology Foresight Exercise, and of the Audits of SETIs and of Indigenous Knowledge, in order to help identify human resource gaps in the system as a whole, including any threats to the country's indispensable basic research capacity. Here the NRF can make valuable use of the network analysis which underlay the Foresight Exercise to stimulate conversations between natural and social scientists across the NSI, and with other players such as the Departments of Education, of Trade and Industry, and of Labour, and civil society. This can be a unique, ongoing opportunity to focus attention on overall human resource needs in science and technology, and to inform deployment of the Innovation Fund accordingly.

The NRF will also have opportunity to intensify the new work begun particularly by the FRD to nourish the "baobabs"-- young black and women science and technology students, and the beleaguered HDI academic staff expected to simultaneously hone their own research capacities and uplift their students as well. For these functions to be adequately exercised, the NRF should have a lean but capable staff experienced in collecting and interpreting information from the NSI and about the education sector.

There is a danger that the complexity of merging the two parent organizations into the new body may be underestimated, with consequences which could impact upon its work. The implications of structure on the possibilities for new thinking and action in the NRF should be carefully pondered. This understanding should drive the design of institutional structures, including its division into departments or other units, and its mechanisms for ensuring the internal flow of ideas and information. As soon as the new, amalgamated staff sets up shop, two distinct organizational cultures will confront one another. Not only is some carry-over of familiar work relations—whether negative or positive—inevitable, but the old organizational cultures will still be the "filters" initially for staff and managers as they decide what to notice, and what to attend to, in the new situation. Meanings constructed over years of work in the past will not be automatically remade and shared; paradigms will not be "unlearned" overnight. Building a distinctly-NRF culture and operating style will be an ongoing task, but it should start consciously and quickly. Such an organizational change is not an easy transition, and the need for expertise in organizational development and strategic human resource management will be acute.

The review panel also notes that exclusion of the health sciences agency function from the new NRF may have impacts upon the strength and cohesion its interdisciplinary thrust. The MRC and DACST should transfer to the proposed Health Sciences Division of the NRF those programmes and proposals likely to benefit from co-operation with a broad range of scientific disciplines.

Among the necessary initiatives , the following stand out:

- The NRF should begin an early round of conversations with NSI actors and stakeholders to help inform thinking about how to use their budget in ways that promote the national interest.
- The transition period should be utilised to begin a cultural audit of the two merging organizations against an anticipated NRF, and to put into place a highly-skilled transition team comprised at the very least of the present leadership of the two organizations and high-quality outside change management expertise, particularly in organizational development and

strategic human resource management (to effectively manage the transition from both ends).

- Agreement from all the relevant Departments should be obtained as expeditiously as possible for clarity/assurance of continuity of disbursement commitments over a minimum period of two years on NRF resuming operation.

Recommendations of the system-wide review

The establishment of the new national funding agency is a logical and necessary step in the further development of the South African research base. In view of the challenges provided by the process of establishing a new institution and, at the same time, integrating the existing FRD and CSD, it will be necessary to put into place a highly skilled transition team comprised of the present leadership of the two organizations and high-quality outside change management expertise, particularly in organizational development and strategic human resource management.

The NRF should begin an early round of conversations with NSI actors and stakeholders to help inform thinking about how to use their budget in ways that best support national policy priorities and the NSI.

In addition, earmarked funds should be provided by the National Research Foundation for a research program specifically designed to stimulate research on cultural, social, economic, and technological change in Africa in order to develop new research capacities within South Africa's higher education institutions.

12. National Facilities

The strategic review of current and potential National Facilities (NF's) has emphasized the need for a framework of policy and decision-making as well as a specific mode of funding, operating, and maintaining NFs which are regarded as important elements of the SET infrastructure of South Africa.

For quite some time, and in many countries throughout the world, NFs were defined as institutions which rested on substantial instrumentation and equipment, and required a considerable amount of government resources. Due to recent developments in various areas of SET, e.g. in modern biology as well as in other data-based sciences, an increasing trend can be observed towards the creation of multi-locational networks of institutions, which collaboratively contribute to the provision of an urgently needed research infrastructure. A common feature of all of these NFs is that the respective research community has a right to access them on a competitive basis, according to their research needs.

In order for an institution to be considered as an NF, the review panel proposed that the following criteria should be met:

- The facility or network of facilities should have a unique position in South African SET;
- The core technologies, research methods, or data pools should live up to international standards;

- The goals for establishing the NF should be well aligned with the overall objectives of the South African system of innovation, especially with regard to the diffusion of new knowledge;
- Critical mass of equipment, skills, and users, especially with regard to researchers from universities and technikons, but also from SETIs and (where appropriate) from industry;
- The potential for networking and for attracting international collaborators to South Africa;
- Prospects and opportunities for human resource development; especially with regard to efforts being made to get disadvantaged researchers involved.

It is appropriate to separate the functions of policy advice to government and system-oversight with respect to National Facilities from the function of managing the system of National Facilities which may evolve in South Africa.

For the framework of policy and decision-making to be developed, it is important that government can take its decisions based upon expert advice which is institutionally independent of the researchers preparing specific proposals. In the South African context, the appropriate body for providing this advice as well as for conducting evaluations at a strategic level, is the newly-established National Advisory Council on Innovation (NACI).

The process of establishing, operating, and maintaining National Facilities, as well as the preparation of proposals to close down NFs which no longer meet the criteria outlined above, should be a responsibility of the proposed National Research Foundation (NRF). It should be delegated a coordinating role, and should also be responsible for providing the necessary core funding for the NFs, funding opportunities for users from universities and technikons, and for setting up a medium-to-long term investment plan.

As for the operational aspects of NFs, it is essential that access to the facilities be granted based entirely on open and transparent competition. This should also include the NF's own research staff, except in those areas where research is needed for maintaining or upgrading the facility.

Government should move to the enactment of a National Facilities Act to set out the definition of such facilities, of the criteria which they need to meet, of the responsibilities which they would undertake with respect to providing access to researchers from all parts of the country, and of the funding system appropriate to their support – or to a modification of an existing legislative instrument to achieve the same goals

The potential to establish a category for support or baseline information-generating facilities (such as parts of the SAWB or of CGS) should be explored.

Recommendations of the system-wide review

Legislation should be enacted to facilitate the designation and operation of National Facilities. The act should specify the criteria for selecting national facilities, the performance criteria which would need to be met to retain that status, and the funding regime which would apply both to meeting the infrastructure and operating costs of the facilities and to the financing of the use of the facilities by interested parties

NACI, with the support of DACST, should develop an appropriate funding mechanism for declared National Facilities which strikes a viable balance between providing secure infrastructural support for the operators of the facility and funding/empowering users to gain access to the facility on the basis of merit and relevance.

Appendix Membership of the System-Wide Review Panel

Panel Chair: Mr James Mullin,
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Members: Ms. Geri Augusto,
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Dr Wilhelm Krull,
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Mr John Moalusi,
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Mr Peter Masemola,
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Appendix II Examples of Potential Key Performance Indicators

General KPI's, applicable at the level of individual SETIs or SETI core competence clusters.

- Number of new technologies developed - quantitative
- Degree of alignment to government policy - qualitative
- Degree of commercial activity against pre-determined targets - quantitative
- Jobs created – quantitative and qualitative
- Extent of interaction with other NSI stakeholders
- Sectoral GDP growth - qualitative
- Investment promotion - qualitative
- Small businesses created - quantitative
- Sustainability index - quantitative
- HR capacity – scientists, engineers, technicians trained and employed - quantitative
- Patents or other Intellectual Property registered and commercialised - quantitative
- Degree of implementation of technological outputs – quantitative and qualitative
- Licensing agreements successfully implemented- quantitative

Specific KPI's for use as Management Tools within SETIs

- *Executive and Senior Management level*
 - Affirmative Action target for organisation
 - Generic Human Resources KPI
 - Financial performance
 - Income/expenses
 - % cooperative expenditure against target
 - Pricing level compared to competition
 - Productivity and efficiency
 - Safety
 - Alignment with national priorities
 - National contribution
- *Team leader level*
 - Mentorship of trainees and staff
 - Project management performance – adherence to budget, milestones and outputs
 - Technology transfer and diffusion targets

- *Scientist/researcher level*
 - Mentorship of trainees and junior researchers
 - Publications, patents or other intellectual property produced
 - Peer interaction
 - Reputation
 - Income
 - Contract performance
 - Research outputs
 - Project discipline
 - Contribution to the science or to technological advance, as applicable

[Back to System-wide Review page](#)