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# TABLE OF CONTENTS

	EXEC	UTIVE SUMMARY1
1	INTR	ODUCTION6
	1.1 1.2	Background to the Audit6 The Scientific and Technological (S&T) Infrastructure Survey6
		1.2.1Survey Aims and Scope
	1.3 1.4	Definition of S&T9 Acknowledgement and Appreciation10
2	OVEF	VIEW AND DESCRIPTION OF THE S&T INFRASTRUCTURE11
	2.1	Funders of S&T11
		2.1.1Government Sector
	2.2	Performers of S&T12
		2.2.1Science Councils122.2.2Higher Education Institutions (HEIs)132.2.3Government Departments132.2.4National Heritage Institutions (NHIs)142.2.5Non-government Organisations (NGOs)142.2.6Private Sector Research Organisations142.2.7Funding Organisations15
	2.3 2.4	Governance and Ownership Overview15 Regional Representation15
3	CHAF	RACTERISTICS OF S&T PERFORMERS17
	3.1 3.2 3.3	Gross Income
		3.3.1Government Sector

		3.3.3	NGOs	20
		3.3.4		20
		3.3.5		
		3.3.6	Universities	22
	3.4	Capita	al Investment	22
4	S&T	ACTIVI	TIES AND FOCUS	24
	4.1	Perfor	mers of S&T	24
		4.1.1 4.1.2	Types of S&T Activity Major Fields of Application	24 25
	4.2	Funde	ers of S&T	28
		4.2.1	Recipients of S&T Funding	28
		4.2.2	Types of S&T Activity	28
		4.2.3	Major Fields of Application	29
		4.2.4	Output Rationale	31
5	CON	TRIBUT	TION OF THE S&T INFRASTRUCTURE	32
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals	TION OF THE S&T INFRASTRUCTURE	<b>32</b> 32
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1	and Objectives	<b>32</b> 32 32
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2	and Objectives Government Sector National Heritage Institutions	32 32 32 32
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3	and Objectives	32 32 32 32 32
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4	and Objectives Government Sector National Heritage Institutions Non-government Organisations (NGOs) Science and Technology Funders	32 32 32 32 32 33
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5	and Objectives	32 32 32 32 32 33 33
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6	And Objectives	32 32 32 32 32 33 33 33
5	<b>CON</b> 5.1	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7	and Objectives	32 32 32 32 33 33 33 33
5	<b>CON</b> 5.1 5.2	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O	and Objectives	32 32 32 32 33 33 33 33 33
5	<b>CON</b> 5.1 5.2	<b>TRIBUT</b> Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1	And Objectives	32 32 32 32 33 33 33 33 34 34
5	<b>CON</b> 5.1 5.2	TRIBUT Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1 5.2.2	And Objectives	32 32 32 32 33 33 33 33 34 34 34 35
5	<b>CON</b> 5.1 5.2	TRIBUT Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1 5.2.2 5.2.3	and Objectives	32 32 32 32 33 33 33 33 33 33 34 34 35 36
5	<b>CON</b> 5.1	TRIBUT Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1 5.2.2 5.2.3 5.2.4	And Objectives	32 32 32 32 33 33 33 33 33 34 34 35 36 37
5	<b>CON</b> 5.1	TRIBUT Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5	and Objectives         Government Sector.         National Heritage Institutions         Non-government Organisations (NGOs)         Science and Technology Funders         Science Councils         Technikons         Universities         Overnment Sector.         National Heritage Institutions         Science Councils         Technikons         Universities         Science Councils         Technikons         Universities         Science Councils         Technikons         Universities         Science Councils         Technikons         Non-government Organisations (NGOs)         Science Councils         Technikons	32 32 32 32 32 33 33 33 33 33 33 34 34 34 35 36 37 38
5	<b>CON</b> 5.1	TRIBUT Goals 5.1.1 5.1.2 5.1.3 5.1.4 5.1.5 5.1.6 5.1.7 Key O 5.2.1 5.2.2 5.2.3 5.2.4 5.2.5 5.2.6	<b>FION OF THE S&amp;T INFRASTRUCTURE</b> and Objectives         Government Sector.         National Heritage Institutions         Non-government Organisations (NGOs)         Science and Technology Funders         Science Councils         Technikons         Universities         Outputs         Government Sector         National Heritage Institutions         Non-government Sector         National Heritage Institutions         Non-government Organisations (NGOs)         Science Councils         Technikons         Universities         Dutputs         Government Sector         National Heritage Institutions         Non-government Organisations (NGOs)         Science Councils         Technikons         Universities	32 32 32 32 32 33 33 33 33 33 33 33 34 34 34 35 36 37 38 39

6	ASSESSMENT OF THE PUBLIC S&T INFRASTRUCTURE42						
	6.1 6.2 6.3	Introd Recor SA's S	uction nciliation of the South African S&T Infrastructure S&T Infrastructure in International Context	42 43 47			
		6.3.1 6.3.2 6.3.3	Macro-perspective on S&T Infrastructure Internal Structure of S&T Infrastructure Concluding Remarks	47 52 60			
	6.4	Streng	oths and Weaknesses of the S&T Infrastructure	62			
		6.4.1 6.4.2 6.4.3	Background Potential Strengths Weaknesses and/or Obstacles to Growth	62 63 74			
	6.5	Summ	nary of Conclusions	75			
7	RECO	MMEN	IDATIONS	77			
8	REFE	RENCI	ES	78			
Арреі	ndix A	: NA1	TURE AND STRUCTURE OF THE ACCESS DATABASE				
Apper	ndix B	: DET	TAILS OF ORGANISATIONS SURVEYED				
Apper	ndix C	: OVE AS	RVIEW OF POTENTIAL GENERIC FUNDERS USED S START LIST				

# EXECUTIVE SUMMARY

**Background :** The National Research and Technology Audit (NRTA) is a government sanctioned initiative contracted out to the Foundation for Research Development (FRD) by the Department of Arts, Culture, Science and Technology (DACST).

The Scientific and Technological (S&T) Infrastructure Survey is one of five major surveys, which form the first stage of this audit. This S&T survey was undertaken by the specialised techno-economic and market research firm, LHA Management Consultants (LHA).

The primary aim of the survey of the scientific and technological infrastructure was to collate, interpret and assess relevant data related to the national pattern of S&T funding and performing activities in South Africa. In broad terms the survey involved :

- The identification of all relevant organisations that are involved, in total or in part, in S&T activities.
- A description of these organisations in terms of various organisational and financial dimensions, nature of S&T activities and contribution and relevance to current and future national needs.
- An objective assessment of findings, inclusive of the strengths and weaknesses of the S&T infrastructure, its standing in international context and recommendations as to key issues for policy attention.

Both S&T performers and funders were surveyed, but the business sector and public corporations were excluded, since they were covered in the separate Business Sector Survey.

**Coverage :** A total of 189 organisational entities were surveyed, as follows :

National research facilities 3	}
	21
Universities	21
Technikons	12
Government departments and S&T performers 88	8
National heritage institutions (NHIs)	17
S&T Funders, including private sector research	
organisations and 18 NGOs	40

**Methodology :** The S&T Infrastructure Survey is a top-down survey which serves to describe the S&T activities from a corporate perspective, as backdrop to the more in-depth surveys of the relevant organisations by the other consultants. As far as the public sector is concerned, this survey to all intents and purposes comprises a census of all relevant organisations. For the NGOs and S&T funders, a wider top-down scan and a subjective judgement on the part of the consultants resulted in detailed data gathering

and analysis of only those organisations comprising significant proportions of the S&T performed or funded in the area under consideration.

A questionnaire was designed to capture relevant aggregate, top-down information about S&T organisations and was approved by Audit Management. The questionnaire contained sections covering the following issues :

- Solution Organisational identity
- Sectional focus
- Solution Ownership issues
- Structure of activities
- ∠ Assets
- Contraction Sector Sect

and where relevant, for S&T funders

- S&T funding
- E Funding focus

A Microsoft Access database with the same structural outline as the questionnaire was developed to capture the data gathered during the survey.

In all instances annual reports and other available published information on the organisations to be surveyed were used to already complete as much as possible of the questionnaire before submitting this to the organisation in question. This was then followed in most instances with a personal interview and further telephonic interactions. The questionnaire as completed by the organisation's top management was then critically reviewed by the consultants and any uncertainties sorted out with the respondents. Finally the verified questionnaire was entered into the Access database. Once all data sets had thus been verified and entered, the database was rigorously tested for anomalies between organisations, and these were further cleared up with those concerned. The data set described herein is considered the best possible estimate of the South African S&T activities from a top-down perspective which is available at present. It is considered valid for the median year 1995/96.

**Results :** From a macro-perspective, the results of the top-down survey of performers and funders showed that South Africa has an S&T *"industry"* of about R11 billion, excluding the business sector and public corporations.

The S&T performers surveyed by LHA returned a total turnover of R9,55 billion, made up as follows :

	Government	NHIs	<b>NGOs</b> <sup>1)</sup>	HEIs	Science Councils
	R 654 m	R 112 m	R 558 m	R 6 756 m	R 1 470 m
1	Total S	R 9 550 m			

#### LHA S&T Performance Survey

Performers indicated the following sources of financing:

??	Government Sector		R 5 419 m
??	Private Sector and the Public		R 4 041 m
??	International Contracts & Donors R	90 m	
то	TAL		R 9 550 m

It should be noted that recipients of government transfer funding for S&T activities not covered by the LHA survey account for a further R1,55 billion, made up of :

??	Atomic Energy Corporation	R	231 m
??	SAMDI (SA Management Development		
??	Institute R	54 m	
??	Performing Arts Councils	R	94 m
??	Armscor	R	70 m
??	Education & Training [Miscellaneous]	R	521 m
??	Government S&T Initiatives, eg THRIP, SPII	R	50 m
??	Capital for HEIs R	500 m	
??	Miscellaneous other	R	30 m

The LHA S&T funding survey accounted for R6,59 billion, but information supplied as part of the performer survey indicated S&T financing sources outside the scope of the S&T infrastructure survey of another R4,8 billion. The summarised situation regarding the funding of S&T is as follows :



By approximation, the focus of the S&T activities accounting for the R9,55 billion in the performer survey is split as follows :

- By nature of S&T activities :
  - ∠
     Research and Development
     R1 499 m, or 16%

     ∠
     Education and training
     R6 311 m, or 66%
  - Øther S&T activities
- R6 311 m, or 66% R1 739 m, or 18%

By major field of application (excluding education and training and training in the higher education sector) :

Ľ	Engineering and applied technologie	s R	952 m,	or 28%
Ŕ	Agricultural sciences	R	671 m,	or 20%
Ŕ	Social and economic sciences			
	and humanities	R	654 m,	or 19%
Ø	Life and physical sciences R	503 m	or 15	%
		000	, 01.10	/0
Ø	Medical and health sciences	R	456 m,	or 14%
R R	Medical and health sciences Information and computer sciences	R R	456 m, 109 m,	or 14% or 3%

A detailed synthesis was prepared of the classes of goals and objectives, and of outputs, for the different groups of S&T performers. It was concluded that, at least superficially, it would appear that the South African S&T *"industry"* is busy aligning with the imperatives of the government's GEAR strategy.

In the broadest possible aggregation, the outputs from the S&T performers group as follows :

- Applied technologies
- Education and training
- Research capacity building
- Sea Information management
- R&D in support of policy formulation
- Management of specialised collections

**SA's S&T Infrastructure in International Context :** Countries at the forefront of S&T development are invariably in the fast track as far as economic performance is concerned. International benchmark values are used to gauge South Africa's standing with respect to some key, relevant S&T indicators. It is shown that South Africa's gross expenditure on R&D (GERD), as a percentage of GDP is about 0,9%, which puts us in the same league as, for example, Hungary, Spain, Portugal, New Zealand, Chile and Brazil, way behind the industrialised countries which are all above 2%.

Interrelationships between GERD/GDP, percentage of government funding of S&T and number of patents in force are developed for a reference set of 25 countries. It is concluded that the South African figures, although low compared to international values, are in line with the established interrelationships. This allows a first glimpse of how various indicators of S&T could change should more money be put into R&D.

**Strengths and Weaknesses of the S&T Infrastructure :** The S&T Infrastructure Survey is perhaps not the best basis for an overview of strengths and weaknesses of S&T in South Africa, since many debatable issues would be further clarified using the results of the other surveys. Nevertheless, a subjective analysis, based on the information and perceptions gathered during this survey, was done. It showed the potential strengths of the S&T infrastructure to be :

- The degree of alignment of the intent of S&T organisations with the imperatives of GEAR
- Solution The strong focus on applied technologies
- The distinct groupings of S&T performers, with fairly generic goals and objectives by group
- The Science Council concept, with its key elements of market focus, commercialisation and specialisation
- The NGO sector, with its independent "ombudsman" type of S&T assessment of government policy initiatives
- The wide S&T funding base, with 38% of S&T funding originating from outside of government
- The strong infusion of private money into the higher education institutions, with 48% of all money in this sector coming from outside of government
- The S&T *"industry"* has a strong S&T capital equipment base
- The government, NGOs and Science Councils have a complementary S&T funding focus
- SA has a leading edge position regarding many hard technology fields, which can find application elsewhere in industry and towards the achievement of GEAR.

For each of the above potential strengths, obstacles and/or impediments to growth were identified. However, two weaknesses, the solution of which is key to the overcoming of a possible stagnation in S&T impact, are :

- The lack of a strategic South African S&T vision to phase the impact of S&T on the implementation of GEAR, and
- The establishment of an independent S&T Council, to strategically coordinate and manage the development of the impact of the South African S&T industry.

In closing, a platform has been created through the five surveys in the NRTA to start addressing key issues in the South African scientific and technological infrastructure.

# 1 INTRODUCTION

# **1.1 Background to the Audit**

The National Research and Technology Audit (NRTA) is a government sanctioned initiative contracted out to the Foundation for Research Development (FRD) by the Department of Arts, Culture, Science and Technology (DACST).

The aim of this national audit was to assess the strengths and weaknesses of South Africa's economy, society and environment in as far as research, science and technology are concerned. By assessing the research, science and technology system, it is hoped that the government will have the platform on which to develop a meaningful reprioritisation of the existing public science and technology resources.

The first stage of the audit consisted of five major surveys, one of which is the Scientific and Technological (S&T) Infrastructure Survey. This survey was undertaken by the specialised techno-economic and market research firm of LHA Management Consultants (LHA).

# **1.2** The Scientific and Technological (S&T) Infrastructure Survey

## 1.2.1 Survey Aims and Scope

The primary aim of the survey of the scientific and technology infrastructure was to collate, interpret and assess relevant data related to the national pattern of S&T funding and performing activities in South Africa. In broad terms the survey involved :

- The identification of all relevant organisations that are involved, in total or in part, in S&T activities.
- A description of these organisations in terms of various organisational and financial dimensions, nature of S&T activities and contribution and relevance to current and future national needs.
- An objective assessment of findings, inclusive of the strengths and weaknesses of the S&T infrastructure, its standing in international context and recommendations as to key issues for policy attention.

The survey covered a number of distinct segments, as indicated below, with the total number of organisational entities surveyed shown in brackets :

#### S&T Performers

- Science Councils, inclusive of the national facilities of the FRD (11).
- Higher Education Institutions (HEIs), comprising all universities (21) and 12 technikons. The Transkei (Eastern Cape), Setlogelo (Northwest) and Border Technikons could not contribute to this survey.
- Solution Government Departments, largely at the first tier level, but in some cases also at the second tier provincial level (88).
- National Heritage Institutions (NHIs), with emphasis on those organisations accounting for a significant proportion of the segment (17).
- Non-government Organisations (NGOs), again with emphasis on those organisations, not directly affiliated to universities, accounting for a significant proportion of the segment (14).
- Private Sector Research Organisations, which undertake S&T activities on a generic basis for a number of beneficiaries and produce S&T outputs as an end in themselves or on contract for others (14).

In later chapters of this report the latter two segments are combined and collectively referred to as Non-government Organisations (NGOs). However, in the database the distinction has been retained.

## S&T Funders

Funding Organisations, which fund S&T activities on a similar generic basis and which account for a major proportion of national spending on S&T (40).

In total, 189 organisations were covered in this survey, which can be construed as a first of its kind in terms of content and methodology. The profile of organisations covered has a distinct public sector image, with the exception of NGOs and private S&T funders. This allows for a comprehensive assessment of the S&T infrastructure of the public sector, as well as well-founded analyses of private sector activities outside of pure commercial, in-house research undertaken by private companies and state corporations.

It should be specifically noted throughout this report that the survey excludes the business sector, which comprises all private and state corporations. It does, however, include private sector institutions that undertake research and development activities on a non-profit basis for a number of beneficiaries.

## 1.2.2 Survey Methodology

To all intents and purposes, the above-mentioned survey of the S&T

infrastructure comprised a full census of all public organisations. In the NGOs, a wider top-down scan and subjective judgement on the part of the consulting firms participating in the audit resulted in detailed data gathering and analysis of only those organisations comprising significant proportions of the NGO segment.

The nature of this survey dictated data gathering at the organisational or corporate level, with detail regarding human resources, research outputs and equipment augmented by other surveys of the audit. Given the tremendous demands that such surveys place on senior executives and research personnel, care was taken, where possible, to extract the required data from relevant and available published information such as annual reports, research publications, financial statements, directories and databases. With such information at hand, all organisations were thereafter comprehensively and personally surveyed and contacted for updated information, interpretation and verification, by means of an extensive questionnaire. In all cases data gathered and captured includes the most recently available data, as shown in the following table.

Segment	Number of organisations with financial data for				
	1994/95 or calendar year 1994	1995/96 or calendar year 1995	1996/97 or calendar year 1996		
Science Councils	-	8	3		
Universities	6	6	9		
Technikons	7	5	-		
Government Sector	-	10	78		
NHIS	11	6	-		
NGOs <sup>1)</sup>	6	14	20		

# TABLE 1.1DATE OF FINANCIAL INFORMATION

Note : 1) Includes NGOs and private sector research organisations

Whilst in some cases it was possible to obtain data (e.g. total income) for more recent years, the need to provide breakdowns in terms of fields of application necessitated the use of older data. This fact does not, however, detract materially from providing an overall perspective on S&T activities and focus.

Given the year-to-year variations in the actual performance figures of different organisations and the split of latest available data as given in Table 1.1 the data set on the South African S&T infrastructure described herein is considered valid for the median year 1995/96.

#### **1.2.3 Survey Deliverables**

The major deliverables of the survey include:

- This management report, which is a summary document containing information on a segment level, and an objective assessment of the S&T infrastructure based on that information.
- A separate computerised database, containing detailed information by individual organisations. Details of the nature and structure of the database are contained in Appendix A to this report.

# 1.3 Definition of S&T

Based on initial research undertaken by a Task Team as requested by the Audit Management Team, the following definition of science and technology activities was provided :

The Scientific and Technological Infrastructure is a set of institutions, organisations, facilities, programmes and activities that is essential for undertaking/executing activities concerned with research and experimental development and contributing to the generation, dissemination and application of scientific (including natural and human sciences) and technical knowledge. Such activities typically include the following :

- Education and training activities
- The activities of libraries and museums
- Activities involved in the translation and editing of S&T literature
- Surveying activities (hydrological, geological, socio-economic, etc)
- Prospecting
- *E* Data-collection activities in the human sciences
- Testing, standardisation and quality control
- Client counselling activities (agricultural, psychological, educational and industrial advisory services)
- A Patenting and licensing activities by public bodies
- Service Policy-related activities.

To enhance understanding of the definition and simplify the data gathering process, the following LHA version was used during the survey.

The S&T infrastructure is defined as including all activities, which help maintain and/or grow the knowledge base in South Africa. As such it includes the following :

**Research and development:** Activities aimed at new innovations which extend the knowledge base in the country for the public and/or national good, and testing to verify such innovations.

Education and training: At post-matric level, aimed at human

resource development.

**Generation of information:** All activities focused on the gathering and dissemination of data and information, which either support research and development or are maintained for the public and/or national good.

**Deployment of knowledge:** All activities, which use the knowledge generated to transfer knowledge or apply research results for the public and/or national good.

**Standards and guidelines:** The development of policies, standards and guidelines on the basis of research findings, which will benefit the general public and/or the country as a whole.

**Patents and licensing:** All activities aimed at the patenting and/or licensing of scientific research findings, and/or products and services.

# 1.4 Acknowledgement and Appreciation

LHA would like to extend its deepest appreciation to DACST, the FRD and the Audit Management Team for being part of this landmark audit and for the considerable support and direction we received for the duration of the audit. We believe that together we have grown in knowledge and experience and sincerely hope that this initial audit and possible updates will benefit all those concerned with science and technology in South Africa.

Also, we gratefully acknowledge the time and effort expended by responding organisations and the valuable contributions received. A list of these organisations appears in Appendix B.

# 2 OVERVIEW AND DESCRIPTION OF THE S&T INFRASTRUCTURE

# 2.1 Funders of S&T

# 2.1.1 Government Sector

The public sector accounts for the majority of funding for S&T activities in South Africa. During the financial year 1995/96, total funding amounted to R7,4 billion, earmarked as follows :

- ✓ Transfer funding of R6,24 billion
- ∠ In-house funding of S&T activities of R650 million
- Contract funding of R480 million.

The aggregate figures indicated above were extracted from this survey of S&T funders as well as a recent DACST study undertaken by LHA. Transfer funding refers to the direct funding of HEIs, Science Councils, NHIs, state corporations, etc., by means of parliamentary grants. Contract funding implies the funding of external contractors, either public or private, to perform specifically detailed S&T activities. Inhouse funding refers to the funding of all significant S&T entities within government departments as covered in this survey of S&T performers.

Three of the Science Councils, namely the FRD, the HSRC (CSD) and the MRC, have an agency funding role. The funding associated with these three institutions is included in the survey.

## 2.1.2 S&T Funders

Apart from the funders already listed above, a wide selection of NGOs exists which fund S&T. In some cases, the funders are well-known, such as the statutory Water Research Commission. In others, these had to be sought out, and the methodology employed was as follows :

- A comprehensive list was compiled of all control boards, industry associations, generic funding organisations (also those listed as such by the Science Councils) and national representative organisations, such as the National Parks Board.
- These approximately 200 organisations were all contacted telephonically and a first indication obtained as to the relevance of their being on a list of S&T funders.
- The list was shortened to about 50 potential NGO funders on the basis of the telephonic interviews. These 50 organisations were all approached by telefax, and followed up by telephone.
- Eventually, the end the majority of these organisations were

interviewed personally. The cut-off funding level used was R100 000.

Appendix C contains a list of organisations used as the starting point in the process described above.

NGO funders accounted for about R350 million of funding to S&T institutions. As such it is clear that these funders account for only a small percentage of the income streams of S&T performers. All of the above figures exclude own-benefit business R&D funding, which was sampled in the separate Business Sector Survey.

#### 2.2 Performers of S&T

The S&T Infrastructure Survey covers both public and private sector organisations that perform S&T activities and produce outputs as an end in themselves or on contract for others. Excluded from the survey were thus commercial concerns and dedicated, in-house research units that undertake research and development largely aimed at furthering the interests of the concern itself. These organisations, which include private businesses and state corporations, were included in the separate Business Sector Survey referred to above.

A brief overview of organisations covered in this survey is provided below.

#### 2.2.1 Science Councils

Eight Science Councils have been established to date, each under a separate Act of Parliament. The Science Councils are all mandated to serve a particular scientific community, with only the FRD (as an agency) and the SABS (as a regulatory body) different in nature from the others in their specific mandate in that they serve a broad community. The councils are still significantly institutionally funded by the State, but are encouraged to increase external income from other sources, both internationally and locally, through R&D undertaken on a for-profit basis.

The organisations are governed by boards or councils comprising members appointed by the relevant cabinet minister. The responsible government departments of each Science Council are :

*Example 2* Department of Arts, Culture, Science and Technology

Ľ	FRD (Pretoria)
いい	HSRC (Pretoria)

- Department of Trade and Industry
  - SABS (Pretoria)
  - 🖉 CSIR (Pretoria)
- Bepartment of Health

ළඳ MRC (Bellville)

- Solution Department of Agriculture
  - ARC head office (Pretoria)
- *«* Department of Mineral and Energy Affairs

  - Council for Geoscience (Pretoria)

Conceptually the Science Councils, with the exception of the FRD, can be construed as the major performers of S&T activities on behalf of the broader public sector.

The FRD also manages three national research facilities, namely the National Accelerator Centre and the South African Astronomical Observatory in the Western Cape and the Hartebeesthoek Radio Astronomy Observatory outside Pretoria.

# 2.2.2 Higher Education Institutions (HEIs)

The HEIs surveyed comprise a total of 21 universities and 12 technikons, scattered throughout the country, mostly in major urban centres. The HEIs are similarly largely institutionally funded, directly by the Department of National Education and through so-called agency funding mechanisms (e.g. CSD, FRD, etc), with other funding streams accounted for by student fees, grants and private sector contracts.

It is conventional, due to historical and political factors, to distinguish between historically white universities (HWUs) and historically black universities (HBUs), with the University of South Africa falling outside this general classification.

Education and training comprises by far the bulk of the activities of the HEIs, with research and development activities and subsequent output varying significantly from the larger HWUs through to HBUs and technikons.

# 2.2.3 Government Departments

S&T activities performed by government departments are an ambiguous issue in terms of definition, ranging from pure research, research related to policy development, the systematic collection of data and management of databases to activities such as extension

services. This survey covered only those units, directorates or institutes within central and provincial government departments involved in such activities, and excluded public enterprises or state corporations (e.g. Telkom, Armscor, Atomic Energy Corporation) of which the state is the sole or main shareholder.

# 2.2.4 National Heritage Institutions (NHIs)

These institutions comprise museums, libraries, the National Zoological Gardens and the National Monuments Council, and total 17 in number. The institutions administratively fall under the auspices of the Department of Arts, Culture, Science and Technology, which is also responsible for a significant part of their funding.

The institutions undertake a very wide range of S&T activities in many disciplines, including the maintenance and cataloguing of collections, educational and recreational services and displays, as well as pure research. These activities in particular have in recent years been considerably constrained by decreasing funding levels and limited capacity to generate own income.

# 2.2.5 Non-Government Organisations (NGOs)

The recent transition in the country has resulted in a considerable state of flux being experienced in the NGO segment especially, with the relationship between universities and NGOs, in particular, not always clear. This survey focused on major NGOs not associated or affiliated to universities. Those excluded are deemed to maintain some link or tie with universities, albeit that the latter appear not always to formally acknowledge this or afford such organisations research status.

The fragmentation and considerable number of NGOs present a major methodological problem of identifying those that are significant in terms of S&T and/or research activities and outputs. This was overcome through high-level contact with key figures in the segment. Although the final sample of NGOs included in this survey is by no means exhaustive, it provides good insight into the impact of NGOs in the scientific and technological environment.

## 2.2.6 Private Sector Research Organisations

In selected industries or industry branches, research organisations have been established and are maintained to conduct S&T activities, particularly research and development on a generic and collective basis for the benefit of member firms, but often also for the national benefit. By their very nature, organisations that undertake research for in-house purposes or for a larger holding group were excluded.

The organisations covered in this survey contribute to a significant proportion of such generic and collective S&T activities and represent well-established and large non-government organisations, for example, the Sugar Milling Research Institute.

# 2.2.7 Funding Organisations

The inclusion of funding organisations in this survey resulted from the need also to assess the supply-side of the scientific and technological infrastructure rather than only those involved on the demand side. Once again, only those organisations that fund S&T activities that lead to outputs as an end in themselves are included, and not organisations that fund research and development for purely commercial reasons.

# 2.3 Governance and Ownership

The nature of the S&T infrastructure in terms of ownership and legal structure has a distinct public sector image, as can be seen from the following breakdown.

- Of the 189 organisations surveyed, 150 are state-owned entities and 39 are private organisations. The results of this survey thus provide valuable insight into the state's involvement in both the funding and performing of S&T activities, and emphasise the need for relevant information to guide future policy decisions.
- The surveyed organisations are governed in terms of a number of different legal structures, as follows :

R	Statutory Bodies	:	23	
Ŕ	Government Departments/Directorates	:		85
Ľ	National Heritage Institutions	:	17	
Ľ	Higher Education Institutions	:	33	
Ľ	Article 21 Organisations	:	26	
Ø	Companies and Closed Corporations		:	5

Details of the members comprising the councils, boards and executive management cadres of each of the organisations are available on the computerised database.

# 2.4 Regional Representation

An analysis of the regional representation of S&T funders and performers is shown in the table below.

Region	Science Councils	HEIs		Government Departments	NHIs	NGOs <sup>1)</sup>	Total
		Universitie s	Technikon s				
Gauteng	8	6	5	69	5	28	121
Western Cape <sup>2)</sup>	3	3	2	2	6	2	18
Eastern Cape	-	4	1	-	3	2	10
Kwazulu Natal	-	3	3	9	1	7	23
North West	-	2	-	1	-	-	3
OFS	-	1	1	1	2	-	5
Northern	-	2	-	2	-	1	5
Province	-	-	-	2	-	-	2
Northern Cape	-	-	-	2	-	-	2
Mpumalanga							
TOTAL	11	21	12	88	17	40	189

 TABLE 2.1

 S&T INFRASTRUCTURE : REGIONAL REPRESENTATION

 (Number of Different Entities)

Note: 1) Includes NGOs and private sector research organisations

2) Includes national research facilities – the National Accelerator Centre and the South African Astronomical Observatory

The above breakdown has been included for interest only and is by no means representative of regional output and/or contribution. The dominance of Gauteng is noteworthy in terms of in terms of number of entities, 86 of which are situated in Pretoria.

# 3 CHARACTERISTICS OF S&T PERFORMERS

# 3.1 Gross Income

The gross income of the major performers of S&T activities is summarised by segment in the following table.

Segment	Private (Rm)	%	Public (Rm)	%	Inter- national (Rm)	%	Total (Rm)	%
Science Councils Universities Technikons Government NHIs NGOs <sup>2)</sup>	404 2 726 506 - 24 381	10,0 67,5 12,5 - 0,6 9,4	987 2 737 786 654 88 167	18,2 50,5 14,5 12,1 1,6 3,1	80 - - - 10	88,8 - - - - 11,2	1 470 5 464 1 292 654 112 558	15,4 57,2 13,5 6,9 1,2 5,8
TOTAL	4 041	100	5 419	100	90	100	9 550	100

TABLE 3.1S&T PERFORMERS : GROSS INCOME 1)

Note : 1)Valid for median year 1995/962)Includes NGOs and private sector research organisations

Total spending on S&T activities by the six different sectors amounts to R9,55 billion. Due to the dominance of education and training activities at the HEIs, the segment accounts for over 70% of total S&T spending. In total, spending on education and training activities by HEIs amounts to over 90% of income. Should education and training at HEIs be disregarded for argument's sake, a clearer picture of S&T spending on research and development, as well as S&T support activities looks as follows :

Ľ	Total	:	R3	370 m	(100%)	
Ľ	NGOs	:	R	558 m	(16%)	
Ľ	NHIs	:	R	112 m	(3%)	
Ľ	Government		:	R 654	4 m	(19%)
Ľ	HEIs	:	R	575 m	(17%)	
Ľ	Science Councils	:	R1	470 m	(44%)	

A more detailed breakdown, by type of S&T activity, is discussed in Chapter 4, Section 4.1.1.

From an overall perspective (refer Table 3.1), the breakdown of income by source is as shown in the following table.

Segment	Source					
	Private (%)	Public (%)	International (%)			
Science Councils	28	67	5			
Universities	48	52	-			
Technikons	39	61	-			
Government	-	100	-			
NHIs	21	79	-			
NGOs <sup>2)</sup>	68	30	2			
TOTAL	42	57	<1			

TABLE 3.2S&T PERFORMERS : SOURCE OF INCOME 1)

Note : 1)Valid for median year 1995/962)Includes NGOs and private sector research organisations

On average, 57% of the operating income of S&T performers is derived from the public sector, mainly in the form of parliamentary grants, departmental transfers and/or contract funding. In the case of the Science Councils and HEIs, contract income and student fees are, by necessity, growing sources of private income. Various government entities still account for the relatively high percentage of 30% of the income of NGOs. Only in the case of Science Councils is international income a sizeable proportion of total income.

#### 3.2 Staff Profile

The total number of staff and staff breakdown of performers of S&T activities is summarised by segment in the following table. A clearer breakdown by staff and other suitable categories will be available from the separate Human Resources Survey.

Segment	Staff Category										
	Professional/ Technical Support	Admin	Unskille d Labour	Unspecified	Total						
Sajanga Councila	7 065	2 466	000	406	11 660						
Universities	7 903	2 400 8 207	032	400	11 009						
Universities	14 362	8 307	8677	5 327	36 / 53						
Technikons	3 732	2 733	2 185	-	8 623						
Government	5 521	41	-	701	6 263						
NHIs	448	128	232	977	1 785						
NGOs <sup>2)</sup>	1 231	228	168	3 994	5 641						
TOTAL	33 259	13 903	12 094	11 405	70 734						
%	47	20	17	16	100						

TABLE 3.3 S&T PERFORMERS : STAFF PROFILE <sup>1)</sup>

# Note : 1)Valid for median year 1995/962)Includes NGOs and private sector research organisations

The high number of staff classified as unspecified resulted from the inability/ unwillingness of surveyed organisations to provide information as requested, and it should thus be interpreted as possibly also including some of the other categories.

The surveyed S&T performers employ just over 70 000 people, about half of whom are categorised as professional and/or technical support staff. The annual turnover per capita (excluding unskilled labour) in each of the segments under consideration provides an interesting comparison, albeit a very subjective one :

Ł	Average turnover	:	R160 000
Ľ	NGOs	:	R100 000
Ľ	NHIS	:	R 75 000
Ľ	Government		: R105 000
Ľ	Technikons	:	R200 000
Ľ	Universities	:	R200 000
Ľ	Science Councils	:	R170 000

The annual average turnover of R160 000 per capita equates to roughly half of that of the professional services industry.

# 3.3 Major Clients/Funders

The major clients of the entities included in the S&T Infrastructure Survey are listed in the computerised database developed for DACST by the CSIR. A generic grouping of clients by category of organisation is given below.

## 3.3.1 Government Sector

The S&T performers in the government sector typically do not have external clients in the true sense of the word and undertake S&T activities for the public good and in support of other government functions.

## 3.3.2 National Heritage Institutions

The major external income streams are generated from the following funding sources :

- $\measuredangle$  Agency funding from the FRD and the HSRC.
- Local and international S&T community and the general public.
- Local donors, including companies and corporations, trust funds, etc.
- *«* International donor institutions.
- Government departments and agencies, such as DACST, Water Research Commission, etc.

# 3.3.3 NGOs

The NGO segment consists of two distinct sub-segments, the first comprising organisations that champion a specific cause, e.g. education, race relations, land and agriculture policy, etc., and the second consisting of non-government organisations that perform S&T in a given sector, e.g. the sugar industry, the forestry sector, etc. The first sub-segment relies mainly on donors, whereas the second has more traditional client groupings. Client groupings for both groups are listed below :

- International donors, e.g. Danced, ODA, IDRC, NORAD, EU, AusAid, CIDA, etc.
- Local donors, consisting of companies such as Eskom, Anglovaal, Liberty Life, etc, and trust funds/foundations such as the Anglo-American/De Beers Chairman's Fund, the DG Murray Trust, the Independent Development Trust, the Henry Kaiser Family Foundation, etc.
- Clients in the industrial sector, e.g. Eskom, Sasol, Sappi, Illovo Sugar, Tongaat-Hulett Sugar, Transvaal Sugar, the sugar growers, subtropical fruit growers, etc.
- Government, including individual government departments, provincial governments, the constitutional assembly, local authorities, etc.
- Industrial associations, e.g. the SA Timber Growers Association, the SA Wattle Growers Association, the Forest Owners Association, etc.
- Solution Users that pay a levy for a commodity or service.
- $\varkappa$  The public at large.

# 3.3.4 Science Councils

In this segment, it is possible to distinguish between the Science Councils *per se* and the national research facilities. These two groupings are dealt with separately below. **Science Councils :** The client groupings reflect the outputs of these organisations, which are strongly focused on the following :

- Industrial development outputs
- Decision-supportive outputs
- Reconstruction and development outputs.

Chapter 5 provides a more detailed description of such key outputs. The client groupings for the Science Councils are as follows :

- Parliament, which provides funding to the Science Councils for general positioning research. This amounts to about R1 billion per annum, or more than 60% of the collective gross income of all Science Councils.
- Generic funders, which fund specific Science Councils to undertake contract research on behalf of groups of beneficiaries, e.g. the red meat industry, the water industry, etc.
- Contract research clients, which could be in either the private or public sector.

Collectively, for all three of these types of clients, the breakdown of sources of funding is as follows :

Ľ	Public sector		:	67%
Ø	Private sector	:	28%	

✓ International clients : 5%

**National research facilities**: These facilities are maintained by the FRD through the parliamentary grant because of their widespread application and, in most cases, the inability of clients to foot the bill for the maintenance of expensive facilities. The client groupings are :

- Research scientists, both local and international, including students.
- Universities and technikons (as part of their responsibility for human resources development).
- Industry e.g. De Beers, Mintek, etc.

## 3.3.5 Technikons

The technikons are largely funded by government, basically for their

education and training function. This is supplemented by student fees. In addition, the following client groupings can be discerned :

- Agency funding, typically through the HSRC (CSD) and FRD.
- Private sponsorships, industrial grants and international donor funding.

#### 3.3.6 Universities

As with the technikons, the universities receive government funding, largely for their education and training function. This is supplemented by student fees. The following additional client groupings can be discerned :

- Agency funding through the FRD, HSRC (CSD) and MRC.
- National and international donor funding, e.g. from NGOs, trust funds/foundations and international aid agencies.
- Local, provincial and national government funding, for specific S&T initiatives/projects.
- Clients in industrial sectors, e.g. Pretoria Portland Cement, Volkswagen, Gencor, SAB, Iscor, etc.
- Science Councils.

# 3.4 Capital Investment

The total capital investment in the scientific and technological infrastructure is summarised by segment in the following table.

Segment	Capital Investment (Rm)									
	Buildings	Equipment	Other	Unspecified	Total					
Science Councils Universities Technikons Government	54 2 579 948 n/a n/a	4 1 238 245 66 n/a	25 873 86 5 n/a	358 1 423 390 101 36	441 6 113 1 669 172 36					
NHIS NGOs <sup>2)</sup>	75	42	103	63	283					
TOTAL	3 656	1 595	1 092	2 371	8 714					

# TABLE 3.3 S&T PERFORMERS : CAPITAL INVESTMENT 1)

*Note*: 1) Valid for median year 1995/96

#### 2) Includes NGOs and private sector research organisations

The figures shown reflect book values and account for more than 90% of the total fixed investment in the S&T infrastructure. A number of organisations were unable to provide the required information, hence the unspecified column in the table. The category "other" reflects investment in assets such as books, paintings, africana, movable assets, furniture, etc. Assuming that some components of unspecified assets could also include equipment, it is concluded that the total investment in S&T equipment is between R1,5 and R2,5 billion. Greater clarity on this aspect will only become available on the basis of the results of the Research and Training Equipment Survey.

The average ratio of annual turnover to capital investment of approximately 1:1 relates poorly to ratios of 3–4:1 as generally experienced in the professional services industry. The average ratio is, however, significantly influenced by the HEIs, with the other segments achieving higher ratios.

#### 4 **S&T ACTIVITIES AND FOCUS**

#### 4.1 Performers of S&T

# 4.1.1 Types of S&T Activity

With reference to the earlier definition of S&T activities, the following table provides a breakdown of S&T spending by the three major types of activities.

Segment	Research and Development		Educatio Train	tion and Other ining Activ		S&T ties	Total	
	Rm	%	Rm	%	Rm	%	Rm	%
Science Councils	728	48	38	<1	704	41	1 470	15
Universities	566	38	4 898	78	-	-	5 464	57
Technikons	9	<1	1 282	20	-	-	1 292	14
Government	55	4	54	1	545	31	654	7
NHIs	14	1	5	<1	93	5	112	1
NGOs <sup>2)</sup>	127	8	34	<1	397	23	558	6
Total	1 499	100	6 311	100	1 739	100	9 550	100
%	16	-	66	-	18	-	100	-

**TABLE 4.1** S&T SPENDING BY ACTIVITY 1)

**Note** : 1)

Valid for median year 1995/96

2) Includes NGOs and private sector research organisations

The S&T infrastructure comprises both public and non-government organisations that perform S&T activities and produce outputs as an end in themselves or on contract for others to the value of R9,55 billion. These activities were grouped into three major types :

#### **Research and Development** Ľ

This includes all R&D and accounts for 16% of the total, or R1,5 billion in value. This is roughly equivalent to 0,3% of South Africa's GDP. The major performers of R&D activities are the Science Councils and universities, together accounting for more than 85% of the total.

Whilst no historical data on the various segments was gathered, it is evident that the availability of funding for R&D activities is declining, with other income streams being afforded higher priority. This is particularly so at the Science Councils and HEIs.

## **Education and Training**

This includes both education and training undertaken for academic purposes by the HEIs and in-house training activities performed by mainly government departments. The former segment accounts for 98% of the total spending on education and training. In total, education and training activities account for 66% of total S&T spending.

## Source States St

This category accounts for 18% of all S&T activities in value terms and includes a variety of activities including largely the generation, dissemination and application of scientific and technical knowledge and information. A detailed breakdown in terms of four major sub-categories is as follows :

Ľ	Generation of Information :	R	500 m
			(29
			%)
Ľ	Deployment of Knowledge :	R1 028 m	(59%)
R	Standards and Guidelines :	R 184 m	(11%)
Ľ	Patents and Licensing :	R 27 m	(1%)
	Total :	R1 739 m (100%	%)

The Science Councils (41%), government departments (31%) and non-government organisations (23%) are dominant in this regard. Activities undertaken mostly by museums, to the value of R93 million, should not be disregarded, however.

## 4.1.2 Major Fields of Application

Disregarding the large component of predominantly academic education and training activities of the HEIs (refer Table 4.1 for total of R6 180 million), the balance of R3 370 million of S&T spending is accounted for by the following ten fields of application (see Table 4.2)

With regard to the focuses of the six segments under consideration, the following points are worth mentioning :

- Science Councils : The activities of this segment centre around mainly applied technologies, agricultural sciences, engineering sciences and medical and health sciences.
- Universities : Four disciplines, namely medical and health sciences (21%), social sciences (19%), humanities (17%) and life

and physical sciences (21%) account for the bulk of university R&D of about R566 million. This figure represents 10% of the total operating income of universities.

#### S&T INFRASTRUCTURE

Segment							Field of Ap	plication (F	tm)	
		Agricul- ture	Enginee- ring	Info & Computer	Medical/ Health	Mathe- matics	Techno- logy & applied sciences	Social	Econo- mics	Humanitie
Science Councils	Rm	369,5	199,4	50,6	71,9	0,0	541,8	96,3	1,4	2
	%	25,1	13,6	3,4	4,9	0,0	36,9	6,5	0,1	(
Universities	Rm	17,9	44,6	6,6	117,4	17,7	12,3	107,8	27,5	93
	%	3,2	7,9	1,2	20,8	3,1	2,2	19,1	4,9	16
Technikons	Rm	0,3	3,1	0,6	0,6	0,6	0,4	0,7	1,3	1
	%	3,7	32,5	6,7	6,1	6,4	3,7	7,4	13,5	11
Government	Rm	208,6	22,9	47,9	14,2	4,6	0,1	74,4	139,8	27
	%	31,9	3,5	7,3	2,2	0,7	0,0	11,4	21,4	2
NHIS	Rm	0,0	0,0	0,0	0,0	0,5	0,0	7,6	0,5	30
	%	0,0	0,0	0,0	0,0	0,4	0,0	6,8	0,4	27
NGOs 3)	Rm	74,7	96,7	3,7	252,2 <sup>2)</sup>	0,0	31,0	41,6	0,0	(
	%	13,4	17,3	0,7	45,2	0,0	5,6	7,5	0,0	(
Total	Rm	671,1	366,7	109,2	456,3	23,3	585,5	328,4	170,5	154
	%	19,9	10,9	3,2	13,5	0,7	17,4	9,7	5,1	4

# TABLE 4.2 S&T SPENDING BY FIELD OF APPLICATION 1)

Note : 1)

Valid for median year 1995/96 Mostly from SAIMR

2) 3)

Includes NGOs and private sector research organisations

27

- Technikons : Whilst R&D spending at technikons is relatively low (less than 1% of operating income), it is fairly evenly spread among all disciplines, with engineering and economic sciences the most prominent.
- Government : The activities of this segment centre largely around mainly the agricultural sciences (32%), economic sciences (21%) and life and physical sciences (17%).
- National Heritage Institutions : These organisations collectively focus largely on life and physical sciences (65%) and humanities (27%).
- NGOs: The S&T activities of this segment are dominated by the medical and health sciences (45%), with agricultural sciences (13%), engineering (17%) and life and physical sciences (10%) also significant.

An overview of responsible segments by major fields of application indicates the following :

Agricultural Sciences :	Science Councils (55%); Government (31%)				
Engineering Sciences :	Science Councils (54%); NGOs (26%)				
Information & Computer Scienc	es : Science Councils (46%); Government (44%)				
Medical and Health Sciences :	SAIMR (55%); Universities (26%); Science Councils (16%)				
Mathematics :	Universities (75%)				
Applied Technologies :	Science Councils (93%)				
Social Sciences :	Universities (33%); Science Councils (29%); Government (23%)				
Economics :	Government (82%)				
Humanities : Univ	versities (60%)				
Life and Physical Sciences :	Science Councils (27%); Universities (24%); Government (23%); NHIs (15%)				
	Agricultural Sciences : Engineering Sciences : Information & Computer Science Medical and Health Sciences : Mathematics : Applied Technologies : Social Sciences : Economics : Humanities : Univ				

While the above indicate the potential for significant overlap and duplication, this aspect will become clearer on the basis of the results of the *Scholarship*, *Research and Development Survey*.

# 4.2 Funders of S&T

# 4.2.1 Recipients of S&T Funding

The table below summarises the data on recipients of S&T funding. The higher education institutions (HEIs) are by far the largest recipient of S&T funding, primarily from the central government budget. If the HEIs are excluded, the Science Councils and the NGOs receive 75% of all S&T funding outside of government funding to HEIs.

With reference to Table 4.3, it is important to note that Science Council funding is in essence also government funding. These Science Councils (FRD, HSRC, MRC) serve basically in an agency role and only transfer funding received from government. The important task of prioritisation is undertaken as part of the agency role of the Science Councils concerned.

Funding Organisation		Recipients of S&T Funding (Rm)								
	Science Council s	HEIS	NHIS	NGOs <sup>2)</sup>	Bursaries & Grants	Other	Total			
Science council funding (agency)	-	86,7	12,3	1,2	-	1,8	102,0			
Government funding (transfer)	786,9	4 483,9	43,7	503,3	190,5	127,7	6 136,0			
NGO Funding	42,6	81,6	-	167,4	1,7	60,5	353,8			
Total Funding	829,5	4 652,2	56,0	671,9	192,2	190,0	6 591,8			
%	12,6	70,6	0,8	10,2	2,9	2,9	100			

TABLE 4.3 RECIPIENTS OF S&T FUNDING<sup>1)</sup>

Note : 1)

Valid for median year 1995/96

2) Includes NGOs and private sector research organisations

# 4.2.2 Types of S&T Activity

The table on the following page summarises the data on the types of S&T funded. The main emphasis of government and Science Council funding is on education and training, with R&D taking second place. For NGOs, the most important focus is on R&D, with other S&T activities and education and training less important but of about equal weight. The most important *"other* 

*S&T activity*" for NGOs is in the standards and guidelines area, where policy - related issues are lumped.

Funding Organisation	5-Point Scale			
	R&D	Education & Training	Other S&T Activities	
Science Council Funding	4,0	4,3	2,7	
Government Funding	4,0	5,0	3,5	
NGO Funding	4,0	2,6	2,8	

TABLE 4.4 TYPES OF S&T ACTIVITY FUNDED

Note: 5-Point scale

S Strong focus

∠ 3 Average focus

∠ 1 Low importance

#### 4.2.3 Major Fields of Application

Table 4.5 contains information about funding focus with respect to major fields of application. This table includes the government funding to HEIs for education and training, which amounts to R4 243 million.

In comparing the funding emphasis of each of the three segments, the following is evident :

- The Science Councils are, from a public funding perspective, responsible for the funding of R&D activities related to the information/computer sciences, and mathematics.
- Government funding of R&D activities centres on largely the following mainly via the Science Councils and state corporations :

Ś	Agricultural Sciences	:	16%
Ľ	Applied Technologies	:	36%
Ľ	Social Sciences	:	23%
Ľ	Life/physical Sciences	:	16%

NGO funders are largely responsible for funding humanities (96% of total), information and computer science (62% of total), economics (39% of total), engineering (24% of total), medical/health sciences (26% of total) and life/physical sciences (19% of total). In other areas, their contribution is relatively insignificant.
#### S&T INFRASTRUCTURE

## TABLE 4.5 S&T FUNDING BY MAIN FIELD OF APPLICATION <sup>1)</sup>

Segment		Field of Application (Rm)							
	Agricul- ture	Enginee- ring	Info & Computer	Medical/ Health	Mathe- matics	Techno- logies & applied science	Social	Econo- mics	
Science Council Funding	7,44	14,96	2,29	4,32	4,32	3,24	13,16	1,13	
Government Funding	317,87	74,40	0,00	51,82	0,00	714,83	436,04	37,08	
NGO Funding	26,55	28,01	3,82	19,50	0,00	35,74	51,00	24,56	
Total Funding	351,86	117,38	6.11	75,64	4.32	753,81	500,20	62,77	
%	5,3	1,8	0,1	1,1	0,0	11,4	7,6	1,0	

*Note*: 1) Valid for median year 1995/96

#### 4.2.4 Output Rationale

With reference to the Growth, Employment and Redistribution (GEAR) strategy of the government, six key elements were measured, on a five-point scale (see Table 4.6). The values for government funding were not filled in by the respondents, but estimated averages were added by LHA to allow a comparison.

Table 4.6 shows that the main reasons for S&T funding of the various groups of funders are :

- Science Councils : Capacity building
- Second Se
- NGOs : Economic growth International competitiveness Capacity building.

## TABLE 4.6OUTPUT RATIONALE FOR S&T FUNDERS

Funding Organisation	5-Point Scale							
	Meeting Basic Needs	Economic Growth	Capacity Building	Democratising State/Society	Implemen- ting the RDP	International Competitive- ness		
Science Council Funding	2,7	2,7	4,7	2,0	3,0	3,3		
Government Funding	4,5	4,0	4,5	4,0	4,0	3,0		
NGO Funding	3,2	4,1	3,4	1,7	2,6	3,4		

Note : 5-Point scale

ي 5 Strong focus

∠ 3 Average focus

*z* 1 Low importance

Overall, capacity building and meeting basic needs appear to be the main emphasis of government funding organisations.

## 5. CONTRIBUTION OF THE S&T INFRASTRUCTURE

## 5.1 Goals and Objectives

The goals and objectives of the categories of S&T institutions are very uniform per category and are summarised below.

#### 5.1.1 Government Sector

- Establishment and maintenance of up-to-date information systems to provide accurate, reliable, appropriate and timely management, research and surveillance information.
- Sector Coordination and facilitation of policy development.
- Creation of an environment that is conducive to the promotion of industrial development.
- Supply of and upholding of scientific services of national impact, e.g. weather and climate research and services, agricultural services, national diseases, hydrology and water supply, etc.
- Focus on development of technology to support the achievement of the new economic and development priorities of South Africa.
- Establishment and maintenance of national norms and standards.

## 5.1.2 National Heritage Institutions

- ? The collection, conservation and study of national heritage materials, to enable a better understanding of the future through the interpretation of the past.
- ? Develop and strengthen the capacity of communities to participate in heritage management.
- ? Foster a culture of learning and enlightenment and increase understanding for and tolerance of the diverse elements of South African society.

## 5.1.3 Non-Government Organisations (NGOs)

- Promote public dialogue and coordination, and initiate, support, assist and encourage investigations into matters related to the public good, in support of policy formulation.
- ? Facilitation and promotion of technology education and training, e.g. of documentation methodology, human rights norms and concepts and other public good issues.
- ? Execution of large-scale, multi-disciplinary, community-based research projects.
- ? Gathering and dissemination of accurate research data on public consumption patterns, water research needs and priorities, our African neighbours, etc.
- ? Perform R&D to develop new technologies, products, processes and services to improve the competitiveness of particular industrial sectors.

#### 5.1.4 Science and Technology Funders

- ? The development and maintenance of research institutions, research culture and research capacity.
- ? Enhanced access for the disadvantaged sectors of the South African economy to infrastructure and the maintenance of momentum with the development process.
- ? The establishment, management, maintenance and expansion of a balanced R&D portfolio for South Africa in support of our growth, employment and redistribution strategy.
- ? The promotion of the interests of particular industrial sectors.

## 5.1.5 Science Councils

- ? To play a leadership role in the planning, coordination and execution of research programmes and portfolios aimed at supporting the growth, employment and redistribution strategy of South Africa.
- ? Development of research programmes and portfolios aimed at the competitiveness of industry and better decision making.
- ? To perform world class research, to facilitate science capacity building and to foster a science culture.
- ? To provide world class facilities for use by any researchers in South Africa or internationally.
- ? Develop and publish S&T indicators and manage S&T information databases.

#### 5.1.6 Technikons

? To maintain education and training institutions with a career-focused training philosophy.

## 5.1.7 Universities

- ? Create an equitable, enabling learning environment (with academic freedom and equal access for all to information) that fosters academic excellence and leads to the dissemination of findings through teaching and learning, for the benefit of society.
- ? Develop community linkages which will enrich the mission of the universities to develop, maintain and implement sustainable curricula.
- ? Make university education accessible to potential students in all geographic areas of South Africa.
- ? Equip students to take positions in the public and/or private sector and produce the leaders of tomorrow.

## 5.2 Key Outputs

The key strategic outputs as listed by the performers of S&T activities are grouped and categorised *per sector* below.

#### 5.2.1 Government Sector

This sector comprises government departments, directorates, provincial agricultural departments and research organisations falling inside government, such as the Sea Fisheries Research Institute. In total, 88 such entities were surveyed. The focus of S&T activities in the government sector is strongly on information management and activities in support of policy formulation. Details are given below. The outputs have been grouped generically, and should be read against the breakdown of S&T activities, as assessed by the respondents. Generation of information, which includes information management, is indeed representative of over 50% of the S&T activities undertaken in and by government.

The following generic grouping was made of the stated strategic outputs.

**Information management :** Information management is assumed to include the gathering of data, information dissemination, data development, maintenance of databases and related activities.

Some typical examples of such outputs are :

- EXE The population census and the dissemination of census results.
- **KE** The compilation of an environmental atlas for South Africa.
- See Operation of interactive databases, e.g. on crime statistics, crime information management, etc.
- Establishment of geographic information systems which allow integration of data from various government departments.
- **Data quality control initiatives.**

**R&D in support of policy development :** One of the main functions of government is the development and maintenance of legislation, policies and guidelines in accordance with the SA Bill of Rights. This set of outputs includes R&D in support of this government function. Some typical examples are :

- Restitutional land rights, tenure rights, etc.
- Mine Health and Safety Act.
- Sectoral industrial policy development.
- KK Working environment safety guidelines.
- EXE Development of norms, standards, guidelines.
- The Foresight Programme.
- EXE Technology and industry.

Education and Training : Includes the education and training of public servants, which is directly in support of the democratisation of state and

society, as well as guidance and guidelines in the setting of curricula for primary, secondary and higher education. Some examples of typical outputs are :

- العام Development of curricula.
- **EXE** Full-time and advanced technical training.

**R&D Services :** In some instances in-house R&D in government departments or institutions is in support of other activities of such departments, etc., and also makes meaningful contributions to the international body of knowledge. Some examples in this respect are :

- SE Occupational health dependencies.
- Agricultural research, such as agricultural economics, etc.
- طره Climatology prediction capability.
- **Conservation of marine ecosystems.**
- العام R&D on SAAF clothing.
- العام Water quality assessments, etc.

**Deployment of knowledge :** Typically includes S&T activities which make use of R&D outputs to facilitate the use of government S&T results to achieve benefits outside of government. Some examples are :

- **EXE** Implementation of systems, e.g. Health Systems.
- Scientific support for sportsmen.
- EXE Forestry for rural communities.
- Advisory services re Acts of Parliament.

#### 5.2.2 National Heritage Institutions

This category includes mainly museums, and contains a total of 17 entities. Typically the activities of national heritage institutions consist of collection, conservation, research, publication and education. The main focus of these institutions is therefore also on the establishment and maintenance of specialised collections, with a secondary but related emphasis on education and training. The outputs can generically be grouped as follows :

**Management of Specialised Collections :** Contains all elements of the generation of information which are related to specialised and/or unique collections. Outputs are typically the following :

- EXE Collection and conservation of material
- Background research re collection material
- Specialised databases
- **Dissemination through publications, exhibitions, seminars and conferences.**

**Research, Education and Training :** Includes focused own research and educational issues, such as :

- الا الحريقة Educational programmes
- Specialised research topics, e.g. fish research.

### 5.2.3 Non-government Organisations (NGOs)

This category includes NGOs with an S&T component and S&T organisations outside of government. A total of 28 entities were surveyed. The following terminology is used herein to partly describe the outputs, since it represents a useful generic summation, namely

- a) Industrial development outputs; which include research outputs with the purpose of improving the competitiveness of the recipients, such as an industry, for example. Examples are given below.
- **b) Decision supportive outputs;** which cut across private and public sector activities and include research outputs that contribute to better decision making; and
- c) Reconstruction and development outputs; which include research outputs that contribute directly and/or indirectly to the development of South Africa, specifically in the meeting of basic needs.

Over and above these three categories of outputs, two other groups of research outputs are identified, namely :

# R&D in support of the formulation of standards, policies, guidelines and legislation and

#### Education and training.

Examples of specific outputs in these categories are as follows :

#### Industrial development outputs

- Industry-focused R&D to improve competitiveness of particular industries, e.g. curing of hides and skins, waste destruction units, waste water treatment package plants, etc.
- A variety of outputs in the agricultural sector, such as new citrus cultivars with improved shelf life, new sugar cane varieties, subtropical fruit industry, horticultural processes, new root stock, post harvest treatment re exports, disease control in table grapes, etc.

#### **Decision supportive outputs**

- R&D re national sexually transmitted disease control.
- EXE Publication of relevant national and regional statistics.
- ビビ Hydrological information system.
- د المعند Coal characterisation database.
- Reports, memoranda, research reports, publications and R&D in support of strategic decision making.

#### **Reconstruction and development outputs**

- **Consultative orientation process.**
- SE Outreach to coastal communities.
- EX Health promotion.
- العام Urban research agenda for SA.
- SE Water treatment package plants.
- SE Water quality management processes.
- **KE** Creation and sustaining of interest in R&D re national diseases.
- EXE Photovoltaic electrification system.

## R&D in support of formulation of standards, policies, guidelines and legislation

- SE Briefing, policy and working papers.
- Monitoring of parliamentary legislation.

#### **Education and training**

- **EXE** Implementation plans for education and training.
- R&D re distance learning and education and training programmes for industry.
- Human resource development through formal and informal education and training at all levels.
- **Training and research related to health and health systems.**
- R&D related to international trends in the use of technology in educational materials.
- د المعنى Language programmes, etc.

#### 5.2.4 Science Councils

This grouping includes the 8 science councils and the 3 national facilities of the FRD, i.e. in total 11 entities. The list of strategic outputs received for the science councils is substantially longer than that for all other sectors together. However, the generic types of output are much more

homogeneous than those for the other sectors. Therefore, the listed outputs are relatively short.

#### Industrial development outputs

- A multiplicity of products, processes and services to improve competitiveness of both industrial sectors and individual companies, in virtually all sectors of the South African industry, including the aeronautical, agricultural, communications, construction, food, information, manufacturing, materials, medical and health, microelectronics, minerals beneficiation and mining sectors.
- Establishment of standards and quality control guidelines to improve and maintain product quality.

#### **Decision supportive outputs**

Establishment of processes, procedures and services to facilitate decision making and policy formulation, amongst others related to environmental issues and participatory decision making.

#### **Reconstruction and development outputs**

A multiplicity of processes, services and products aimed at facilitating the reconstruction and development process in South Africa, such as R&D aimed at a national and household food security programme, low cost housing materials and construction methods, infrastructure development products, small-scale mining methods, facilitation and participatory decision making methods, etc.

#### **Research capacity building**

- **Developing high-power human capacity and facilitative environments to achieve it.**
- Competitive research infrastructure. Research capacity through publication of research findings internationally in peer review journals.

#### 5.2.5 Technikons

In total, 12 entities were surveyed. Apart from the education and training function of the technikons, their research outputs have a very applied nature, which corresponds with the applied technology framework of the Science Councils very well.

#### Industrial development outputs

Typical strategic outputs listed include :

- Process technology outputs, e.g. separations technology, process control, intelligent industrial control, materials chemistry, signal processing, materials in manufacturing, computer integrated manufacturing, etc.
- العام المعامة Information technology outputs.
- Technologies related to game farm management, horticulture, food management, etc.

#### **Reconstruction and development outputs**

Typical strategic outputs listed are :

Health care for developing society, solar energy for developing communities, low cost nutritional enrichment, renewable energy, paramedical technology and health care, etc.

#### Education and training

Only referred to obliquely, and only as related to distance education technology.

#### 5.2.6 Universities

In total, 21 entities were surveyed. The key strategic outputs listed for the Universities reflect a balance between the development of human and research capacity and the development of solutions to national problems.

#### Industrial development outputs

Typical outputs are :

- Image: Second Second
- Medical/health related outputs, e.g. specific R&D results re human genetics, sperm mobility quantification, the Klinolab, already patented in Canada, etc.
- R&D focused on the manufacturing industry, e.g. materials modelling environmental chemistry, R&D for the Micro-satellite project, water pollution technology, etc.

#### **Reconstruction and development outputs**

Typical strategic outputs are :

Social R&D, e.g. social/economic interactions, motivational therapy technologies, etc.

R&D programmes with strong RDP links.

#### Research capacity

Typical strategic outputs listed include :

- Establishment of a research culture, with typical outputs such as publications, degrees, research articles, academic advancement and multi-organisational research centres.
- Education and training *per* se, leading to capacity building.
- Specific research outputs, e.g. marine discovery, contributions to national research programmes such as the Benguela ecology programme, etc.

#### **R&D** in support of policy formulation

Examples quoted are that of the Constitution, Property Law and Land Reform.

## 5.3 Output Rationale

The subjective rating of output rationale for S&T activities, as supplied by the respondents, is given in Table 5.1. The most important findings of this assessment are :

Areas where the groups of organisations focus strongly :

Science councils	: -	Competitiveness, industrial development and economic growth
Universities and Technikons	: -	Capacity building
Government Sector	: -	Meeting basic needs and economic growth
NHIs and NGOs	: -	Meeting basic needs.

It would appear that all groups of organisations see the importance of GEAR and have key focus areas in the various building blocks of GEAR. Areas where the S&T groupings do not focus are :

Democratising state and society	: -	Generally low focus
Economic growth and competitiveness	: -	NHIS
Implementation focus		: - NHIs and technikons

#### **TABLE 5.1 OUTPUT RATIONALE FOR S&T PERFORMERS**

Funding Organisation	5-Point Scale						
	Meeting Basic Needs	Economic Growth	Capacity Building	Democratising State/Society	Implemen- ting the RDP	International Competitive- ness	
Science Councils	3,7	3,4	3,9	2,3	3,5	4,3	
Universities	3,3	3,5	4,0	3,8	3,6	3,5	
Technikons	3,5	3,5	4,5	-	0,4	2,0	
Government Sector	3,4	3,5	3,4	2,8	3,3	0,1	
NHIs	3,7	-	2,7	0,3	-	1,9	
NGOs <sup>1)</sup>	3,6	2,4	3,3	2,6	3,3	2,8	

Note : 1) Includes NGOs and private sector research organisations

Note : 5-Point scale

∠ 5 Strong focus
∠ 3 Average focus
∠ 1 Low importance

## 6 ASSESSMENT OF THE PUBLIC S&T INFRASTRUCTURE

### 6.1 Introduction

The South African scientific and technological (S&T) infrastructure is a R11 000 million *"industry"*, 85% of which was covered in this survey. The balance includes government funding of state corporations (e.g. AEC), miscellaneous education and training activities and capital expenditure. The business sector is not addressed at all, and is part of a separate survey. The estimate of business sector S&T should be added to the R11 billion quoted above.

In essence thus this survey provides an all-encompassing overview of S&T activities, both funded and performed, by each of the following categories of organisations :

- と
  だ
  Science Councils
- ビビ Higher Education Institutions
- KK National Heritage Institutions
- SE Government
- **KE** Non-government Organisations.

The main characteristics of the *"industry"* covered in this LHA survey are summarised briefly below :

- تعامل Turnover of R9,55 billion, some 57% of which is public sector funds.
- Employment of about 71 000 people, with 47% of these classified as professional and technical support staff.
- Capital investment of nearly R9 billion, implying an average ratio of annual turnover to capital investment of approximately 1:1.
- Higher education and training dominating S&T activities in terms of spending (66%), with research and development (16%) and other S&T activities (18%) sharing the balance.
- With regard to the latter two categories of activities, natural sciences account for 80% and human sciences for 20% respectively.
- Government (treasury) accounts for 95% of generic funding of S&T (R6,2 billion), with the balance accounted for by student fees, contract income and income derived from investments and donations.

The information relating to the pattern of S&T funding and performing activities provides all stakeholders in the "*industry*", especially government as a major funding and policy-making body, with new insights as to the importance of balancing socio-political considerations with the need to increase South Africa's international competitiveness and economic growth

potential.

## 6.2 Reconciliation of the South African S&T Infrastructure

One of the basic pre-conditions for the strategic coordination of the S&T infrastructure is to understand the flows of funds from funders to performers, the nature of S&T and the disciplinary focus of the S&T performed.

As a first step towards such an understanding, a pro-forma balance sheet was developed and is presented in Table 6.1. It shows that the performance survey picked up about 85% of the S&T performed and also outlines those areas outside the scope of the LHA survey that account for the other 15%. In the funding part of the LHA survey, 60% of the total funding was accounted for. Of the remaining 40%, student fees account for 28%, and government's own research, government-contracted research and other private sector funding for 12%. All these percentages can be derived from information supplied in the S&T performer survey. Table 6.1 (on the following page) also shows that the total S&T performance estimate of R11 100 million differs from the total S&T funding estimate of R11 400 million by about 3%. This discrepancy can be explained by :

- Not all the 189 organisations surveyed supplied data for the same financial year, although most data sets reflect data from either 1995/96 or 1996/97.
- Some of the government-contracted S&T on the funding side could also have been included on the performance side, thus giving rise to some double counting, which would not have amounted to more than R481million (about 4,5%).
- Inclusion of capital expenses as part of government funding, which is not accounted for in the performer survey. Here the HEIs are an exception, since their capital is reflected as a special item under the performance side of the balance sheet.

All in all, the extent to which the S&T performance and funding sides match is remarkable.

A second reflection of the South African S&T infrastructure is given in Figure 6.1, which graphically shows the focus by type of S&T and application area.

Figure 6.1 shows that applied technologies (an accumulation used mainly by the Science Councils to reflect their focus), agricultural sciences and medical/health sciences account for more than 50% of the S&T performed, excluding education and training. The figure also re-affirms the predominance of education and training as an S&T element. If this is to be excluded, research and development roughly account for 50% of the rest of S&T, followed by the deployment of knowledge at 30% and supported by the generation of information, which includes database management, at 15%.

## TABLE 6.1 : Reconciliation of S & T Performance and Funding as per LHA Survey <sup>1)</sup>



Ľ	Performing Arts Councils	R	94 m	
Ľ	Armscor	R	70 m	
Ľ	Higher Education & Training [Misc.]	R	521 m	
Ľ	Government S&T Initiatives, eg THRIP	R	50 m	
Ľ	Capital for HEIs	R	500 m	
Ľ	Miscellaneous other	R	30 m	

Estimated TOTAL S & T Performance ~ R 11 100 m

#### **S&T INFRASTRUCTURE**



Note : 1) Valid for median year 1995/96

## Figure 6.1 : S & T Focus<sup>1)</sup>

## A. All sectors : S & T Spending by application field

## B. Nature of S & T Spending for all sectors combined



*Note :* 1) Valid for median year 1995/96

## 6.3. SA's S&T Infrastructure in International Context

A comparison between the South African S&T infrastructure and its international counterparts can be undertaken at macro-level, to compare the general make-up of the S&T infrastructure or of its internal structure and to match specific S&T indicators with those for other countries. Where relevant, such comparisons are given below.

#### 6.3.1 Macro-perspective on S&T Infrastructure

The South African S&T infrastructure can be described in terms of welldefined groupings, i.e. Science Councils, Higher Education Institutions, Nongovernment Organisations, government S&T and National Heritage Institutions. As shown earlier in the report, each of these different groupings has well-articulated, broadly-defined visions, missions and goals and objectives. When comparing these elements between groupings, it appears as if there is some degree of complementarity. However, the output focus shows that quite considerable duplication of effort also occurs.

A look at the international best practice in this regard shows that numerous countries have strategic, direction-giving S&T bodies which guide/ oversee/coordinate S&T activities in their countries. Some examples are Japan, Taiwan, the USA, Finland and the Hashemite Kingdom of Jordan. The latter example is an interesting case in point. For the last three years, Jordan has scored roughly equal to South Africa in the World Competitiveness rankings, and has in fact been gaining on South Africa. Its economy is much smaller than that of South Africa, with a GDP of about US \$6 billion in 1995. It has a well-defined S&T "community", consisting of science councils, higher education institutions and other organisations very like our NGOs but with some state interest. Furthermore, over all of these performers they have a Higher Council for Science and Technology (HCST), with its Executive Council consisting of the Crown Prince, key cabinet ministers, the presidents of Science Councils, the president of the Amman Chamber of Industry and a few other relevant individuals.

The HCST Law of 1987 stipulates that the Council "aims at building the national science and technology base, and guiding and developing it for the purpose of achieving economic, social and cultural development in the Kingdom". In addition, the law states that the HCST is to "exercise its rights to set up a public policy of S&T, define its priorities, establish relevant S&T programmes and plans, follow up its implementation and evaluation and draw up a strategy appropriate for the development of the scientific and technological potential in the Kingdom".

Lofty words, but coming from a developing country in the same World Competitiveness league as South Africa, perhaps a goal for South Africa to ascribe to as well. The present S&T initiatives coordinated by DACST, of which the NRTA Audit is one, is a step in this direction. Finland is another example where the type of prioritisation referred to above for Jordan is taken down to specific objective level, e.g. development of technologies to make the Finnish forestry industry more competitive worldwide. Blocks of funding are allocated to such themes upon the acceptance of business plans for the envisaged S&T work. One of the key success factors in the Finnish system is the development of appropriate partnerships to bring the best team of specialists together for the research.

In the Netherlands, the Dutch government contracted Arthur D Little to help develop a technology map for Dutch business as one of the inputs to the development of a Dutch technology strategy, aimed at making the Netherlands more competitive internationally. The new strategy is poetically called "*Knowledge in Motion*". Key building blocks of the new strategy are the stimulation of in-company innovation and the enhancing of the synergy between the Dutch "*public knowledge infrastructure*" and industry with regard to R&D investments.

If one talks about the level of R&D funding, say as a percentage of GDP, South Africa is a small player. The table below contains R&D figures for the ten leading **companies** worldwide.

Company	Annual R&D Expenditure
General Motors	R22,6 bn
Ford Motor	R16,9 bn
Hitachi	R15,6 bn
Siemens	R15,5 bn
Matsushita	R12,3 bn
IBM	R11,0 bn
Daimler Benz	R10,9 bn
Fujitsu	R10,6 bn
Toshiba	R10,0 bn
Nippon	R 9,9 bn
South Africa	R 4,5 bn

#### TABLE 6.2 SOUTH AFRICA'S R&D EXPENDITURE IN THE CONTEXT OF INTERNATIONAL INDUSTRIAL R&D

One should bear in mind that the figures presented in this report exclude the business sector and public corporations. The figure for R&D as found here is about R1 500 million, which amounts to 0,3% of GDP.

The Business Sector Survey sampled 298 businesses, representing about 3% of the organisational entities in the manufacturing sector but importantly accounting for 37% of the turnover. The total R&D in these organisations equals about R1,1 billion. Depending on the method of extrapolation, this can lead to a total business sector R&D of between R2 billion and R4,5 billion. The statistics mentioned above tend to indicate that the survey focused primarily on large companies (3% of companies account for 37% of turnover). Therefore it is more than likely that simple extrapolation will overestimate the total business sector R&D, and the actual value is most likely in the range of R2 billion to R3 billion.

The World Competitiveness Yearbook 1996 (IMD/WEF, 1996) quotes the business sector's expenditure on R&D in South Africa for 1994 as US \$409 million. This would translate to R2,0 billion for 1996. The National Science Board (1996) quotes that more than 25% of all industrial R&D performed in the United States in 1993 was done in non-manufacturing firms. The impact of such a phenomenon on the South African business R&D figure is not clear, but given this fact, the value of business sector R&D for the purposes of this discussion is estimated at R3 billion. However, a more detailed analysis and extrapolation of the business sector R&D can be found in the separate report on the Business Sector Survey.

Using the above numbers, it would therefore appear that a total R&D figure of around R4 500 million is about the ballpark. This translates to 0,9% of the 1996 GDP. The same *World Competitiveness Yearbook 1996* quotes the total South African expenditure on R&D as US \$795 million, or R3 800 million in 1996 figures.

	Source	Best estimate <sup>1)</sup>
1	NRTA Audit ≪ S&T Infrastructure Survey ≪ Business Sector Survey (including some innovation) Best estimate	R1 500 m R3 200 m
	Gross expenditure on R&D	R4 700 m
2	World Competitiveness Yearbook 1996Image: Sector R&DImage: Sector R&DImage	R2 000 m R3 800 m

In summary, the various sources lead to the following estimates of gross expenditure on R&D.

*Note*: 1) Valid for median year 1995/96

49

The Yearbook also quotes R&D expenditure as a percentage of GDP. The following comparison is possible.

South Africa	North America		
South Africa	0.00/	North America	0.4494
S&T Infrastructure Survey	0,3%	USA	2,44%
(excludes business sector and public		Canada	1,45%
corporations)			
S&T Infrastructure expanded to include 0,9%		Leading Australasian Co	untries
business sector and public corporations			
World Competitiveness Yearbook 1996		Japan	2,88%
Public Sector	0,36%	Korea	2,29%
Business Sector	0,40%	Taiwan	1,80%
European Countries	0,76%	Australia	1,61%
Leading European Countries		Singapore	1,18%
Sweden	3,25%	New Zealand	0,89%
Switzerland	2,68%	China	0,50%
France	2,38%	Malaysia	0,17%
Germany	2,37%	Indonesia	0,16%
Finland	2,21%	Thailand	0,16%
United Kingdom	2,18%	Leading South American	Countries
Netherlands	1,87%	Chile	0,76%
Denmark	1,80%	Brazil	0,71%
Norway	1,74%	Venezuela	0,47%
Belgium	1,66%	Argentina	0,29%
Austria	1,53%		
Russia	1,35%		
Czech Republic	1,25%		
Ireland	1,22%		
Italy	1,21%		
Hungary	0,93%		
Spain	0,84%		
Portugal	0,65%		
Greece	0,49%		
Turkey	0,45%		

# TABLE 6.3R&D EXPENDITURE AS % OF GDP (GERD/GDP)

The above table indicates a scoreboard of how countries spend, but not to what extent they deliver on R&D. A more detailed analysis, falling outside the scope of this comparison, would be needed to establish that. What is clear, however, is that South Africa's R&D spending is in the same league as that of Hungary, Spain, Portugal, New Zealand, Chile and Brazil.

**Outputs** : The S&T Infrastructure Survey compiled a comprehensive set of outputs per S&T grouping. The international literature does not contain comparable sets of findings to enable a comparison. However, if one argues that the outputs are a measure of innovativeness, and equate the number of patents to the degree of innovation, it is possible to reach some conclusions.

The figure for South Africa of 23 patents in force per 100 000 of the population was derived from data supplied by the SA Patents Office (30 716 patents renewed for 1997, of which about 70% are held by international concerns, i.e. 23 domestic patents in force/100 000 of the population).

The data in Table 6.4 is ordered in the same manner per region as the gross

expenditure on R&D as a percentage of GDP (GERD/GDP), i.e. in Europe, Sweden has the highest GERD/GDP ratio. It is immediately apparent that a good correlation exists, generally, between the GERD/GDP ratio and the number of patents in force/100 000 of the population.

South Africa	23	North America	
Leading European Countries		USA	438
Sweden	1 029	Canada	1 107
Switzerland	1 496	Leading Australasian Cou	ntries
France	514	Japan	506
Germany	322	Korea	108
Finland	369	Taiwan	61
United Kingdom	n/a	Australia	409
Netherlands	617	Singapore	n/a
Denmark	318	New Zealand	n/a
Norway	384	China	n/a
Belgium	811	Malaysia	22
Austria	247	Indonesia	n/a
Russia	30	Thailand	1
Czech Republic	147	Leading South American Co	untries
Ireland	197	Chile	58
Italy	n/a	Brazil	32
Hungary	188	Venezuela	9
Spain	44	Argentina	n/a
Portugal	88		
Greece	60		
Turkey	11		

TABLE 6.4NUMBER OF PATENTS IN FORCE PER 100 000 OF THE POPULATION

Comparing South Africa with those countries having a similar GERD/GDP ratio, one finds that, with the exception of New Zealand, for which no data was available, all the other countries with similar GERD/GDP ratios to South Africa have up to one order of magnitude more patents in force than South Africa.

This could be a first indication of benefit/cost, although one should be careful. For example, Switzerland and Japan have similar GERD/GDP ratios, but Switzerland has three times more patents/100 000 of the population than Japan. Even more striking are the examples of Taiwan and Denmark. They have the same GERD/GDP ratio but Denmark has 5 times as many patents. A more detailed analysis, outside the scope of this comparison, may bring other determining factors to the fore.

A comparison of the data in Tables 6.3 and 6.4 shows that a good relationship exists between the normalised patents (per 100 000 of the population) and the GERD/GDP ratio, as is shown in Figure 6.2. What is of particular note is that if South Africa were to increase its GERD/GDP ratio to around 1,5%, the number of patents would increase by about an order of magnitude (to around 200). It will be shown later that this will in fact only be possible if the number of S&T personnel in South Africa is substantially increased, which places an important focus on S&T capacity building.

6

Four indicators of the internal make-up of the S&T infrastructure are discussed here, namely, the sources of funding for the S&T infrastructure, the staff profile, the relative disciplinary focus and the capital expenditure as a percentage of the operational S&T expenditure.

**Sources of Funding :** Earlier in the report the Rand value and breakdown of sources of funding to the different groupings of S&T performers was given. Using only the aggregate value, and expanding it to include as first estimate the impact of the business survey and the public corporations, this funding source profile can be compared with the target countries, as per Table 6.2. The results are shown in Table 6.5. Since the countries are again ordered by GERD/GDP ratio, it would appear that there is some tendency for the percentage of government funding to increase with lower GERD/GDP ratios. This premise is tested in Figure 6.3, and is indeed proven.

### TABLE 6.5 SOURCES OF S&T FUNDING

Country	Government funding	Private funding	International funding	Other
South Africa				
S&T Infrastructure Survey - Table 6.1 (excludes business sector)	61%	38%	1%	-
S&T Infrastructure expanded to include business sector and public corporations	46%	53%	1%	-
World Competitiveness Yearbook 1996	32%	47%	-	21%
Leading European Countries				
Sweden	36%	61%	1%	2%
Switzerland France Germany Finland United Kingdom Netherlands Denmark Norway Belgium Austria Russia Czech Republic Ireland Italy Hungary Spain Portugal Greece Turkey	48% 33% 44% 34% 45% 40% 49% 28% 43% 21% 46% 52% 42% 45% 57% 74%	43% 65% 54% 51% 51% 44% 70% 53% 78% 54% 44% 52% 47% 27% 23%	8% 2% 1% 2% 4% 5% 1% 3% - - - 4% 3% 7% 5% 3%	1% - 1% 2% 5% 2% 1% 1% - 5% 1% 11% -
North America	400/	50%		40/
Canada	46% 36%	50% 41%	- 10%	4% 13%
Leading Australasian Countries				
Japan Korea Australia Singapore New Zealand Thailand	18% 17% 56% 39% 65% 69%	82% 82% 39% 60% 33% 10%	- 1% 1% - 2% 14%	- 4% 1% - 7%
Leading South American Countries				
Chile Brazil Argentina	71% 67% 85%	18% 20% 8%	3% 5% 2%	8% 8% 5%

The figure shows that the South African data point falls in the lower half of the data scatter. In fact, it would be more in line, for a fixed percentage

government income, if GERD/GDP were around 1,5%, and if GERD/GDP is kept fixed at 0,9%, then percentage government funding should be about 50% to 55%. This figure tends to suggest that :

- 1) Business has to play the leading financing role in the government/ business partnership to grow the contribution of R&D to the development of the country.
- 2) In South Africa, R&D is most probably underfunded by both government and business.

When interpreting Figure 6.2, it would be better to use the combined results of the S&T Infrastructure, Business Sector and Research and Scholarship surveys to allow a more accurate representation of the South African situation. One also has to bear in mind that in certain countries, such as in Australia, government plays a dominant role in driving and funding R&D by design.

#### FIGURE 6.3 PERCENTAGE GOVERNMENT FUNDING FOR S&T vs THE GERD/GDP RATIO

In this context, it may be interesting to compare now, for example, the South African Science Councils compare to a variety of international R&D organisations as far as the split between government income and contract research and related income is concerned. Table 6.6 contains such a comparison, published courtesy of Mr H Hofmeyr (CSIR).

When interpreting tables such as this, one has to bear in mind the nature of activities undertaken in each of these organisations. For example, organisations such as ITRI, SABS and TNO, with government grant below 40% of turnover, have a captive market for at least part of their activities, since certain tests on new products and services are controlled by national statutes. On the other hand, organisations with high percentage government

grants, such as Max Planck and the FRD, are concerned much more with the development of research capacity and are thus much more dependent on government money. Nevertheless Table 6.6 shows that the South African Science Councils are on a par with similar organisations worldwide.

#### TABLE 6.6

## COMPARISON OF SOURCES OF INCOME FOR SOUTH AFRICAN SCIENCE COUNCILS AND SELECTED INTERNATIONAL R&D ORGANISATIONS<sup>1)</sup>

Organisation 4)	Country	Year	Government grant <sup>3)</sup>	Contract research & other related income <sup>2)</sup>	Notes
SABS CSIR MINTEK HSRC MRC ARC FRD	South Africa South Africa South Africa South Africa South Africa South Africa	93/94 95/96 94/95 93/94 93/94 93/94 93/94 94/95	31,7% 46,2% 69,0% 73,7% 83,0% 85,8% 99,5%	67,3% 53,8% 31,0% 26,3% 17,0% 14,2% 0,5%	Actual Actual Unaudited Actual Actual Actual
ITRI Sintef National Physical Lab. Tech. Research Centre Singapore Inst. Stds. Indus. Res. TNO Fraunhofer National Engineering Lab Alberta Research Council Austrian Res Centre Seibersdorf Nat. Inst. Of Stds & Technology CSIRO Flemish Inst Technol Res CSIR Rutherford Appleton Lab Julich Research Centre Nat. Research Council CNRS	Taiwan Norway UK Finland Singapore Holland Germany UK Canada Austria USA Australia Belgium India UK Germany Canada France	91/92 91 94 92/93 93 93 90/91 93/94 94 92 93/94 93 92/93 90 91 90/91 93	1,8% $18,1%$ $35,1%$ $36,1%$ $39,9%$ $41,1%$ $44,0%$ $50,0%$ $53,8%$ $54,3%$ $67,3%$ $75,0%$ $77,0%$ $83,0%$ $88,3%$ $91,0%$ $93,6%$	98,2% 81,9% 64,9% 63,9% 61,1% 60,1% 58,9% 56,0% 50,0% 46,2% 45,7% 32,7% 25,0% 23,0% 17,0% 11,7% 9,0% 6,4%	Actual Ac

#### Notes :

1) Sorted in descending order by percentage contract income

- 2) Chiefly income from contracts and services but some other income may be included in some cases. As far as possible interest and non-technological activity related (e.g. rental) income is excluded
- 3) Where possible government grant excludes amounts for agency type research grants. Percentage calculation based on total of government grant and contract etc. income
- 4) Data on the Council for Geoscience not included

**Staff Profile :** The figures as obtained in this survey of the South African S&T infrastructure differ from those in the *UNESCO Statistical Yearbook 1995.* Both sets are given in Table 6.7. South Africa's number of S&T personnel per million of the population is very low compared to the cross-section of countries listed, and is of a similar order of magnitude to the figures for Portugal, Malaysia, Chile and Argentina. Of these countries, Portugal and Chile also have comparable gross expenditure on R&D (GERD) per GDP, whereas Malaysia and Argentina have much lower GERD/GDP ratios, thus using less money to sustain the same pro-rata number of S&T staff.

Similarly, of those countries with similar GERD/GDP to South Africa, namely, Hungary, Spain and New Zealand, have appreciably higher S&T staff numbers/million of the population. This also points to a more effective use of S&T funds.

As far as the number of technicians per scientist/engineer is concerned, the range of numbers internationally is wide, from 0,2 to 1,3, with no apparent pattern. The South African value of 0,4/0,5 falls close to the median, but that is not considered meaningful, given the erratic variation of this number.

Another indicator of the degree of staff utilisation is the ratio of total staff cost to total operational cost. Table 6.8 contains such data for the selected countries. Apart from a few others, which will be discussed below, all the data fall in a close bracket, mainly between staff cost/total operational cost ratios of 55% to 65%.

China, Hungary and the Czech Republic have very low staff cost percentages, probably due to low labour costs. Portugal, on the other hand, has a very high staff cost percentage of 76%, which would imply that it is delivering too little for the human capital investment made. Swart and Toerien (pers. com.), in a study of labour cost in individual research establishments in various countries, concluded that a "Rule of 55" could be established, which states simply that organisations are healthy and generally return positive margins as long as the staff cost is below 55% of the total operational cost. Once it goes beyond 55%, the turnover generated is too low for the human capital investment, and if market factors do not allow an expansion in the market penetration, staff shrinkage is unavoidable. The overall South African figure, drawn from the UNESCO Statistical Yearbook, is 55% and appears still to be in line. However, this would tend to indicate that there are South African S&T organisations where the staff cost is higher than 55%. Such organisations are under pressure either to increase their market share or shrink their numbers.

#### S&T INFRASTRUCTURE

TABLE 6.7					
S&T PERSONNEL STATISTICS					
Country	No of scientists/ engineers per Million of population	No of technicians per million of population	No of S&T staff per million of population	No of technician s per scientist/ engineer	
South Africa					
S&T Infrastructure Survey UNESCO Statistical Yearbook 1995	538 319	292 132	830 451	0,5 0,4	
Leading European Countries	0.00/	<u> </u>			
Sweden Switzerland France Germany Former GDR Former FROG	2 409 2 267 7 819 2 882	3 148 1 374 2 972 4 149 1 966	6 229 3 783 5 239 11 968 4 848	1,0 0,6 1,3 0,5 0,7	
Finland United Kingdom Netherlands Denmark Norway Belgium	2 282 n/a 2 656 2 341 3 159 1 856	2 093 n/a 1 774 2 663 1 594 2 041	4 375 n/a 4 430 5 004 4 753 3 897	0,9 n/a 0,7 1,1 0,5 1,1	
Austria Russia Czech Republic Ireland Italy Hungary	1 146 5 930 3 248 1 801 1 366 1 200	1 101 1 354 1 298 366 742 697	2 247 7 284 4 546 2 167 2 108 1 897	1,0 0,2 0,7 0,2 0,5 0,6	
Spain Portugal Greece Turkey North America	956 599 53 n/a	299 381 49 n/a	1 255 980 102 n/a	0,3 0,6 0,9 n/a	
USA	3 873	n/a	n/a	n/a	
Canada	2 322	978	3 300	0,4	
Leading Australasian Countries					
Japan Korea Taiwan Australia Singapore New Zealand China Malaysia Indonesia Thailand	5 677 1 990 n/a 2 477 1 284 1 555 1 128 326 181 173	869 349 n/a 943 583 785 428 69 n/a 51	6 546 2 339 n/a 3 420 1 867 2 340 1 556 395 n/a 224	0,2 0,2 n/a 0,4 0,5 0,5 0,4 0,2 n/a 0,3	
Leading South American Countries					
Chile Brazil Venezuela Argentina	364 391 208 350	231 n/a 32 197	595 n/a 240 547	0,6 n/a 0,2 0,6	

#### TABLE 6.8 TOTAL STAFF COST AS A PERCENTAGE OF TOTAL OPERATIONAL EXPENDITURE

South Africa		North America	North America		
S&T Infrastructure Survey	Not surveyed	USA			
World Competitiveness Yearbook 1996	55%	Canada			
Leading European Countries		Leading Australasian	Countries		
Sweden	55%	Japan	51%		
Switzerland	70%	Korea	49%		
France		Taiwan			
Germany	65%	Australia	64%		
Finland	63%	Singapore	63%		
United Kingdom		New Zealand			
Netherlands	61%	China	19%		
Denmark	62%	Malaysia			
Norway	58%	Indonesia			
Belgium		Thailand			
Austria	58%	Leading South Ameri	Leading South American Countries		
Russia		Argentina	53%		
Czech Republic	36%				
Ireland					
Italy	56%				
Hungary	29%				
Spain	69%				
Portugal	76%				
Greece					
Turkey	54%				

**Relative Disciplinary Focus :** The actual disciplinary distribution of S&T expenditure per country depends strongly on whether the country is a developing or a developed country, its climate, the degree of industrialisation, the wealth of natural resources, the country's strategic objectives for growth, etc. Therefore a general comparison for the countries listed in Table 6.2 would be meaningless. Nevertheless, Table 6.9 gives a comparison of this split for South Africa, three other Southern Hemisphere temperate countries and Portugal, which has a similar GERD/GDP to South Africa. More detailed analyses of this nature would advisedly be better based on the results of the *Scholarship, Research and Development Survey*.

Country	Natural Sciences, Engineering and Technology	Medical Sciences	Agricultural Sciences	Social Sciences and Humanities	Other
South Africa <sup>2)</sup>	48%	14%	19%	19%	-
Australia	36%	9%	11%	20%	24%
Argentina	59%	13%	12%	14%	2%
Chile	49%	26%	8%	17%	-
Portugal	46%	9%	14%	16%	15%

TABLE 6.9RELATIVE DISCIPLINARY SPLIT OF S&T EXPENDITURE 1)

Notes : 1) Relative split calculated on assumption that R&D personnel split and S&T expenditure split are linearly correlated

2) South African split calculated on actual S&T expenditure in Rand

**Capital expenditure as a percentage of operational expenditure :** According to the S&T Infrastructure Survey, the value of the capital holdings of S&T organisations in South Africa amounts to about R8,7 billion, with an annual depreciation of R480 million being accrued as an operational expense. Moreover, the annual spending on fixed assets is about R1,4 billion, or 15% of the stated turnover. These figures imply that it would need 6,5 years' worth of depreciation to foot the bill for one year's worth of capital expenditure. Given the nature of capital holdings in S&T institutions, with computer hardware having a useful life of 2 to 5 years, laboratory equipment 5–10 years and buildings more than 20 years, this is an acceptable situation.

One has to bear in mind, however, that inflation will prolong the required period. As far as maintenance is concerned, the maintenance cost equates to 5,5% of capital holdings, giving an 18 year return period for maintenance. Again, this is acceptable, since the 18 year maintenance pay-back period is longer than the depreciation payback period of 6.5 years.

Data of this nature is not readily available for other countries. However, Table 6.10 contains the range of capital expenditure to operational expenditure ratios for the selection of target countries.

South Africa		North America	
S&T Infrastructure Survey	15%	USA	3%
(excludes business sector and public	1070	Canada	070
corporations)			
UNESCO Statistical Yearbook 1995	10%		
		Leading Australasian Count	ries
		Japan	18%
		Korea	39%
		Australia	16%
		Singapore	67%
		New Zealand	12%
		China	31%
		Indonesia	33%
		Thailand	27%
Leading European Countries		Leading South American Co	ountries
Sweden	9%	Argentina	27%
France	11%	3	
Germany	14%		
Finland	13%		
United Kingdom			
Netherlands	11%		
Denmark	16%		
Norway	13%		
Austria	19%		
Czech Republic	19%		
Ireland			
Italy	15%		
Hungary	12%		
Spain	24%		
Portugal	25%		

#### TABLE 6.10 CAPITAL EXPENDITURE AS A PERCENTAGE OF OPERATIONAL EXPENDITURE

Apart from some puzzling anomalies that must be related to specific capital expansion programmes, e.g. in Singapore, the data vary in a narrow band with a median value of 16%. For a more detailed analysis, refer to the Equipment Survey report.

#### 6.3.3 Concluding Remarks

The comparison of data obtained in the S&T Infrastructure Survey with published data for a selection of target countries highlights some key issues, namely :

In order to be able to pro-actively manage the contribution of R&D and S&T to the growth and development of South Africa, it is imperative that a science and technology strategy be adopted in partnership with business and that joint action plans be set to achieve

#### objectives.

- In the execution of such a South African masterplan for S&T, it would be advisable to have a strategic direction-giving body at a more senior level than the performers in S&T. It would set direction, help facilitate priority-setting and monitor implementation – all in a strategic rather than an operational manner. It should be done in such a manner that S&T performers in the public, private and NGO arenas still maintain jurisdiction over their own affairs.
- The gross-expenditure on R&D (GERD) in South Africa is very low compared with other developed and developing countries. Associated phenomena (indicators) are low numbers of S&T staff per million of the population and a low output of patents.
- The contribution to GERD by both government and the private sector is too low and should be increased, but only after a joint strategic vision and partnership have been established.
- Although supporting information is not conclusive, it would appear that capacity building should put more emphasis on training technical support staff in order to bring the South African numbers more in line with international benchmarks.
- There are some signs that, compared with benchmark data for countries with similar GERD/GDP ratios, South Africa is producing less per capita. This conclusion must be tested using the findings of the *Scholarship, Research and Development Survey.*
- With reference to all of the above, one has to bear in mind that supply and demand dictate the development of the S&T "*industry*". If the market demand is not there for the services being offered, a scaling down will have to take place, which will have disastrous consequences for the development of South Africa.
- The South African situation with regard to capital seems sound as far as purchasing and depreciation are concerned. However, one has to note that quite a lot of the capital items are very old and replacement may require much faster acquisition cycles than dictated by the levels of depreciation accrual.

In closing, it is important to note that all of the comparisons above are based on results averaged countrywide. This could mask underlying trends in individual organisations or even in certain S&T groupings. A better analysis would be possible using the other survey results.

## 6.4 Strengths and Weaknesses of the S&T Infrastructure

#### 6.4.1 Background

The government's strategy of Growth, Employment and Redistribution (GEAR) is designed to generally uplift the South African people and to create an industrial sector which is productive and competitive in international context. Particularly in the light of the increasing globalisation of business, it is important that considerations of employment, equity and redistribution should be balanced with a vigorous focus on issues of industrial development and the improvement of South Africa's competitive position in world terms.

This balance will not be possible without, on the one hand, a clear vision at the highest level, a so-called SA Incorporated vision for say twenty years hence, of where the country should go and how to go about achieving it and, on the other hand, a firm partnership between business and government. It was shown in the previous section that the successful world players do just that.

As a basis for such a vision of the future development of the country, one could use the elements of the government's GEAR strategy, i.e.

- Meeting basic needs and implementing the RDP
- د المحمد Capacity building
- EXE Democratising of state and society
- Economic growth and industrial development
- المعامد International competitiveness.

The first three items should receive the primary focus of the government and larger public sector, whereas the last two should be the primary concern of However, this does not imply a compartmentalisation of business. responsibilities. In fact, the very success of such a holistic approach would lie in the government/public sector and business also playing a role in the field that is the primary responsibility of the other. For example, the current trend of Science Councils being forced to penetrate private sector business to a greater extent should be encouraged in order to ensure that the maximum possible competence is brought to bear on the development of industrial competitiveness. At the same time, the policy initiatives of government should be undertaken in association/alliance with business, to ensure compatibility between the policy intent and the desired development outcomes. The development of an SA Incorporated vision and an associated S&T plan to support its achievement will be strongly underpinned by a clear understanding of what is required.

In this respect, the split in focus between the various disciplinary S&T application areas required to achieve the vision will have to become the subject of intense debate between government/public sector and business.

It is more than likely that the present distribution will be substantially altered

through such a process. In addition, the right blend between the different S&T activities, such as research and development, education and training, etc., should be an outcome of the debate. It is again important that the various elements holistically support one another in order to ensure that these are not developed in isolation, without the appreciable synergy that can be achieved through a joint vision and collaboration.

#### 6.4.2 Potential Strengths

The assessment of the strengths and weaknesses of the S&T *"industry"* is by nature a highly contentious debate and very dependent on one's point of departure. The approach followed in this section is to identify the potential strengths of the South African S&T infrastructure and to discuss these in context with those factors that influence and/or obstruct successful implementation.

**#1**: Alignment of intent: It was shown in Section 5 that the goals and objectives of all the S&T groupings in the country broadly align with the imperatives of the government's GEAR strategy. The same is true of the strategic outputs per S&T grouping and for individual organisations. It is quite impressive to see the richness and diversity of strategic outputs as captured in the database. In summary, the output focus of the different categories of S&T organisations, as described in Section 5.2, can be synthesised as follows :

Type of Output	Government Sector	National Heritage Institutions	Non-government Organisation	Science Councils	Technikons	Universities
Information management	??		?	?		
Management of specialised collections		??				
Applied technologies			??	??	?	?
Research capacity building		?		??	?	??
Education and training	?			?	??	??
R&D in support of policy formulation	?		??	??		?

??

Primary location Secondary location If one takes these generic output types and relates them to the elements of GEAR, the following matrix results.

Generic output categories	Meeting Basic Needs	Economic Growth	Capacity Building	Democratising State/Society	Implement RDP	International Competitiveness
Information management	??	?	?	?	?	?
Management of specialised collections	?		?	?		
Applied technologies	??	??	?	?	??	??
Research capacity building	?	?	??	?	?	?
Education and training	?	?	??	?	?	?
R&D in support of policy formulation	?	?	?	??	?	?

?? Primary function

? Secondary function

It is therefore apparent that the generic output categories, as distilled from the individual responses captured in the database, underpin the elements of GEAR comprehensively. One would need to delve deeper into individual projects and programmes, as was done in the *Scholarship, Research and Development Survey*, to ascertain whether this good fit is due to windowdressing or is indeed the result of an in-depth review of previous focus areas to get in line with the imperatives as dictated by GEAR. However, looking from the top down, as was the case in the S&T Infrastructure survey, it indeed looks as if a real alignment has been achieved.

Issues which could potentially hamper this strength, are the following :

The modes of financing range from parliamentary grant, with はは little if any strings attached as far as specifying exactly what is to be done, to contract research for either public or private sector clients who dictate exactly what they want researched. Table 3.2 states than 57% of the R9.6 billion accounted for in the S&T Infrastructure Survey originates from the state, which amounts to about R5,5 billion. Table 6.1, which extends beyond the scope of the S&T Infrastructure Survey, shows that the government funds R6,2 billion and contracts about R0,5 billion for specific outputs. Thus, a large proportion of state funding does not specify outputs. The degree of fit between the outputs generated/planned for by S&T performers on the one hand and the imperatives dictated by the GEAR strategy on the other would be improved if the state were to insist on pre-conditions with respect to a larger percentage of their funding ("attached" parliamentary grant). A way in which this can be achieved would be to "reduce" the unattached parliamentary grant, ultimately by as much as 50%, and to allow S&T performers to bid for the remainder in a competitive manner. Specific objectives in line with GEAR would have to be set for this remainder. Such an approach would, however, only work if it is possible to streamline the process of evaluating competitive bids for "attached" parliamentary grants.

- The S&T "*industry*" is continually losing highly skilled professional and technical staff to both the corporate and professional service sectors of the economy. New entrants into the S&T job market are mostly highly skilled but less experienced than those leaving. This puts a strong emphasis on research capacity creation in S&T organisations, which needs to be an ongoing process. Coupled to this is the fact that the staff in these organisations are not adequately equipped for the type of consultative research and development frequently needed to underpin the imperatives of GEAR. There is a definite role for S&T players in the social sciences and humanities in helping S&T organisations in the natural sciences, engineering and applied technologies to develop an R&D culture appropriate to GEAR.
- As stated earlier, the success of GEAR lies in a balanced focus on all elements of GEAR. However, because of the stark realities of the plight of many South Africans, it is only natural for there to be a tendency to focus more on equity and redistribution issues, typically those associated with meeting basic needs, than on economic growth and international competitiveness. This can be likened to affirmative action, which is a strategy aimed at achieving diversity in the workplace, and which is, as such, an interim strategy. In the same way, the affirmative application of technology to support/underpin the part of GEAR concerned with meeting Basic Needs must receive additional support as an interim strategy. The danger is that the pendulum will swing too far and that this will happen at the expense of S&T in support of economic growth and industrial competitiveness.

**#2** Focus on Applied Technologies : The data gathered during the S&T Infrastructure survey show that 66% of the expenditure by S&T performers is aimed at what can broadly be termed applied technologies, i.e. (refer Table 4.2) :

Engineering and applied technologies	33,7%
Agriculture	19,1%
Medical/health	<u>13,5%</u>
Total	66,3%

This shows a very strong output focus aimed at implementing technology rather than research *per se*.

One has to say, however, that the top-down data tend to indicate that there is potentially a lot of redevelopment of issues from basic principles, rather than tailor-making the application of technologies acquired from the best S&T supplier in the field world-wide. This is but an observation and must be subjective at present. It would be useful to verify or disprove it on the basis of the *Scholarship, Research and Development Survey*.

Nevertheless, though, coupled with the first strength above, we have an
application-focused S&T community in the country, seemingly well-equipped to underpin from an S&T perspective the implementation of GEAR.

**#3** Distinct Groupings of S&T Performers : The S&T performers can be classified into clear groupings :

- E The Science Councils
- EXE The higher education institutions
- KKThe non-government organisations
- SE Government S&T institutions
- **National heritage institutions.**

Chapter 5 shows clearly on the basis of the goals and objectives of the various categories of organisations that each of these has a very distinct character, which is also reflected in their generic outputs. This makes it easy to identify which role players are best suited to contribute to which aspects of GEAR, for example.

However, if one delves below this top-down overview of the different groupings, some issues emerge which could potentially deter the achievement of holistic synergy in the S&T community. These are :

Table 6.11 show the spread of organisational entities per output application or discipline.

	Government Sector	NHIs	NGOs <sup>1)</sup>	Science Councils	Technikons	Universities	Total
Agricultural Sciences	17	-	7	1	5	8	38
Biological Sciences	5	9	3	1	-	-	18
Chemical Sciences	1	1	3	1	-	-	6
Earth and Marine Sciences	11	2	4	2	-	-	19
Engineering Sciences	4	-		1	8	10	26
Info and Computer	4	-	1	1	7	14	27
Medical/Health Science	5	-	3	2	6	17	33
Mathematical Sciences	2	1	-	-	5	14	22
Physical Sciences	2	1	-	3	7	-	13
Applied Technologies	1	-	3	4	7	11	26
Social Sciences	19	5	15	1	7	18	65
Economic Sciences	17	1	-	2	7	17	44
Humanities	3	11	-	1	7	17	39
Life and Physical Sciences	-	-	-	-	-	17	17

### TABLE 6.11 SPREAD OF ORGANISATIONAL ENTITIES PER OUTPUT APPLICATION/DISCIPLINE

Note : 1) Includes NGOs and private sector research organisations

The large numbers in the "*total*" column in the table reflect the multiplicity of organisations that focus on every one of the disciplines. On the one hand, this is healthy because it leads to competition, but on the other hand, it should be questioned whether a small S&T infrastructure such as that found in South Africa can afford such a degree of duplication.

- Building on the previous point, it is even more important to know the extent to which real operational partnerships exist between different organisational entities in the S&T infrastructure. In this respect, it is not enough to have "*Memoranda of Understanding*" with others regarding potential collaboration. It necessary rather to provide an incentive to organisations to work together. Such incentives could be linked to elements of GEAR and cut across organisational boundaries.
- A matter of more fundamental concern, however, is the fact that these groupings of categories of S&T organisations and also, in many cases, particular organisations themselves, are the result of thinking in

the past which may have aligned to the imperatives of a previous era. Therefore it is quite possible, and in fact likely, that better groupings of organisations, or a better definition of individual organisations, may be found now. Once a strategic vision is in place it would be possible to debate the pluses and minuses of such re-engineering of certain organisations or groups of organisations to better address the challenges of South Africa. Some examples are given in points #3 and #4 below.

**#4 Science Council Concept :** The concept of science councils as used in South Africa allows for considerable market focus, commercialisation and specialisation. In principle, this is sound. The Science Councils can be a key instrument in the hands of government to help achieve all elements of the GEAR strategy, in partnership between Science Councils, with government, and importantly, with the private sector as and when relevant.

However, in building on the sound concept, as outlined above, one has to bear certain key issues in mind :

- Some of the Science Councils have a very definite marketrelated focus, which leads to a strong output-driven culture. These are the ARC, CSIR, MRC and Mintek.
- The SABS has a distinct service culture and a large proportion of its work is in a captive market since it is imposed by statutes.
- The FRD and HSRC, on the other hand, play a much stronger role in the facilitation of the establishment of individual and institutional research capacity and culture. These organisations transcend marketrelated boundaries defining the fields of operation of the other councils.
- The FRD manages three national research facilities, namely the National Accelerator Centre, the South African Astronomical Observatory and the Hartebeesthoek Radio Astronomy Observatory. By nature of their brief these organisations fit better in the academic community than as part of the FRD. However, provided that this management structure works, it may be better to continue with it.
- Because of the present science council structure on the one hand and the incentives for good performance, which are linked to the achievement of financial and market targets on the other, the natural tendency is for individual groups to develop their own capacity, rather than acquiring best competence from elsewhere in the family of science councils or even inside the same council. This leads to development in isolation, and the building of multiple small centres of excellence, many or all of which have problems with critical mass. The government has to consider seriously the introduction of a prioritysetting system with incentives to promote the building of real partnerships and complementary skills.

**#5 NGO Sector :** The unaligned NGOs serve a very important role with an independent "*ombudsman*" type of S&T assessment of government policy initiatives. This valuable contribution to the establishment of a democratised state and society should be maintained and expanded.

From the data gathered in the S&T Infrastructure Survey, it would appear that the major stumbling block for these NGOs is the availability of sufficient funds to continue their work. It is envisaged that once a strategic S&T vision and work plan to achieve it have been developed jointly by government and the business sector, that it will be easier for NGOs to obtain funding through the private sector than at present. However, the independence of the NGOs must remain untouched at all costs.

**#6 Wide S&T Funding Base :** If the government's own research is excluded, Table 6.1 shows that 62% of the funding for S&T (excluding higher education) originates from the state and 38% from non-state sources. This includes student fees, private sector income for HEIs and contract research fundings. The private sector funded research amounts to at least R2,2 billion, or 20%. Although this is already a good spread, particularly if one bears in mind that the business sector and public corporations are excluded from this number, it also shows that appreciable scope still exists for growth in the private sector's contribution.

The impact of such private sector funding will be greatly enhanced if better coordination could exist between funding agencies in the public sector and private sector financiers. This obviously excludes contract research where the client–supplier relationship prevails. Nevertheless, such coordination should not be at the expense of the autonomy of the private sector participants.

The NRTA database can play an important role in facilitating the coordination process.

**#7** Strong Infusion of Private Money in HEIs : Table 6.12 contains a breakdown of the sources of funding for universities and shows that 48% of the funding for Universities, i.e. R2 841 million, originates from outside of government. Student fees account for 24%, or R1 300 million, and the rest is from other private sector sources. In the case of the technikons, the state subsidy amounts to 61%, with 39% from student fees and other private sector sources. Cumulatively, R3 347 million of the total funding of R6 756 million to higher education institutions, or by chance exactly 50%, originates from outside the state subsidy.

FUNDING SOURCES TO UNIVERSITIES <sup>1)</sup>

**TABLE 6.12** 

Subgroups of	Total	Percentage breakdown of income
Universities	funding	sources

		State subsidy	Student fees	Other private income
Historically black universities	R1 540 m	61%	22%	17%
Historically white universities (Afrikaans)	R1 744 m	46%	20%	34%
Historically white universities (English)	R1 457 m	51%	26%	23%
Historically white universities (Total)	R3 201 m	48%	23%	29%
Distance learning universities	R 722 m	50%	33%	17%
TOTAL	R5 464 m	52%	24%	24%

Note : 1) Valid for median year 1995/96

#### Note :

- KE Historically black universities
- Multi University of Venda
- Mr University of Zululand
- Mc University of Western Cape
- Market University of Fort Hare
- Met University of North West
- Me University of the North
- Mc University of Durban-Westville
- se University of Transkei
- se Medunsa

Historically white universities (Afrikaans)

- See Potchefstroom University of CHE
- Mc University of Stellenbosch
- Multiversity of the Orange Free State
- Market University of Pretoria
- Rand Afrikaans University

Historically white universities (English)

- Me University of the Witwatersrand
- He University of Cape Town
- Rhodes University
- Matal
- Me University of Port Elizabeth

Distance learning universities

🛩 UNISA

いい

😹 VISTA

The private sector is thus playing an important role in allowing the higher education institutions to keep on fulfilling their capacity building task. Some of the characteristics of the HEI funding pattern as depicted in Table 6.12 are the surprisingly high other private income of 34% for historically white Afrikaans universities, the relatively high student fee contribution of distance learning universities (33%) and the high state subsidy to historically black

universities (61%).

In order to make maximum use of the state and private funding, it is necessary that the evaluation formula for HEI funding be adjusted to give it a more balanced output focus, which includes measurables for achievement towards the new imperatives. Ways and means need to be researched to improve the partnership between the state and the private sector as far as the setting of priorities is concerned. It is also considered essential that the government start dictating the proportions in which it expects its funding to be used for different curricula at HEIs. The present system propagates curricula that are popular among students without necessarily focusing on the needs of the country.

**#8** An "industry" with a 60 000-strong workforce : To get a feeling of the size of the S&T "industry", with its 60 000-strong workforce (excluding unskilled labour) consider the civil engineering construction industry, with a workforce of about 70 000 strong, a large proportion of which comprises unskilled labour. Of course, although a 60 000 workforce is sizeable, one has to consider that only about 33 000 of these are S&T professional/technical support staff. Furthermore, the fast track countries and some countries with which we regularly compare ourselves, such as Australia and New Zealand, have between three and eight times more scientists and engineers per million of the population than South Africa.

If one uses the professional services industry as a yardstick, where the annual per capita turnover is between R300 000 and R400 000, the S&T *"industry"* should be capable of a turnover of between R18 billion and R24 billion. This is in the order of between 4% and 5% of GDP, a sizeable *"industry"* indeed. The present turnover of the *"industry"*, however, is only about R10 billion, or roughly 50% of the potential capacity.

A subjective assessment is given below of the obstacles to a higher output for the "*industry*".

- Market potential will dictate the level of "*industry*" development. Some of the Science Councils have already started looking for work outside the borders of South Africa in an effort to get paying customers, thus counteracting the after inflation drop in real state grants. The fact that such a large portion of the S&T funding is given by the state with little demanded in the form of specific returns means that it would be difficult to ascertain the correct level of funding for the "*industry*".
- Although it is but a subjective opinion, it is thought possible that a large percentage of the R10 billion referred to above could be used to maintain past and/or duplicate organisational structures, thus increasing the overhead cost component. Equally, bureaucratic practices lead to loss of productive worktime and, in the end, the effective/productive working hours are much lower than the full-time equivalent counts would suggest.

- Re-invention of basic phonema/findings, as opposed to the adaptation for application of acquired technologies, is expensive and should only be allowed selectively, if at all. Focus on research not directly applicable should be well motivated, and in all cases, research proposals should contain a cost comparison with the acquisition option.
- The loss of skilled and competent professional/technical staff to the corporate, professional services and business sectors is increasing the pressure to perform on those left behind. This is exacerbated by the fact that certain key individuals play a pivotal role in research, development and implementation. Their departure would therefore leave multiple holes to fill.
- Levels of training and/or capacity building are not nearly enough to allow higher worker output ratios, especially in the light of the loss of experienced professionals referred to above and the pressure on creating more contract research income.
- Differences in remuneration policy between different organisational entities in the S&T infrastructure could mitigate against partnerships to improve the benefit/cost of outputs.

The above facts leave us with some conflicting signals. On the one hand, it would seem that the "*industry*" can produce and deliver a lot more, e.g. per capita income rates, various factors leading to time loss, etc., whereas, on the other hand, it would almost seem that the industry is overstaffed, e.g. a large percentage of funding has no strings attached, market demand, etc. It is recommended that the results of the other surveys be used to further investigate these subjective viewpoints.

**#9 Strong S&T Capital Equipment Base :** The survey results for the 189 organisations surveyed show that these organisations have capital holdings equal to roughly their aggregated annual turnover, and that annual capital expenditure amounts to about 15% of turnover. These figures are in line with median values for other countries, and it would appear that we have a good platform in this regard.

However, again subjectively, the opinion was created in a number of instances that a large proportion of our capital holdings is old and outdated and would need to be replaced soon. One would have to consider this against the S&T capital equipment requirements dictated by the imperatives of GEAR.

**#10 Complementary S&T Funding Focus for Government, Science Councils and NGOs :** The data in Section 4.2 indicates the following primary focus areas for the funding originating from the government sector, NGOs and the private sector and science councils.

Elements of GEAR	Funding Organisation				
	Government Sector	NGOs/Private Sector	Science Councils		
Meeting basic needs	??	?	?		
Economic growth	?	??	?		
Capacity building	??	?	??		
Democratisation state/society	?				
Implementation of RDP	?		??		
International competitiveness		?	??		

Note: ?? Denotes primary focus ? Denotes secondary focus

This schematic table shows a good complementary focus on the various elements of GEAR.

One should, however, bear in mind that :

- **KK** This complementarity it is not necessarily by design.
- It would be possible to improve the situation significantly if (1) the funders set performance criteria in line with the imperatives of GEAR, non-adherence to which would lead to non-payment; and (2) funding organisations liaise about complementarily without compromising the independence of these organisations.

**#11 Leading Edge Position Regarding Many Hard Technology Fie Ids :** South Africa could be considered at the forefront in many "*hard*" technology fields, such as defence and nuclear technologies.

- The reprioritisation of research spending and more short-term needs, however, very quickly result in an erosion of capability and to pockets of expertise that are unable to achieve sufficient synergy to maintain a reasonable level of output at the very least.
- The challenge in this regard is to re-deploy the developed competence and capacity, primarily into the manufacturing industry, but also in support of South Africa's redevelopment initiatives.

### In summary :

The S&T infrastructure contains a number of potentially good elements, creating a platform for growth, as shown above. However, a number of

substantial impediments to growth have been highlighted, together with suggestions for alleviating them.

### 6.4.3 Weaknesses and/or Obstacles to Growth

In Chapter 6.4.2, a number of factors were highlighted which impede the full realisation of the strengths listed. The points discussed below have already been mentioned in this context but are thought to be pivotal to sustainable growth in the South African S&T "*industry*". They are thus being singled out again.

**#1 Lack of a Strategic South African S&T Vision :** Over the past few years, since just before the elections of 1994, substantial consultative effort has gone into the development of a set of imperatives to guide, in a sustainable manner, the growth and redistribution process in the country and lead to the creation of jobs. This lead in 1996 to the government's GEAR strategy, which has been referred to extensively in this report. What is still lacking, however, is that the vision, as encompassed by GEAR, be translated into an S&T vision with clear directives as to the time scales of implementation, the guiding principles for the deployment (or redeployment) of S&T resources, human and otherwise, as well as interim targets towards the achievement of objectives.

#2 The South African S&T " Council" : No body exists at present which can strategically coordinate/manage the development of the S&T "industry" in South Africa, inter alia through the actions and activities listed in the previous point. Whether such a body should be a "council" per se is not important. What is important, however, is that it should be independent of the main role players performing S&T, as articulated in this report. This task is at present fulfilled in part by the Department of Arts, Culture, Science and Technology. However, it could better be separated from government itself, although government should play a pivotal role in its activities, as would the business sector, NGOs, labour and other interested and affected parties. Although the Jordanian model described in Section 6.3.1 is not necessarily submitted as a recommendation on how it should be done, it is a case in point about independence on the one hand and inclusiveness on the other. Details of how such a body could and should look should be the topic of a separate study, once a suitable brief has been developed as part of the action plans associated with establishing an S&T vision.

For the moment, it is important just to note that apart from what has already been mentioned, the following would also be key success factors :

Strategic direction to the S&T "*industry*" in South Africa could be effected by the new body through a redistribution of the priorities for S&T in line with the imperatives of GEAR. This could lead to changed priorities in terms of :

Market Types of S&T

### See Disciplines/output focus Elements of GEAR.

Aspects which may typically rise in importance, as far as S&T effort is concerned, are crime, employment creation, competitiveness, road accidents, SMMEs, sustainability of effort, etc.

The distribution of specific types of S&T activities between and through organisations needs to be reassessed in terms of available resources, developed organisational competence, capacity and culture. A key determinant in such an assessment would be complementarity versus unnecessary duplication of S&T effort. If necessary, certain adjustments would have to be made in time to those organisations identified during a proper consultative process.

Associated herewith would be clear directives as to the required outputs for S&T funding. This implies that funders could dictate to S&T performers what specific outputs should be achieved with funding obtained. This would also be true for the focus of education and training and higher education institutions, to ensure that the trained S&T workforce meets the challenges.

## 6.5 Summary of Conclusions

The National Science Board (1996) reports the results of a survey conducted in 1995 amongst the R&D directors of the largest US R&D performing companies to ascertain the biggest problems faced by the R&D "*industry*" in the United States. The following ten issues are listed :

- (1) Measuring and improving R&D productivity/effectiveness.
- (2) Balancing long-term/short-term R&D objectives/focus.
- (3) Reducing cycle-time R&D.
- (4) Making innovation happen.

- (5) Integrating strategic technology planning with corporate strategic planning.
- (6) Managing R&D for business growth.
- (7) Gaining access to external sources of technology.
- (8) Managing the R&D portfolio.
- (9) Organising and determining the role of R&D in centralised businesses.
- (10) Integrating the enterprise (coordinating R&D with all other corporate activities).

The results of the S&T Infrastructure Survey, as contained in this Chapter, focus more on the public R&D "*industry*" in South Africa, but similar concerns to those listed above are also applicable here. At a more strategic level, the five key issues facing the South African R&D "*industry*" are :

- Build a partnership between the state and the business sector to strategically manage the South African S&T industry.
- Align S&T objectives with the imperatives of GEAR, integrating aspects of items (2), (5), (6) and (9) above.
- Translate the strategic intent of the South African S&T "*industry*" to workplans and the designation of roles and responsibilities to the various players in the S&T arena. This includes elements of (8), (9) and (10) above.
- Establish a prioritisation approach for engagement in new R&D and an associated system of measuring performance, integrating elements of items (1) to (4) above.
- Grow the contribution towards the South African R&D effort of both the state and the business sector.

### 7. **RECOMMENDATIONS**

The Scientific and Technological Infrastructure Survey highlighted some key issues, which are debated at length in Chapters 6.1 to 6.5. With only the results of this S&T Infrastructure Survey at hand, it may be premature to make firm recommendations. However, two issues stand out as pivotal in furthering the process of enhancing the impact of S&T for the benefit of the country as a whole. These are, briefly :

# Recommendation 1 : A strategic South African S&T vision aligned to GEAR

Various current initiatives such as the NRTA Audit, THRIP, the Industrial Cluster study, etc., are paving the way to translate the S&T White Paper to just such a strategic approach. What is important, though, is that as has been the case during this process, every effort be made to ensure the inclusivity of the final outcome.

# Recommendation 2 : An independent strategy body for S&T in South Africa

Various arguments have been put forward in Chapter 6 about this issue. Suffice it to say that although the Department of Arts, Culture, Science and Technology has done excellent work in the initial phases of enhancing the impact of Science and Technology, it will only be possible to really start building the partnership between the state and the business sector once a representative, independent body has been established. It can in time develop its own plan of action for all other issues of importance.

## 8. **REFERENCES**

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# **APPENDIX A**

# NATURE AND STRUCTURE OF THE ACCESS DATABASE

79

## TABLE OF CONTENTS

1	INTRODUCTION	.1
2	ORGANISATIONAL ID	.1
3	ORGANISATION FOCUS	.2
4	OWNERSHIP ISSUES	.2
5	STRUCTURE OF ACTIVITIES	.3
6	ASSETS	.3
7	OUTPUT FOCUS	.4
8	S&T FUNDING	.4
9	FUNDING FOCUS	.4

#### INTRODUCTION

The data collected during the S&T Infrastructure survey was used to populate 8 tables, each of which deals with a particular aspect of the data set as follows :

Table 1 : Organisation ID Table 2 : Organisation Focus Table 3 : Ownership Issues Table 4 : Structure of Activities Table 5 : Assets Table 6 : Output Focus Table 7 : S&T Funding Table 8 : Funding Focus

The data in the eight tables is connected through the used of an or ganisation ID number. Depending on the nature of the organisation being described and its activities it could have entries in all or part of the 8 tables.

#### ORGANISATIONAL ID

This table reflects WHO the organisation is and gives contact details, namely :

- Solution Organisation ID and where relevant parent organisation ID.
- Solution of the second second
- *K* Category of organisation, e.g.

  - ✓ Science Council
  - 🖉 Technikon
  - ∠ University.
- Street and postal addresses
- Telephone and telefax number and E-mail address
- Contact person(s), with space for up to 10 persons.

For housekeeping reasons this first table also contains the following details :

- Collection date
- Mode of data collection, e.g. personal interview, telephone interview, reply by telefax, etc.
- Zeta Security
- KE Verification by LHA; yes/no.

#### ORGANISATION FOCUS

This table outlines the strategic and operational focus of the organisation, such a s :

- Mission and Vision
- ∠ Goals and objectives
- Z Descriptive text about core business
- A percentage distribution of the nature of organisational core business, namely :
  - Research and development
  - Education and training
  - Beneration of information
  - ß Deployment of knowledge
  - Standards and guidelines
  - Real Patents and licensing.

#### **OWNERSHIP ISSUES**

The third table contains data on :

- ∠ Legal structure, e.g. :
  - Article 21 Organisation
  - *i* Declared cultural institutions
  - Education institutions
  - 🗷 Parastatal
  - 🖉 Statutory body
  - ß Government department
  - *K* Company, limited company or closed corporation.
- ∠ Ownership, e.g.
  - ∠ State-owned, or
  - Reference Privately owned.
- Sector Governance, e.g. Control or Executive Board.
- Sector Operational top management.

#### STRUCTURE OF ACTIVITIES

This table includes :

- ∠ Staff numbers, split into
  - Reference Professional staff
  - ∠ Technical support staff
  - Administrative staff
  - ø Unskilled labour
  - ∠ Total S&T staff
  - ∠ Other non-S&T staff
  - ∠ Total staff
- ß Income statement data
- Major clients
- Sources of funding, s plit into
  - Reference Private sector income
  - ∠ Public sector income
  - ∠ International income
- Sector Gross income and year for which data is valid
- Split of income to field of application, namely :
  - Agricultural sciences
  - Biological sciences
  - Chemical sciences
  - ∠ Earth and marine sciences
  - ∠ Engineering sciences
  - ø Information and computer sciences
  - Medical and health sciences
  - Mathematical sciences
  - Physical sciences
  - Applied sciences
  - ∠ Social sciences
  - Economic sciences
  - ∠ Humanities
  - Life and physical sciences, added specifically for the Universities, and being a combined field for biological, chemical, earth & marine and physical sciences.

#### ASSETS

This table lists details of the fixed assets as supplied by the organisation :

- Basis for data, e.g. book value, original purchase cost or replacement value.
- Note: Note: Kinetic Strain Str
  - ∠ S&T equipment
  - ∠ Land and buildings
  - ø Other fixed assets
  - Z Total fixed assets
- Depreciation values for the same categories
- Annual maintenance cost
- Annual spending on capital, split to the same categories as above
- Zero Total research space and unused research space
- Box Date for which the above data is valid.

#### OUTPUT FOCUS

This table measures the outputs of the organisation, through :

- Degree to which organisations meets the elements of the Growth, employment and redistribution (GEAR) policy of the Government, namely :
  - Meeting basic needs
  - 🗷 Economic growth
  - Z Capacity building
  - Bemocratising of State and Society
  - *K* Implementing the RDP, and
  - *«* Creating international competitiveness.
- A description of major strategic S&T outputs.

#### S&T FUNDING

For those organisations that fund science and technology, this table lists :

- Box Date for which data is valid
- The cost of and associated staff numbers which control/manage the fund ing activities
- The total S&T funding
- The private/public sector split of funding destinations
- The generic recipients of S&T funding, categorised as :

  - A Higher education institutions
  - ∠ National heritage institutions
  - 🗷 NGOs
  - Bursaries and grants
  - ese Other recipients.

#### FUNDING FOCUS

This table inspects the reasons for the S&T funding, as follows :

 $\swarrow$  The type of S&T activity being funded, i.e.

- Research and development
- Education and training
- ∠ Deployment of knowledge
- Standards and guidelines.
- Focus on the Government's GEAR strategy, i.e.
  - ∠ Meeting basic needs
  - ∠ Economic growth
  - ∠ Capacity building
  - Democratising state and society
  - *∠* Implementing the RDP
  - *«* Creating international competitiveness.
- Split of funding to field of application, namely :
  - Agricultural sciences
  - Biological sciences
  - Chemical sciences
  - Earth and marine sciences
  - Engineering sciences
  - *i* Information and computer sciences
  - Medical and health sciences
  - ∠ Mathematical sciences
  - References Physical sciences
  - Applied sciences
  - Social sciences
  - Economic sciences
  - ∠ Humanities
  - Life and physical sciences, added specifically for the Universities, and being a combined field for biological, chemical, earth & marine and physical sciences.

## **APPENDIX B**

# DETAILS OF ORGANISATIONS SURVEYED

Organisation ID	Parent ID	Organisation Name	Parent Name	Category of Organisation
1		Central Economic Advisory Service		Government sector
2		Central Statistical Service		Government sector
3		Department of Arts, Culture, Science and Technology		Government sector
4	3	Directorate of State Archives and Heraldic Services	Department of Arts, Culture, Science and Technology	Government sector
5		Department of Agriculture		Government sector
6	5	Directorate Agricultural Resource Conservation	Department of Agriculture	Government sector
7	5	Plant and Quality Control	Department of Agriculture	Government sector
8	5	Animal Health	Department of Agriculture	Government sector
9	5	Veterinary Public Health	Department of Agriculture	Government sector
10	5	Directorate : Communication	Department of Agriculture	Government sector
11		Department of Foreign Affairs		Government sector
12		Dept of Post, Telecommunication and Broadcasting		Government sector
13		Transvaal Museum		National Heritage Institution
14		JLB Smith Institute of Ichthyology		National Heritage Institution
15		Natal Museum		National Heritage Institution
16		War Museum of the Boer Republics		National Heritage Institution
17		The Afrikaans Language Museum		National Heritage Institution

18		National English Literary Museum		National Heritage Institution
19		Michaelis Collection		National Heritage Institution
20		William Fehr Art Collection		National Heritage Institution
21		Albany Museum		National Heritage Institution
22		National Zoological Gardens		National Heritage Institution
23		National Botanical Institute		National Heritage Institution
24		National Cultural History Museum		National Heritage Institution
25		South African National Museum of Military History		National Heritage Institution
26		Foundation of Education Science and Technology		National Heritage Institution
27		National Museum		National Heritage Institution
28		South African Museum		National Heritage Institution
29		South African Cultural History Museum		National Heritage Institution
30		Natal Parks Board		Government sector
31		National Parks Board		Government sector
32	76	Nedlac (National Economic Labour Council)	Department of Labour	Government sector
33		Land and Agriculture Policy Centre(LAPC)		NGO
34		South African Institute of Race Relations		NGO

35		Centre for Education Policy		NGO
		Development, Evaluation and Management ( CEPD )		
36		Group for Environmental Monitorinç		NGO
37		Ort Science and Technology Education Project		NGO
38		National Labour and Economic Development Institute ( NALEDI )		NGO
39		Community Agency for Social Enquiry (CASE)		NGO
40		Human Rights Institute of South Africa (HURISA)		NGO
41		Molteno Project		NGO
42		Institute of Urban Primary Health Care (IUPHC)		NGO
43		Institute for Democracy in South Africa (IDASA)		NGO
44		Souh African Council on Alcoholism and Drug Dependence SANCA)		NGO
45		USWE Adult Basic Education and Training (USWE)		NGO
46	76	NPI (National Productivity Institute)	Department of Labour	Government sector
47	12	SABC Broadcasting Research Unit	Department of Post, Telecommunication and Broadcasting	Government sector
48	50	SATOUR: Information Management and Research	Department of Environmental Affairs and Tourism	Government sector
49		South African Communication Services		Government sector
50		Department of Environmental Affairs and Tourism		Government sector
51	50	Chief Directorate Environmental Management	Department of Environmental Affairs and Tourism	Government sector

50	50	Objet Directorete Oce Fisheries	Descentes and of Environmental	O au ante a stan
52	50	Chief Directorate Sea Fisheries	Affairs and Tourism	Government sector
53	50	Chief Directorate Weather Bureau	Department of Environmental Affairs and Tourism	Government sector
54	50	Chief Directorate Tourism	Department of Environmental Affairs and Tourism	Government sector
55	50	Chief Directorate Administration- Antarctica and Islands	Department of Environmental Affairs and Tourism	Government sector
56	57	Directorate Senior Primary and Secondary Programmes	Department of Education	Government sector
57		Department of Education		Government sector
58	57	Directorate Teacher Education	Department of Education	Government sector
59	57	Directorate Distance Education, Media and Technological Services	Department of Education	Government sector
60		Department of Finance		Government sector
61	60	Unit for Fiscal Research	Department of Finance	Government sector
62		Department of Health		Government sector
63	62	Chief Directorate Health Information, Evaluation and Research	Department of Health	Government sector
64		Department of Housing		Government sector
65		Department of Land Affairs		Government sector
66		Human Sciences Research Counci		Science Council
67		Forest Owners Association		NGO, S&T Funding
68		Medical Research Council		Science Council

69		Health Systems Trust		NGO, S&T Funding
70		South African Sugar Association Experiment Station		NGO, R&D
71		Cement & Concrete Institute		NGO, R&D
72		Africa Institute of South Africa		NGO, R&D
73		National Accelerator Centre		Science council
74		The South African Institute for Medical Research		NGO, R&D
75		Natal Blood Transfusion Service		NGO, R&D
76		Department of Labour		Government sector
77		Department of Welfare		Government sector
78	79	SA Law Commission	Department of Justice	Government sector
79		Department of Justice		Government sector
80		Hans Merensky Foundation		NGO, R&D
81		Sugar Milling Research Institute		NGO, R&D
82		South African Bureau of Standards (SABS)		Science council
83		Institute for Commercial Forestry Research		NGO, R&D
84		South African Astronomical Observatory		Science council
85		Chamber of Mines		NGO, S&T Funding

86		South African Advertising Research Foundation		NGO, S&T Funding
87		Outspan International Ltd.		NGO, R&D NGO, S&T Funding
88	49	Directorate : Research	South African Communication Services	Government sector
89	94	Research : Policy and Strategy	South African Police Service	Government sector
90	94	Crime Research : Crime Information Management Centre	South African Police Service	Government sector
91	94	Secretariat for Safety and Security	South African Police Service	Government sector
92	94	Forensic Science Laboratory	South African Police Service	Government sector
93	94	Corporate Development	South African Polce Service	Government sector
94		South African Police Service		Government sector
95		South African Communication Services		Government sector
96	97	Directorate Minerals Bureau	Mineral Development Branch	Government sector
97	98	Mineral Development Branch	Department of Mineral and Energy Affairs	Government sector
98		Department of Mineral and Energy Affairs		Government sector
99	98	Mining Branch	Department of Mineral and Energy Affairs	Government sector
100	104	Directorate of Policy Analysis and Strategy	Department of Trade and Industry	Government sector
101	104	Directorate of Patents, Trade Marks, Copyright and Designs	Department of Trade and Industry	Government sector
102	104	Chief Directorates 1 and 2 of Industrial Promotion	Department of Trade and Industry	Government sector

103	104	Directorate of Technology	Department of Trade and Industry	Government sector
		Promotion		
104		Department of Trade and Industry		Government sector
105		University of Zululand		University
106		Potchefstroom University for Christian Higher Education		University
107		University of the Witwatersrand		University
108		University of Venda		University
109		University of Orange Free State		University
110		Rand Afrikaans University		University
111		Epidemiology Research Unit		Government sector
112		South African Association for Marine Biological Research		NGO, R&D
113		University of the North		University
114		University of Transkei		University
115		Vista University		University
116		Medical University of Southern Africa		University
117		University of South Africa		University
118		MINTEK		Science council
119		Technikon Pretoria		Technikon

120		Technikon Northern Transvaal		Technikon
121		Technikon South Africa		Technikon
122		Mangosuthu Technikon		Technikon
123		Peninsula Technikon		Technikon
124		Cape Technikon		Technikon
125		Natal Technikon		Technikon
126		Port Elizabeth Technikon		Technikon
127		Technikon Free State		Technikon
128		Technikon Witwatersrand		Technikon
129		Vaal Triangle Technikon		Technikon
130		ML Sultan Technikon		Technikon
131		Unifruco Research Services (Pty) Ltd		NGO, R&D NGO, S&T Funding
132		Northwest Province : Department o Agriculture		Government sector
133		Western Cape : Department of Agriculture		Government sector
134		Mpumalanga : Department of Agriculture		Government sector
135	134	Sub-Directorate Agricultural Technology	Mpumalanga : Department of Agriculture	Government sector
136		Northern Cape : Department of Agriculture		Government sector

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137	136	Grootfontein Agricultual Development Institute	Northern Cape : Department of Agriculture	Government sector
138		Northern Provence : Department of Agriculture		Government sector
139	138	Chief Directorate : Agricultural Support Services. Directorate- Technology Development	Northern Province : Department of Agriculture	Government sector
140	143	Directorate : North East Region	Kwazulu Natal : Department of Agriculture	Government sector
141	143	Directorate : Agriculture & Rural Development	Kwazulu Natal : Department of Agriculture	Government sector
142	143	Engineering and Soil Conservation	Kwazulu Natal : Department of Agriculture	Government sector
143		Kwazulu Natal : Department of Agriculture		Government sector
144	143	Directorate of Veterinary services	Kwazulu Natal: Department of Agriculture	Government sector
145	143	Directorate : Technology Development and Training	Kwazulu Natal : Department of Agriculture	Government sector
146	143	Directorate : South West Region	Department of Agriculture : Kwazulu Natal	Government sector
147	143	Directorate : North West Region Chief Directorate : Agriculture and Rural Development	Kwazulu Natal : Department of Agriculture	Government sector
148		Gauteng : Department of Agriculture		Government sector
149	148	Directorate : Agriculture	Gauteng : Department of Agriculture	Government sector
150		Council for Geoscience		Science Council
151	148	Nature Conservation Sub-directorate : Technological Services.	Gauteng : Department of Agriculture	Government sector
152		Free State : Department of Agriculture		Government sector
153		CSIR		Science council

154		Umgeni Water		NGO, R&D
155		University of Pretoria		University
156	64	Directorate Information	Department of Housing	Government sector
157	64	Directorate Economics	Department of Housing	Government sector
159		Department of Correctional Services		Government sector
160	159	Directorate Communication Services	Department of Correctional Services	Government sector
161		Department of Water Affairs and Forestry		Government sector
162	161	Chief Directorate Scientific Services	Department of Water Affairs and Forestry	Government sector
163		SA Wool Board		NGO, S&T Funding
164		Rhodes University		University
165		University of Stellenbosch		University
166		University of the Western Cape		University
167		University of Port Elizabeth		University
168		University of Fort Hare		University
169		University of Cape Town		University
170		University of Natal		University
171		University of the North West		University

172		University of DurbanWestville		University
173		Agricultural Research Council		Science Council
174		Water Research Commission		NGO, S&T Funding
175		Minerals & Energy Policy Centre (MEPC)		NGO
176		Cotton Board		NGO, S&T Funding
177		Foundation for Research Development		Science council
178		SIMRAC		NGO, S&T Funding
179		Eskom Technology Group		NGO, Industry-based R&D
180		Department of Transport		Government sector
181	180	Directorate : Research and Development	Department of Transport	Government sector
182	64	Directorate Information	Department of Housing	Government sector
183	0	Hartebeeshoek Radio Astronomy Observatory		Science Council
184	0	Development Bank of South Africa		NGO, S&T Funding
185	0	Maize Board		NGO, S&T Funding
186	0	Wheat Board		NGO, S&T Funding
187	0	Meat Board		NGO, S&T Funding
188	0	Department of Land Affairs		Government sector

189		South African National Defence Force	Government sector
190	0	LIRI Technologies	NGO, R&D

# **APPENDIX C**

# OVERVIEW OF POTENTIAL GENERIC FUNDERS USED AS START LIST

Meat Board	SA Abattoir Corp
R Greyling Ave	R Greyling Ave
Domestic Scientist	Box 3574
74 Sanlam Plaza	Tel (051) 33 2992
Tel (051) 33 3521, 30 4419	Fax (051) 33 3485
SA Blood Transfusion	SA Bureau of Standards
94 St Georges St	116 Church St
Box 1080	Box 132
Tel (051) 47 4122	Tel (051) 47 4408
Fax (051) 47 1220	Fax (051) 30 3485
SA Co-ordinating Consumer Council 130 Sanlam Plaza Box 6590 Tel (051) 47 6034 47 5298 Fax (051) 30 8306	SA Institute for Estate Agents 53a Kellner St Westdene Tel (051) 30 4404
SA Institute of Chartered Accountants	SA Mutton Merino Breeders' Soc
Atrium Building Elizabethstr	Central Show Grounds
Tel (051) 30 4240	Curie Av
Fax (051) 48 0630	Tel (051) 47 7812, 47 7813
SA National Council for Child & Family Welfare Box 6203 Tel (051) 30 5848, 30 7507, 30 7510 Fax (051) 30 8548	SA National Tuberculosis Assn 406 Volkskas Building Tel (051) 48 1880
SA Stud Book Assn	SA Tourism Board
Henry St	Charles St
Tel (051) 48 9347	Tel (051) 47 1362

BLOEMFONTEIN

### CAPE

SA Apple & Pear Producers Assn DFB Building WV Schoor Av Building Box 1096 Oakdale Tel (021) 948 5526	SA Archaeological Soc Box 15700 Vlaeberg Tel (021) 24 3330
Fax (021) 9f4 1523	

SA Bird Atlas Project University Cape Town Tel (021) 650 2423 SA Centre for Management Studies 25 Rand St Durbanville Tel (021) 96 1101	SA Bloodstock Agency Chatsworth House Nova Constantia Rd Constantia Village Box 432 Constantia Tel (021) 794 6122 SA Commercial Travellers' Assn 805 Thibault House Tel (021) 21 6777 Fax (021) 419 7435
Fax (021) 96 9913 SA Council of Civil Investigators Tel (021) 92 9009	SA Diabetics Assn Cuthberts Building Plein St Tel (021) 461 3715
SA Federation of Civil Engineering Contractors Box 1536 Cape Town Tel (021) 21 5180	SA Fish Meal Marketing Co (Pty) Ltd SA Fish Meal Producers' Ass SA Fish Oil Marketing Co. SA Fish Oil Producers' Ass 902 Pearl House Hrngracht Tel (021) 25 1500 SA Foundation for Process 4 Bucksburn Rd Newlands Tel (021) 64 2556
SA Foundation for Process 4 Bucksburn Rd Newlands Tel (021) 64 2556	SA Foundation for the Conservation of Coastal Birds Seabird Centre Pentz Drive Table View Box 11116 Bloubergrant Tel (021) 557 6155 Fax (021) 557 8804
SA Inshore Fishing Industry Assn 902 Pearl House Hrngrcht Tel (021) 25 1500 Fax (021) 419 7058	SA Medical Scholarships Trust 5 Hares Ave Woodstock Tel (021) 448 7348 Fax (021) 448 7498
SA National Council for the Aged 510 Saambou Building Tel (021) 24 6270 Fax (021) 23 2168	SA National Council for the Blind 94 Klip Rd GrssyPrk Box 157 Cape Town Tel (021) 705 3753
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SA National Council for the Deaf Standard House FirSt Observatory Tel (021) 47 4740	SA National Council on Alcoholism West Cape Soc 36 Burg St Tel (021) 24 5260
SA National Epilepsy League National Office 2a Milton Rd Box 73 Observatory Tel (021) 47 3014	SA National Multiple Sclerosis SOC Kenilworth Crt Highwick Ave Kenilworth Tel (021) 761 8289
SA National Zakah Fund Bridgetown Msq Cornflower St Brdgtwn Box 241 Gatesville Tel (021) 638 4541	SAPES Research Institute 88 Station Rd Observatory Tel (021) 47 2017 Fax (021) 47 2029
SA Red Cross Society 21 Broad Rd Box 18032 Wynberg Tel (021) 797 5360 Fax (021) 797 4711	SA Retiits Pigmentosa Soc Box 125 Newlands Tel (021) 685 2845
SA Riding for the Disabled Assn Box 235 Constantia Tel (021) 794 4393 Fax (021) 794 2497	SA Soc for Surgery of the Hand Box 2721 Bellville Tel (021) 99 7907
SA Soc of Physiotherapy Masa Building Pinelands Tel (021) 531 2717	SA South Coast Lobster Assn (Pty) Ltd 902 Pearl House Hrngrcht Tel (021) 25 1500
SA Students Education Trust 5 Hares Ave Woodstock Tel (021) 47 1313	SA Trade Union Assurance Soc Tygerberg Centre Voortrekker Rd Building Tel (021) 946 4700

SA Travellers Assn	SA Veterinary Assn
805 Thibault House	Box 189
Tel (021) 21 6777	Diep River Tel (012) 61 4147

#### JOHANNESBURG

SA Advance Education Projects Management Placement Training Braamfontein Centre 23 Jorrisen St Box 32980 Braamfontein Tel (011) 403 7950 Fax (011) 403 7949	SA Assn of Consulting Engineers 367 Surrey Ave Ferndale Box 1644 Randburg Tel (011) 787 5949
SA Advertising Research Foundation Charlton House Georgian Cres Bryanston Box 98874 Sloane Park Tel (011) 463 5340 Fax (011) 463 5010	SA Associates for Academic Development 76 Juta St Braamfontein Tel (011) 339 3751 Fax (011) 339 5869
SA Board for Personnel Practice 19 Girton Rd Parktown Box 31390 Braamfontein Tel (011) 642 7272 Fax (011) 642 3526	SA Bureau of Standards National Electrical Test Facility Apollo Midrand Tel (011) 316 2005 SA Cement Producers As
Portland Park Pretoria Mn Rd PB X11 Halfway House Tel (011) 315 0300 Fax (011) 315 0054	SA Geographical Soc Box 31201 Braamfontein Tel (011) 339 1951
SA Granite Assn 8 Beechwold Rd Saxonwold Tel (011) 646 5037 Fax (011) 646 9496	SA Haemophilia Foundation Box 87642 Houghton Tel (011) 849 1733

SA History Archive Trust Cancer Assoc House Smit St Braamfontein Tel (011) 339 7546	SA Housing Trust Ltd 291 Surrey Av Box 3316 Randburg Tel (011) 889 000 Fax (011) 886 4448
SA Industrial Refrigeration & Air Conditioning Contractors Assn Donmed House Kirkby Rd Bedford Gardens Tel (011) 622 3890 Fax (011) 622 2534	SA Inherited Disorders Assn Box 1038 Johannesburg Tel (011) 484 3281
SA Institute for Quality & Reliability Management Training Consultants Delbree House Bree St Tel (011) 336 1764	SA Institute of Building Box 2142 Halfway House Tel (011) 315 2810 Fax (011) 315 2931
SA Institute of Chartered Accountants 7 Zulberg Clse Bria Box 59875 Kengray Tel (011) 622 6655 Fax (011) 622 3321	SA Institute of Electrical Engineers 18a Gill St Observatory Box 93541 Yeoville Tel (011) 487 3003 Fax (011) 487 3002
SA Institute of Electrical Technician Engineers PB X2 Highlands N Tel (011) 887 1433 Fax (011) 887 1434	SA Institute of Foundry Men 1 Science Park Klvn Box 77 Wits Tel (011) 802 5145
SA Institute of Intellectual Property Law Box 4685 Pretoria Tel (011) 442 7385	SA Institute of International Affairs Jan Smuts House Box 31596 Braamfontein Tel (011) 339 2021 Fax (011) 339 2154

SA Institute of Management Braamfontein Centre Jorissen St Box 31828 Braamfontein Tel (011) 339 2364 Fax (011) 403 1441	SA Institute of Materials Handling Village Wlk Rivonia Rd Sandton Tel (011) 883 0339 Fax (011) 883 0716
SA Institute of Mathematics Box 498 Cramerview Tel (011) 706 6261	SA Institute of Measurement & Control 18a Gill St Observatory Tel (011) 487 3003
SA Institute of Mining & Metallurgy Cape Towers Maclaren St Marshalltown Tel (011) 834 1273 Fax (011) 838 5923	SA Institute of Race Relations Head Office Box 31044 Braamfontein Tel (011) 403 3600 Fax (011) 403 3671
SA Institute of Reflexology 95 Avondale St Sdnhm Tel 640 1504	SA Institute of Steel Construction Metalland House 42 Anderson St Box 1338 Johannesburg Tel (011) 838 1665 Fax (011) 834 4301
SA Institute of Town & Regional Planners Maclaren St Box 61236 Marshalltown Tel (011) 836 6418 Fax (011) 834 3733	SA Institute of Translators & Interpreters 5 Henry Rd Rivonia Tel (011) 803 2681
SA Institution of Chemical Engineers 18a Gill St Observatory Tel (011) 648 2992 Fax (011) 487 1089	SA Institution of Civil Engineers 18a Gill St Observatory Box 93495 Yeoville Tel (011) 648 1184 Fax (011) 648 7427

SA Institution of Mechanical Engineers 18a Gill St Observatory Tel (011) 648 1322	SA National Council for Child & Family Welfare Melhof Building 2 Melle St Box 30990 Braamfontein Tel (011) 339 5741 Fax (011) 339 8123
SA National Council for the Blind Homefinder House Ruby St Rosettenville Tel (011) 683 4266	SA National Council for the Deaf 20 Napier Rd Richmond PB X04 Westhoven Tel (011) 482 1610 Fax (011) 726 5873
SA National Council on Alcoholism & Drug Dependence 318 Happiness House Johannesburg Coloured Soc Robert Ave W Coloured Township Tel (011) 725 5810 Phoenix House Plantation Rd Auckland Park Tel (011) 726 4210	SA National Council of Tunnelling 18a Gill St Observatory Box 93480 Yeoville Tel (011) 487 1556
SA National Epilepsy League Orpiment Rd Drsly Park Tel (011) 816 2040/2057/2061 Fax (011) 816 1501	SA National Multiple Sclerosis Soc Box 317 Melville Tel (011) 726 7494
SA National Tuberculosis Assn 621 Leisk House 195 Bree St Box 10501 Johannesburg Tel (011) 336 9636 Fax (011) 333 9057	SANCA 73 Market St Tel (011) 337 8400

4	
SA Press Assn Kine Centre 141 Commissioner St Box 7766 Johannesburg Tel (011) 331 0661 Fax (011) 331 7473	SA Property Owners Assn Hunts End Office Park 36 Wierda Rd W Wierda Valley Box 78544 Sandton Tel (011) 883 0679 Fax (011) 883 0684
SA Regional Tourism Council 132 Jan Smuts Av Prkwd Box 600 Parklands Tel (011) 788 0742 Fax (011) 788 1200	SA Reinforced Concrete Engineers Assn Aecmsa 42 Anderson St Tel (011) 834 6181 Fax (011) 834 4792
SA Tourism Board North State Building Market St Box 849 Parklands Tel (011) 333 8082 Fax (011) 333 0896	VM Services Portman Place Portman Rd Bryanston Box 1894 Rivonia Tel (011) 463 1851 Fax (011) 463 1852

#### PIETERMARITZBURG

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SA Timber Growers Assn	SA Wattle Growers' Union
211 Burger St	211 Burger St
Tel (0331) 45 1366	Tel (0331) 45 1368
Fax (0331) 42 1076	Fax (0331) 94 8484
Royal Agricultural Soc of Natal Showgrounds Commercial Rd P O Box 524 Tel 45 6274 Fax 94 3540	

SA Abattoir Corp Buick St Markman Tel (041) 61 1504 Fax (041) 61 1146	SA Bureau of Standards 30 Kipling Rd Kensington Box 3013 Tel (041) 33 7748 Fax (041) 33 2281
SA Co-op Citrus Exchange Cold Storage 2 Quay Harbour Tel (041) 56 3825 Fax (041) 56 0752	SA Hides & Skins Shippers' Assn Trade Centre Diaz Rd Tel (041) 33 7801
SA Institute for Medical Research Buckingham Rd Box 467 Tel (041) 33 7951 Fax (041) 33 8695	SA Institute of Building P O Box 12427 Centrahil Tel (041) 531 1385
SA National Council on Alcoholism & Drug Dependence 67b Russel Rd Tel (041) 55 1927	SA Nasionale Raad vir die Blindes Agency Building 103 Perkinstr Nrdnde Tel (041) 54 5006 Fax (041) 54 1466
SA National Zakah Fund Moslem Movement Hll Van Rooyen St Prksde Tel (041) 47 1459	SA Wool Board SA Wool Board Building 18 Grahamstown Rd P O Box 2191 North End Tel (041) 54 4301 Fax (041) 54 6760
SA Wool & Mohair Buyers Assn 16 Grahamstown Rd Tel (041) 54 5252 Fax (041) 545629	SBDC Finance/Advisory Services Small Business Centre 266 Main St Box 1745 Tel (041) 52 1601 Fax (041) 55 2297

PORT ELIZABETH

PRETORIA	
SA Assn for Sport Science Physical Education & Recreation Box 13206 Clubview Tel (012) 663 3290	SA Bureau of Racial Affairs 1332 Dunwoodie Ave Waverley Tel (012) 428 7911
SA Centre Redeeming Cultures 322 Genl Erasmus St Waterkloof Ridge Tel (012) 347 0998	SA Certification Council Southern Life Park Persequor Tel (012) 349 2450 Fax (012) 349 1511
SA Chocolate & Sweet Manufacturers Assn Soutter St Box 933 Tel (012) 327 1487 Fax (012) 327 1501	SA Council for English Education 101 Dianahof Sunnyside Tel (012) 344 1768
SA Council for Valuers Kingsley Centre Church St Arcadia Tel (012) 341 2437	SA Dairy Foundation Sanwood Park Queen Cres Lynnwood Box 72300 Lynnwood Ridge Tel (012) 348 5345 Fax (012) 348 6284
SA Feedlot Assn De Jongh Centre 457 Rodericks St Lynwood Box 35721 Menlo Park Tel (012) 47 7649 Fax (012) 348 3930	SA Foundation for Public Management & Development Kudu Building Pretorius St Tel (012) 323 2821
SA National Consumer Union Botha Mans Celliers St Sunnyside Box 26242 Arcadia Tel (012) 341 8158	SA Tourism Board 442 Rigel Ave Erasmusrand PB X164 Pta Tel (012) 347 0600 Fax (012) 45 4889

SA Veterinary Assn	SBDC Finance/Advisory Service
47 Gemsbok St	Box 444
Box 25033	Irene
Monument Park	North/Eastern Tvl Munimed Building
Tel (012) 346 1150	Koranna St
Fax 346 2929	Doringkloof
	Tel (012) 667 1320
	Fax (012) 667 1647