South African Science and Technology
Key Facts and Figures 2002

National Advisory Council on Innovation (NACI)

Branch: Science and Technology, Department
of Arts, Culture, Science and Technology (DACST)

How can we say that the half of the human race which has yet to make or receive a telephone call, let alone use a computer, is taking part in globalisation?…

We need to get [our member states] working together on global issues… [grouped] under three headings, each of which I relate to a fundamental human freedom – freedom from want, freedom from fear, and the freedom of future generations to sustain their lives on this planet.…

In short, we need a new ethic of stewardship. We need a much better informed public.… And we need more accurate scientific data.

Above all we need to remember the old African wisdom which I learned as a child – that the earth is not ours. It is a treasure we hold in trust for our descendants.… We are at the service of the world's peoples.…

Kofi Annan, in his Millennium Report, "We the Peoples: The role of the United Nations in the 21st Century" (3 April 2000)

Contents

Foreword

This publication gives easy access to selected key information about the science and technology (S&T) system of South Africa. It summarises policy and strategic issues, and offers data on selected S&T indicators.

Such facts and figures, indispensable for monitoring and evaluating the effects of S&T policy on competitiveness and transformation, need regular updating. South Africa's S&T system has changed so dramatically over the past six years, moreover, that statistical updates have in certain instances fallen behind, and there is currently no single source of reference containing reliable up-to-date information.

The National Advisory Council on Innovation (NACI) and the Branch: Science and Technology of the Department of Arts, Culture, Science and Technology (DACST) have therefore published *South African Science and Technology: Key Facts and Figures 2002* as a short-term resource for policy makers, analysts, students, and other interested parties.

Further current projects that should, in the medium to long term, significantly improve the availability of information about South Africa's S&T include:

- a (Frascati-guided) research and development (R&D) survey (commissioned by DACST)
- an (Oslo-type) innovation survey (University of Pretoria)
- an S&T profile of South Africa (NACI and the Foundation for Education, Science and Technology (FEST)).

Important changes to the S&T system may be introduced over the medium term. Three developments in particular are expected to have profound implications. First, goverment has approved its new research and development strategy, *South Africa's National R&D Strategy,* which represents a radical departure for the country and will significantly alter its S&T. Second, government has accepted far-reaching national proposals for restructuring higher education. Given the major contribution of universities and technikons to national R&D, the changes will have noticeable effects on developments in S&T. Third, NACI has commissioned an evaluation of the National System of Innovation (NSI), which could lead to a reconsideration of some of its aspects.

This publication does not cover all the topics normally found in S&T indicator reference works. The compilers selected the material that they believed is most often used and details of which have not been readily available. They considered it important to address issues of method in cases where data may, at face value, seem questionable. The matter of internal validity should, they believe, receive more attention in national surveys. Too many publications limit themselves by reflecting on the extent to which they can generalise from available findings, without investigating further the reliability of the data being used. Finally, this reference guide contains information not published before, specifically in the areas of R&D expenditure and outputs. As is common in publications of this kind, it draws on various sources, and, where data appear inconsistent, problems are addressed in explanatory notes.

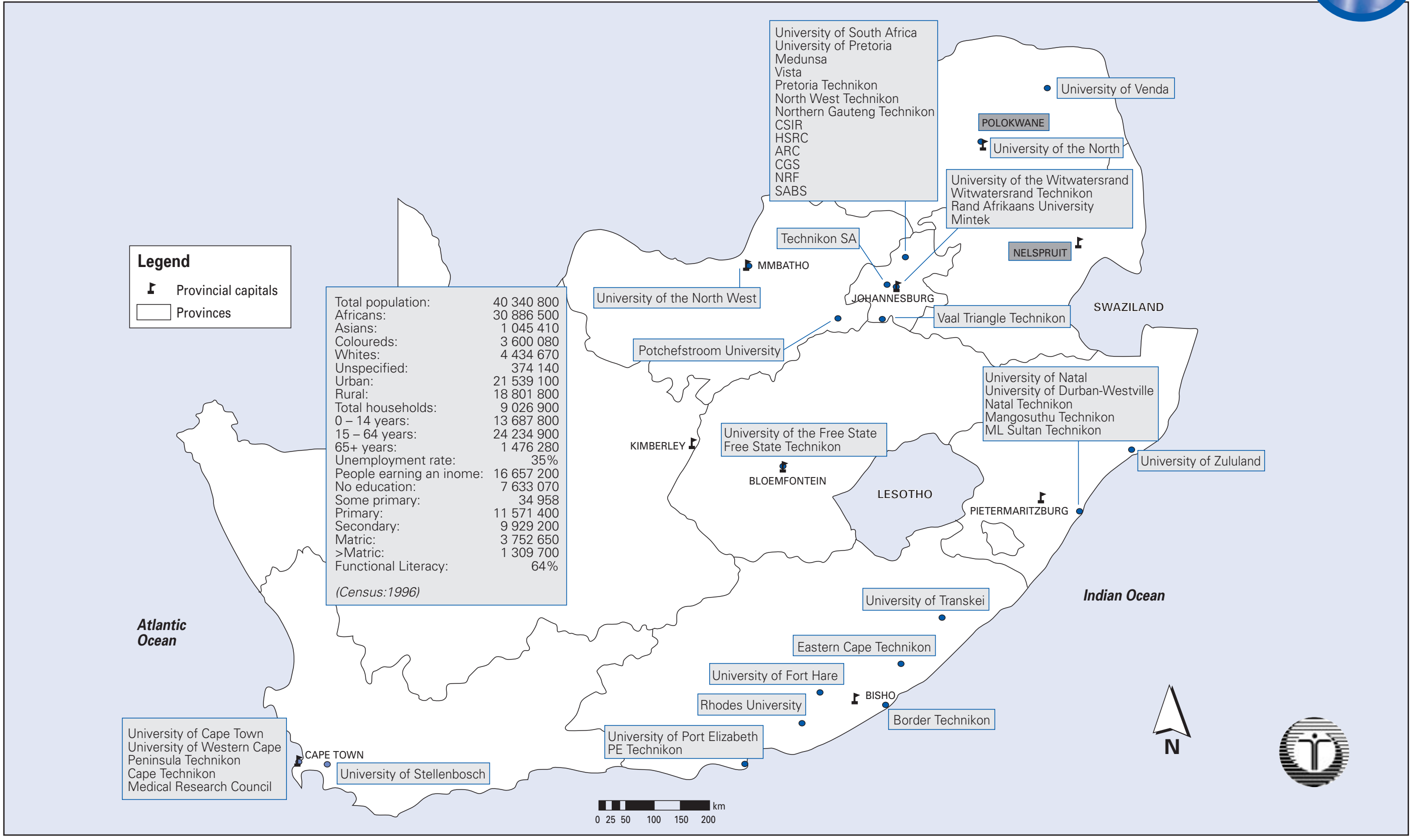
I wish to thank the following, whose contributions made this publication possible: The Human Sciences Research Council (HSRC) for the reproduction of the map in Section 1; from DACST, Dr Rob Adam for his initiatives in transforming South Africa's S&T system and Dr Adi Paterson for his support and his contribution of Sections 2 and 7; Dr H.C. Marais and the NACI secretariat for initiating and managing this project (they are responsible for Sections 3, 4, and 8); Professor Johann Mouton (and his team) of the Centre for Interdisciplinary Studies (CENIS) at the University of Stellenbosch, who were commissioned to research input and output indicators (Sections 5 and 6 are based entirely on their report); Rudolf Gouws of the Rand Merchant Bank for supplying the information in the Appendix; Mr Imraan Saloojee of DACST for his insights and for additional information about the business sector; Dr Graham Baker of the *South African Journal of Science* for critical comment; Dr Elisabeth Lickindorf in her role as copy and production editor.

The publication of *South African Science and Technology: Key Facts and Figures 2002* will, I trust, help to make our S&T system more accessible. To the extent that our country is becoming a 'knowledge society', we need – and will continue to need – reliable and valid indicators for decision making in the sphere of S&T policy.

Roy Marcus
Chairperson: *NACI*

31 July 2002

THE DEMOGRAPHIC AND INSTITUTIONAL LANDSCAPE OF SOUTH AFRICA



Total population:	40 340 800
Africans:	30 886 500
Asians:	1 045 410
Coloureds:	3 600 080
Whites:	4 434 670
Unspecified:	374 140
Urban:	21 539 100
Rural:	18 801 800
Total households:	9 026 900
0 – 14 years:	13 687 800
15 – 64 years:	24 234 900
65+ years:	1 476 280
Unemployment rate:	35%
People earning an inome:	16 657 200
No education:	7 633 070
Some primary:	34 958
Primary:	11 571 400
Secondary:	9 929 200
Matric:	3 752 650
>Matric:	1 309 700
Functional Literacy:	64%

(Census:1996)

Section 2

THE POLICY CONTEXT

Governments need good data and information to measure performance and to support sound strategies. South Africa is part of a globalising world, so the forces acting on our nation are becoming more complex and inter-related. We therefore need clear strategic direction and realistic planning to achieve national goals and objectives.

The publication of *South African Science and Technology: Key Facts and Figures 2002* is part of a wider communication process for providing stakeholders with the information and data needed to enable all of us, working together, to develop effective responses that will serve our nation in years to come. We cannot fully predict our future requirements, but it is important to adopt a strategy that is relevant and workable in our own context, while, at the same time, reflecting globally accepted 'good practice'. This data book aims to promote such an approach.

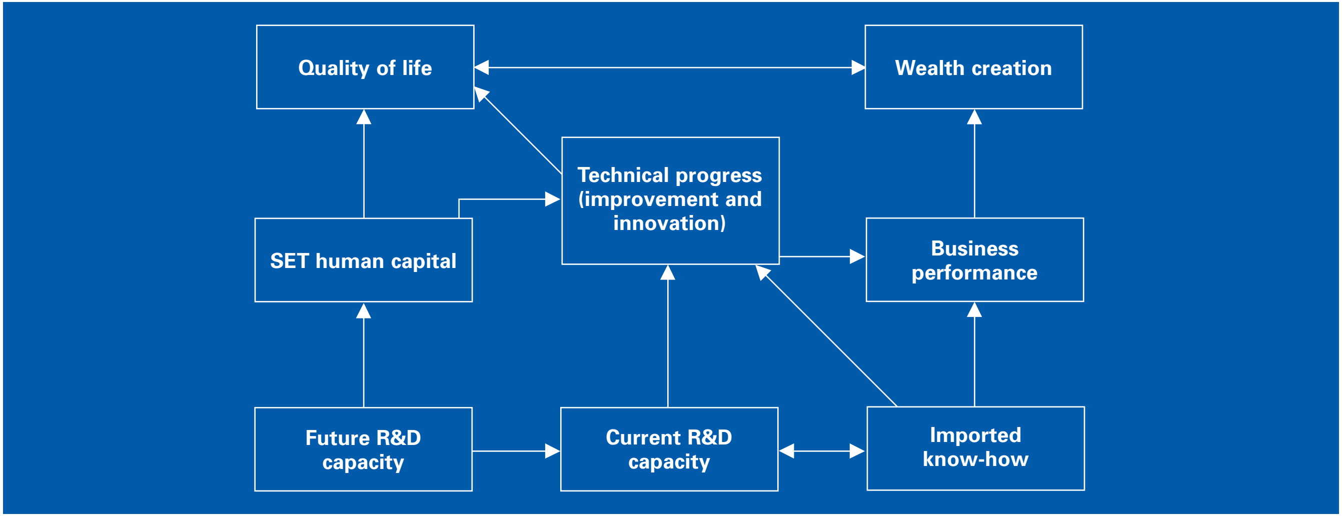
Science and technology (S&T) policy in South Africa is based on the framework of a National System of Innovation (NSI), whose two prime functions are to deliver quality of life to citizens, and economic growth and wealth creation to the nation. S&T is crucial for achieving both, but the process by which such outcomes are delivered is neither trivial nor mechanistic. It is based on complex interactions that include: the people who work in science, engineering, and technology (SET); core innovation processes; and economic factors such as access to capital (including venture capital and tax incentives).

South Africa produces about 0.5% of global public research. This means that we need to be intimately connected with issues that the rest of the world finds pressing. South Africa registers some 100 patents per annum in the patent office of the United States. This is a far smaller proportion than we might expect, given our contribution to the world's research publications. Furthermore, we have an ageing population of contributors to research, and we are failing to make significant progress in the demographic transformation of our S&T.

There are many constraints, challenges, and problems. It is possible to limit our responses to a type of anecdotal mimicry of policy frameworks, programmes, and institutions elsewhere. We do not plan to take this route. We intend, instead, to design a long-term strategic framework for developing science, technology, and innovation in South Africa, based on robust, authenticated indicators.

Figure 2.1 diagrammatically represents South Africa's NSI. The effective operation of this NSI depends on putting and keeping in place the core capacities and processes outlined below, from which it is possible to develop indicators that demonstrate the current status of this system.

Figure 2.1 The South African National System of Innovation



This diagram focuses on the dynamic processes, rather than the structures, on which the NSI is based.

'Quality of life' and 'wealth creation' are the two requirements that the NSI must address, and they provide the ultimate measure of any system of innovation. 'Wealth creation' depends on 'business performance', which in turn is influenced – in terms of S&T – by 'imported know-how' and 'technical progress'. South Africa at present has limited capacity to be truly innovative, and is increasingly dependent on 'imported know-how'.

Effective innovation requires a combination of our 'current R&D (research and development) capacity' and 'SET human capital', which underpin the little-understood process through which knowledge is embodied in products and services (i.e. the 'technologising' process). This process may often be difficult for decision makers to articulate, but it is, nevertheless, critically important.

Every viable system needs a future. This publication contains disturbing indications that South Africa's 'future R&D capacity' may be at risk. Decisive action is needed to respond to this challenge.

Figure 2.2 shows the potential indicators of the NSI's core components. When quantified by means of reliable surveys and data sources, they not only provide a useful instrument for monitoring the health of our own system of innovation, but also allow comparison with others. The results are sobering. Both the internal data and benchmarking with other countries suggest that South Africa's S&T capacity is not growing and, in addition, that its current capacity is too small for it to respond effectively to the challenges it faces. Measuring the present situation provides the context for the future of the system.

Figure 2.2 Potential indicators of the National System of Innovation

Quality of life

- Technology Achievement Index

Growth and wealth creation

- Technology-based growth

Science, engineering and technology human capital

- Researchers per thousand of workforce
- SET demography

Technical progress (improvement and innovation)

- Patents
- High-tech start-ups
- Business innovation investment
- Key technology missions

Business performance and key industrial sectors

- Technology/trade mix
- Proportion of high-tech firms
- Sectoral performance

Future R&D capacity

- University enrolments (SET proportion)
- S&T post-graduate degrees
- Matriculants with Maths and Science

Current R&D capacity

- Publications
- Global share of publications
- R&D intensity (investment)

Imported know-how

- Technology balance of payments
- Imported high-tech equipment
- Imported ICT[a]

NSI indicators provide insight into the strategies currently in operation, and allow objective assessment of its condition and trajectories.

[a]ICT: Information and communications technology

THE STRUCTURE OF THE S&T SYSTEM

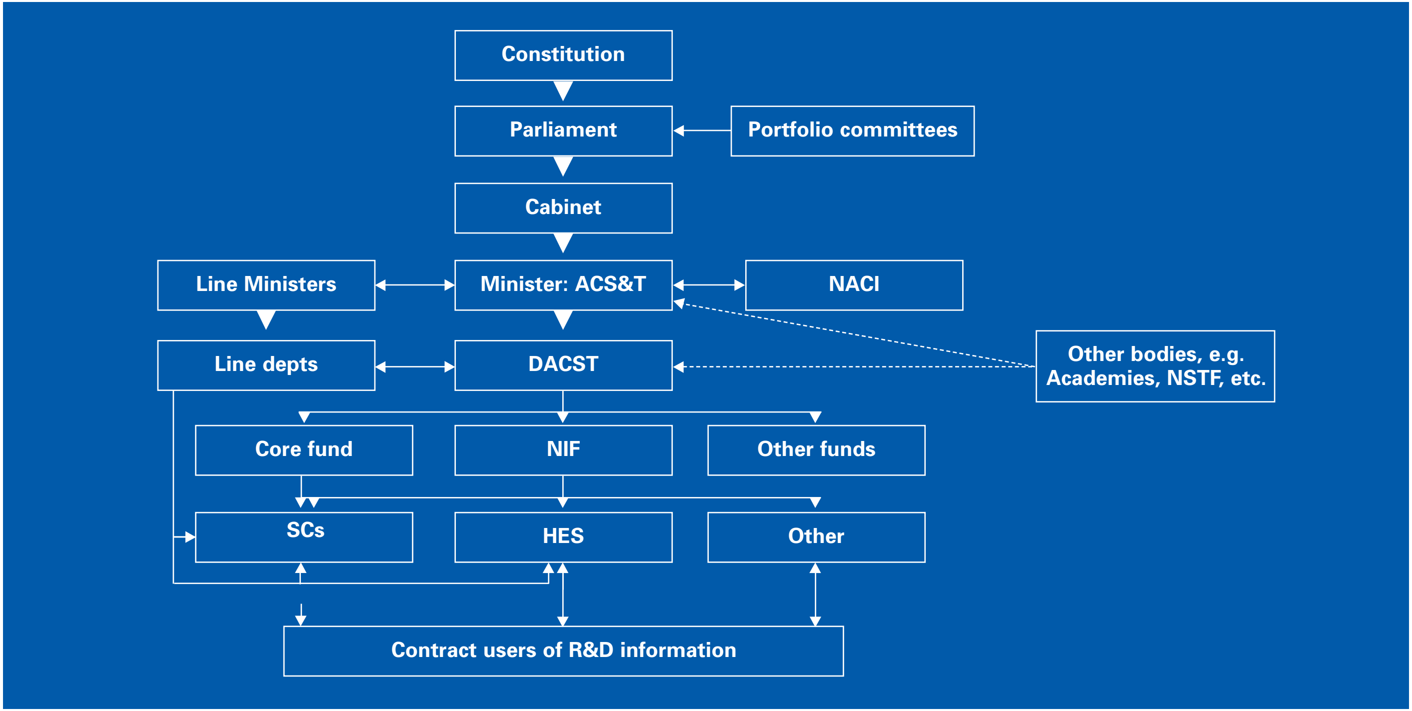
The South African S&T system changed fundamentally after the first democratically elected government took office in 1994. There were two definitive markers in this transformation. First, this government immediately established the new Department of Arts, Culture, Science and Technology (DACST), part of whose work was dedicated to science and technology*. Second, in 1996, a new consolidated policy was published, *The White Paper on Science and Technology: Preparing for the 21st century* (DACST:1996).

This new policy:

- broadened the scope of policy from S&T to innovation
- recognised R&D as crucial to growth and to the improvement of quality of life
- supports the coordination and non-duplication of structures
- pursues the levelling of historical inequalities and human capacity building
- provides core funding in terms of a three-year cycle through the MTEF (medium-term expenditure framework) for capacity building and maintenance in R&D and related activities, while R&D services for clients are managed on a commercial basis with full cost recovery
- requires regular reviews of government science, engineering, and technology institutions (SETIs)

* *On 1 August 2002, the single Department of Arts, Culture, Science and Technology became two departments: the Department of Arts and Culture and the Department of Science and Technology.*

Figure 3.1 A simplified map of the S&T system



This simplified map of South Africa's S&T system after April 1994 emphasises structure and relationships rather than processes. It omits details of 'cross-cutting' bodies such as COHORT (Committee of Heads of Organisations of Research and Technology, a SETI interest group), and of dynamic processes (such as the process whereby NACI makes recommendations to the Minister of Arts, Culture, Science and Technology about the allocation of the parliamentary science vote).

ACS& T: Arts, Culture, Science and Technology
NIF: National Innovation Fund
HES: Higher education sector
NSTF: National Science and Technology Forum
NACI: National Advisory Council on Innovation
SCs: Science Councils

Section 4

THE SIZE OF THE SYSTEM

Institutions

Figure 4.1 indicates the composition of the science system (as at March 2002). Government provides funding for the higher education sector (HES)*, numbering 36 state-supported universities and technikons; the science councils; and other SETIs and government units. Working independently of government are commercial research houses (comprising significant divisions and organisations in the business sector whose work is largely dedicated to R&D), and research NGOs (non-governmental organizations), financed by donors and contract work.

Figure 4.1 Institutions in the science and technology system

Type	No.
Universities	21
Technikons[a]	15
Science councils[b]	8
Other SETIs[c] & government units[d]	35
Commercial research houses[e]	45
Research NGOs[f]	80+

[a]Institutions of tertiary education (similar to polytechnics elsewhere in the world) that focus on applied S&T and industry-related teaching and research.
[b]Statutory government-supported institutions, all performing research (except the National Research Foundation (NRF), which is a research funding agency but also takes responsibility for the work of five national research facilities).
[c]E.g. The Africa Institute of South Africa and FEST; such organizations work in close association with government departments.
[d]These include national museums and active research performance units within government departments.
[e]A wide spectrum of research groups in the business sector, ranging from mining house research laboratories to market research organizations. (Their number is estimated on the basis of data in various sources including R&D surveys conducted during the 1990s.)
[f]These render services primarily to communities and commit more than 25% of their activities and resources to research. (See HSRC:2000 and Jennings *et al.*:1995.)

** In May 2002, the Minister of Education announced government approval for a plan to restructure the HES by: reducing the number of universities to 11 and that of technikons to six; and adding four 'comprehensive institutions' and two National Institutes for Higher Education (in the provinces of the Northern Cape and Mpumalanga, respectively, where no higher education facilities exist at present).*

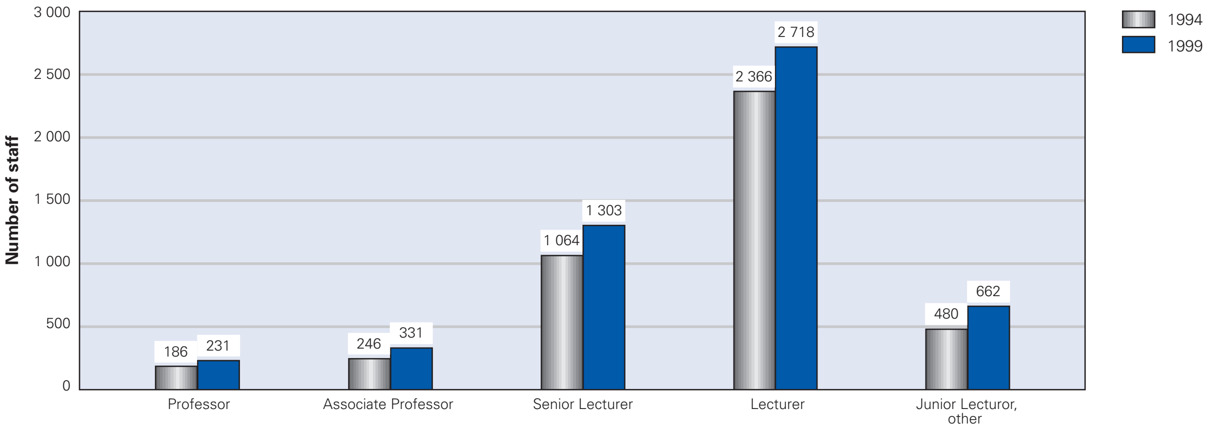
Human resources

The data indicate that South Africa's professional R&D workforce totals approximately 30 000 people. The most reliable statistics currently available about R&D workers in the HES, the science councils, and other R&D organizations are summarized below.

Higher education sector

The total head count of R&D staff (i.e. educators, researchers, and technical support staff) in permanent employment in the HES in 1999 was 13 073. Of these, 8 759 (67%) held a minimum of a master's degree (Marais:2000). Some idea of the HES research capacity may be gained from the 1997/98 R&D survey (DACST:2000), which reported the following numbers of 'full-time equivalent' R&D staff: researchers (2 138) and technicians (2 566). Figure 4.2 shows the distribution of university teaching staff across post levels. The proportions at each level remained similar from 1994 to 1999.

Figure 4.2 Academic staff in the higher education sector



Source: CHE:2002

Science councils

The science councils' statistical returns for 2000 showed a total of 10 060 members of staff, of whom 1 600 held at least a master's degree or equivalent qualification (Marais:2000).

Other R&D organizations

Problems of definition in the available data make it difficult to provide reliable and exact statistics. Derived from a variety of sources (DACST:1998a and other R&D surveys and directories), the figures below are, at best, mere pointers to the size of the R&D workforce in these sectors. Cautious estimates of professional staff numbers are as follows:

• Business sector (researchers and technicians)	6 300
• Other SETIs and government units (excluding science councils)	320
• Research NGOs (see HSRC:2000)	300

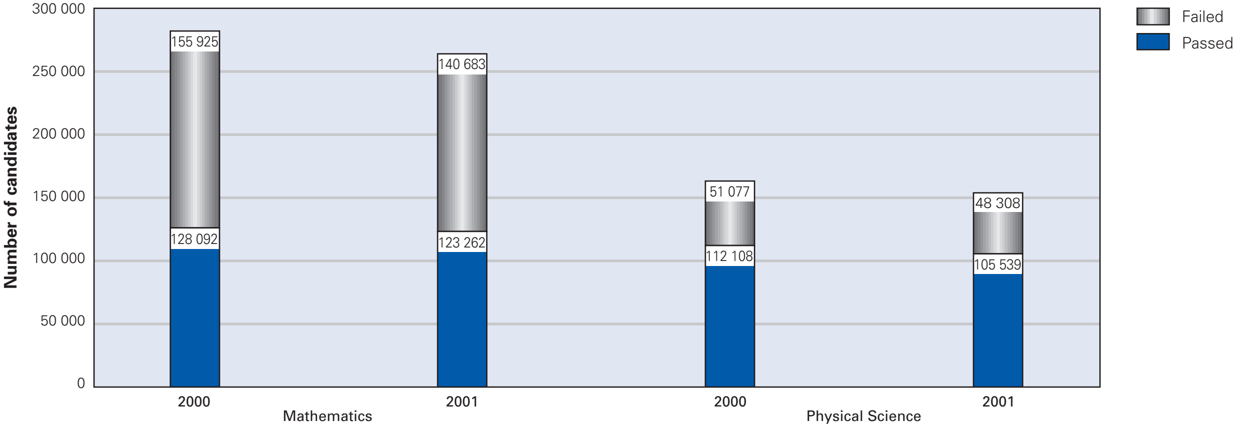
Potential capacity

Secondary schools

Of the approximately 450 000 candidates for the school-leaving matriculation examination (at both 'standard' and 'higher' grades*) in 2001, about 59% enrolled for mathematics and about 34% for physical science (i.e. physics and chemistry). The pass rates** for 2000 and 2001 are summarized in Figure 4.3.

The mean pass rate in mathematics and physical science in the years 2000 and 2001 should be compared with the mean pass rate across all subjects for those years, which was 58% in 2000 and 62% in 2001. Equally important is the number and proportion of those passing matriculation 'with university exemption' in mathematics and physical science: in 2000 this was only 5% of the total enrolled.

Figure 4.3 National matriculation-level pass rates in physical science and mathematics



Source: CHE:May 2002

* *South African matriculation examination subjects are written at 'higher grade' or at 'standard grade' (the latter covers a narrower syllabus).*

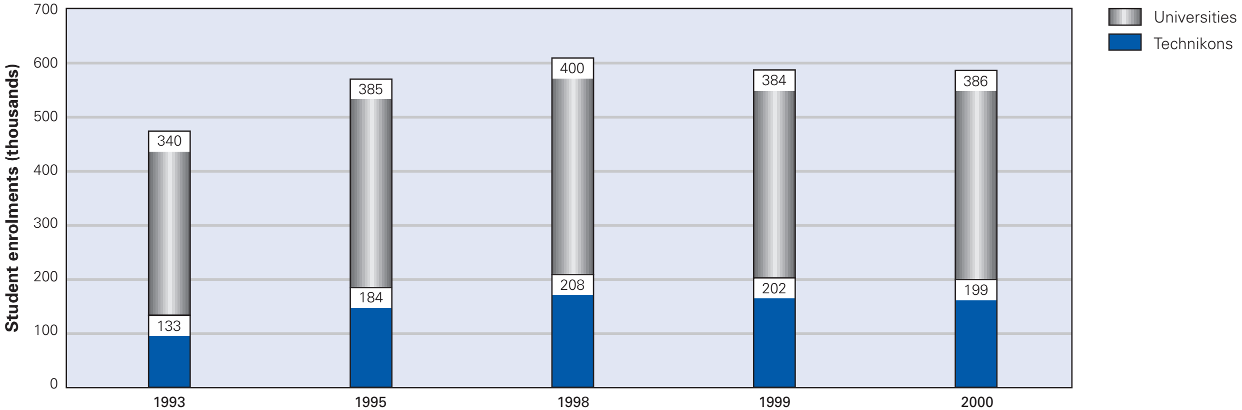
** *A matriculation-level 'pass' means that the candidate has met the minimum requirements, and obtained at least 40% for subjects written at higher grade and 33.3% for those written at standard grade. A pass 'with university exemption' means a pass in at least four subjects at higher grade and an aggregate of 960 marks, which will allow entry to an undergraduate degree course at a higher education institution.*

Higher education

Total enrolments

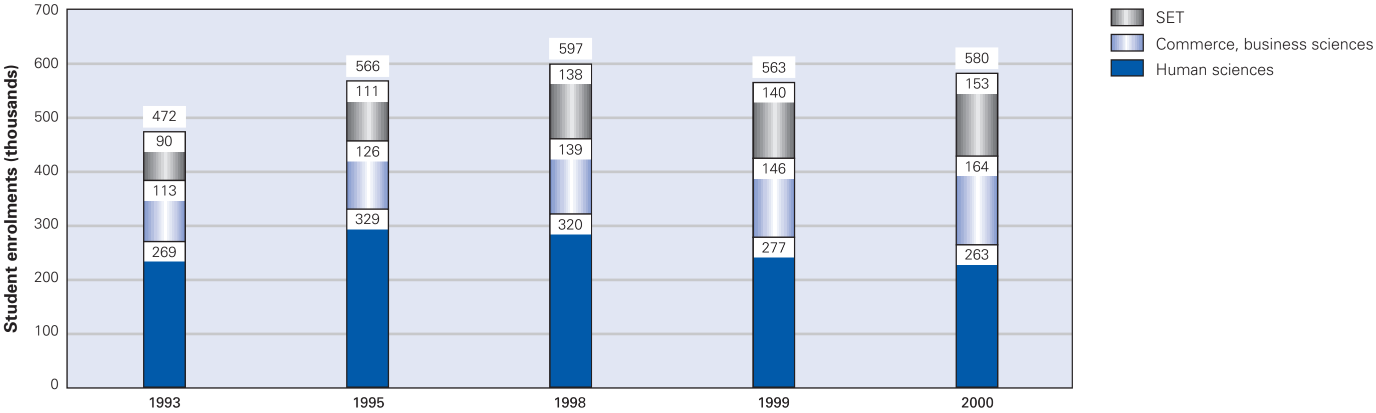
Student enrolments in the HES are reflected in Figure 4.4. They peaked in 1998 at just over 600 000, then the total number declined owing to the fall in university enrolments after 1998. Technikon student enrolments accounted for approximately one third of total HES enrolments in 2000.

Figure 4.4 Student enrolments in the higher education sector



Source: CHE:2002

Figure 4.5 Student enrolments in the higher education sector by disciplinary field



Source: CHE:2002

The proportions of student enrolments by disciplinary field in 1995 and 2000 are shown below. During these five years, the numbers enrolling in SET fields rose by 1.3% (to 26%), those in commerce and business sciences rose by about 1.3%, and those in the human sciences (i.e. in the humanities and social sciences) dropped by about 22%.

Disciplinary field	1995	2000
Science, engineering, and technology	20%	26%
Commerce and business sciences	22%	28%
Human sciences	58%	45%

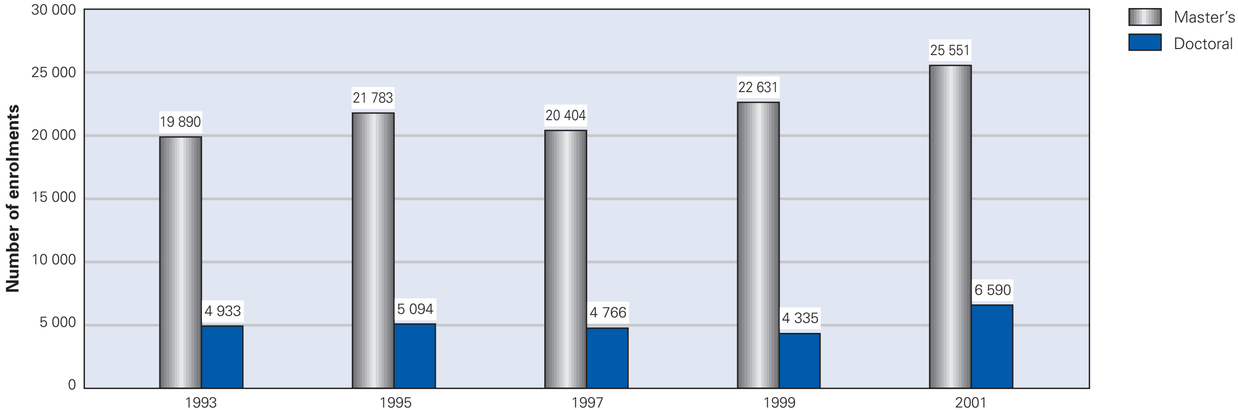
Postgraduate enrolments

Department of Education statistics give the numbers of postgraduate enrolments (i.e. enrolments for all qualifications that require a first degree as a prerequisite) at universities and technikons in the last two years as follows.

Institutions	2000	2001
Universities	66 042	67 133
Technikons	1 244	2 062

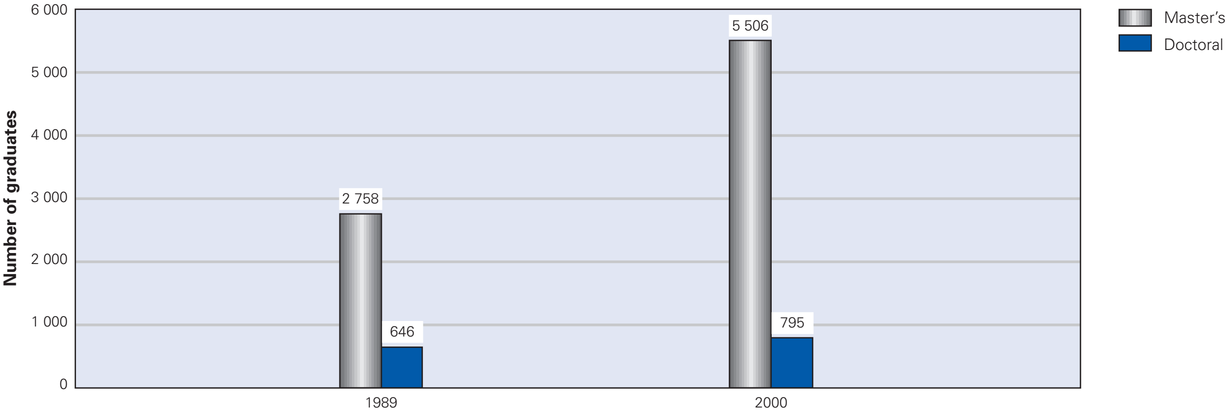
Figure 4.6 shows the head counts of master's and doctoral students enrolled at universities and technikons since 1993. Over the period 1993 – 2001, enrolments for master's degrees increased by 28% and for doctorates by 33%.

Figure 4.6 Enrolments at master's and doctoral levels



Source: DoE:SAPSE (The 2001 figures are provisional.)

Figure 4.7 Master's and doctoral graduates



Source: Cloete *et al.*:2002 (p.168)

The completion rate for master's and doctoral degrees is not high in relation to enrolments, either because students are taking a long time to complete their studies or because of a relatively high 'drop-out' rate. Figure 4.7 shows the numbers graduating at these two levels in 1989 and 2000. The total number of master's graduates doubled during this period, and the number of doctorates awarded grew by 23%.

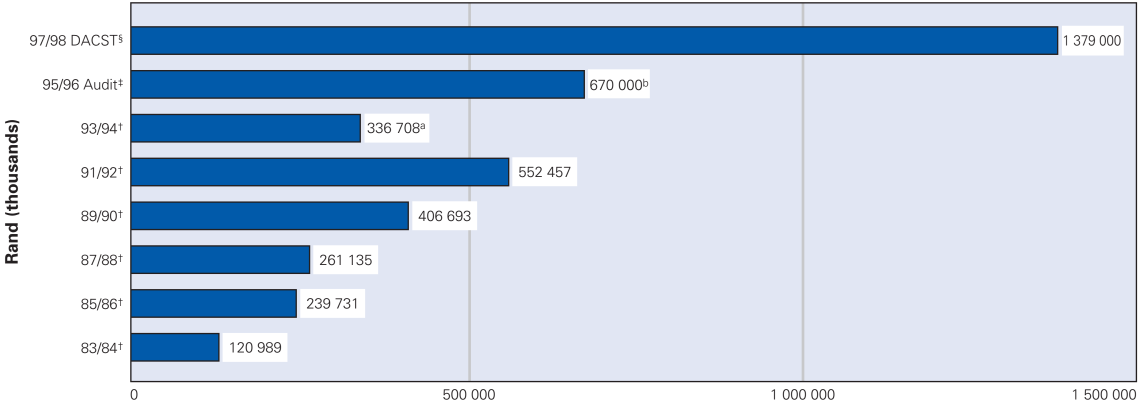
R&D FUNDING*

South Africa's R&D is concentrated in three sectors: the HES (universities and technikons), the business and industry sector, and the government sector (parastatal research institutions).

Higher education sector

The most recent data on R&D expenditure in the HES are the 1997/98 figures, released by DACST in 2000, showing R&D expenditure by the HES of nearly R1.4 billion. Figure 5.1 gives the increase, in nominal rands*, of R&D expenditure in the HES in South Africa over the past decade and a half. Data for the period 1983-92 were based on biennial R&D surveys following Frascati guidelines (FRD:1996).

Figure 5.1 R&D expenditure in the higher education sector (1983-98)



Sources: †FRD:1996, ‡DACST:1998a, and §DACST:2000 (website)

[a]The discrepancy for 1993/94 may be a function of the data-gathering methods used, in which the HES was covered less extensively than in previous years, and the R&D expenditure on overheads was adjusted downwards.

[b]The information for 1995/96 (DACST:1998a) was considered at the time of publication to be a conservative estimate.

* *Nominal rands: Throughout this publication, income and expenditure figures are quoted in nominal rands. For Rand-US$ exchange rates and the effect of inflation on rand value, see Appendix.*

Figure 5.2 R&D income by source in the higher education sector (R million)

	1996	1997	1998 Totals (Rm)	1999	2000
Internal	95.9	99.9	117.4	131.7	150.9
Agency	121.4	130.2	155.8	171.5	199.9
THRIP[†]	24.1	46.6	65.4	86.1	116.7
Contracts	288.1	349.6	417.1	504.5	637.4
TOTAL	529.5	626.3	755.7	893.8	1 105.0

	1996	1997	1998 %	1999	2000
Internal	18	16	16	15	14
Agency	23	21	21	19	18
THRIP[†]	5	7	9	10	10
Contracts	54	56	55	56	58
TOTAL	100	100	101	100	100

Sources:CENIS:2002b and [†]NFR:2001

A CENIS survey in 2001 (CENIS:2002b) of directors of research at South African state-funded universities and technikons, covering the period 1996-2001, categorised R&D sources of income as follows: funding from the institution's own research budget; funding from national research funding institutions (e.g. NRF, Medical Research Council (MRC), Agricultural Research Council (ARC)); and income from contract research. Figures for funding from the Technology and Human Resources for Industry Programme (THRIP)*, which allocates research funding, were obtained from the THRIP annual report of 1999/2000. The CENIS survey elicited responses from some 75% of South Africa's universities and technikons. Estimates for the remaining 25% were based on the proportion of their contributions to higher education R&D expenditure in the 1991/92 R&D survey (FRD:1996).

Figure 5.2 gives R&D income by source, based on the CENIS survey (including the estimates for non-responding institutions). It shows that, in nominal terms**, R&D income in the HES more than doubled over five years, from R529 million in 1996 to R1.1 billion in 2000. A decline in the proportions of internal and agency funding was reported: internal and agency funding comprised 18% and 23%, respectively, of research funding in 1996, but dropped to 14% and 18%, respectively, in 2000. An increase in THRIP and contract funding was recorded.

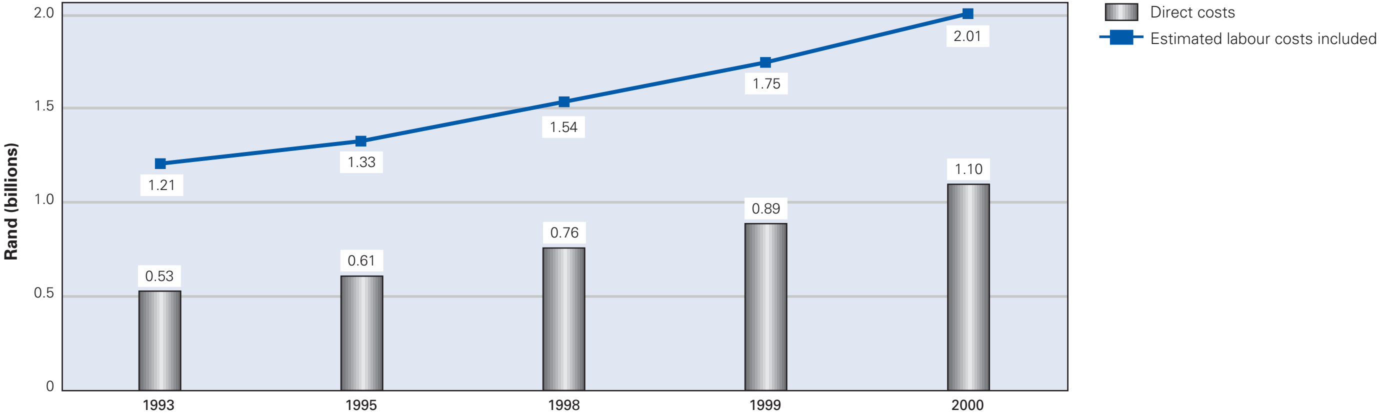
* *THRIP is a competitive R&D research funding programme focused on technology, funded by the Department of Trade and Industry (DTI) in partnership with South African business, and administered by the NRF.*

** *See Appendix.*

Accounting for labour costs

Figure 5.1 excludes expenditure on labour (i.e. the cost of researchers' time) in R&D in higher education institutions. As a rough estimate, we have calculated this labour cost as 13% of the budget allocated by the Department of Education (DoE) for universities and technikons, and, in Figure 5.3, added it to the direct costs of R&D. (This 13% estimate is based on the fact that the annual subsidy allocation by the DoE to universities and technikons includes a so-called 'blind' component to cover research costs, which amounts to 15% of the DoE's subsidy to universities, and 10% of its subsidy to technikons.) In nominal rands*, total R&D expenditure in the HES increased steadily over five years: from R1.2 billion in 1996 to R2.0 billion in 2000.

Figure 5.3 R&D expenditure in the higher education sector (including estimated labour costs)



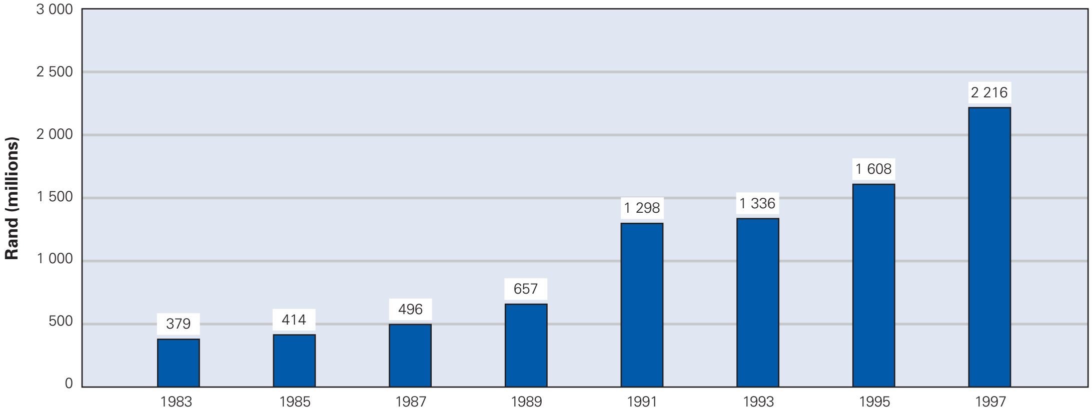
Source: CENIS:2002b

** See Appendix.*

Business sector

DACST's 1997/98 R&D survey (DACST:2000) gives the most recent figure for R&D expenditure in the business sector as R2.2 billion in 1997 (Figure 5.4). Data for the period 1983-92 were based on the biennial R&D surveys of the former Foundation for Research Development (FRD:1996). The 1995 figure of R1.6 billion was the estimate produced by the National Research and Technology Audit (DACST:1998b). The task of collecting data on R&D monies spent in the private sector was so great that figures could only be estimated for 2000: the estimate of R2.5 billion was based on the 1997 figure (R2.2 billion) plus an annual increase of 5%. For another indication of current R&D expenditure, reference can be made to a limited survey on a purposive sample of the 17 largest corporations in the country undertaken early in 2002 by DACST: R&D expenditure had declined from 1.46% to 0.97% of the total company budgets between 1997 and 2001, and the percentage of research work outsourced had increased from 7% to 26% over this period.

Figure 5.4 Estimated R&D expenditure in the business sector



Sources: FRD:1996, DACST:1998b, and DACST:2000

Government and non-profit sector

According to DACST's 1997/98 R&D Survey (DACST:2000), R&D expenditure in the government and non-profit sector (e.g. science councils, and government and other SETIs) totalled R1.38 billion for 1997/98. The most significant research performers in this sector are the eight science councils*, the national facilities**, and a number of government-based institutions such as the South African Weather Service.

Figure 5.5 summarises the allocation of government funding to the science councils for the years 1997-2001. Estimates are given for 2001/02 and 2002/03.

Figure 5.5 Government funding to science councils* (R million)

Institution	1997/98	1998/99	1999/2000	2000/01	2001/02	2002/03
ARC	316.2	284.0	279.2	265.3	262.1	261.6
CGS	64.6	66.8	63.8	60.6	66.0	66.4
CSIR	316.4	313.5	315.6	299.9	302.9	301.3
HSRC	89.8	93.2	64.4	61.2	65.5	65.1
Mintek	83.0	83.1	81.8	77.7	76.9	76.4
MRC	66.3	76.4	79.6	108.2	127.2	145.5
NRF[a]	(162.6)	(210.4)	250.6	271.7	304.5	336.3
SABS	67.1	75.0	77.7	78.7	81.4	85.0
Total	1 166.0	1 202.4	1 212.7	1 223.3	1 286.5	1 337.6

Source: Treasury:2001

[a]In 1999, the newly formed NRF replaced the research funding agency functions of the former FRD (which had been the agency for the natural sciences and engineering) and the former Centre for Science Development (which had been the agency for the humanities and social sciences and had operated as a division of the HSRC).

The proportions of government allocations have risen steadily for the NRF and the MRC. If they were to continue being adjusted in the same way, the NRF's share of government funding could increase to 25.1% of the total in 2002/03, and the MRC's from 5.7% in 1997/98 to 10.9% in 2002/03. The ARC's, however, would fall from 27.1% in 1997/98 to 19.6% in 2002/03 (CENIS:2002c).

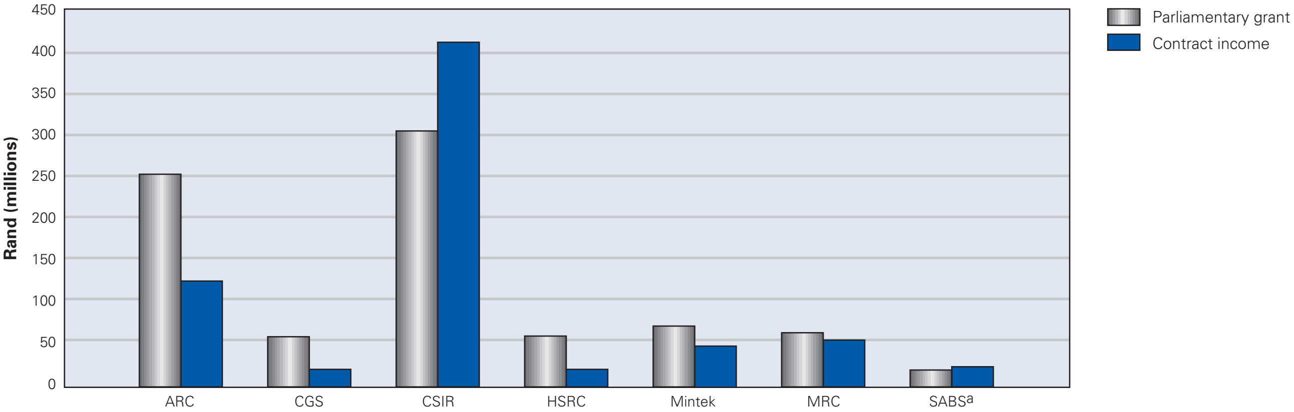
* *The eight science councils are: the Agricultural Research Council (ARC), the Council for Geoscience (CGS), the CSIR, the Human Sciences Research Council (HSRC), the Council for Mineral Technology (Mintek), the Medical Research Council (MRC), the National Research Foundation (NRF), and the South African Bureau of Standards (SABS).*

** *'National facilities' are institutions with substantial research equipment and infrastructure unique in the country and requiring significant government funding. Access to their facilities is available to the country's research community on a competitive basis. In 1997/98 there were four national facilities; a fifth was added in 2001.*

Government budget allocations (as shown in Figure 5.5) do not represent the total income of the science councils. An overview of the actual monies received was obtained from the financial statements in the science councils' annual reports for the year 1999/2000. The monies were listed in two categories: money received from government from the parliamentary grant, and money received from contract income. In 2000, the R&D performing science councils obtained an overall total of R970 million of research funding from the parliamentary grant, and R740 million from contracts (which included government as well as industrial contracts).

Figure 5.6 indicates the distribution of parliamentary grant funding and contract income by science council for 1999/2000. (Estimates have been made where there were information gaps. The NRF is not included as it functions exclusively as a funding agency.)

Figure 5.6 Science councils' sources of income (1999/2000)



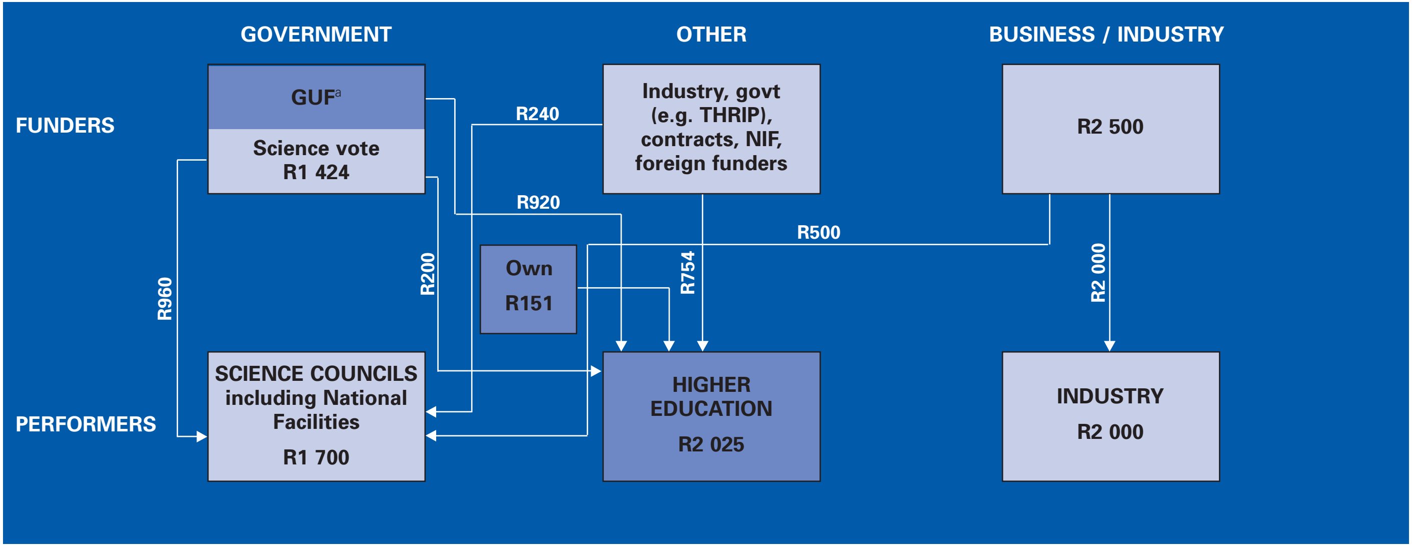
Source: CENIS:2002c

[a]Since the SABS is predominantly a body that controls standards, only 20% of its parliamentary grant funding and contract income is assumed here to be research-related.

Total R&D expenditure

The estimated total R&D expenditure in the three R&D performing sectors for 2000, together with their sources of funding, is represented in Figure 5.7.

Figure 5.7 Major flows of R&D funding in 2000 (R million)



Source: CENIS:2002c

[a]GUF: General University Funds

** For conclusions that can be drawn from Figure 5.7 please see next page.*

The following conclusions can be drawn from the information in Figure 5.7:

- Industry and government are the main funders of R&D in South Africa.
- The HES and the business and industry sector perform most of the country's R&D.
- Higher education R&D is funded mainly by government (i.e. from General University Funds (GUF), research agency funding, THRIP, and contracts from government departments and related institutes such as parastatals). In contrast, the HES contributes minimally to its own research funding (i.e. only about 7%, from non-contract income sources, e.g. student fees, interest, donations, etc.).
- About 56% of the funding for science councils is channelled through the parliamentary science vote. The remainder is made up of contributions from industry (29%), and government contracts and foreign funders (15%).
- The country's total estimated gross expenditure on R&D for 2000 was R5.725 billion. This total excludes military R&D (which, some sources estimate, amounts to approximately R300 million for 2002). It also excludes research done by research NGOs and research consultancies.

Figure 5.8 Gross domestic expenditure on R&D (R million)

	1997/98	1997/98 adjusted	2000 estimate
GERD[†]	4 103	4 935	5 712
GDP (cmprices)[a]	685 730	685 730	887 795
GERD/GDP(%)[‡b]	0.60	0.72	0.64

Sources: [†]DACST:2000 and [‡]CENIS:2002a

[a]GDP (cmprices): GDP (at current market prices)

[b]GERD/GDP(%): GERD as a proportion of GDP (expressed as a percentage)

Figure 5.8 shows the Gross Domestic Expenditure for R&D (GERD) for 1997/98, and an estimate for 2000. The figure of R4.1 billion comes from the 1997/98 R&D survey (DACST:2000). The estimate of R&D expenditure in higher education for 1997 in Figure 5.3 was used to obtain a GERD of R4.94 billion. GERD as a proportion of GDP (at current market prices) shows a small increase (from 0.60% in 1997/98 to 0.64% in 2000) if the 1997/98 survey (DACST:2000) figures are used. If adjusted for underestimated higher education expenditure (where differing survey methods were used), the picture is markedly different, showing a sharp decline (of 8%) in the proportion of GERD to GDP between 1997/98 and 2000.

R&D OUTPUTS

Patents

The number of South African patents registered with the United States Patent Office (USPO:2002) since 1990 varied between a low of 101 (in 1992 and 1993) and a high of 137 (in 2001). They include utility patents (i.e. patents for inventions/discovery) and other types (e.g. design patents, plant patents, etc.). Between 1997 and 2001, individually owned patents were by far in the majority (193), followed by Sasol Technology (10), Denel (9), Water Research Commission (9), Implico (8), Eskom (7), Atomic Energy Corporation (5), and Farmarc Nederland (5). The four technology classes (out of a total of 460 classes) that accounted for the largest contributions over this five-year period were: Drug, bio-affecting and body treating compositions (29); Liquid purification or separations (26); Communications: electrical (24); and Hydraulic and earth engineering (15).

Figure 6.1 relates the number of utility patents to the world competitiveness rankings of countries in the same range. Of these, only India and Russia registered more patents in 2001 than South Africa.

Figure 6.1 Number of utility patents for countries with world competitiveness rankings comparable with South Africa's

Country	World Competitiveness Yearbook ranking (2001)	Number of utility patents (2001)
Slovak Republic	37	1
Thailand	38	24
Slovenia	39	21
Philippines	40	12
India	41	177
South Africa	**42**	**120**
Argentina	43	51
Turkey	44	11
Russia	45	234
Colombia	46	12
Poland	47	16

Sources: IMD:2002 and USPO:2002

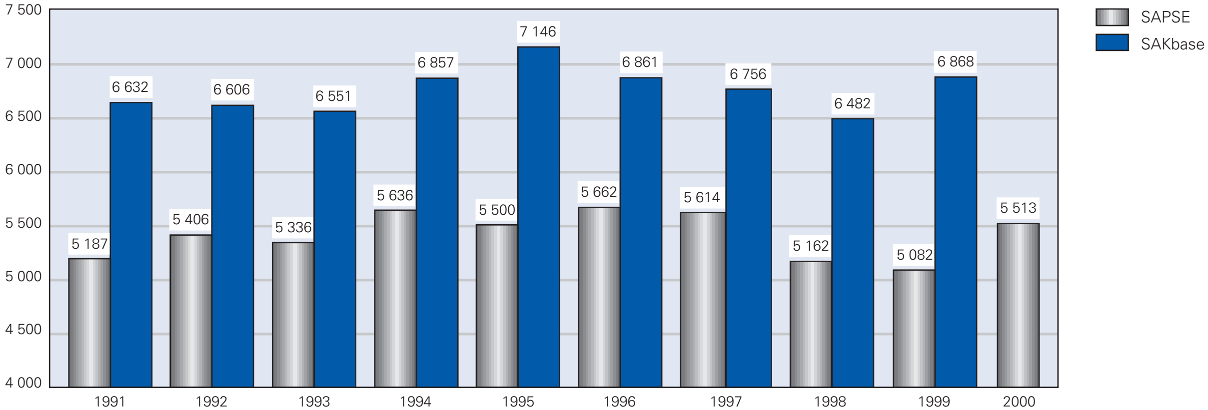
Publications

Two data sources were used for compiling statistics of South Africa's R&D publications output: the South African Post-secondary Education (SAPSE) database* and the South African Knowledgebase (SAK)**.

Figure 6.2 summarises South Africa's output of scientific articles, books, and chapters in books and anthologies as recorded in the SAPSE database, as well as the peer-reviewed articles in the SAK. The SAK number is greater, as it includes all journal articles authored by South Africa's scientists and scholars, whereas SAPSE includes only those journal articles (and a small proportion of other publications) submitted for subsidy purposes by the HES, and excludes publications authored by scientists in the science councils, national facilities, museums, etc.

The chart indicates that South Africa's scientific output was relatively stable in the early 1990s, with a small decline in scientific output from 1996 onwards. Whether or not this performance points to a real decline or merely a shift in forms of scientific publication (e.g. authors may be increasingly doing contract research, which results in technical and contract reports that would not be published in the open literature) is a matter for debate. The figures rise again in the 1999 SAK data (CENIS:2002a) and in the 2000 SAPSE data.

Figure 6.2 Research publications output (1991 – 2000)



Sources: DoE:SAPSE and CENIS:2002a

* *The South African Post-secondary Education (SAPSE) database contains information from 1985 to the present (DoE:SAPSE). The SAPSE-based government funding formula specifies that research outputs qualify for subsidy (i.e. for the universities and technikons in which the researcher was based in the year of publication) according to the number of scientific articles published in some 5 000 peer-reviewed journals specifically 'accredited' by the DoE. (The list is obtainable through the DoE.) Books and chapters in anthologies were later also included for subsidy purposes, although these make up no more than about 5% of the total number of 'accredited' publication units. The SAPSE figures represent the number of publications that attracted DoE subsidy.*

** *The South African Knowledgebase (SAK), developed by CENIS, is a database currently containing information about more than 72 000 articles published by South Africa's researchers (i.e. authors with addresses in South Africa at the time of publication) from 1991 to 1999 (CENIS:2002a). The articles were drawn from 11 000 peer-reviewed academic journals in all disciplines (including those in the indices of the Institute for Scientific Information (ISI) in Philadelphia, those accredited by the DoE including the 205 published in South Africa, and others).*

Figure 6.3 Scientific publications per million of the population

	1996	1997	1998	1999	2000
South Africa (1)	141	137	123	119	126
South Africa (2)	171	165	155	160	
EU-15					
Austria	599	657	696	717	
Belgium	734	741	788	810	
Denmark	1 089	1 117	1 200	1 214	
Finland	1 005	1 048	1 080	1 157	
France	610	618	653	652	
Germany	584	608	661	657	
Greece	282	297	336	340	
Ireland	448	479	527	542	
Italy	420	424	453	457	
Luxembourg	117	170	161	133	
Netherlands	935	972	977	963	
Portugal	156	179	199	248	
Spain	387	415	446	471	
Sweden	1 328	1 335	1 402	1 431	
UK	930	896	929	949	
USA	726	709	709	708	
Japan	445	447	485	498	

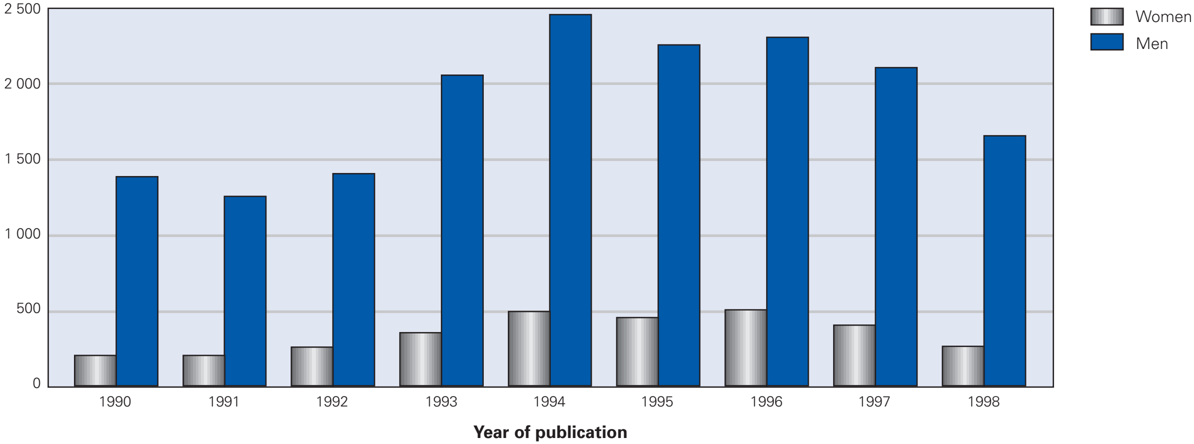
South Africa (1) = SAPSE
South Africa (2) = SAK

Sources: DoE:SAPSE, CENIS:2002a, and STI-ERA:2002 *(http://www.cordis.lu/rtd2002/ indicators/ind_publications.htm)*

If we consider ISI-indexed articles alone, South Africa's research publications represent approximately 0.5% of the world's output. When these, in turn, are expressed as citations per million of the population, South Africa's figures range between a low of 81 (in 1997 and 1998) and a high of 87 (in 1999). In contrast, Egypt's range from a low of 31 (1997, 1998, and 2000) and a high of 34 (1996 and 2001); whereas South Korea's range from 154 (1996) to 306 (2001), and Australia's from 1 037 (1996) and 1 116 (1999).

** The correlation between the SAPSE and the STI-ERA data is closer than the correlation between these two and SAK.*

Figure 6.4 Number of publications by gender* of authors**



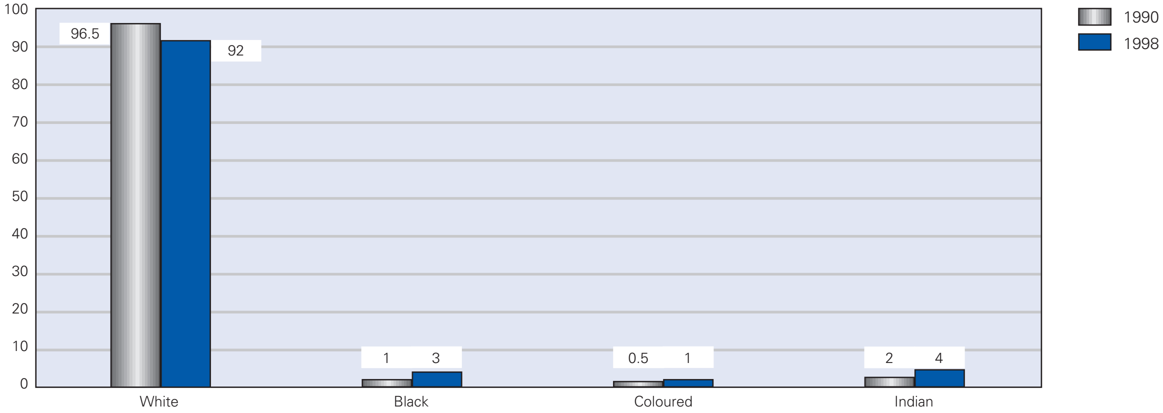
Source: DoE:SAPSE and CENIS:2002a

Figure 6.4 shows that men produced 83% of the total research publications recorded in the SAPSE data for the period from 1990 to 1998 inclusive, and women produced 17%. The breakdown by year shows that, although the number of SAPSE publication units declined from 490 in 1994 to 335 in 1998, the overall proportion of output by women remained constant at 17%.

* *A subset of approximately 20 000 articles in the SAK was linked to the demographic data of the authors. Figure 6.4 focuses on gender patterns from the data contained in that subset.*

** *All listed authors were taken into account in the data for publications by gender, race, qualification, and age (Figures 6.4 – 6.8). A fraction was calculated where more than one author was listed, and all fractions were summed to generate the totals.*

Figure 6.5 Percentages of publications by race of authors*



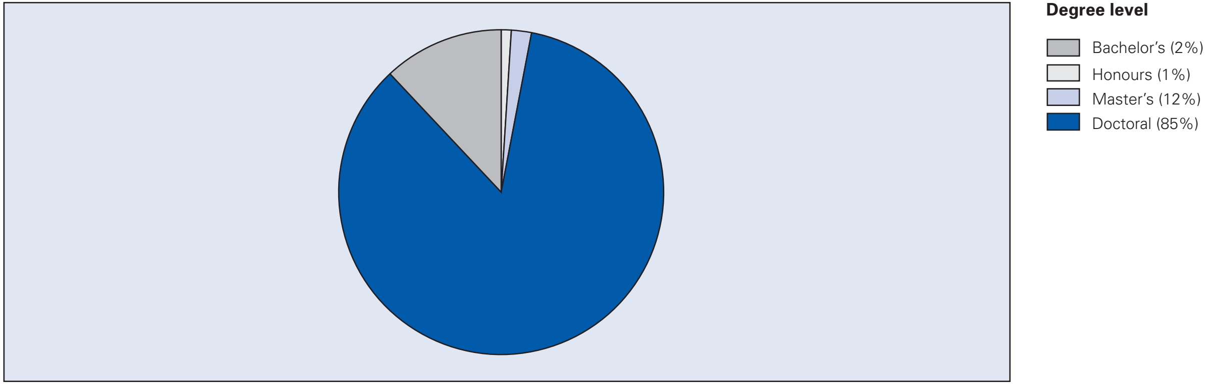
Source: CENIS:2002a

The greatest proportion of the scientific publications recorded by SAK and published in the years 1990 and 1998 was authored by white academics (i.e. an average of about 94%), followed by Indian (3.2%), African (2.1%) and Coloured (1.0%) authors. Comparison of the data for 1990 and 1998 in Figure 6.5 indicates no significant shift towards authorial demography that is more representative of South Africa's population as a whole (see Section 1**). The small change from 96.5% of white authors in 1990 to 92% in 1998 confirms the dominance of white scholars as authors of research publications in the country.

* *A subset of approximately 20 000 articles in the SAK was linked to the demographic data of the authors. Figure 6.4 focuses on racial patterns in the data contained in that subset. All listed authors were taken into account. A fraction was calculated where more than one author was listed, and all fractions were summed to generate the totals.*

** *These proportions should be compared with the following South African population statistics of 1996: Africans (30.9 million); Asians (1.0 million), Coloureds (3.6 million), Whites (4.4 million).*

Figure 6.6 Proportions of output by qualification of authors (1990 – 98)*

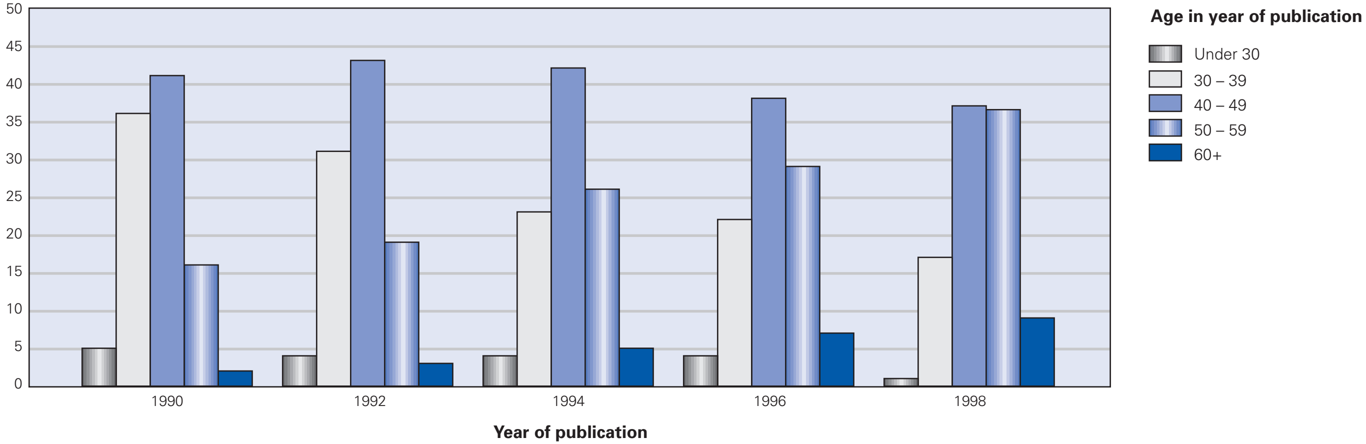


Source: CENIS:2002a

For the period 1990 to 1998 (inclusive), the great majority of research publications were produced by authors* with doctoral degrees (85%), and by a significant but much smaller proportion (12%) of authors with master's degrees. Figure 6.6 overestimates the contribution of authors with doctorates, however, since it includes all those who held a doctorate in 2002, even if, at the time of publishing during the previous twelve years, they were not yet in possession of a doctoral degree.

** A subset of approximately 20 000 articles in the SAK was linked to the demographic data of the authors. Figure 6.6 focuses on the patterns in authors' qualifications revealed by the data in that subset. All listed authors were taken into account. A fraction was calculated where more than one author was listed, and all fractions were summed to generate the totals.*

Figure 6.7 Percentages of publications by age cohort*



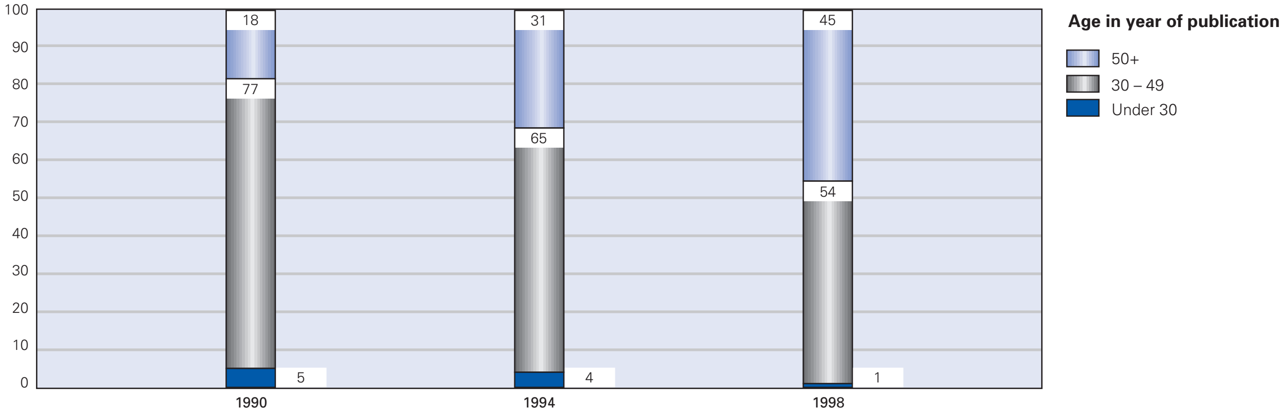
Source: CENIS:2002a

The production of research publications as a function of the age of the researchers who write them helps in diagnosing the state of the R&D system in that it reflects the system's ability to sustain itself in the medium- to long-term future. Figure 6.7 summarises by age cohort the proportions of scientific publications recorded in the SAK data for the period from 1990 to 1998.

The results show a decline in the proportion of scientific publications that were recorded in the SAK data and produced by authors in the 30 – 39 and 40 – 49 age cohorts, and a concomitant increase in the output of authors in the 50 – 59 and 60+ cohorts.

* *A subset of approximately 20 000 articles in the SAK was linked to the demographic data of the authors. Figures 6.7 and 6.8 focus on age patterns in the data contained in that subset. All listed authors were taken into account. A fraction was calculated where more than one author was listed, and all fractions were summed to generate the totals.*

Figure 6.8 Percentage of research outputs and the ageing of the R&D workforce



Source: CENIS:2002a

The proportions of publications by age cohort in Figure 6.7 point to a gradual 'ageing' of the publishing population, which becomes clearer in Figure 6.8, where some of the age intervals are collapsed. In 1990, for example, 77% of the publications in the SAK database were produced by authors in the 30 – 49 age bracket. The corresponding proportion for 1998 is only 54%. Similarly, whereas 18% of the 1990 authors were in the above-50 age bracket, this proportion increased to 45% in 1998. The most obvious explanation is that the same authors, now aged by nearly a decade, are still producing the majority of publications. If this is the case, it (1) points to stagnation in the R&D workforce, where insufficient rejuvenation is taking place, and (2) indicates a need for decision-makers in science policy to avert the possibility of a radical decline in South Africa's scientific output over the next decade or so.

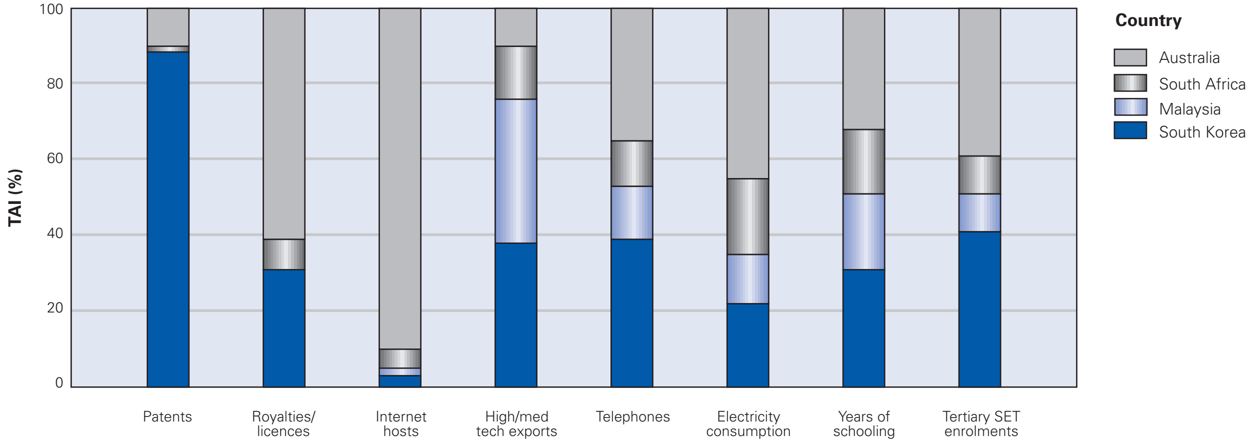
OVERVIEW AND STRATEGIC PERSPECTIVES

South Africa's S&T policy is directed primarily at growth and the improvement of the quality of life for all. The link between a country's state of development and its overall S&T is indirect, however, and the extent of its technology development may offer a more sensitive measure of its general development. The Technology Achievement Index (TAI)*, developed by the United Nations Development Programme (UNDP:2001), allows countries to be compared in terms of technological achievement.

Comparative analysis

Figure 7.1 summarises the TAI for South Africa and the three relevant comparator countries, South Korea, Malaysia, and Australia. The indicators have been normalized relative to each other.

Figure 7.1 The Technology Achievement Index as a measure of S&T strategy*



Sources: UNDP:2001 (South African information on patents calculated by A. Paterson)

** Figure 7.1 tabulates the components of the TAI. The graph indicates the normalized values proportionately for each country, giving a visual representation of the 'performance' of the country for the different components of the index.*

	Patents[a]	Royalties/ licences[b]	Internet hosts[c]	High/med tech exports[d]	Tele- phones[e]	Electricity consumption[f]	Years of schooling[g]	Tetiary SET enrolments[h]
Australia	75.0	18.2	125.9	16.2	862	8 717	10.9	25.3
South Africa	2.5	1.7	8.4	30.2	270	3 832	6.1	3.4
Malaysia	–	–	2.4	67.4	340	2 554	6.8	3.3
South Korea	779.0	9.8	4.8	66.7	938	4 497	10.8	23.2

Sources: UNDP:2001 (South African information on patents calculated by A. Paterson)

[a]Patents: number of patents per million population
[b]Royalties/licences: US$ per 1 000 population
[c]Internet hosts: per 1 000 population
[d]High/med tech exports: expressed as % of total goods exports
[e]Telephones: number of mainline and cellular telephones per 1 000 population
[f]Electricity consumption: kilowatt-hours per capita
[g]Years of schooling: mean years of schooling of population aged 15 and above
[h]Tertiary SET enrolments: gross tertiary-level SET enrolment ratio of total tertiary-level enrolment (expressed as a percentage)

The TAI ranges empirically from 0.744 (Finland) to 0.066 (Mozambique). The following are the TAI indices for the four countries being compared here:

- South Korea 0.666
- Australia 0.587
- Malaysia 0.396
- South Africa 0.340

Their TAI indices put South Korea and Australia among the so-called ‘leader’ countries, Malaysia among the ‘potential leaders’, and South Africa among the ‘dynamic adopters’ (together with countries such as Uruguay, China, Tunisia, Indonesia, and India).

Implications: Technology strategies

The TAI comparisons show that the three countries, Australia, South Korea, and Malaysia, have very different but well-articulated technology strategies.

- Australia uses research, knowledge, and information technology to add value to its resource-based economy.
- South Korea focuses on advanced manufacturing and on creating a knowledge base for industrial innovation. Its high levels of spending on education, postgraduate research, and the development of patents differentiate this strategy from all the others.
- Malaysia has opted for a 'fast follower' strategy, concentrating on the importation of know-how through foreign direct investment. It consequently pays less attention to research and patenting than it does to effective technology transfer and the broadening of scientific literacy in the general population. This strategy paid evident dividends in the short term, but the country has been unable to maintain its previous high growth rates.

These comparisons signal the need for South Africa to develop its human capital further, and to stimulate higher levels of spending on R&D and innovation to achieve the type of economic progress that South Korea, after long-term investment, has attained (see Goverment of South Africa:2002).

Malaysia's 'fast follower' route is not open to South Africa. Malaysia and South Africa enjoy similar levels of GDP per capita and similar levels of human capital, but Malaysia's recent history suggests that South Africa would need to push for a more knowledge-intensive strategy.

South Africa has a greater high and medium technology export profile than Australia, and, in addition, a strong natural resources base. It can therefore adopt a strategy that, in line with that of South Korea, capitalizes on this established resource base and at the same time actively strengthens its manufacturing, information technology, and biotechnology.

The composition of the TAI

The TAI is a composite measure of four dimensions of technology:

- Intellectual capital, represented by patents and remittances from patents (source: World Intellectual Property Organization) and licences (source: World Bank);
- Recent innovations, represented by Internet hosts (source: International Telecommunications Union) and the level of high and medium technology exports (source: United Nations Statistical Division);
- Diffusion of older innovations, represented by access to telephones (source: International Telecommunications Union) and the level of electricity consumption (source: World Bank);
- Human capital, represented by years of schooling (Barro & Lee:2000) and the proportion of the relevant age cohort studying SET at tertiary level (source: UNESCO).

CONCLUDING COMMENTS

The information in *South African Science and Technology: Key Facts and Figures 2002* presents measures of South Africa's S&T system. It assembles summaries of the most recent information about the S&T system in an endeavour to provide a source for policy makers, analysts, and researchers, in the context of different data-gathering methods used.

The material is insufficient as a basis for mapping detailed contours of the rapidly changing S&T landscape of this country. It provides signs, however, of several of its important current characteristics.

- The NSI, as conceived in the *White Paper on Science and Technology* (DACST:1996), was and continues to aim at improving quality of life and growing the economy. The new framework being developed at present will be indicator-driven and monitored.
- Over the past five years or so, national data banks of S&T indicators have not consistently been updated in a consolidated, reliable, or valid way. This situation is due largely to the comprehensive transformation during this period of the entire S&T system including the HES. Some of the official statistics reported in this publication – for R&D, for example – date back to 1997/98, but the new framework described in Section 2 will change the situation in future.
- For a developing country, South Africa is privileged in having a well-developed S&T infrastructure. The policy space as well as the performer space are well populated with diverse and productive institutions. There are moves in both S&T and higher education to transform the country's institutions and enable them to respond to the nation's development needs.
- The potential human capacity for S&T in South Africa is a cause for concern. On the one hand, the population that produces research results is ageing; on the other hand, the number of enrolments for mathematics and science at school and at tertiary education institutions remains disturbingly low. In particular, matriculation pass rates with university exemption are inadequate for the country's future needs, and the proportion of SET students in the HES has remained more or less constant at 27% over the past five years.
- Expenditure on R&D is low, compared with the 'ideal' minimum of one per cent of GDP: in 2000, gross domestic expenditure on R&D as a percentage of GDP stood at 0.64. The total estimated gross expenditure in 2000 on R&D was R5.725 billion. Industry and government were the main funders and the HES and industry the main performers.
- Scientific output since the mid-1990s shows a small decline. In 1999, South Africa produced some 160 scientific publications per million of the population. Great discrepancies become noticeable when demographic patterns are analysed. The overall research output of women accounted for 17% of the total, whites were responsible for some 92%, and the output of the age cohort 30 – 49 dropped from 77% in 1990 to 45% in 1998.
- South Africa's comparative technological achievement places it in the category of 'dynamic adopters', as distinct from a country like Australia, which is classified as a 'leader'. Analysis of South Africa's comparative performance indicates that it needs a knowledge-intensive R&D strategy that emphasises the development of human capital and the strengthening of manufacturing, information technology, and biotechnology, as discussed in the national R&D strategy of 2002.
- For the first time since 1994, this publication brings together an easily accessible summary of the salient facts and figures of South Africa's S&T system. There is commitment for the NSI to be guided in future by reliable, valid, and timely information. In this context, *South African Science and Technology: Key Facts and Figures 2002* may be seen as providing an interim overview of the state of S&T in the country.

Rand/US$ exchange rates, consumer price index, and the effect of inflation on rand value

Year	CPI[a]	CPI inflation	Rand/US$
1983	100	12.4	1.11
1984	112	11.5	1.48
1985	130	16.3	2.23
1986	154	18.7	2.28
1987	179	16.2	2.04
1988	202	12.8	2.27
1989	231	14.7	2.62
1990	264	14.3	2.59
1991	305	15.3	2.76
1992	347	14.0	2.85
1993	381	9.7	3.27
1994	415	8.9	3.55
1995	451	8.7	3.63
1996	484	7.3	4.32
1997	526	8.6	4.62
1998	562	6.9	5.56
1999	591	5.3	6.12
2000	623	5.3	7.00
2001	658	5.7	8.74

Source: Rand Merchant Bank

[a]CPI: Consumer Price Index (=100 in 1983)

List of abbreviations

ARC	Agricultural Research Council
CENIS	Centre for Interdisciplinary Studies, Stellenbosch
CGS	Council for Geoscience
CPI	Consumer price index
CSIR	(formerly) Council for Scientific and Industrial Research
COHORT	Committee of Heads of Organizations of Research and Technology
DACST	Department of Arts, Culture, Science and Technology
DoE	Department of Education
DTI	Department of Trade and Industry
FEST	Foundation for Education, Science and Technology
FRD	Foundation for Research Development
GDP	Gross domestic product
GERD	Gross domestic expenditure for research and development
GUF	General University Funds
HEMIS	Higher Education Management Information System
HES	Higher education sector
HSRC	Human Sciences Research Council
ISI	Institute for Scientific Information, Philadelphia
Medunsa	Medical University of Southern Africa
Mintek	Council for Mineral Technology
MRC	Medical Research Council
MTEF	Medium-term expenditure framework
NACI	National Advisory Council on Innovation
NGO	Non-governmental organization
NIF	National Innovation Fund
NRF	National Research Foundation
NSI	National System of Innovation
NSTF	National Science and Technology Forum
R&D	Research and development
SABS	South African Bureau of Standards
SAK	South African Knowledgebase
SAPSE	South African Post-secondary Education
SET	Science, engineering, and technology
SETI	Science, engineering, and technology institution
S&T	Science and technology
TAI	Technology Achievement Index
THRIP	Technology and Human Resources for Industry Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization

References

Barro & Lee:2000 — Barro, R.J. and Lee, J.-W. (2000). International Data on Educational Attainment: Updates and implications. NBER Working Paper 7911. Cambridge, MA.: National Bureau for Economic Research.

CENIS:2002a — Centre for Interdisciplinary Studies (2002). South African Knowledgebase. Electronic data. Stellenbosch: University of Stellenbosch, CENIS.

CENIS:2002b — Centre for Interdisciplinary Studies (2002). Sources of Income of Higher-education Sector R&D. Unpublished report. University of Stellenbosch, CENIS.

CENIS:2002c — Centre for Interdisciplinary Studies (2002). S&T Indicators: New estimates of R&D expenditure and R&D output in South Africa. Unpublished report commissioned by NACI. University of Stellenbosch, CENIS.

Census:1996 — Statistics South Africa (1998). *The People of South Africa: Population Census 1996. Census in brief.* Report 03-01-11. Pretoria: Statistics South Africa.

Cloete *et al*.:2002 — Cloete, N., Fehnel, R., Maassen, P., Moja, T., Perold, H., and Gibbon, T. (2002). *Transformation in Higher Education: Global pressures and local realities in South Africa.* Pretoria: Centre for Higher Education Transformation.

CHE:2000 — Council on Higher Education (2002). *Annual Report 2000/2001*. Pretoria: Council on Higher Education.

CHE:May 2002 — Council on Higher Education (21 May 2002). Electronic data. (www. che.org.za)

DACST:1996 — Department of Arts, Culture, Science and Technology (1996). *White Paper on Science and Technology: Preparing for the 21st century.* Pretoria: Department of Arts, Culture, Science and Technology.

continued on p.38

continued from p.37

DACST:1998a	Department of Arts, Culture, Science and Technology (1998). *National Research and Technology Audit: Scholarship, research and development.* Pretoria: Foundation for Research Development and Department of Arts, Culture, Science and Technology.
DACST:1998b	Department of Arts, Culture, Science and Technology (1998). *National Research and Technology Audit: Technology base of the South African business sector.* Pretoria: Foundation for Research Development and Department of Arts, Culture, Science and Technology.
DACST:2000	Department of Arts, Culture, Science and Technology (2000). *Survey of Resources Allocated to Research and Development 1997/98.* Pretoria: Department of Arts, Culture, Science and Technology.
DoE:SAPSE	Department of Education. SAPSE Statistics with regard to Students and Personpower for Universities. Electronic data. (The name of this database changed in 1999 to the Higher Education Management Information System (HEMIS).)
FRD:1996	Foundation for Research Development (1996). *South African Science and Technology Indicators 1996.* Pretoria: Foundation for Research Development.
Goverment of South Africa:2002	*South Africa's National R&D Strategy* (2002). Pretoria: South Africa.
HSRC:2000	Human Sciences Research Council (2000). *PRODDER: The South African development directory.* Pretoria: Human Sciences Research Council.
IMD:2002	International Institute of Management Development (2002). *World Competitiveness Yearbook.* Lausanne: IMD.
Jennings *et al.*:1995	Jennings, R., Milautzi, J., Everat, D., and Orkin, M. (1995). Human Sciences Research performed by NGOs. In Van den Berg, H., Prinsloo, R., and Pienaar, D., *Directory of Human Sciences Research Organisations and Professional Associations in South Africa.* Pretoria: Human Sciences Research Council. 97–116.
Marais:2000	Marais, H.C. (2000). *Perspectives on Science Policy in South Africa.* Menlo Park: Network Publishers.
NRF:2001	National Research Foundation (2001). *THRIP Annual Report 1999/2000.* Pretoria: Technology and Human Resources for Industry Programme.
STI-ERA:2002	STI-ERA (2002). Science and Technology Indicators for the European research area. Electronic data. (http://www.cordis.lu/rtd2002/indicators/ind_publications.htm)
Treasury:2001	National Treasury (2001). 2001 Estimates of National Expenditure (Vote 13: Arts, Culture, Science and Technology). Pretoria: National Treasury.
UNDP:2001	United Nations Development Programme (2001). *Human Development Report: Making new technologies work for human development.* New York: Oxford University Press.
USPTO:2002	United States Patent Office (2002). *Patents Counts by Country/State and Year: All patents, all types. January 1, 1977-December 31,2001. A technology assessment and forecast report.* Washington D.C.: United States Patent and Trademark Office. (www.uspto.gov/web/offices/ac/ido/oeip/

Universities, technikons, science councils, and other S&T-related institutions*

* Contact details believed correct at time of going to press

Universities

Medical University of Southern Africa: PO Box 203, Medunsa 0204
Tel +27 (0) 12 521 4111 Fax +27 (0) 12 521 3749
www.medunsa.ac.za

Potchefstroom University for CHE: Private Bag X6001, Potchefstroom 2520
Tel +27 (0) 18 299 1111 Fax +27 (0) 18 299 2799
www.puk.ac.za

Rand Afrikaans University: PO Box 524, Auckland Park 2006
Tel +27 (0) 11 489 2911 Fax +27 (0) 11 489 2191
www.rau.ac.za

Rhodes University: PO Box 94, Grahamstown 6140
Tel +27 (0) 46 603 8111 Fax +27 (0) 46 622 5049
www.ru.ac.za

University of Cape Town: Private Bag, Rondebosch 7701
Tel +27 (0) 21 650 9111 Fax +27 (0) 21 650 2138
www.uct.ac.za

University of Durban-Westville: Private Bag X54001, Durban 4041
Tel +27 (0) 31 204 4111 Fax +27 (0) 31 204 4383
www.udw.ac.za

University of Fort Hare: Private Bag X1314, Alice 5700
Tel +27 (0) 40 602 2011 Fax +27 (0) 40 602 1643
www.ufh.ac.za

University of the Free State: PO Box 339, Bloemfontein 9300
Tel +27 (0) 51 401 9111 Fax +27 (0) 51 401 2117
www.uovs.ac.za

University of Natal (Durban Campus): Durban 4041
Tel +27 (0) 31 260 1111 Fax +27 (0) 31 260 2214
University of Natal (Pietermaritzburg Campus): Private Bag X1106, Sovenga 0727
Tel +27 (0) 33 260 5111 Fax +27 (0) 33 260 5599
www.nu.ac.za

University of the North: Private Bag X1106, Sovenga 0727
Tel +27 (0) 15 268 2491 Fax +27 (0) 15 268 2306
www.unorth.ac.za

University of North-West: Private Bag X2046, Mmabatho 2735
Tel +27 (0) 18 389 2111 Fax +27 (0) 18 392 5775
www.uniwest.ac.za

University of Port Elizabeth: PO Box 1600, Port Elizabeth 6000
Tel +27 (0) 41 504 2111 Fax +27 (0) 41 504 2574
www.upe.ac.za

University of Pretoria: Pretoria 0002
Tel +27 (0) 12 420 4111 Fax +27 (0) 12 362 5190/5168
www.up.ac.za

University of South Africa (UNISA): PO Box 392, Pretoria 0003
Tel +27 (0) 12 429 3111 Fax +27 (0) 12 429 3221
www.unisa.ac.za

University of Stellenbosch: Private Bag X1, Matieland 7602
Tel +27 (0) 21 808 9111 Fax +27 (0) 21 808 4499
www.sun.ac.za

University of Transkei: Private Bag X1, Umtata 5100
Tel +27 (0) 47 502 2111 Fax +27 (0) 47 532 6820
www.utr.ac.za

University of Venda: Private Bag X5050, Thohoyandou 0950
Tel +27 (0) 15 962 8000 Fax +27 (0) 15 962 4749
www.univen.ac.za

University of the Western Cape: Private Bag X17, Belville 7535
Tel +27 (0) 21 959 2911 Fax +27 (0) 21 959 3126
www.uwc.ac.za

University of the Witwatersrand: Private Bag X3, Wits 2050
Tel +27 (0) 11 717 1000
www.wits.ac.za

University of Zululand: Private Bag X1001, KwaDlangezwa 3886
Tel +27 (0) 35 902 6644 Fax +27 (0) 35 902 6431
www.uzulu.ac.za

Vista University (Central Campus): Private Bag X634, Pretoria 0001
Tel +27 (0) 12 337 6000 Fax +27 (0) 12 320 0528
www.vista.ac.za

Technikons

Border Technikon: PO Box 1421, East London 5200
Tel +27 (0) 43 708 5200 Fax +27 (0) 43 708 5331
www.bortech.ac.za

Cape Technikon: PO Box 652, Cape Town 8000
Tel +27 (0) 21 460 3911 Fax +27 (0) 21 460 3695
www.ctech.ac.za

Durban Institute of Technology (formerly ML Sultan Technikon and Technikon Natal): PO Box 1334, Durban 4000
Tel +27 (0) 31 308 5100 Fax +27 (0) 31 308 5103
www.dit.ac.za

Eastern Cape Technikon: Private Bag X3182, Butterworth 4960
Tel +27 (0) 47 401 2000 Fax +27 (0) 47 492 0735
www.tktech.ac.za

Mangosuthu Technikon: PO Box 12363, Jacobs 4026
Tel +27 (0) 31 907 7111 Fax +27 (0) 31 907 2892
www.mantec.ac.za

Peninsula Technikon: PO Box 1906, Belville 7535
Tel +27 (0) 21 959 6911 Fax +27 (0) 21 951 5617
www.pentech.ac.za

Port Elizabeth Technikon: Private Bag X6011, Port Elizabeth 6000
Tel +27 (0) 41 504 3911 Fax +27 (0) 41 583 3644
www.petech.ac.za

Technikon Free State: Private Bag X20539, Bloemfontein 9300
Tel +27 (0) 51 507 3911 Fax +27 (0) 51 507 3199
www.tofs.ac.za

Technikon Northern Gauteng: Private Bag X07, Pretoria North 0116
Tel +27 (0) 12 799 9000 Fax +27 (0) 12 793 0966
www.tnt.ac.za

Technikon North West: Private Bag X31, Rosslyn 0200
Tel +27 (0) 12 521 0500 Fax +27 (0) 12 703 2255
www.tnw.ac.za

Technikon Pretoria: Private Bag X680, Pretoria 0001
Tel +27 (0) 12 318 5911 Fax +27 (0) 12 318 5114
www.techpta.ac.za

Technikon SA: Private Bag X6, Florida 1710
Tel +27 (0) 11 471 2000 Fax +27 (0) 11 471 2134
www.tsa.ac.za

Technikon Witwatersrand: PO Box 17011, Doornfontein 2028
Tel +27 (0) 11 406 2911 Fax +27 (0) 11 402 0475
www.twr.ac.za

Vaal Triangle Technikon: Private Bag X021, Vanderbijlpark 1900
Tel +27 (0) 16 950 9000 Fax +27 (0) 16 950 9999
www.tritek.ac.za

Science Councils

Agricultural Reseach Council (ARC): PO Box 8783, Pretoria 0001
Tel +27 (0) 12 427 9700 Fax +27 (0) 12 430 5814
www.arc.agric.za

CSIR (formerly Council for Scientific and Industrial Research): PO Box 395, Pretoria 0001
Tel +27 (0) 12 841 2911 Fax +27 (0) 12 841 3789
www.csir.co.za

Council for Geoscience (CGS): Private Bag X112, Pretoria 0001
Tel +27 (0) 12 841 1911 Fax +27 (0) 12 841 1203/1221
www.geoscience.org.za

Council for Mineral Technology (Mintek): Private Bag X3015, Randburg 2125
Tel +27 (0) 11 709 4111 Fax +27 (0) 11 793 2413
www.mintek.co.za

Human Sciences Research Council (HSRC): Private Bag X41, Pretoria 0001
Tel +27 (0) 12 302 2999 Fax +27 (0) 12 326 5362
www.hsrc.ac.za

Medical Research Council (MRC): Private Bag X385, Pretoria 0001
Tel +27 (0) 12 339 8500 Fax +27 (0) 12 339 8591
www.mrc.ac.za

National Research Foundation (NRF): PO Box 2600, Pretoria 0001
Tel +27 (0) 12 481 4000 Fax +27 (0) 12 349 1179
www.nrf.ac.za

South African Bureau of Standards (SABS): Private Bag X191, Pretoria 0001
Tel +27 (0) 12 428 7911 Fax +27 (0) 12 344 1568
www.sabs.co.za

Other

Africa Institute of South Africa: PO Box 630, Pretoria 0001
Tel +27 (0) 12 328 6970 Fax +27 (0) 12 323 8153
www.aisa.org.za

Committee of Technikon Principals (CTP): Private Bag X680, Pretoria 0001
Tel +27 (0) 12 326 1066 Fax +27 (0) 12 325 7387
www.technikons.co.za

Council on Higher Education (CHE): PO Box 13354, The Tramshed 0126
Tel +27 (0) 12 392 9100 Fax +27 (0) 12 392 9110
www.che.org.za

Department of Arts, Culture, Science and Technology (DACST): Private Bag X894, Pretoria 0001
Tel +27 (0) 12 337 8000 Fax +27 (0) 12 323 2720
www.dacst.gov.za

Foundation for Education, Science and Technology (FEST): PO Box 1758, Pretoria 0001
Tel +27 (0) 12 392 9300 Fax +27 (0) 12 392 9350
www.fest.org.za

National Advisory Council on Innovation (NACI): PO Box 1758, Pretoria 0001
Tel +27 (0) 12 392 9300 Fax +27 (0) 12 392 9353
www.naci.org.za

South African Universities Vice-Chancellors Association (SAUVCA): PO Box 27392, Sunnyside 0132
Tel +27 (0) 12 429 3015 Fax +27 (0) 12 429 3071
www.sauvca.org.za

Think Creative

Published by the National Advisory Council on Innovation and the Department of Arts, Culture, Science and Technology, Pretoria

ISBN 0-620-29335-7

Further information is available at *http://www.naci.org.za* and *http://www.dacst.gov.za*

For a copy of this publication, please contact:

The Publications Officer
South African Science and Technology: Key Facts and Figures 2002
NACI Secretariat
PO Box 1758
Pretoria
0001
South Africa

Tel +27 (0) 12 392 9352 Fax +27 (0) 12 392 9353
Email: *mzolo@dacst5.pwv.gov.za* or *wb44@dacst5.pwv.gov.za*