Science Engagement Strategy

Science and society engaging to enrich and improve our lives

science
& technology
Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA

CONTENTS

FOREWORD

South Africa is currently considered one of the most technologically advanced countries in Africa, and has moved up five places in the 2014 Global Innovation Index. Ranked 53rd out of 143 countries, South Africa is working to profile its scientific achievements and to advance its position among the world's scientifically and technologically advanced countries. I believe that South Africa has the potential to be among the world's top 20 scientifically and technologically advanced countries.

In order to realise this potential, it will be necessary to accelerate our efforts to build a society that is scientifically literate. This means that we must ensure that our citizens are aware of the importance of science for the growth of the economy and the well-being of ordinary people, and are sufficiently informed about science to engage critically with policymakers. It also means that we must support science education and promote careers in science.

Science, technology and innovation serve to make people's lives easier and more comfortable in many ways, but may also have negative effects on society and the environment. A scientifically literate population will be ready and able to understand scientific and technological developments, and to develop informed opinions on whether the science and technology programme followed by government is aligned to the national development goals and responsive to real challenges.

This Science Engagement Strategy provides the basis for the national coordination of science engagement initiatives that will stimulate an appreciation of the role of science and technology in building a knowledge-intensive economy and a better life for all. The Department of Science and Technology will collaborate with sectoral and institutional role players to ensure the dynamic implementation of this Science Engagement Strategy to achieve all its goals.

I urge stakeholders to join hands with the Department to educate and enthuse every South African about the important role of science in the nation's development.

Naledi Pandor

Mrs Naledi Pandor, MP
Minister of Science and Technology

EXECUTIVE SUMMARY

Modern nations place great emphasis on scientific literacy, as this is seen as a foundation for the productive application of science and technology in national development. The Department of Science and Technology (DST) has several programmes to improve public understanding of science, scientific literacy and science engagement. "Science engagement" is an overarching term that includes the former two concepts, among others.

This Strategy for advancing science engagement in South Africa is intended to improve the coordination of and encourage science promotion, communication and engagement activities across the Department, its entities, higher education institutions, other government departments, science councils and museums, and partners outside the public sector.

The Science Engagement Strategy is inclusive of all knowledge fields insofar as it draws on a wider social scientific perspective to explore the value of public engagement in the context of a broad, progressive understanding of "science". By integrating the natural sciences, engineering, and social sciences and humanities, it aims to foster better, more valuable science engagement.

The Strategy has been strongly informed by the values of contemporary, post-apartheid South Africa, most specifically the imperative of empowering its citizens to engage with processes and issues that affect them. At the core of the Strategy are four strategic aims, under which several proposed or existing interventions or initiatives are outlined. To a great extent, the Department's existing science engagement activities already overlap with many of those indicated in this document, but this Strategy provides a systematisation and organisation to those initiatives that is intended to enhance their collective impact.

Strategic Aim 1: *To popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers.* Generally, these initiatives will fall into three broad categories, namely, science for the public, science for education support, and the promotion of careers in science. The strengthening of science centres and capacity building for science promotion practitioners are crucial in the popularisation of science.

Strategic Aim 2: *To develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society.* The Department seeks to provide support to timely, broad dialogues through managed engagements with key stakeholders around disputed developments and issues with a strong science and technology component. The South African Agency for Science and Technology Advancement (SAASTA) and the Academy of Science of South Africa (ASSAf) are important institutional platforms for this support. Where necessary, other platforms will be created for public discussions on policy directions regarding the uptake of new technologies, and policy decisions involving science-driven ventures.

Strategic Aim 3: *To promote science communication that will enhance science engagement in South Africa.* Without effective science communication, no science engagement is possible. However, science communication is underdeveloped in South Africa, both as a professional discipline and as a medium. Extending traditional journalism to advance science engagement, developing and nurturing the culture of communicating science to the public, providing incentives for scientists and researchers to communicate their work, and targeting higher education institutions and school learners will be among the interventions to address this aim.

Strategic Aim 4: *To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing their public standing.* Attention will be focused on profiling, among other things, (a) scientific areas in which the country has a geographic and/or knowledge advantage, including associated scientific and technological developments; (b) state-of-the-art research infrastructure that positions South Africa as an international research destination; and (c) local inventions and discoveries that have the potential to or have changed the world. Through such efforts, opportunities for science tourism will be explored.

The Strategy recognises that the realisation of the four strategic aims depends on key enablers that are (a) an effective coordination function to promote and ensure the strategic and operational alignment

of science engagement initiatives across a wide range of stakeholders, (b) appropriate institutional and legislative platforms provided by an enabling regulatory framework through a revision of the National Research Foundation (NRF) Act to formally incorporate science promotion and engagement as a mandate of SAASTA within the NRF, (c) funding to broaden the scope and scale of the DST's current science engagement portfolio, and (d) a science engagement information management system.

In order to avoid duplication and the ineffective and inefficient use of resources, the Science Engagement Strategy maps out the respective roles and responsibilities of the various stakeholders whose contributions are crucial to the implementation of the Strategy. It also lists performance indicators and measures that will be used to monitor progress.

An implementation plan will be developed and reviewed on an annual basis in the light of financial and other resource considerations, as well as changes in the external environment for science engagement. The implementation plan will detail precise targets from year to year and prioritise the range of interventions to be implemented on an annual or medium-term basis. The plan will be finalised in consultation with SAASTA, which will be the Department's main agent in rolling out the Science Engagement Strategy.

1

INTRODUCTION

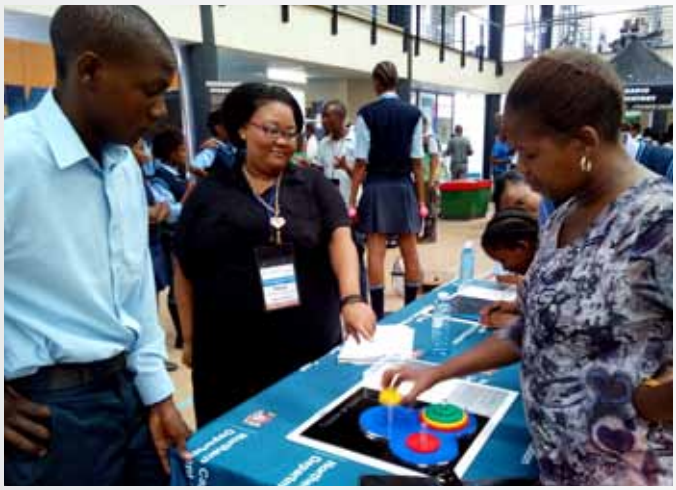
Human, social and economic development have been inextricably linked to the development of science and technology, for better and for worse.

1. INTRODUCTION

1.1 The science-society interface

Human, social and economic development have been inextricably linked to the development of science and technology, for better and for worse. In spite of ideological differences, modern nations seek to enhance the state of their national science, technology and innovation systems, and recognise the importance of scientific literacy among their populations in this imperative. Scientific literacy is important for the maintenance and expansion of national systems, because it can enhance the appeal of science as a career and as a social knowledge system. However, it is equally important to ensure that science and technology serve society by enabling citizens to engage in debate around matters of public interest that are scientifically or technically complex.

Especially since the Second World War, the interplay between science and society has been the subject of fairly extensive study and debate, resulting in the establishment of academic programmes on science, technology and society, and research programmes and institutions dedicated to deepening understanding of this interplay. A lexicon of related terms and concepts (e.g. "science communication", "science engagement", "science diplomacy" and "public understanding of science and technology") has emerged, and many governments have established a wide range of initiatives to stimulate science literacy and public engagement with science and technology. Especially in the past two or three decades, the global trend toward a more systematised understanding and management of the science-society interface has almost certainly been informed by a greater focus on the socio-economic roles of science and technology in innovation, and the emergence of the national system of innovation concept. Such systems are now widely regarded as the foundation of national development and global competitiveness, and it is becoming an economic and political imperative to enhance understanding of their dynamics so that they can be better managed.



In South Africa, the Department of Science and Technology funds several programmes aimed at enhancing scientific literacy and awareness, and through its agencies has implemented a variety of initiatives across a wide range of science and technology fields. Some other government departments are also active in this area, especially those with strong science and technology bases, such as the Departments of Higher Education and Training, Environmental Affairs, Energy and, in respect of the palaeosciences, Arts and Culture.

At an operational level, the various initiatives – especially those of the DST entities – have been coordinated to some extent, but it is now necessary to provide strategic guidance to the DST and its partners and stakeholders in their collective effort. This need has become especially acute in view of the increasing emphasis placed on science and technology in national development at the highest political levels. The Science Engagement Strategy serves that purpose.

1.2 Policy context

The imperative for South Africa's national system of innovation to contribute to the creation of a sustainable and prosperous society that derives enduring and equitable benefits from science and technology has informed and been expressed in several high-level policy documents in the past decade.

Most recently, the 2012 National Development Plan (NDP) highlighted science and technology as one of seven key drivers of development, beginning with the following statement: "Developments in science and technology are fundamentally altering the way people live, connect, communicate and transact, with profound effects on economic development. Science and technology are key to development, because technological and scientific revolutions

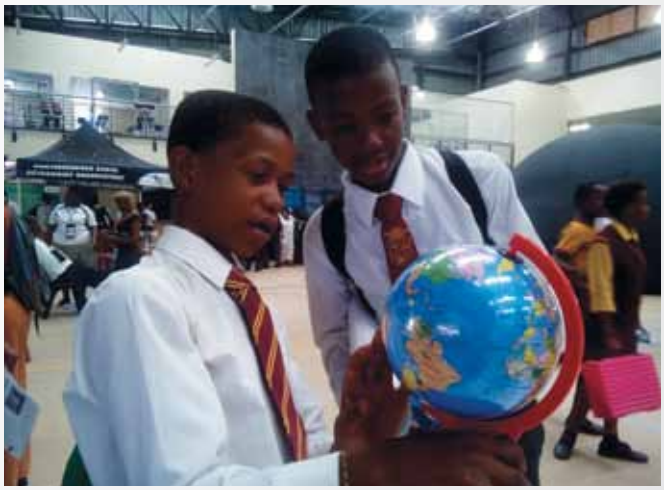
underpin economic advances, improvements in health systems, education and infrastructure" (p 70). The importance of scientific knowledge and literacy is reflected in the statement that the "extent to which developing economies emerge as economic powerhouses depends on their ability to grasp and apply insights from science and technology and use them creatively" (p 71). While the NDP focuses extensively on the application of science and technology in national development, it also makes reference to the corollary of their effective application – the importance of scientific literacy – in the statement that to "promote technological advances, developing countries should invest in education for youth ... and should ensure that knowledge is shared as widely as possible across society" (p 72).

In 2002 the National Research and Development Strategy (NRDS) committed the Department to the establishment of an "Institute for the Promotion of Science" through the transformation of the Foundation for Engineering, Science and Technology. The strategy projected extensive investment by the Department in science promotion, focused specifically on the need to "make science attractive, accessible and relevant through media, public engagement and promotional programmes", to "attract learners into science and technology through … large public science programmes", and to "massify a number of public understanding and engagement activities", including "out-of-school maths and science programmes to increase the number of matriculants achieving university entrance in Mathematics and Science [programmes]", as well the "enhanced use of the media to promote mathematics, science and computing subject choices among learners".

The above quotations highlight the implicit assumption in the NRDS that the systematic and focused provision of adequate information about science and technology would serve to interest more people (especially learners) in science and generally improve public appreciation of science and technology. Within the field of science and society studies, this approach has come to be known as the "deficit model" for science promotion and communication; the strategic framework presented here goes beyond that model. Moreover, although the Institute for the Promotion of Science was not established, the functions that were envisaged for it have largely been accommodated in SAASTA, which operates as a branch of the National Research Foundation.

By the time the Department formulated its Ten-Year Innovation Plan for South Africa (TYIP), the above conceptual approach had become more nuanced in that the dialectic relationship between science and society was recognised: "Government's starting point is that the members of [the] public are not merely passive recipients of science and technology, but are important players in processes that shape the focus and patterns of science, technology and development." However, the TYIP contextualised the imperative "to support the public understanding of and engagement with science" specifically in terms of the Human and Social Dynamics Grand Challenge – the purpose of which is to develop a scientific understanding of the nature of social change in order to better anticipate, promote, steer, mitigate against or adapt to it – and not in terms of the more general aim of developing a scientifically literate society. Nevertheless, the 1996 White Paper on Science and Technology acknowledges that building a strong national system of innovation requires a society that values and understands science and technology as social tools, and their role in sustainable development. The construction of such a society requires science engagement programmes that (a) increase familiarity with the natural world; (b) promote understanding of some key science and technology concepts; (c) foster the ability to use science and technology to enhance personal, social, economic and community development; and (d) demonstrate science, engineering and technology as social tools.

Most recently, the Ministerial Review Committee on the Science, Technology and Innovation Landscape in South Africa (2012) commented on two aspects of the public promotion and awareness of science.



First, it focused on the utility value of society's "appetite for innovation" to the national system of innovation that would result from an enhanced understanding of science. It argued that this appetite should be fostered by well-designed and well-executed interventions using the media, the systemic upgrading of among others the science centres, and public merit awards in the form of medals or prizes. Second, the committee recognised the importance of "bringing scientists and the public into open debate concerning topics of pressing interest", and advocated the use of consensus conferences as an instrument to advance informed public input on science-heavy policy issues.

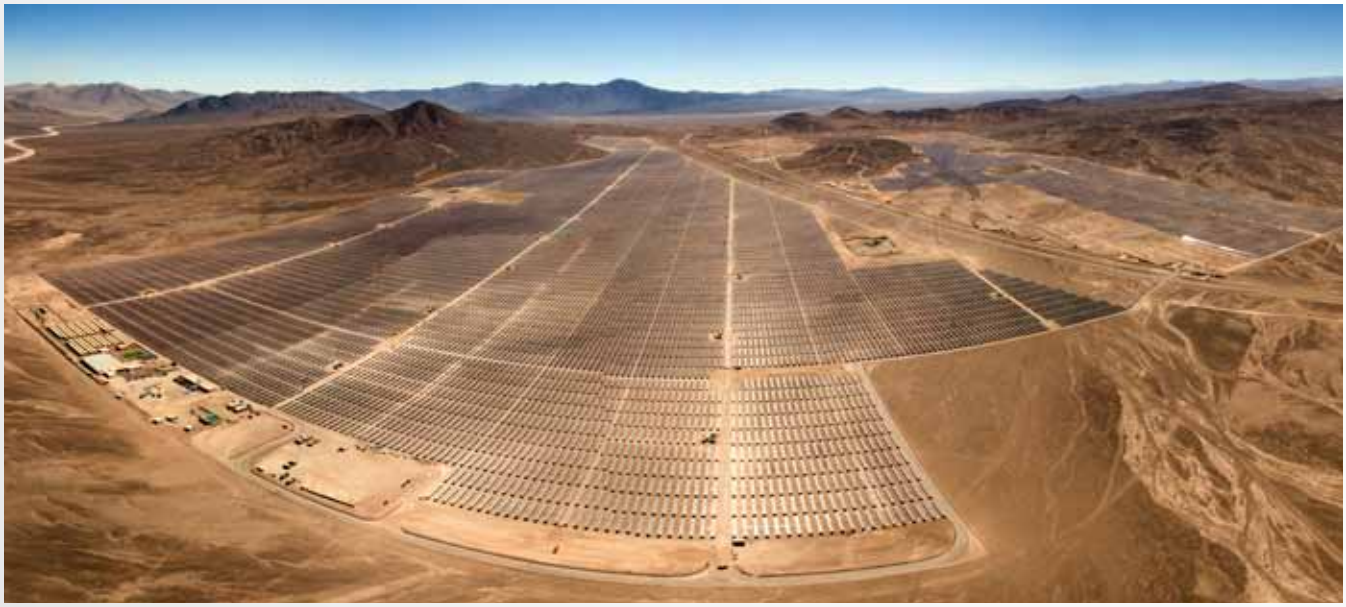
Although the Department had not previously formulated a high-level framework or strategy for its science promotion activities, those activities have been guided by two documents formulated around the DST science centre programme, namely (a) the Framework for the Promotion of Excellence in a National Network of Science Centres (2012), and (b) the National Roll-out Plan for a Network of Science Centres in South Africa (2006), the latter formulated in response to the NRDS. Moreover, in clarifying its mandate around education, especially science and technology education, the DST has adopted a Framework of DST activities in support of basic education, and the Human Capital Development Strategy for Research, Innovation and Scholarship; the former is particularly relevant to this document.

Lastly, the Department has used various terms interchangeably in reference to its "science and society" activities, such as "science promotion", "science engagement", "science awareness", "science communication", and "public understanding of science and technology". In later sections, this Strategy standardises the application of these terms, settling on "science engagement" as most apt to describe the DST's strategic purpose in this domain. However, until then, these terms will still be used somewhat interchangeably in reference to existing DST initiatives. It is in this context that the scope of this Strategy also extends to the notion of science communication.

1.3 Operational context and landscape

The science engagement programme led by the DST, which started with the 1998 Year of Science and Technology under the then Department of Arts, Culture, Science and Technology, has evolved significantly over the past 15 years.

Developments to date in this regard include the Department's establishment of a reliable network for collaboration in implementing its science engagement activities. The network includes the higher education sector, science councils, state-owned enterprises, the corporate and non-governmental sectors, science centres, and government departments (national, provincial and local), particularly those with science and technology activities. Its science engagement portfolio includes general science engagement activities (such as the annual National Science Week), as well as content-driven engagement activities meant to create public



awareness in priority areas of the Department, such as astronomy or palaeosciences.

Partner institutions act as delivery agents for the DST's science awareness activities, as well as implementing their own science engagement activities using their own financial resources. However, the majority of DST science awareness programmes are implemented through SAASTA, a business unit of the NRF. The Human Sciences Research Council (HSRC), also a DST entity, is integral to the monitoring and evaluation endeavours that accompany the implementation of the DST's science engagement programmes. All DST entities maintain science and/or corporate communication functions that promote public appreciation of the DST entities through the dissemination of information about their scientific activities and contributions. The DST Science Communication division coordinates these activities.

The network of institutions collaborating with the DST in the delivery of science engagement programmes includes science centres, which constitute the basic infrastructure for science engagement.

The internationalisation of science engagement has seen South Africa participating in discussions on improving dialogue with society on scientific issues (such as nanotechnology and biotechnology) under the auspices of the Organisation for Economic Co-operation and Development Global Science Forum, as well as hosting international conferences. These conferences include the 7th International Network on Public Communication of Science and Technology in 2002, the International Workshop on the Changing Roles of Science Centres under the auspices of the Non-Aligned Movement Science and Technology Centre in 2008, and the 6th Science Centre World Congress in 2011.

DST-led science engagement programmes are gradually becoming an instrument that enhances the country's international relations. Science engagement activities featured in the celebrations of the German-South Africa Year of Science 2012/2013. Furthermore, in the past five years, South Africa participated in at least one science engagement initiative hosted by another African country every year. Mozambique, Lesotho, Uganda and Namibia are some of the countries that are collaborating with South Africa on science engagement programmes. Lastly, under the DST-NRF South African Research Chairs Initiative (SARChI), a chair for science communication has been established as part of the Department's unfolding science engagement programme.

1.4 Scientific (disciplinary) context

Often when the science-society interface is considered, a focus on the role of the natural and physical sciences eclipses the humanities and social sciences (HSS). However, the latter have made very important theoretical, historical and philosophical contributions to the understanding of this interface, often being at the forefront of debates related to this broad topic. In part, the distance of HSS researchers from the practice of natural and physical sciences may play a role in their critical contributions to this field, and for this reason the Science Engagement Strategy recognises specific contributions that HSS researchers can make across the full spectrum of science communication and public engagement practice, from the dissemination of knowledge to consultation and collaboration. Moreover, the HSS disciplines are well placed to engage with debates around the role of the HSS in the public sphere, the theory and practice of public engagement, and how this plays out in the current public higher education and research sector, including the focus on demonstrating the impact of research in the HSS.

In fact, in the context of this Strategy, the HSS disciplines have a unique contribution to make to –

- enhancing dialogue on science in public debate;
- enabling members of the public to have greater confidence in the ways in which scientific insight is applied by government and other sectors;
- improving the interaction between academic researchers and public policymakers;
- engaging with the public to strengthen the case for increased funding for the HSS;
- stimulating greater public interest and enthusiasm for the HSS;
- contributing to greater public understanding of science and the importance of evidence, and understanding uncertainty;
- engaging scholarship that produces co-created, self-reflective knowledge and new formations of community in the process.

PURPOSE

This document is intended to provide an overarching structure for advancing science promotion and engagement in South Africa

2. PURPOSE

This document is intended to provide an overarching structure for advancing science promotion and engagement in South Africa, in pursuit of a society that understands and values science and technology and their critical role in national prosperity and sustainable development, and engages critically in their development. As such, the Strategy guides the coordinated development and implementation of individual and collective science promotion and engagement initiatives on behalf of the DST, its entities and strategic partners, and seeks to influence other government departments to support similar initiatives. It enjoins the private and public sectors, through the work of different government departments and their agencies, as well as institutions such as higher education institutions, science councils and museums, which play a significant role in science promotion and engagement, to work together toward realising the aims of this Strategy.

CONCEPTUAL DEFINITIONS

For the purposes of this discussion, the Science Engagement Strategy embraces a broad understanding of "science" and "the sciences"

3. CONCEPTUAL DEFINITIONS

3.1 Science and the sciences

For the purposes of this discussion, the Science Engagement Strategy embraces a broad understanding of "science" and "the sciences", encompassing systematic knowledge spanning natural and physical sciences, engineering sciences, medical sciences, agricultural sciences, mathematics, social sciences and humanities, technology, all aspects of the innovation chain and indigenous knowledge. Public engagement requires awareness and the discussion of not only scientific and technical matters, but also of societal and attitudinal aspects.

The role of HSS cannot be understated in the context of this document. Research in these disciplines enriches and informs social, economic and cultural well-being, and provides the context in which policy and technological innovations can advance. The disciplines have an important role to play in the development of critical and independent thinking, which is key to a healthy and vibrant democracy – and the effectiveness of science. HSS researchers are well placed to assist efforts to engage the public's interest in the challenges facing society today, as well as contributing knowledge and understanding in this regard, and can influence public debate, which can in turn affect policy development. Research in these disciplines also plays an essential role in enabling society to anticipate, and respond to, unexpected challenges and change.

3.2 Field definition

The meaning of science communication and other terms used in the field of scientific literacy has been plagued by an unfortunate lack of clarity. Terms such as "public awareness of science", "public understanding of science", "scientific literacy" and "scientific culture" are often used interchangeably. Although they have much in common, and their aims are broadly compatible, they have different philosophies, approaches and emphases.

A broad range of field perspectives and definitions exist in the literature on science literacy, science engagement and related topics, but for the purposes of this document, the following basic definitions have been adopted:

- **Indigenous knowledge** refers to the local knowledge that is unique to a given culture or society. This is usually passed down from generation to generation by word of mouth. It is the basis for agriculture, fishing, health care, food preparation, education, carpentry, tool making, environmental conservation and a host of other activities (Fien, 2010).
- **Public awareness of science** aims to stimulate awareness of and positive attitudes to or opinions about science (Burns, O'Connor and Stocklmayer, 2003).
- **Public understanding of science** focuses on understanding science, its content and processes, as well as social factors (Burns, O'Connor and Stocklmayer, 2003).
- **Scientific literacy** is where people are aware of, interested and involved in, form opinions about and seek to understand science (Burns, O'Connor and Stocklmayer, 2003).
- **Scientific culture** is a society-wide environment that appreciates and supports science and scientific literacy. It has important social and aesthetic aspects (Burns, O'Connor and Stocklmayer, 2003).
- **Science communication** is defined as the use of appropriate skills, media, activities and dialogue to produce one or more of the following personal responses to science: awareness, interest, enjoyment, opinion-forming and understanding (Burns, O'Connor and Stocklmayer, 2003).
- **Corporate communication** refers to the message issued by a corporate organisation, body, or institute to its publics. Publics can be both internal (employees or stakeholders) and external (media, government, industry bodies and institutes, and the general public). Corporate communications help organisations explain their mission and combine its many visions and values into a cohesive message to stakeholders (IACACT, 2012).
- **Science diplomacy** is the use of scientific collaborations among nations to address common problems and to build constructive international partnerships (Wikipedia, 2017).
- **Public engagement** with science refers to activities, events, or interactions characterised by mutual learning – using a dialogue approach, not one-way transmission from "experts" to publics – among people of varied backgrounds,

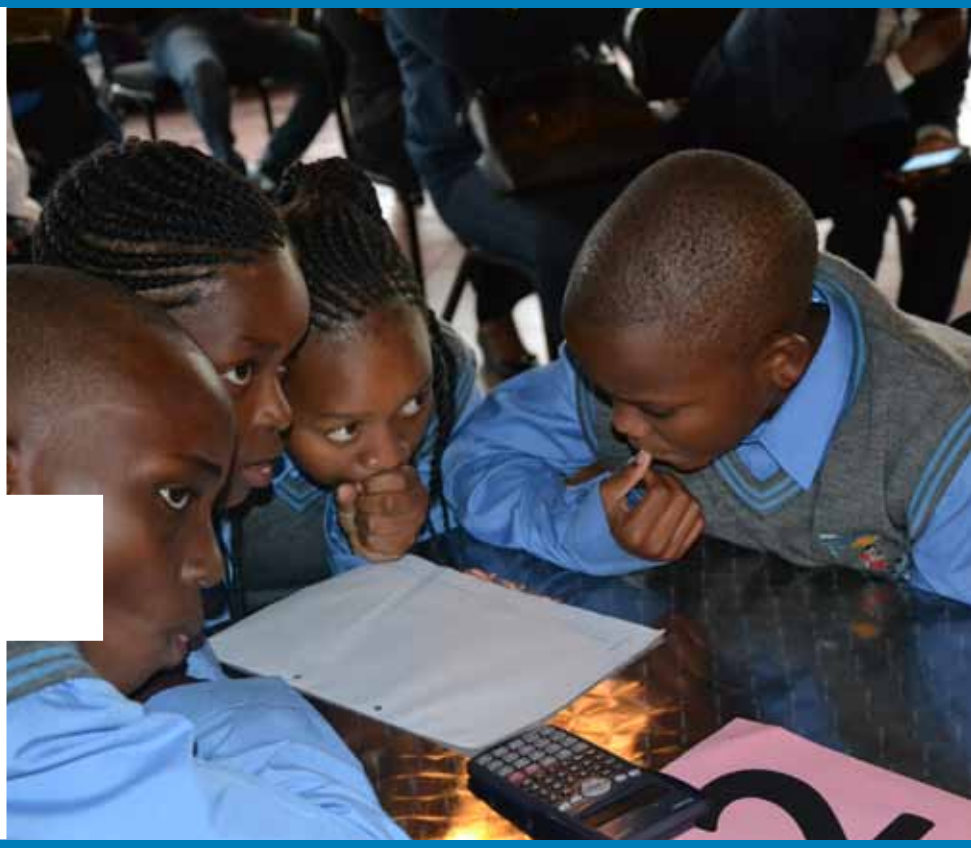
scientific expertise and life experiences, who articulate and discuss their perspectives, ideas, knowledge and values (McCallie et al., 2009). The philosophy espoused is for a holistic and normative epistemology that is oriented towards the development and happiness of the individual and society, while affirming the validity of all knowledge systems (local and global).

From a citizen-centred approach, public engagement is seen to allow people to join the public dialogue about a problem, and provides them with tools to do so productively (Public Agenda, 2008). The two-way dialogue model emphasises the importance of listening and interaction as key characteristics of public engagement and is inclusive of issues from a combination of scientific, social, political and technical perspectives. Upstream engagement attempts to capture public involvement in setting the values and priorities that direct scientific research, are more often attempted in applied research areas like nanotechnology.

For the purposes of this Strategy, the use of the overarching term "science engagement" includes all aspects of public engagement with science, science communication, science literacy and science outreach and awareness. In other words, reference to the DST science engagement portfolio incorporates activities across the span of science literacy initiatives outlined above. This aligns with current international practice.

It is important to note that the iterative, discursive or dialectical engagement with science and technology across different social actors, as implied here by the concept of public engagement, is also much better aligned to the contemporary democratic ethos of South Africa than a more unilateral, top-down approach (the deficit model) would be.

4



PROBLEM STATEMENT

This section outlines six key areas in which interventions are required to enhance the combined impact of the DST's science engagement portfolio

4. PROBLEM STATEMENT

As mentioned before, despite the absence of a coordinating framework, the DST and its partners have initiated numerous science engagement activities in the past decade. This section outlines six key areas in which interventions are required to enhance the combined impact of the DST's science engagement portfolio.

4.1 Regularisation and coordination of science engagement

Although there have been significant developments with regard to the DST-led science engagement programmes, there are several shortcomings in the system, which this Strategy seeks to address. Firstly, coordination of the science engagement programmes has so far been pursued on an ad hoc basis, with SAASTA playing a related role without a formal mandate and with inadequate resources (financial or human). In terms of the current National Research Foundation Act, 1998 (Act No. 23 of 1998), science engagement is not formally part of the organisation's mandate. Secondly, a more systematic approach to the coordination of science engagement activities across the DST entities is required, and this Strategy is intended to serve that purpose.

Thirdly, the formulation of this Strategy will systematise a programme of science engagement activities, which ought over time to allow an increase in the resources allocated to science activities. In 2014/15 the entire portfolio was valued at about R70 million per annum, of which almost one fifth was dedicated to just one event – National Science Week. The remainder of the allocation is dedicated to a wide range of other science engagement activities, including support to science centres, which constitute a key institutional platform for delivering on science engagement, but which are seriously underfunded at present.

4.2 Strategic alignment of science engagement activities

The DST science engagement programme has been largely constructed from the bottom up in an activity-driven approach, in the absence of a strategy. This has led to several imbalances in the portfolio of activities and their content. For example, activities have mostly lent toward initiatives of the science awareness or public understanding of science type, while the imperative of encouraging a more active and critically reflective engagement with science has been underserviced. Similarly, DST-supported science awareness activities have to some extent been informed by the notion that they can have a measurable impact on the number of school learners pursuing science subjects and science careers, whereas the DST's resources and mandate permit exposure to only a very small fraction of learners, and can therefore not make a systemic impact at that level. This Strategy is required to improve the balance in the portfolio of activities and sharpen its focus.

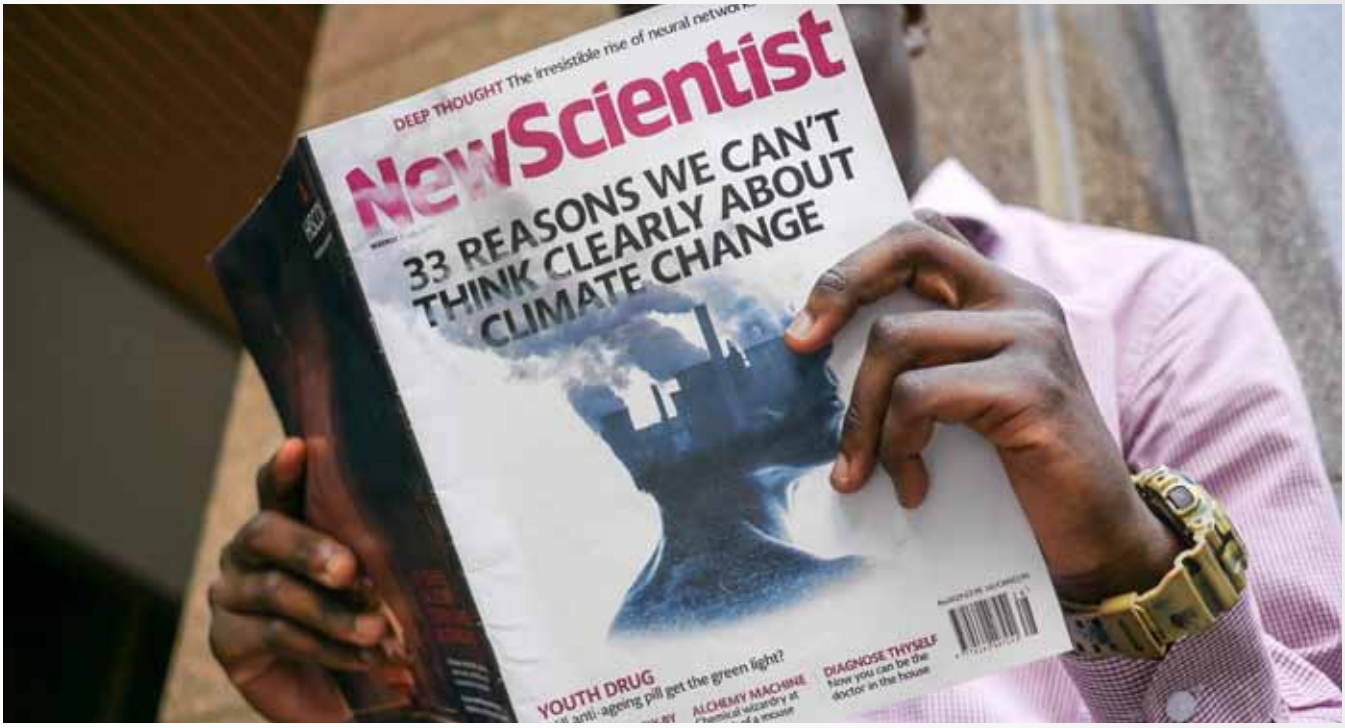
4.3 Monitoring and evaluation

Ensuring a deep, lasting impact from the DST's science engagement programmes is critical, but very difficult in the absence of a coordinated effort in this regard. Currently, effective monitoring and evaluation instruments are lacking, as are meaningful indicators to measure outcomes and impact (besides attendance figures). On the same note, evaluations are done mainly on activities, like the 10-year review of National Science Week in 2011. This framework will encourage a more coordinated and systematic approach to monitoring and evaluation.

4.4 Popularisation of science, engineering and technology

The NRDS recommended support for interventions to increase participation and performance of disadvantaged learners in mathematics and science, as well as attracting matriculants to degree and postgraduate courses in science, engineering and technology (SET). For example, over the 2008 to 2013 period, the number of learners who wrote Physical Science dropped by 15%, while the number of those who wrote Mathematics declined by 19% in national senior certificate examinations. At higher education institution level, total enrolment in science and technology majors (including health sciences) increased only marginally, from 29% in 2005 to 34% in 2012. Neither of these examples bode well for South Africa's ambitions with regard to science, technology and innovation.

Popularising science, engineering and technology is an important intervention to draw more learners into science, especially if the focus is not only on the learners, but also on their parents. However, on its



own, this is not enough to ensure significant growth in the number of students enrolling for science degrees, or the number of parents encouraging their children in this regard – several concomitant interventions outside the mandate of the DST are also required, e.g. improving the skills of Science and Mathematics teachers, the provision of exciting and modern laboratories and equipment in all schools, and the provision of broadband Internet connectivity to all schools. This Strategy seeks to maximise the DST contributions to popularising science and technology, but within the limits of the DST's mandate and resources.

4.5 Developing critical engagement between the public and science

Existing science engagement programmes are biased towards the youth. More than 70% of the participants in National Science Week, which is the DST's science engagement flagship activity, are school learners in the further education and training band. Schoolgoing learners on average constitute more than 68% of the visitors to local science centres. While most current science engagement activities in South Africa aim to increase awareness about science, make science fun or more appealing, or support educational programmes, few aim to encourage critical thinking about and engagement with scientific issues among the general public. This is not unlike the situation found in other countries, e.g. in a recent audit of Australian science engagement activities (Metcalfe, Alford and Shore, 2012).

South Africa is a democratic, constitutional state that guarantees public participation in policy development. Before a Bill becomes law, it goes through various stages, including being published in the Government Gazette for public comment. Meaningful public participation in policy development, to safeguard the people of South Africa and their environment, is crucial at all times. Controversial debates such as those around hydraulic fracturing in the Karoo, the provision of nuclear energy, using genetically modified crops for food, stem cell technologies, and nanotechnology should be accessible to all members of society rather than only a small part of the population. The area of indigenous knowledge is of specific reference here, as public and scientific engagement around this topic is largely ill-informed and historically and/or culturally biased, undermining the development of rational management approaches.

The above imperative – empowering the general public to engage critically with science and technology – means that it is necessary to empower "science" as a social phenomenon to engage the public. In practice, this could mean, for example, ensuring regular exposure of science practitioners (i.e. scientists and researchers) to platforms in which they need to communicate their craft in accessible

ways to the general public. Through such two-way engagement the dialectical relation between science and society can begin to be shaped and to inform the development of science in the true national interest.

4.6 Science communication and profiling South African science

While the DST and its entities have been fairly successful in profiling specific South African science, technology and innovation successes – in areas such as HIV/Aids, astronomy and the palaeosciences – there is general agreement that more can be achieved in terms of profiling science generally, and more consistently. For the purpose of this Strategy, there are three important areas in which improvement is needed. The first has to do with improvements that could be achieved in corporate communications efforts within the DST stable. The second has to do with a shortage of science communication skills outside the DST, its entities, and other public science councils, specifically in the realm of science journalism, and the general coverage of science, technology and innovation in the media. Very few media houses have in-house science journalists, or set aside regular space for science articles. The third area in which science communication can and must be improved is within the scientific fraternity and its relevant institutions.

There is no coordinated effort to promote South Africa's scientific profile internationally beyond isolated exhibitions such as the 2010 Shanghai Expo in China in which South Africa participated. Consistent participation by South Africans in the European Union Framework Programmes, the latest iteration of which is the Horizon 2020 programme, under the European-South African Science and Technology Advancement Programme, provides local researchers with opportunities to partner with European researchers. While this creates and harnesses research collaborations, it does not constitute science communication in the broader sense of this Strategy. A holistic plan to profile South African science internationally is still required.

STRATEGIC CONTEXT

A stimulated and engaged South African society that is inspired by and values scientific endeavour, critically engages with key science and technology issues

5. STRATEGIC CONTEXT

5.1 Vision

A stimulated and engaged South African society that is inspired by and values scientific endeavour, critically engages with key science and technology issues, and participates in a fully representative innovative science and technology workforce.

5.2 Mission

To support and promote communication about and engagement with science to diverse constituents at all levels of society, using the most appropriate and innovative means, and guided by the basic principles set out below.

5.3 Principles

In striving to remain relevant to the internal and external operational environment, science engagement will uphold the country's constitution and advance the NDP. To this end, the following basic principles will underpin the DST-led science engagement programmes:

- Access to information will be upheld to actively promote a society in which there is effective access to information that enables citizens to exercise and protect their rights fully. Appropriate, targeted communication tools will be used to reach different types of audiences.
- South Africa is a multicultural society, characterised by many languages, and several ethnic and religious groups. Implementation of this Strategy should promote respect for human dignity and cultural, language and religious diversity.
- Opportunities will be created to support and influence the development of science, engineering and technology human capital (including supporting basic education).
- Opportunities will be sought to enhance the intentions of the Strategy by interfacing science and technology with indigenous knowledge systems.
- The Strategy will use science engagement to strengthen South Africa's international collaborations.
- The popularisation of science should be guided by the core principles of ethics and social responsibility.
- Interdisciplinarity is essential to the impact of science engagement; no single scientific discipline has sufficient scope to develop understanding and shape the complexity of the science-society interface.

5.4 Strategic aims

In response to the above challenges and the overarching purpose of this Strategy, its aims have been defined as follows:

- To popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers.
- To develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society.
- To promote science communication that will enhance science engagement in South Africa.
- To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing their public standing.

In the following section the above strategic aims are discussed in some detail, after which examples are given of interventions the Department will, or will continue to, support, initiate or explore in pursuit of each specific strategic aim.

Strategic Aim 1:

To popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers.

The popularisation of science and technology is broadly understood as the system of measures aimed at the dissemination, appropriation and valuing of science and technology goods, which include critical thought, ideas and values, the history and sociology of scientific knowledge, how science is practised, and the results of scientific research and technological development (Workshop on the Popularization of Science and Technology, 2004).

Generally, initiatives towards achieving this aim will fall into three broad categories, which are not mutually exclusive, but are helpful in achieving focus and improving coordination. They are as follows:

(a) Science for the public

The 2013 South African Social Attitudes Survey, which incorporated questions to determine the public's attitude to science in South Africa, showed some stability in attitudes to science for the 1999 to 2013 period. The emerging trends are somewhat contradictory. The majority of South Africans said they believed that science and technology (a) make their lives easier, healthier and more comfortable; (b) make their work more interesting; and (c) provide more opportunities for the future. However, at the same time, they expressed concern that science was changing their way of life too fast, and that there is too much dependence on science and not enough on faith. Worryingly, between 1999 and 2013, there was a slight overall weakening in (positive) attitudes of promise and an overall strengthening in (negative) attitudes of reservation (Reddy et al., 2013).

In addition to intentions to improve the public's attitude to science, the fact that science and technology affects everyone's life means that the public must be provided with timely, accessible and accurate information to promote transparency in line with the Constitution. Science popularisation promoted by this Strategy will seek to create an atmosphere that enables the public to engage with both the positive and the negative consequences of science and technology.

(b) Science education support

Some science and mathematics Olympiads and competitions, like the local Eskom Expo for Young Scientists, provide schoolgoing aspirant scientists with an opportunity to communicate science, as they have to explain their science projects to other people. Learners' involvement enables them to refine and display their own understanding of the knowledge and techniques acquired from the formal classroom teaching and learning provided by basic education. Part of what has started emerging from the tracking of the DST's Talent Development Programme is that learners in this programme, who participated in such Olympiads and competitions, achieved better marks in Mathematics and Physical Science than those who did not participate.

(c) Careers in science

Provision of information about careers in science is crucial in increasing the number of students that follow science-based careers. Owing to the

historical exclusion of the majority of South Africa's population from most science-based career paths, an understanding of such careers is still not deeply embedded in most South African families, who are thus not in the best position to guide their children in this regard. Significantly, this constraint also sometimes applies to science teachers, who have themselves often not developed the requisite understanding necessary to provide career advice to learners. Considerable work has been undertaken to close this gap, but the intention is that every learner or student should be exposed to career information and opportunities for discussion with scientists, engineers and technologists (role modelling).

Proposed interventions

- Exploring the feasibility of establishing a flagship national science and technology museum or centre, to act as the focal point for national science engagement activities, and in due course perhaps as the home of a national science engagement institute.
- Strengthening the national network of science centres by (a) upgrading existing science centres, and (b) establishing new science centres in strategic locations.
- Improving the technical support provided to the organisers of science engagement activities (including science centres and science festivals) to increase the number and diversity of new science engagement programmes in the country.
- Encouraging science and mathematics Olympiads as a means of stimulating learners' interest and participation in science.
- Continuing to support mass participation activities such as National Science Week and science festivals, while aligning their implementation strategies with the aims of this Strategy.
- Implementing the existing framework of the DST's activities in support of basic education.
- Continuing to produce the annual science, engineering and technology career booklet.
- Collaborating with ASSAf in piloting inquiry-based science education in science centres. (The approach enables learners to develop understanding about the scientific aspects of the world around them through the development and use of inquiry skills).

Strategic Aim 2:

To develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society.

Science and technology are not carried out in a social vacuum, but are affected by a range of social actors in social settings. Researchers (in public and private research institutions) define research and development questions under the influence of those who finance the research (government and industry), while the latter are influenced to a greater or lesser extent by the electorate or shareholders. This chain of socio-economic and socio-political relations ultimately shapes the science and technology that emerge. It is the duty of progressive government to enable citizens to exercise authority over this chain not only through procedural democracy (regular elections), but also by empowering its citizenry to engage with substantive questions relating to the national science and technology enterprise, and to help shape its agenda directly in terms of what sort of science is undertaken and to what end, and whose interests are served.

Traditionally, citizen engagement with science in many countries has largely centred on questions of environmental issues, health, education, labour, housing and developmental issues. In modern societies, science and technology are now at the heart of enormous change happening at ever-increasing speeds. For example, it is recognised that virtually every aspect of modern life has been touched by some form of information and communication technology, and major advances in computing are raising ethical questions about personal and corporate privacy, international security, and politics, among other things. Social media have opened up public spaces for community activism, presenting a communication platform for debate, thus increasing the possibility of robust public participation. Despite advances, tensions remain at various levels and may include the nature of relationships between civil society and the state, considerations of private benefit or public good, perceptions of consultation or subtle manipulation, and questions of economic viability or exploitation.

In the South African context of a politically pluralistic society committed to open, transparent democracy, it thus remains important to empower citizens to engage in debate on issues relating to science and technology. Given the persistent wide divergence in educational levels and exposure to science across South African society, and their very strong correlation with economic and political power, empowerment (especially of poor and marginal populations) is also critical for the development of their self-esteem and belonging, and hence to the project of nation-building.

Actively fostering dialogue about science with society within a developing knowledge economy will be strengthened by –

- a lively and active civil society (e.g. associations, co-operatives and non-governmental organisations) that widely recognises the need for public participation in science and technology;
- the emergence of new groups of stakeholders and recognition for stakeholders' practical knowledge;
- a strong participatory tradition in areas of technology assessment and environmental decision-making, e.g. consensus conferences and scenario workshops;
- an active attempt by the academic sector to bridge the gap between higher education institutions and the public (community engagement);
- increased access to scientific knowledge for the public at local and municipal levels;
- a stronger focus on the applicability of science (solving practical problems) and cooperation with other societal actors (e.g. formal dialogue across sectoral divides such as between the public and the private sector, or with labour).

South African society has made significant progress in many of the above areas. A specifically powerful example can be found in the history and activities of the Treatment Action Campaign, a civic NGO focused on HIV/Aids issues. The Treatment Action Campaign successfully encouraged public participation in the debate around antiretroviral roll-out in South Africa and, through this, arguably effected a major shift in prevailing public policy on HIV/Aids treatment. This example demonstrated how enhanced understanding of the key scientific issues (e.g. that the HIV virus causes Aids, that transmission of the virus spreads the disease, and that treatment with antiretrovirals slows the negative impact on health) can result in massive changes to the roll-out of science-intense interventions through scientifically informed social action.

Other examples can be found in the fracking and nuclear energy debates, where both sides of the debate claim scientific superiority for their facts and figures, with government intent on pursuing both fracking and nuclear energy as vehicles for future economic growth. Technology transfer and communication platforms like the Risk and Vulnerability Atlas have been introduced by the DST to assist national, provincial and local target groups with spatial-based risk and vulnerability information. The National Recordal System is knowledge infrastructure for the documentation and management of indigenous knowledge systems, and its carefully negotiated introduction to indigenous communities – accompanied by relevant training – is proving to be instrumental in empowering those communities to manage their intellectual property and defend it against external threats. The DST supports science outreach activities across many of its science programmes, including nanotechnology, biotechnology, palaeosciences and astronomy. However, future science and society dialogue will need to anticipate increasing pressure from lobby groups and the prevention of bias, confusion between risk and uncertainty, debates starting too early or, more often, too late, traditions of representative democracy, the sometimes emotional responses of the public, and procuring legitimate roles for NGOs in the science and technology debate.

The proposed initiatives in this thrust may be organised under the following broad categories:

(a) Citizen-centred dialogues

There is already a large reservoir of experiences of dialogue formats, both nationally and internationally, including consensus conferences, focus groups, referendums, and citizen juries, as well as games like PlayDecide that foster citizen debate. Regular dialogues on key science, technology and innovation topics should be built into the fabric our society.

(b) Public engagement in research

This aspect includes considerations of research agenda setting, community engagement, and the dissemination of research results in consultation with communities. Higher education institutions and ASSAf will be closest to this aspect of critical dialogue.

(c) Media as a form of dialogue between science and society

This looks beyond the use of media for traditional marketing. The media have generally contributed to enabling debate, as well as organising and structuring it. They are also instrumental in informing the public on many matters that might otherwise have been ignored. This focus stresses a broader inclusion of all media platforms for engagement with science matters. Examples of current initiatives include the NRF's "Science for Society" lecture series, media round tables, and the Wits Radio Academy show "The Science Inside".

Proposed interventions

- Encouraging researchers and research institutions to systematise science outreach and/or science engagement activities in alignment with the level of research resources allocated to them. For example, all centres of excellence and SARChI chairs will be encouraged to present their work to non-scientific audiences on a regular basis.
- Exploring the feasibility of incorporating science outreach as a formal component of continuing professional development obligations for professional scientists registered with the South African Council for Natural Scientific Professions.
- Exploring, with the NRF, the feasibility of integrating wider societal input in the formulation of research questions or priorities at both programme and project level.
- Establishing sector-specific science outreach and/or engagement activities, such as the Science, Technology and Innovation Summit that seeks specifically to facilitate cooperation between public and industry-based research institutions.
- Ensuring that science communication strategies and interventions are informed by the strategic priority of developing a critical public that engages in the science and technology discourse to the benefit of society, meaning that their content will reflect the socio-economic complexities and trade-offs that accompany different technologies.
- Encouraging DST entities to implement interventions that deepen the dialectical engagement between science and society, by strengthening society's capacity to reflect critically on science-related matters. ASSAf's approach to consensus reports and conferences should be broadened to include non-specialist members of civil society.
- Requesting that new and existing DST programmes consider establishing science engagement components as an integral part of the programme and its budget, as has already been done with

several programmes, including those for the palaeosciences, indigenous knowledge systems, astronomy and marine sciences.

- Continuing to support science engagement activities and increasing support as resources permit; this applies to interventions such as National Science Week and science festivals.

Strategic Aim 3:

To promote science communication that will enhance science engagement in South Africa.

Empowering public science engagement necessarily requires effective communication about science, which in turn requires that (a) the content and medium of the communication delivers on its purpose, and (b) the skills of the communicators are adequate to the task. These imperatives will be dealt with separately below.

(a) Science communication media

The content and medium of any science communication need to be informed after due consideration and with respect for the target community. It has been demonstrated that the medium of the public communication of science (science books, press articles, audio-visual material, and activities such as visits to science museums) plays a significant role in awakening a vocation for science (Stekolschik et al., 2010). The need for greater scientific engagement and an ability to assess the credibility of scientific information remains a critical priority in most societies.

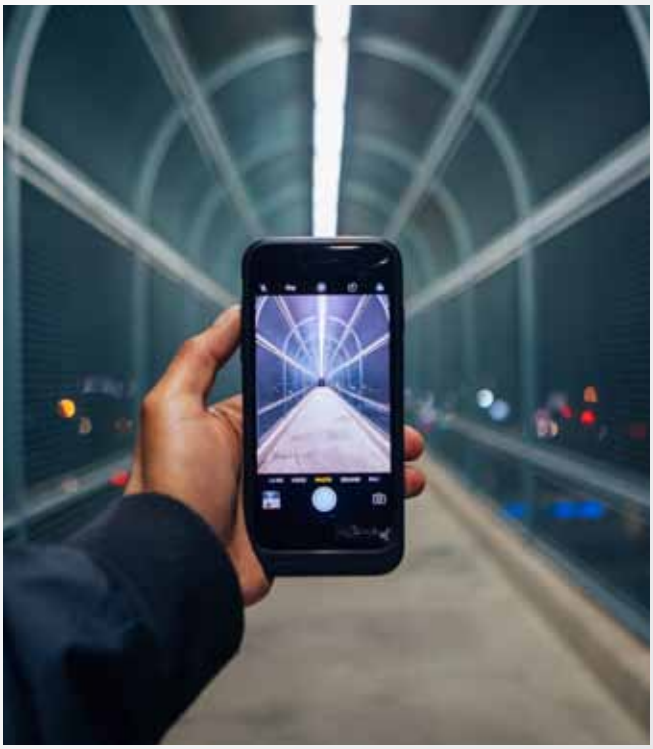
In terms of communicating science, the media are seen as brokers between science and the public, framing the social reality for their readers and shaping the public consciousness about science-related events. They are, for many readers, the only accessible source of information about science and technology. In short, the way people understand science and technology is influenced to a significant degree by media coverage, interpretation and presentation (Makerere University, 2011).

The public awareness of scientific issues and discoveries, and the way scientifically illiterate members of the public generally interpret and use them, are closely linked to the role of media in reporting on science and technology. The media generally constitute the forum through which the public make moral judgments about science. In South Africa, various studies have shown neglect by the media in reporting science, with exceptions in the field of the environment, health and medicine (Claassen, 2011).

Yet in Africa, very few studies have systematically investigated the volume, quality, scope, and perceptions of the coverage of science and technology. One such study by Rooyen (2002) – cited in Makerere University (2011) – examined the state of science and technology coverage in the print media of South Africa, concluding that there were relatively few science and technology articles in the sample of newspapers studied. One can assume there may be several reasons for this, chief among these being that "science" in general is not considered newsworthy, apart from specific important or spectacular breakthroughs, and that there is a dearth of science communication and journalism skills among scientists, science institutions, and the media.

Proposed interventions

- Promoting online interactions (e.g. on Facebook and Twitter) as an effective medium for the scientific community to engage with each other and for engagement between the scientific and the non-scientific communities.



- Promoting face-to-face events such as public lectures and science cafés, particularly as part of the effort to develop a critical public that actively engages and participates in the national discourse on science and technology. These events will add to existing interventions such as the NRF's "Science for Society" lectures, which are delivered by the research chairs, and the annual Palaeontological Scientific Trust lectures.
- Improving the use of traditional journalism (print and broadcast) to advance science engagement, and the relations between scientists and media.
- Developing and nurturing the culture of communicating science to the public, targeting existing scientists and researchers, and aspirant scientists at higher education institution and school levels. Activities like science, technology, engineering, mathematics and innovation Olympiads and competitions are useful in identifying aspirant scientists at school level who would be equipped with skills to communicate their scientific work to the public.
- Creating an incentive scheme to encourage scientists and researchers to communicate science to the public.
- Promoting the communication of science using the arts and performing arts.

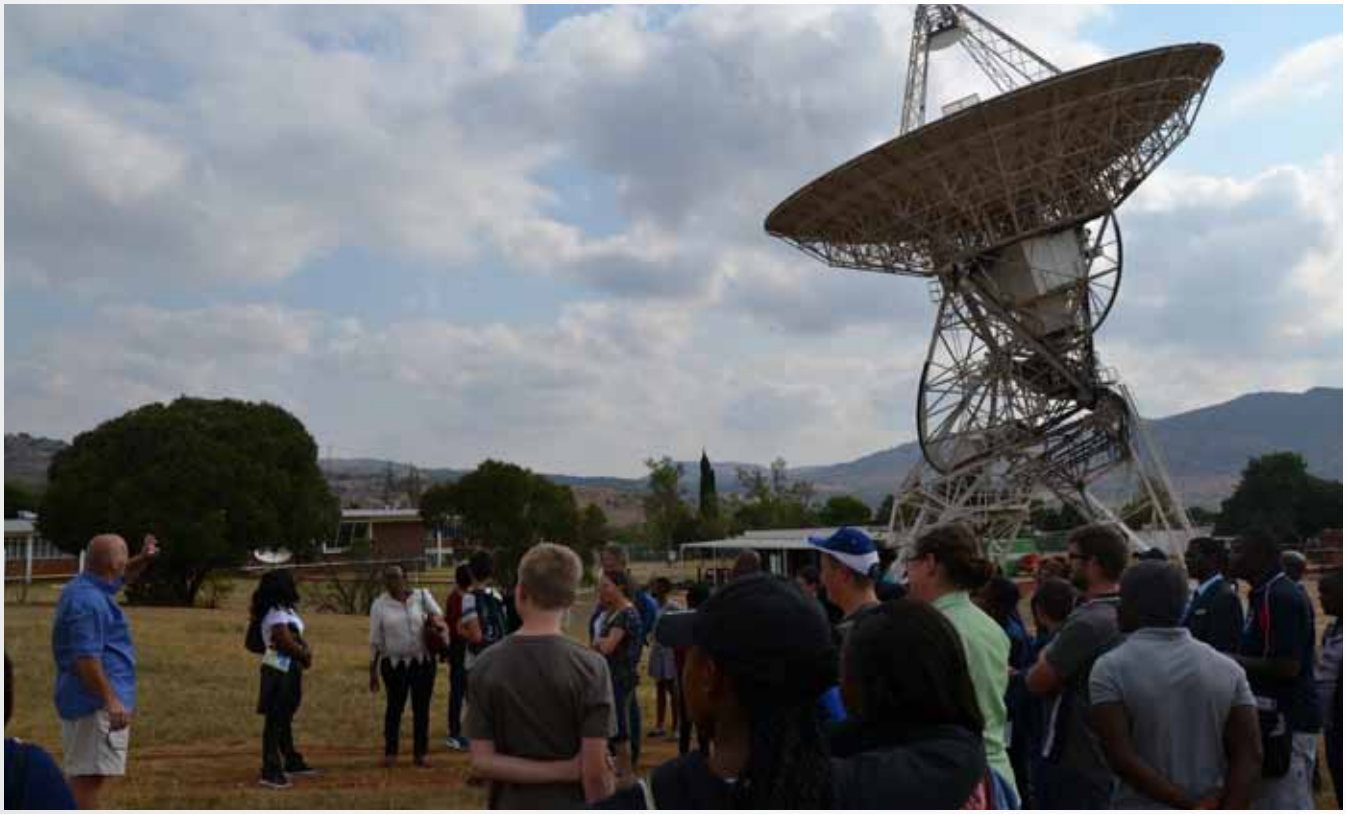
(b) Science communication as a professional field

Claassen (2011) reports that of all South African newspapers, magazines, broadcast stations or Internet news sites, only one has a structured and organised science desk managed by a designated science editor with a team of trained science journalists. At higher education institutions, only the Stellenbosch University Department of Journalism offers a module in science and technology journalism. Hence, supporting and building professional science journalism and communication in the South African context remains a strategic imperative if the country is to invest in, build and sustain the relationship between science and society.

Furthermore, in general, no training in science communication is required of or provided to postgraduate science students or researchers.

Science communication cuts across all of the strategic aims of this Strategy, and if science communication is to play a meaningful catalytic role in our science engagement programmes, it is important to develop the necessary capacity.

Locally, science communication capacity building is characterised by infrequent workshops, which are not



accredited, usually organised by a higher education institution or the local journalism community of practice with ad hoc support from the Department. In this context, collaboration with foreign academic institutions could provide some support. In the past five years, for example, a group of science communicators and illustrators from the local science centre community had an opportunity to enhance their skills through accredited training offered by the Australian National University. Furthermore, the establishment of a DST-NRF research chair is a step in the right direction as it creates the necessary platform for science communication research.

Proposed interventions

- Establishing accredited programmes to increase the skills of practising journalists and illustrators in museums and science centres, and communication officers of science-based organisations, especially public research councils.
- Exploring the feasibility of training scientists and researchers in science communication skills and the possible content of training interventions.
- Creating research capacity in science communication by exploring existing bilateral agreements (signed at government and departmental levels) as a basis for facilitating partnerships between local higher education institutions and their counterparts in countries that have established academic training programmes in science communication. The envisaged partnerships would lead to locals accessing accredited short courses in the short to medium term, and fully fledged academic programmes in the long term.
- Developing a framework for regular measuring of science awareness and attitude levels across society, in alignment with international best practice and standards, such as the Eurobarometer surveys and the United State of America's National Science Foundation's indicators.

Strategic Aim 4:

To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing their public standing.

South Africa's science and innovation are critically dependent on two key partnerships, with the private sector and with the international world of science. A further important ingredient for a productive science and innovation system in South Africa is socio-political support, that is, support from the general public and the body politic. The Department's relationships with stakeholders and partners depends on the prevailing

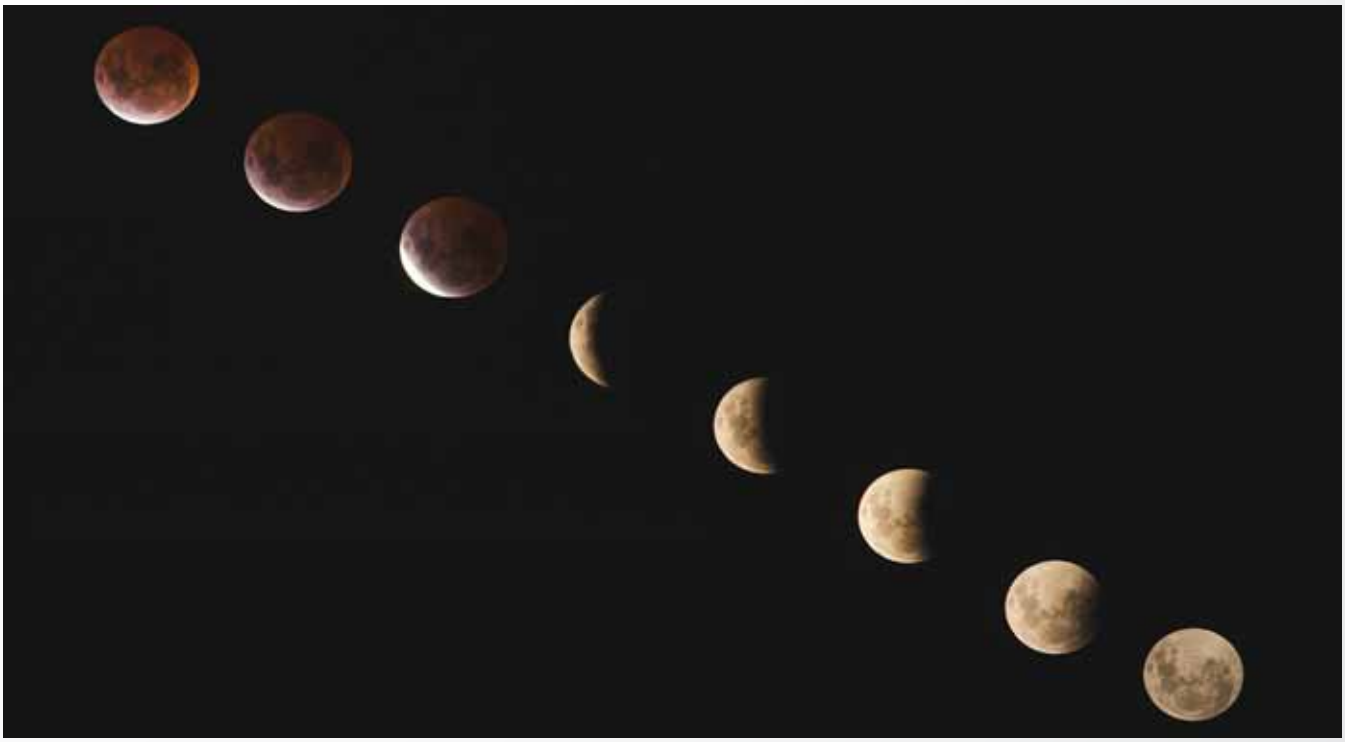


image of South African science (and technology and innovation), South African institutions, and the Department.

Though it may not be widely appreciated, South African science and innovation are comparatively productive and efficient. They have produced world-class knowledge and innovation – and continue to do so. It is important that these successes be profiled effectively to demonstrate the advancement of the country's science system and its contributions to national development. There are fragmented efforts by some stakeholders and partners in the national system of innovation to raise public awareness of South African inventions and discoveries through, for example, websites that publicise them. In 2010 the local science centre community published its first book, Great South African Inventions. The science centre community is working on the first travelling exhibition of South African inventions, which is envisaged to be about 300 m2 in size.

Through the NRDS and the TYIP, the Department has prioritised a range of thematic areas such palaeosciences, astronomy, marine biology, nano-technology, biotechnology, and space science and technology. For many of these areas detailed strategies and/or implementation plans have been drafted, setting out a range of interventions designed to develop and promote knowledge production and application, and many of them also provide plans for science outreach or communication. The latter have generally been developed in close consultation with relevant stakeholders, especially SAASTA.

Internationally, South African science enjoys a comparatively high profile. In part, this results from the geopolitical importance attached to South Africa, and the fact that, according to most indicators, it still leads the continent. However, a large part of the country's standing has been earned by the quality and global impact of South African science, which has a scientometric impact that is considerably higher than the global average in a number of thematic areas. In addition, especially since Africa was chosen to host a major portion of the global Square Kilometre Array project, South Africa's research infrastructure is increasingly attracting global attention, as are the country's geographic advantages for astronomy, marine and Antarctic research, palaeosciences, and Earth system sciences. Together, these strategic advantages present themselves as a very powerful platform, which is arguably not being sufficiently exploited, against which the country and the Department can leverage considerable edge in the public relations and science communication sphere.

In 2012/13 the Department doubled the budget for its Chief Directorate: Science Communication, but further growth in investment will be absolutely necessary to exploit the above advantages fully. Tight coordination of marketing and communication efforts and campaigns across the DST entities is essential. Moreover, the Chief Directorate: Science Communication has also produced a public participation strategy (and implementation plan), and annually produces a communications strategy in response to requirements from the Government Communication and Information System. These strategies should be considered complementary to the Science Engagement Strategy, and they considerably strengthen the Department's communication efforts.

However, a central challenge remains. While science and technology pervade national development in a very deep and broad way, the scope of the Department's formal mandate across the national system of innovation is curtailed through a combination of numerous research and development functions that report to other departments (such as the Medical and Agricultural Research Councils) and the limited scale of its operations (resulting from a comparatively small budget). This contradiction provides a central communication dilemma to the Department in that it (a) needs to communicate the impact of science and technology across fields in which it has little or no footprint, like medicine or agriculture, and (b) where the fields align with its mandate, the Department's ability to generate macro-level impact through its programmes is restricted by the limited scale of its operations.

The above context informs the set of interventions outlined below.

Proposed interventions

- Strengthening the role of the Chief Directorate: Science Communication in coordinating marketing and communication activities across all DST entities, as well as in further systematising and formalising it.
- Establishing interdepartmental science communication and marketing campaigns and structures around science councils and entities located in other government departments in conjunction with

those departments, and under the leadership of the Chief Directorate: Science Communication.

- Sustaining and expanding the priority area-based awareness campaigns that have been started by the DST. The Department already leads awareness and engagement programmes in palaeosciences and astronomy, for instance.
- Investigating the establishment of a science tourism campaign. This could be run as a stand-alone campaign or integrated with other South African campaigns to position the country as a tourist destination targeting both local and international tourists, as well as targeted efforts to build South Africa's image abroad. Brand South Africa and Shot'Left are two of the existing initiatives. Establishing a science tourism route incorporating sites and institutions supporting palaeosciences, astronomy, and Earth system and marine sciences, for example, could be part of this campaign.
- Enhancing current efforts by the local science centre community to publicise local inventions through purposefully made travel exhibitions and dedicated publications.
- Strengthening science centres as part of an overall communication campaign to communicate about science and DST successes and achievements, through capacity development support and coordinated integration into DST-led marketing and communications efforts.
- Continuing periodic national science, technology and innovation events featuring government entities, industry, the higher education sector, and selected projects of school-level aspirant innovators.
- Profiling South Africa as a global leader in strategic domains of science, and as a continental leader in science generally, in order to attract world leaders in science, thereby initiating a virtuous cycle.
- Using multilateral platforms widely to profile South African science and scientists.
- Implementing United Nations observances that have relevance to science engagement programmes as appropriate.
- Expanding periodic bilateral science cooperation celebrations, such as the German-South African Year of Science.

STRATEGIC ENABLERS

Successful pursuit of the strategic aims of science engagement depends on an effective and efficient coordinating function

6. STRATEGIC ENABLERS

Successful pursuit of the strategic aims of science engagement depends on an effective and efficient coordinating function, adequately resourced institutional support, increased programmatic funding, and the development of relevant monitoring and evaluation mechanisms and performance indicators. Success in pursuing the four strategic intentions of this Strategy depends on a number of key strategic enablers.

6.1 Effective coordinating function

Science engagement requires integrated action by knowledge producers (such as scientists, researchers and intellectuals, and sometimes members of communities), knowledge disseminators and communicators (such as journalists, science centre personnel, publicists, museologists, educators, audio-visual aid producers, and sometimes also members of communities), and members of scientific, cultural, and social institutions. A coordinated strategy will require leadership to stimulate collaboration and co-investment across government, industry, academia, cultural and professional associations and community organisations.

In South Africa, approximately 25 other government departments have science and technology activities. In discharging their various mandates, some of these departments conduct awareness activities, but because these are usually intended to effect a specific behavioural change aligned with the purpose of that department, their science engagement or communication impact is marginal or coincidental. An example of this is the Department of Health's health awareness campaigns, which may have a significant impact on public health, but are not used to communicate the broader point about the role of science and technology in health provision. Nonetheless, departments engaged in science and technology activities, especially those with science councils, are very important partners in implementing a government-wide science communication, engagement or outreach campaign, precisely because the impact of science and technology is so close to their fundamental mandate (such as health provision, water, sanitation and energy) and therefore easily contextualised and communicated.

Clearly, effective coordination across relevant stakeholders, including different government departments, is essential if the impact of this Strategy is to be maximised.

At departmental level, the DST has adopted a science engagement model in which programmes in priority areas include science engagement programmes in their areas of focus. As a result, several priority area-based strategies exist in the Department, for example, the Nano-Science and Technology Awareness Strategy and the Public Understanding of Biotechnology Strategy. Such existing individual strategic plans will be aligned with this overarching Strategy in the ensuing stages of its implementation.

The management of science engagement activities within the DST will also be coordinated around this Strategy, and the implementation plan will provide further details in this respect. For example, although the Department's Directorate: Science Promotion is assumed the custodian of science engagement in the DST, there are no internal coordinating systems in place. The shortcomings of this include a lack of central accountability for the performance of DST-wide science engagement programmes, and confusion among external stakeholders.

Proposed interventions

- Pursuing government-wide coordination using instruments such as clusters (science engagement belonging to the social cluster, which includes the former human development cluster), bilateral agreements with the relevant departments, and other government structures.
- The DST's Directorate: Science Promotion will coordinate all science engagement activities in the Department, excluding those conceived as corporate marketing and communication initiatives (which the Chief Directorate: Science Communication will coordinate across the DST entities).
- SAASTA will play the role of coordinating science engagement within the science system after this function is incorporated into the NRF Act.
- Higher Education South Africa will be requested to coordinate higher education-related work, and the Committee of Heads of Organisations of Research and Technology will be requested to coordinate the work of science councils.

6.2 Institutional and legislative platforms

Coordination around science engagement across a wide scope of stakeholders and institutional types requires an appropriate institutional base. A 2013 Australian Council of Learned Academies international comparison of science, technology, engineering and mathematics (STEM) education indicated that structures such as centres, agencies and institutes have been established as part of the STEM infrastructure. The objectives of such coordination structures vary and may include provision of advice to government, communication of science to the community, and stimulation of young people's interest in STEM education and professions.

Further, in the Australian model, the leadership for their latest national initiative is provided by Questacon, a federally funded national science and technology centre located under the Department of Innovation, Industry, Science and Research. In the USA, several institutional variations exist for promoting science engagement, including the American Association for the Advancement of Science Center for Public Engagement with Science and Technology, which is a key catalyst of science and society dialogues.

The effectiveness of the coordination function, to a significant extent, depends on its operational location. In structuring an institutional landscape to promote science engagement and coordinate individual institutional initiatives across similar organisations, a delicate balance has to be struck. The central function needs to be vested in an organisation enjoying credibility in both the national science system and the broader public base, while not being located too close to the central political "landlord" of the science system. Locating the function in an institution with weak or no standing in the science community dooms its efforts to failure, while placing it too close to the political centre creates at least the impression of a conflict of interest – that science engagement will become a pretext for propaganda and non-critical, purely positivist dissemination of science information.

For several years, the National Research Foundation, through SAASTA, has played a major role in implementing a variety of science engagement activities, both of its own volition and on behalf of the Department. In conjunction with SAASTA and the NRF, the Department will formalise and systematise SAASTA's role as its agency for science engagement, and over the medium term investigate the feasibility of establishing a separate national agency for science engagement.

The current statutory mandate of the NRF does not explicitly incorporate the role that SAASTA plays in science promotion and engagement. The Department will therefore need to amend the NRF Act to incorporate an explicit mandate for science promotion and engagement, thereby formalising the function of the NRF and SAASTA in this regard. Moreover, in conjunction with the NRF, the Department will seek to grow SAASTA's core or baseline budget by incorporating into its core business relevant projects SAASTA currently manages on behalf of the DST on an ongoing basis.

In the meantime, SAASTA will be requested and supported to –

- establish and implement an effective and efficient grant management system to support the participation of the network of collaborative institutions in science engagement programmes;
- design and implement programmes that enhance the aims of the Strategy, including establishing necessary partnerships with relevant institutions;
- design an appropriate performance monitoring and evaluation system for science engagement, specifically for SAASTA and DST programmes;

- collect, collate, analyse and disseminate data on the performance of the system, going beyond the work of the DST and its entities to include any institutions that receive support for their science engagement activities or benefit from the grant system operated by the coordinating body;
- extend its coordination of science engagement activities across all DST entities, and develop a systemic way of reporting on their involvement in or support of science engagement activities.

6.3 Funding

Before the 2002/03 financial year, the DST had a Directorate: Science and Society with a dedicated annual budget allocation. The adoption of the NRDS resulted in the replacement of this directorate with the Directorate: Science and Youth, in an attempt to contribute to the development of the SET human capital pipeline. Beginning in the 2014/15 financial year and coupled to the formulation of this Strategy, the Directorate: Science and Youth became the Directorate: Science Promotion, and a dedicated science engagement budget line was established in the Estimates of National Expenditure. In the 2013/14 financial year, the budget for this function was R67 million, growing to R70 million in 2014/15 by an annual average increase of 5% over the 2014/15 Medium Term Expenditure Framework.

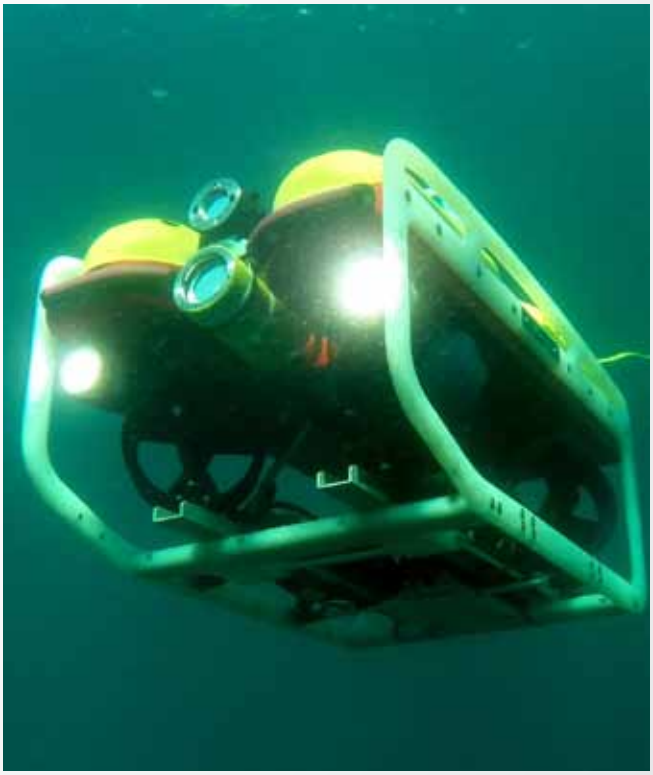
It is important to stress that this amount is not the only budget for science engagement activities funded by the DST or by its entities, as several other programmes and projects (within the DST and its entities) allocate smaller budgets to science engagement activities in specific thematic areas, such as nanotechnology and biotechnology; however, the formal science engagement budget accounts for about 85% of DST spending on science engagement (and spending through its entities), excluding corporate communications. Obviously, this level of funding is not sufficient to roll out a national programme based on the four aims of this Strategy.

Proposed interventions

- Making ongoing efforts to secure significant new funding for the development of the science centre infrastructure, and sustaining current funding levels.
- Increasing science engagement core funding to resource SAASTA's coordinating role and its programmatic activities, including capacity building.
- In line with several international examples, expecting DST-funded entities to commit a percentage of their total corporate budgets to science engagement and corporate communication work. At least 4% of budgets will be dedicated to science engagement initiatives (excluding corporate communications), and the usage of the top-sliced budget will be detailed in this Strategy's implementation plan.
- Requesting the NRF to encourage research grant applicants, especially for large grants, to include relevant science engagement activities in their research proposals that will then receive "science engagement top-ups".

6.4 Science engagement information management system

An effective performance information management system that collects and manages science promotion and engagement data on an ongoing basis is essential to assess the impact of the efforts made by the country in this regard. While surveys and flagship programmes are crucial, so is an ongoing system that stores and retrieves the essential data on science promotion and engagement. SAASTA will be requested to facilitate the establishment of a suitable system.



INSTITUTIONAL AND SECTORAL ROLES

The goals of this Strategy will be realised through the collective roles of different organisations as outlined below

7. INSTITUTIONAL AND SECTORAL ROLES

The goals of this Strategy will be realised through the collective roles of different organisations as outlined below.

7.1 Department of Science and Technology

The DST, in its role to deliver the country's science engagement programmes, will –

- provide strategic direction to science engagement programmes nationally, ensuring at all times that the implemen-tation of this Strategy remains aligned to the overall strategic direction of the Department and government priorities as outlined by the NDP and the Medium Term Strategic Framework, as well as relevant strategic plans at departmental level;
- support SAASTA in its coordination and implementation functions across all DST stakeholders and entities;
- ensure that DST entities budget and set targets for all science communication and engagement programmes and activities and report on these through their compliance reporting (performance plans, annual reports, etc.);
- coordinate corporate communications across all DST entities in alignment with this Strategy and the DST Communications Strategy;
- manage interdepartmental relations to leverage benefits for the implementation of this Strategy;
- develop an implementation plan for the Strategy, which will complement the Department's role of overseeing SAASTA's activities, and a concept paper guiding the reconfiguration of SAASTA to deliver on its mandate;
- provide guidance regarding opportunities to advance South Africa's international relations through science engagement programmes;
- source funding from the National Treasury and official development assistance for the implementation of this Strategy; and
- monitor and evaluate the implementation of this Strategy.

7.2 South African Agency for Science and Technology Advancement

Informed by this Strategy, SAASTA will strategically coordinate its implementation across the national system of innovation by –

- establishing and implementing a grant management system to support the participation of relevant institutions in science engagement programmes;
- endeavouring to establish and maintain a network of collaborating institutions active in science engagement activities;
- designing and implementing programmes to enhance the aims of the Strategy, including

establishing necessary partnerships with relevant institutions;

- establishing appropriate platforms and forums that promote multistakeholder engagement on science and technology issues;
- ensuring alignment of its programmes with government policies, in general, and DST priorities in particular; and
- overseeing the efficient and effective usage of resources (financial and human) relevant to science engagement;
- establishing a performance management system to monitor and evaluate science engagement achievements across DST stakeholders and entities, and to capture key system-level data;
- maintaining the performance management system by collecting, collating, analysing and disseminating national data on the performance of the national system, going beyond the work of the DST and its entities;
- leveraging external resources (financial, infrastructure and human) to advance science engagement.

7.3 Network of collaborating institutions

The DST collaborates with a wide network of institutions in the delivery of science engagement programmes. The network, which includes educational institutions, science councils, science centres and museums, professional associations, international partners, and private business has grown significantly in the past decade, with science engagement taking place in both formal and informal science settings and community organisations. The various institutions that will receive attention are highlighted below, although science engagement activities are not limited to this list.

(a) Government entities

A range of government entities, including science councils, national facilities, museums, ASSAf, and the National Advisory Council on Innovation (NACI), currently participate in science engagement activities. The roles of these institutions will be as follows:

- To ensure alignment of their science engagement activities with the aims and interventions of this Strategy.
- To provide SAASTA with reliable science engagement data related to the success indicators for this Strategy, transcending ordinary Public Finance Management Act and Treasury reporting standards.
- DST entities will commit a determined portion of their total budgets to science engagement activities (as mentioned above). The usage of the top-sliced budget will be detailed in this Strategy's implementation plan.

In addition to the above roles, the HSRC, ASSAf, and NACI will implement the following:

- The HSRC will track and measure the performance of the science engagement system, and be a key partner in developing an information management system for science engagement.
- Evidence-based science reports and opinions should be communicated more broadly with public audiences through platforms such as media, science-and-society dialogues or lecture series, media round tables and community organisations. In particular, research findings should be accessible to policymakers and parliamentarians to support leaders and decision-makers on science-related issues such as climate change, environmental management, and health issues.
- Policy advice through these reports and communiqués should be made more transparent

to both scientific communities and non-scientific audiences.

(b) Higher education institutions Higher education institutions should –

- encourage all researchers to present their research work to non-specialist communities;
- use their resources (extensive infrastructure, researchers, funding) to advance science engagement aligned to the aims and interventions of this Strategy;
- establish qualifications and short courses that will create capacity development specifically in science communication;
- create incentives for researchers who lead science engage-ment initiatives related to their research projects.

(c) Network of science centres

The network of science centres (including natural science museums, zoos, aquariums and botanical gardens) is a significant part of the science engage-ment landscape and will support the implementation of this Strategy by –

- providing the basic platform or infrastructure for pursuing the Strategy's intentions;
- addressing the four strategic goals of science centres that are aligned to and supported by the DST: (a) promoting science awareness among the youth and general public; (b) identifying and nurturing talent and potential; (c) providing mathematics, science and technology support; and (d) providing SET career education.

(d) Industry, non-governmental organisations and professional bodies

The role of industry in science engagement includes the provision of supplementary resources (human, infrastructure and financial) that enhance the implementation of the science engagement programmes, and exposing the public to tech-nologies that have changed or have the potential to change the world. Industry's involvement is crucial in implementing the interventions that address the aims of this Strategy. This involvement is equally important for international industry partners whose research and development activities are located in South Africa.

A number of non-governmental organisations are already participating and implementing science promotion initiatives. Partnerships with these organisations will be encouraged to enhance the implementation of this Strategy while ensuring efficiencies. In pursuit of their various objectives, non-governmental organisations such as the National Science and Technology Forum could provide a platform for public debate in association with SAASTA.

Science, technology and innovation knowledge workers in South Africa are affiliated to various professional bodies. These bodies (including the South African Council for Natural Scientific Professions) will be encouraged to contribute to the Strategic Engagement Strategy by creating incentives for their members or registered scientists to communicate their work in an effective manner to the broader society.

(e) Society

The physical extent of South Africa and the diversity of the sources for information and knowledge to be exchanged to achieve the envisioned society will be enhanced by voluntary involvement of various sections of society. In the same context, access to community infrastructure meant for other purposes (such as public libraries) will lend impetus to the implementation of the Strategy.

MONITORING AND EVALUATION

The absence of periodic, dedicated studies measuring public attitudes to science leaves the system without sufficient baseline data

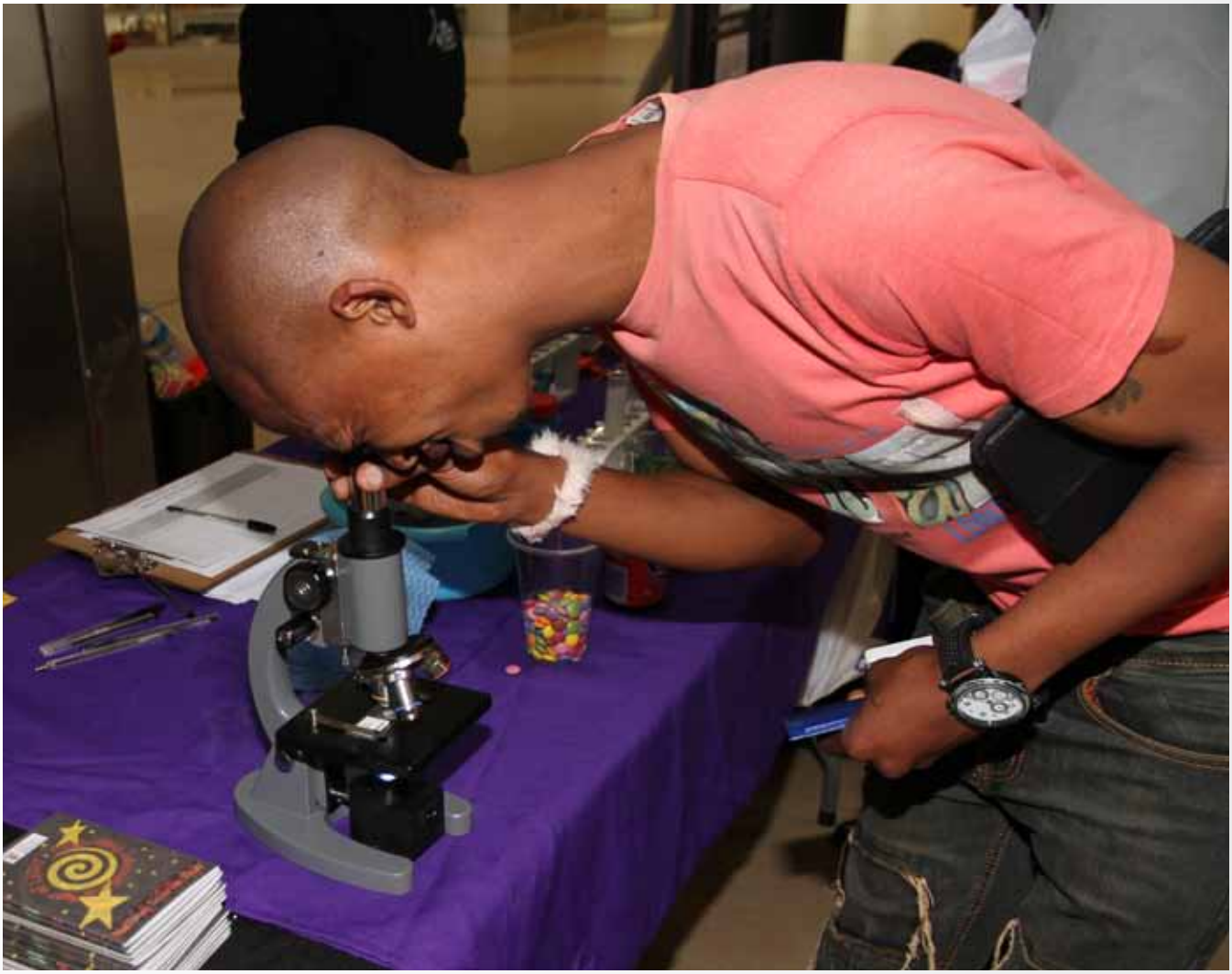
8. MONITORING AND EVALUATION

The absence of periodic, dedicated studies measuring public attitudes to science leaves the system without sufficient baseline data to establish if science engagement programmes are making any difference in society. The HSRC's South African Social Attitudes Survey, which has been the only instrument to measure public attitudes to science, does not provide an in-depth study, as its core aim is to monitor change and continuity in a variety of social, economic and political values over time. Nonetheless, the survey provides a limited opportunity to advance the science engagement cause, as each round of interviewing accommodates rotating modules on specific themes with the intention of providing detailed attitudinal evidence to inform policy and academic debate.

"If you do not measure results, you cannot tell success from failure" (National Treasury, 2007). The implementation of this Strategy will therefore be –

- continuously monitored to establish if planned work towards realising the strategic aims is on track, with the process including continuous data collection on interventions to implement the Strategy in order to prepare for periodic evaluation;
- periodically evaluated to determine the impact on society in terms of its four strategic aims and vision.

While the monitoring and evaluation approach to accompany the implementation of the Strategy will be geared to measure performance at system level, it will allow for the evaluation of individual interventions as and when necessary. The input, output, outcome and impact indicators will be included in the Strategy implementation plan.



Strategic aims	Performance indicators			
	Input	Output	Outcome	Impact
To popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers	• Size of funding invested in relevant programmes • Number of science communicators participating in the programmes • Number of science promotion institutions participating in the programmes (e.g. science centres, higher education institutions, natural science museums and science councils)	• Number of existing science centres upgraded and newly established science centres • Number of science awareness programmes • Number of participants in science awareness programmes	• Increased uptake of Mathematics, Science and Technology (MST) school subjects by learners • Increased student enrolment for higher education science studies • Improved public confidence, interest in, and attitude towards science • Teaching and learning of MST subjects enhanced	• Improved public perception about the critical role of science and technology in ensuring national prosperity and sustainable development • Improved science and technology literacy among the citizens of South Africa • SET human capital development endeavours enhanced
To develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society	• Number of science institutions providing a platform for public engagement with science	• Number of programmes and/ or opportunities for citizens' engagement with science • Number of participants (individuals and organisations) in science engagement programmes	• Increased participation by people in science dialogue programmes • Increased participation by people in public hearings on science and technology issues	• Development of a society that critically scrutinises key scientific issues enhanced • Reduced possibility of discourse on science and technology issues being the preserve of the scientific community and business institutions • Attainment of civic scientific literacy – citizens able to formulate their own opinions on opposing views of scientific issues
To promote science communication that will enhance science engagement in South Africa	• Size of funding invested in relevant programmes • Number of local and international partnerships established	• National qualification framework for science communication developed • Established ongoing science communication capacity-building programmes benefitting learners, local science communicators, journalists, scientists and researchers • Number of learners, science	• Access to formal and accredited science communication capacity-building programmes by local science communicators, journalists, scientists and researchers • Increased media coverage of science and technology issues • Increased availability of qualified science communicators and	• Improved public perception about the critical role of science and technology in ensuring national prosperity and sustainable development • Improved science and technology literacy among the citizens of South Africa

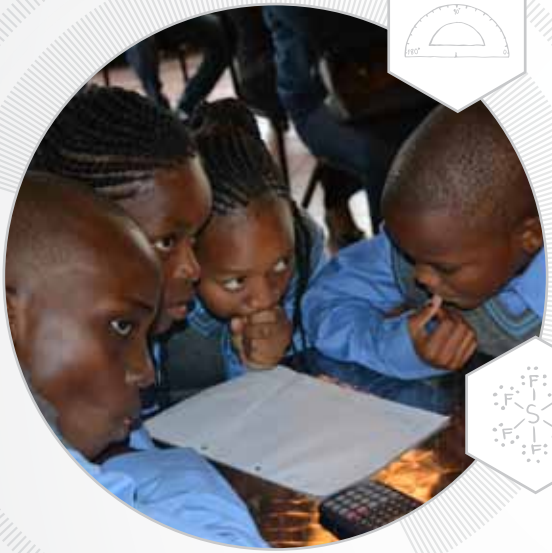
Strategic aims	Performance indicators			
	Input	Output	Outcome	Impact
		communicators, journalists, scientists and researchers • Number of learners, science communicators, scientists, researchers and journalists who benefit from science communication capacity-building programmes	trained scientists, researchers and journalists • Improved relations between media and the scientific community • Established environment for developing and nurturing the culture of communicating science to the public by aspiring scientists and researchers	• SET human capital development endeavours enhanced
To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing their public standing	• Size of funding invested in relevant programmes • Number of science promotion institutions participating in the programmes (i.e. science centres, higher education institutions, natural science museums and science councils) • Number of local and international partnerships established	• Targeted science awareness and engagement programmes established on each priority area of the DST • Local scientific inventions and discoveries mainstreamed in awareness and engagement programmes • Science tourism concept institutionalised	• Increased public confidence in and respect for science • Increased public interest in and familiarity with the local scientific and technological environment • Enhanced international standing of South Africa on science and technology issues	• South Africa's scientific competitive advantage enhanced • Improved public perception of the critical role of science and technology in ensuring national prosperity and sustainable development • Improved science and technology literacy among the citizens of South Africa

REFERENCES

1. Australian Government Department of Industry, Innovation and Science. (2009). *Inspiring Australia: A national strategy for engagement with the sciences.*
2. Burns, T., O'Connor, D. and Stocklmayer, S. (2003). Science Communication: A Contemporary Definition. *Public Understanding of Science*, 12, pp. 183-202.
3. Claassen, G. (2011). Science and the media in South Africa: Reflecting a "dirty mirror". *Communication*, 37(3), pp. 351-366.
4. Department of Arts, Culture, Science and Technology. (1996). *White Paper on Science and Technology: Preparing for the 21st Century.*
5. Department of Science and Technology. (2002). *National Research and Development Strategy.*
6. Department of Science and Technology. (2008). *Innovation Towards a Knowledge-based Economy: Ten-Year Plan for South Africa.*
7. Department of Science and Technology. (2006). *National Roll-out Plan for a Network of Science Centres in South Africa.* Unpublished.
8. Department of Science and Technology. (2012). *Framework for the Promotion of Excellence in a National Network of Science Centres.*
9. Department of Science and Technology. (2012). *Final Report of the Ministerial Review Committee on the Science, Technology and Innovation Landscape in South Africa.*
10. Department of Science and Technology. (2014). *Framework of DST Activities in Support of Basic Education.* Unpublished.
11. Department of Science and Technology. (2015). *Draft Human Capital Development Strategy for Research, Innovation and Scholarship.*
12. Fien, J. (2010). *Indigenous Knowledge and Sustainability.* [online] Teaching and Learning for a Sustainable Future. Available at: http://www.unesco.org/education/tlsf/mods/theme_c/mod11.html
13. Human Sciences Research Council. (2013). *South African Social Attitudes Survey.*
14. IACACT, (2012). *Corporate Communication.* [online] Available at: http://www.iacact.com/?q=corpcomm
15. Makerere University. (2011). *Media Coverage of Science and Technology in Africa.*
16. McCallie, E., Bell, L., Lohwater, T., Falk, J., Lehr, J., Lewenstein, B., Needham, C. and Wiehe, B. (2009). *Many Experts, Many Audiences: Public Engagement with Science and Informal Science Education.* A CAISE Inquiry Group Report. Washington, D.C.: Center for Advancement of Informal Science Education.
17. Metcalfe, J., Alford, K. and Shore, J. (2012). *National audit of Australian science engagement activities. Project final report.*
18. National Treasury. (2007). *Framework for Managing Programme Performance Information.*
19. Niculae, M., Niculae, C. and Barna, E. (2011). Non-formal Science Education Promoting Learning through Experiment. *Romanian Reports in Physics,* 63(3), pp. 890-897.
20. Organization of American States Office of Education, Science and Technology. (2004). *Workshop on the Popularization of Science and Technology.* Brazil.
21. The Presidency Republic of South Africa. (2012). *National Development Plan 2030. Our future – make it work.*
22. Public Agenda. (2008). *Public Engagement: A Primer from Public Agenda.* Center for Advances in Public Engagement.
23. Reddy, V., Gastrow, M., Juan, A. and Roberts, B. (2013). Public attitudes to science in South Africa. *South African Journal of Science,* 109(1/2).
24. Science diplomacy. (2017). *Wikipedia, The Free Encyclopaedia.* Available at: https://en.wikipedia.org/w/index.php?title=Science_diplomacy&oldid=787369472
25. Stekolschik, G., Draghi, C., Adaszko, D. and Gallardo, S. (2010). Does the public communication of science influence scientific vocation? Results of a national survey. *Public Understanding of Science,* 19(5), pp. 625-637.

ABBREVIATIONS

ASSAf	Academy of Science of South Africa
CAISE	Center for the Advancement of Informal Science Education
DST	Department of Science and Technology
HSRC	Human Sciences Research Council
HSS	humanities and social sciences
MST	Mathematics, Science and Technology
NACI	National Advisory Council for Innovation
NDP	National Development Plan
NRDS	National Research and Development Strategy
NRF	National Research Foundation
SAASTA	South African Agency for Science and Technology Advancement
SARChI	South African Research Chairs Initiative
SET	Science, Engineering and Technology
STEM	Science, Technology, Engineering and Mathematics
TYIP	Ten-Year Innovation Plan



Department of Science and Technology

Building 53, Meiring Naudé Road, Scientiae Campus
(CSIR) South Gate Entrance
Brummeria, Pretoria 0001, South Africa
Tel : +27 (12) 843 6300
Fax: +27 (12) 349 1030
www.dst.gov.za