science
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Science Engagement Framework

Science and society engaging to enrich and improve our lives

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CONTENT

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 established numerous programmes to improve public understanding of science, scientific literacy and science engagement. The latter is an overarching term that includes the former two concepts, among others.

This document provides an overarching strategic framework to advance science engagement in South Africa. It is intended to improve coordination of and encourage science promotion, communication and engagement activities across the Department, its entities, universities, other Government departments and science councils, museums, and partners outside the public sector.

This Science Engagement Framework is inclusive and integrative 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'. As such, the Framework is committed to integrating the natural sciences, engineering, and social sciences and humanities, aiming to foster better, more valuable science engagement.

The strategic framework has been strongly informed by the values of contemporary, post-apartheid South Africa, most specifically the imperative of empowering its citizens to engage processes and issues that impact on their lives. At the core of the framework are four strategic aims, under which are outlined several proposed or existing interventions or initiatives. To a great extent, the Department's existing science engagement activities already overlap with many of those indicated in this document, but this strategic framework 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, in this thrust initiatives will fall under three broad categories, which are science for the public, science for education support, and the promotion of careers in science. Crucially important in science popularisation is the strengthening of science centres, and capacity building for science promotion personnel.

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.* Around disputed developments and issues with a strong science and technology component, the Department seeks to provide support to timely, broad dialogues through managed engagements across key stakeholders. The South African Agency for Science and Technology Advancement and the Academy of Science of South Africa constitute 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. But 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, incentivising scientists and researchers to communicate their work, and targeting higher education institutions and school-level 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 its public standing.* Attention will be focused on profiling among others (a) scientific areas in which the country has a geographic and 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, the concept of science tourism will be explored.

Furthermore, the framework recognises that the realisation of the four strategic aims depends on key enablers which are: (a) an effective coordination function to promote and ensure 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 NRF Act to formally incorporate science promotion and engagement as a mandate of the South African Agency for Science and Technology Advancement (SAASTA) within

the National Research Foundation; (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 ineffective and inefficient use of resources, the science engagement framework maps out the respective roles and responsibilities of the various stakeholders whose contribution is crucial to the implementation of this framework. The framework also lists performance indicators and measures that will be used to monitor progress.

Lastly, an implementation plan will be developed and reviewed on an annual basis in light of financial and other resource considerations as well as changes in the external strategic environment for science engagement. This 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, and will be finalised in consultation with SAASTA, who will be the Department's main agent in rolling out this science engagement framework.

1 INTRODUCTION

1.1 The science–society interface

Human, social and economic development has been inextricably linked to the development of science and technology, for better and for worse. Across all 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 replication and expansion of the national system because it can enhance the appeal of science as a career and as a social knowledge system. But 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 such as "Science, Technology and Society", and numerous research programmes and institutions dedicated to deepening our understanding of this interplay. A lexicon of related terms and concepts has emerged, such as science communication, science engagement, science diplomacy, and public understanding of science and technology, and many governments have established a wide range of programmes and initiatives to stimulate science literacy and public engagement with science and technology. Especially in the last 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 concept of a national system of innovation. Such systems are now widely regarded as the foundation of national development and global competitiveness, and enhanced understanding of their dynamics and, consequently, their improved management are becoming economic and political imperatives.

In South Africa, the Department of Science and Technology (DST) funds numerous flagship programmes aimed at enhancing scientific literacy and awareness, and through its agencies has implemented a variety of initiatives across a wide scope 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 Arts and Culture (around palaeosciences).

At an operational level, these various initiatives have been somewhat coordinated – especially across the DST entities – but a need now exists for the formulation of a strategic framework guiding the DST and its partners and stakeholders in their collective effort from a strategic perspective. The need for this framework has become especially acute in light of the increasingly strong emphasis placed on science and technology in national development at the highest political levels in South Africa, and across all social actors. This document serves that purpose.

1.2 Policy context

The imperative for South Africa's national system of innovation (NSI) 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 enshrined in several high-level policy documents over the last decade. Most recently, for example, the National Development Plan (2012) highlights 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" (page 70). The importance of scientific knowledge and literacy are 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" (page 71). While the NDP focuses extensively on the application of science and technology in national development, it also make reference to the corollary to 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" (page 72).

Within the DST, the National Research and Development Strategy (NRDS, 2002) 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 (our) large public science programmes", and to "massify a number of public understanding and engagement activities ... (and) 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 quotes highlight the implicit assumption in the NRDS that systematic and focused provision of adequate information about science and technology would serve to turn more people (especially learners) to 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 within the South African Association for Science and Technology Advancement (SAASTA), which operates as a branch of the National Research Foundation.

By the time the Department formulated its Ten Year Innovation Plan (TYIP, 2007), 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 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" in the specific purpose of the Human and Social Dynamics Grand Challenge – to develop a scientific understanding of the nature of social change in order to better anticipate social change in order to promote, steer, mitigate against or adapt to it – and not in a more general purpose of developing a scientifically literate society. Nevertheless, the White Paper on Science and Technology (1996) acknowledges that building a strong NSI 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 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 Science and Technology (2012) commented on two aspects of public promotion and awareness of science. First, it focused on the utility value to the national system of innovation of society's "appetite for 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 for its activities in the field of basic education, and a strategy for Human Capital Development for Research, Innovation and Scholarship; particularly the former is 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 framework standardises the application of these terms, settling on the notion of "science engagement" as most apt in describing the DST's strategic purpose in this domain; but until then, these terms will still be used somewhat interchangeably in reference to existing DST initiatives. It is in this context that scope of this framework 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 (YEAST) under the then Department of Arts, Culture, Science and Technology (DACST) has evolved drastically over the past 15 years. Notable developments have occurred to date in this regard.

The Department has established a reliable network of institutions with which it collaborates in implementing its science engagement activities. These include the higher education sector, science councils, state-owned enterprises, the corporate and non-governmental sectors, science centres, and Government departments at various levels, 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 on the priority areas of the Department, such as astronomy or palaeosciences.

Partner institutions act both as delivery agents for the DST's science awareness activities and they implement their own science engagement activities using own financial resources. However, the majority of DST science awareness programmes are implemented through the South African Agency for Science and Technology Advancement (SAASTA), which is a business unit of the National Research Foundation (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 communications functions which promote public appreciation of the DST entities through the dissemination of information about their scientific activities and contributions. The DST Communications division coordinates these activities.

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

Internationalisation of science engagement has seen South Africa:

- participating in discussions on improving the dialogue with society on scientific issues (such as nanotechnology and biotechnology) under the auspices of the Organisation for Economic Cooperation and Development (OECD) Global Science Forum; and
- hosting international conferences such as the 7th International Network on Public Communication of Science and Technology (PCST) in 2002, the International Workshop on Changing roles of Science Centres under the auspices of the Non-Aligned Movement Science and Technology Centre (NAM S&T Centre) in 2008, and the 6th Science Centre World Congress in 2011.

The DST-led science engagement programmes are gradually becoming another instrument that enhances the country's international relations. Science engagement activities featured in the celebrations of the Germany–South Africa Year of Science (2012/13). Furthermore, over the past five years, South Africa participated in at least one science engagement initiative per annum hosted by other African countries; Mozambique, Lesotho, Uganda and Namibia are some of the countries that are collaborating with South Africa in science engagement programmes.

Lastly, under the DST-NRF South African Research Chairs Initiative, a chair for science communication has been established, as part of the Department's unfolding science engagement programme.

1.4 Scientific (disciplinary) context

Often, in considering the science:society interface a focus on the role of the natural and physical sciences eclipses that of the humanities and social sciences. However, the humanities and social sciences (HSS) have made very important theoretical, historical and philosophical contributions to our understanding of this interface, often being at the forefront of debates related to this broad topic. In part, the greater distance of HSS researchers to 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 Framework recognises specific contributions HSS researchers can make across the full spectrum of science communication and public engagement practice, from dissemination of knowledge, through 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 HSS research.

In fact, in the context of this strategic framework, the humanities and social science 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 policy makers;
- Engaging with the public to strengthen the case for increased funding for the HSS;
- Stimulate greater public interest and enthusiasm for the HSS;
- Contributing to greater public understanding of science and the importance of evidence, and understanding uncertainty; and
- Engaged scholarship which produces co-created, self-reflective knowledge and new formations of community in the process.

2 PURPOSE

This document is intended to provide an overarching framework 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, while engaging critically in their development. As such, the framework 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 therefore enjoins the private and public sectors, through the work of different Government departments, their agencies and institutions such as universities, science councils, museums that play a significant role in science promotion and engagement to work together toward realising the aims of this framework.

3 CONCEPTUAL DEFINITION

3.1 Science(s)

For the purposes of this discussion, the science engagement framework 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 not only awareness and discussion of scientific or technical aspects of issues, but also of the societal and attitudinal aspects as well.

The role of the humanities and social sciences 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 'Grand Challenges' facing society today, and can influence public debate which in turn can impact on policy development. The HSS fields contributes knowledge and understanding that inform many of the 'Big Questions' facing society today. Research in these disciplines plays an essential role in enabling society to anticipate, and respond to, unexpected challenges and change.

3.2 Field definition

Every day, scientific and technological progress contributes innovations essential to our quality of life and international competitiveness. Our challenges are not only about understanding the current multiple revolutions in science and technology, but also about how they affect the future of humanity and of the Earth. In this framework, the term science encompasses 'global science' as well as localised knowledge systems and indigenous knowledge. Indigenous knowledge systems refers to the knowledge that grows within a social group or community, incorporating learning from own experience over generations, but also knowledge gained from other sources and fully internalized within local ways of thinking and doing (Mascarenhas, 2004: 3). As such, public engagement on science both brings global science to the public to raise awareness and understanding of science, and mainstreams the local and indigenous knowledge. Hence, the increasing demand for greater communication and public engagement with science.

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, public understanding of science, scientific literacy and scientific culture are often used interchangeably. Although considerable commonality does exist between them, with broadly compatible aims, 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:

- **Public awareness** of science aims to stimulate awareness of and positive attitudes (or opinions) towards science (Burns, O'Connor and Stocklmayer, 2003).
- **Public understanding** of science focuses on understanding science, its content, processes and 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 (affective) 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 activities undertaken by an organisation to communicate both internally with its employees and externally with existing and prospective customers and the wider public. The term implies an emphasis on promoting a sense of corporate identity and presenting a consistent and coherent corporate message. The Corporate Communication team will help an organisation/department to build its message, combining its vision, mission and values and will support the organisation by communicating its message, activities and practices to all of its stakeholders (Welcome Trust, 2006).
- **Science diplomacy** is the use of scientific collaborations among nations to address common problems and to build constructive international partnerships (Wikipedia).
- **Public engagement** with science, using the dialogue approach, refers to activities, events, or interactions characterized by mutual learning — 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 (CAISE, 2009). The philosophy espoused is for a holistic and normative epistemology oriented towards the development and happiness of the individual and society, while affirming the validity of all knowledge systems (local and global).

Furthermore, according to the Organisation for Economic Co-operation and Development (OECD) public engagement framework around science, public engagement is defined as described in Table 1 below.

Description	Process
DELIBERATIVE	Emphasises mutual learning and dialogue.
INCLUSIVE	Involves a wide range of citizens and groups whose views would not otherwise have a direct bearing on policy deliberation.
SUBSTANTIVE	Addresses topics that deal with issues related to science and technical questions and is appropriate to exchange.
CONSEQUENTIAL	Makes a material difference to the governance of the various scientific disciplines under focus.

Table 1: Public Engagement of Science – descriptors and associated processes

From a citizen-centred approach, public engagement is seen to allow people to join the public dialogue surrounding 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, more often attempted in applied research areas like nanotechnology.

For the purposes of this framework, the use of the overarching term science engagement is inclusive of all aspects of the public engagement with science, science communication, science literacy as well as 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 practice currently found internationally.

Lastly but very importantly, 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 would be any more unilateral, top-down approach informed by the deficit ideology.

4 PROBLEM STATEMENT

As mentioned before, despite the absence of a coordinating framework the DST and its partners have initiated numerous science engagement activities over the last decade or so. This section outlines six key areas or interventions in which a more systematic and coordinated approach to those activities would greatly enhance the combined impact of the DST science engagement portfolio.

a) Regularisation and coordination of science engagement

Whereas significant developments have taken place with regard to the DST-led science engagement programmes, there are several shortcomings in the system, which this framework seeks to address. 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 (funding and human); in terms of the current National Research Foundation Act (Act No 23 of 1998), science engagement is not formally part of the organisation's mandate. Secondly, a more systematic approach to coordination of science engagement activities across the span of DST entities is required, and this strategic framework is intended to serve that purpose.

Thirdly, the formulation of this strategic framework will systematise a *programme* of science engagement activities, that ought over time to allow an increase in resources allocated to science activities. Presently (in 2014/15), the entire portfolio is valued at about R70m per annum, of which almost one fifth is dedicated to just one event – the 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 under-funded at present.

b) 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 strategic framework. This has led to several imbalances in the portfolio of activities and their content. For example, mostly activities have lent toward science awareness and public understanding of science type initiatives, while the imperative of encouraging a more active and critically reflective engagement with science has been underserviced. Similarly, the 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 generate a systemic impact at that level. A strategic framework is required to improve the balance in the portfolio of activities and sharpen its focus.

c) Monitoring and evaluation

Establishing the deep, lasting impact of the DST's science engagement programmes is critical, but very difficult in the absence of a coordinated effort in this regard. Currently there is a lack of effective monitoring and evaluation instruments, as well as meaningful indicators to measure outcomes and impact (besides attendance figures). On the same note, evaluations mainly take place on activity basis, like the ten-year review of the National Science Week in 2011. This framework will encourage a more coordinated and systematic approach to monitoring and evaluation.

d) Popularisation of science, engineering and technology

The National Research and Development Strategy (2002) recommended support for interventions to increase participation and performance of disadvantaged learners in mathematics and science, as well as attracting matriculants to degree and post-graduate courses in science, engineering and technology (SET). For example, over the period 2008 to 2013, 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 university level, total enrolment in science and technology majors (including health sciences) changed only marginally from 29% in 2005 to 34% in 2012. Both these examples bode ill for South Africa's ambitions in 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. But on its own it clearly does not constitute a sufficient condition for 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, provision of exciting and modern laboratories and equipment in all schools, and provision of broadband internet connectivity to all schools. This strategic science engagement framework seeks to maximise the DST contributions to popularising science and technology, but within the limits of the DST mandate and resources.

e) Developing a critical engagement between the public and science

Existing science engagement programmes are biased towards the youth. More than 70% of the participants in the National Science Week, which is the DST's science engagement flagship activity, are school-going learners in the further education and training band. School-going 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 international situation as found in a recent audit of Australian science engagement activities (Metcalfe et.al 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 so as to safeguard the people of South Africa and their environment is crucial at all times. Controversial debates such as those around Karoo hydraulic fracturing, provision of nuclear energy, genetically modified foods, stem cell technologies, and nanotechnology should be accessible to the entire 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.

Lastly, the above imperative – empowering the general public to engage critically with science and technology – has a corollary in the need to empower "science" as a social phenomenon to engage publicly. 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.

f) Science communication and profiling of SA science

While the DST and its entities have been fairly successful in profiling specific successes of South African science, technology and innovation – such as in HIV/AIDS, astronomy, and palaeosciences – there is general agreement more can be achieved in terms of profiling science, generally, on a more consistent basis. For the purpose of this strategic framework there are three important aspects to this shortcoming. 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 public media: very few media houses have in-house science journalists and set, 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.

Internationally there is no coordinated effort to promote South Africa's scientific profile beyond isolated exhibitions such as the 2010 Shanghai Exposition in China in which South Africa participated. Consistent participation by South Africans in the "European – South African Science and Technology Advancement Programme" (ESTAP) promotes local research to European researchers, and while this creates and harnesses research collaborations, it does not constitute science communication in the broader sense of this framework: a holistic plan to profile South African science internationally is still required.

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 of and engagement with science to diverse constituents at all levels of society, using the most appropriate and innovative means, whilst being guided by the basic principles listed in this framework.

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. Towards that 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 fully exercise and protect their rights. Moreover, appropriate targeted communication tools will be used to reach the different types of audiences.
- South Africa is a multicultural society, characterised by eleven languages, and several ethnic and religious groups. Implementation of this framework 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 framework by interfacing science and technology with indigenous knowledge systems.
- The framework will use science engagement to strengthen South Africa's international collaborations.
- The popularisation of science must be guided by the core principles of ethics and social responsibility.
- Interdisciplinarity is essential to the impact of science engagement; no single scientific discipline on its own has sufficient scope to understanding and shaping the complexity of the science:society interface.

5.4 Strategic aims

In response to the above challenges and the overarching strategic purpose of this framework, its strategic 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 its contribution to national development and global science, thereby enhancing its public standing.

In the following section we describe the above strategic aims in some detail, and then indicate examples of interventions the Department will (continue to) support, initiate or explore in pursuit of that 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 practiced, and the results of scientific research and technological development (Workshop Report Brazil, 2004).

Generally, in this thrust initiatives will fall under three broad categories, which are not mutually exclusive, but helpful in achieving focus and improving coordination:

a) Science for the public

The 2013 South African Social Attitudes Survey, which incorporated questions to determine the public attitude to science in South Africa, showed some stability in – somewhat contradictory – attitudes to science for the 1999 to 2013 period. Thus, the majority of South Africans believe 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. At the same time, though, they expressed concern that science is making their way of life change too fast, and that we depend too much 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 public attitude to science, the fact that science and technology affects everyone's life dictates that the public be provided with timely, accessible and accurate information to promote transparency in line with the country's constitution. Science popularisation promoted by this framework will seek to create an atmosphere that enables the public to engage with the positive and the negative consequences of science and technology.

b) Science education support

Some science and mathematics Olympiads and competitions, such as the local Eskom Expo for Young Scientists provide school-going aspirant scientists with an opportunity to communicate science as they have to explain their science projects to the people. Learners' involvement in this way enables them to refine and display their own understanding of the knowledge and techniques acquired from 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 achieve better marks in Mathematics and Physical Science than those who do not participate.

c) Careers in science

Provision of information about careers in science is crucial in increasing the number of students who follow science-based careers. Due to historical exclusion of South Africa's majority population from most science-based career paths, an understanding of such careers is still not deeply embedded in the majority of South African families, who are thus badly placed to guide their children in this regard. And this constraint may apply significantly also to science teachers, who themselves often have not developed the requisite understanding necessary to provide career advice to their learners. Considerable work has been undertaken to close this deficit, but it is intended that every learner or student should be exposed to career information and opportunities for discussions with scientists, engineers and technologists (role modelling).

Proposed interventions:

- The DST will explore 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.
- The national network of science centres needs strengthening by (a) upgrading existing science centres, and (b) establishing new science centres in strategic locations.
- Technical support for organisers of science engagement activities (including science centres and science festivals) needs to be improved to increase the number and diversity of new science engagement programmes in the country.
- Science and mathematics Olympiads must be encouraged as a means of stimulating learners' interest and participation in science.
- Mass participation activities such as the National Science Week and festivals must continue to receive support, while aligning their implementation strategies with the aims of this framework.
- Implementing the existing framework for science engagement programmes in support of basic education.
- The production of the SET Career booklet must continue.
- Collaborating with ASSAf in piloting the Inquiry-Based Science Education in science centres. (The approach enables learners to develop understanding about the scientific aspects of the world around 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 socially constructed – they don't just emerge in a social vacuum, but are created and shaped 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 subject to influence 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. And 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: what sort of science is undertaken and to what end; 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, there is recognition of the fact 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 in areas of personal and corporate privacy, international security, and politics to name but a few. Social media has opened up public spaces for community activism, presenting a communication platform for direct citizen debate, thus increasing possibilities of achieving a robust public sphere. Despite advances, tensions remain at various levels and may include, amongst others, the nature of relationships between civil society and the state, considerations of private benefit or public good, perceptions of consultation or subtle manipulation, questions of economic viability or exploitation.

Modern scientific and technological issues thus require an enlargement of the available democratic practices with the public accepted as a key stakeholder with her/his own knowledge interests. 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 large 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 critical also to the development of their self-esteem and belonging, and hence to the project of nation-building.

Actively fostering the science and society dialogue within a developing knowledge economy will be strengthened by:

- A lively and active civil society that widely recognises the need for public participation in science and technology (associations, co-operatives, non-governmental organisations, etc.).
- 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 (consensus conference, scenario workshops, etc).
- An active attempt by the academic sector to bridge the gap between universities and the public (community engagement).
- Increased access to scientific knowledge for the public at local and municipal levels.
- A stronger focus on applicability of science (solving practical problems) and co-operation with other societal actors (e.g., formal dialogue across sectoral divides such between the public and the private sector, labour, etc.).

South African society has made significant strides in many of these areas above. A specifically powerful example can be found in the history and activities of the Treatment Action Campaign (TRAC), a non-governmental civic organisation focused on HIV/AIDS issues. In tandem with government, TRAC successfully encouraged public participation in the debate around anti-retroviral 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 retroviral treatment slows its 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 to pursue both developments 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 a knowledge infrastructure for the documentation and management of IKS, and its carefully negotiated introduction to indigenous communities – accompanied by relevant training – is proving to be instrumental in empowering those

communities to manage their IP and defend it against external threats. And 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 emotional character of the public, and procuring legitimate roles for non-governmental organisation roles in the science and technology debate.

The proposed initiatives in this thrust may be organised under broad rubrics of:

Citizen-centred dialogues

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

Public engagement in research

This aspect includes considerations of research agenda setting, community engagement and dissemination of research results in consultation with communities. Universities and the South African Academy of Science will be closest to this aspect of critical dialogue.

Media as a form of dialogue between science and society

This looks beyond 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 elevating the knowledge of the public on many matters which would have been otherwise ignored. This focus stresses a broader inclusion of all media platforms for engagement with issues of science. Examples of current initiatives include: the NRF "Science for Society" lecture series (with phone-in by public), media round tables (scientists and journalists), the Wits science radio, etc.

Proposed interventions:

- Researchers and research institutions will be encouraged to (further) systematise science outreach and/or science engagement activities in alignment with the level of research

resources allocated to them. For example, all SARChI chairs and COEs will be encouraged to present their work to non-scientific audiences on a regular basis.

- The feasibility will be explored of incorporating science outreach as a formal component of continuing professional development (CPD) obligations for professional scientists registered with the South African Council for Natural Scientific Professions.
- With the NRF the feasibility will be explored of integrating wider societal input in the formulation of research questions or priorities at both programme and project level.
- Sector-specific science outreach and /or engagement activities will be established, such as the Science, Technology and Innovation Summit that seeks specifically to facilitated cooperation between public and industry-based research institutions.
- Science communication strategies and interventions will be informed by this strategic priority, meaning that their content will reflect the socio-economic complexities and trade-offs that accompany different technologies.
- DST entities will be encouraged 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 can and must be broadened to include also non-specialist members of civil society.
- New and existing DST programmes will be requested to consider establishing science engagement components as an integral part of the programme and its budget, as has been done already with several programmes, including those for palaeosciences, indigenous knowledge systems, astronomy, marine sciences, and so on.
- The DST's support for science engagement activities will continue and be increased as resources permit; this applies to interventions such as the National Science Week and the National Science Festival.

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 by due consideration and respect for the target community, and 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, Draghi, Adaszko and Gallardo, 2010). The need for greater scientific engagement and an ability to critically assess the credibility of scientific information remains a 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 (UNESCO, 2011).

The public awareness of scientific issues and discoveries, and the way scientifically illiterate members of the public generally interpret and utilize 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 environment, and health and medical news (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 by UNESCO (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” generically is not considered newsworthy, apart from specific

important or spectacular breakthroughs, coupled to a dearth of science communication and journalism skills among both scientists and their institutions, and the media.

Proposed interventions:

- Promoting online interactions (such as face book 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 Palaeontological Scientific Trust annual lectures.
- Improve the usage 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 STEMI 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.
- Create 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 only one South African newspaper, magazine, broadcast station orInternet news site has a structured and organised science desk managed by a designated science editor with a team of trained science journalists. 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. Conversely, apart from very marginal instances, no training in science communication is required of or provided to postgraduate students and/or researchers.

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

The local landscape on science communication capacity building is characterised by infrequent workshops (also not accredited), usually organised by some higher education institutions or the local journalist community of practice with ad hoc support from the Department. In this context, collaboration with foreign academic institutions can provide some support. In the past five years, for example, a group of science communicators or illustrators from the local science centre community got an opportunity to enhance their skills through an accredited training offered by the Australian National University. On the other hand, the recent decision by the DST to establish a research chair is a step in the right direction as it creates the necessary platform for science communication research.

Interventions:

- Establishing accredited programmes for up-skilling practising journalists and illustrators in museums and science centres, and communication officers of science-based organisations, especially public research councils.
- Exploring the feasibility of and possible content of training of scientists and researchers in science communication skills.
- Creation of research capacity in science communication. Explore existing bilateral agreement (signed at Government and departmental levels) as a basis of 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.
- Development of framework for regular measuring of science awareness and attitude levels across society, in alignment with international best practice and standards, such as the Euro barometer and NSF Indicators.

Strategic Aim 4:

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

South Africa's science and innovation are critically dependent on two key partnerships: with the private sector and 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 relationship with all these stakeholders and partners is critically dependant on the prevailing image of South African science (and technology and innovation) and its institutions, and of the Department!

Though it may not be widely appreciated, South African science and innovation are comparatively productive and efficient, and have produced world-class knowledge and innovation – and continue to do so. It is important that these successes be effectively communicated and profiled to demonstrate the advancement of the country's science system and its contributions to national development. There exist fragmented efforts by some stakeholders and partners in the national system of innovation to raise public awareness of these South African inventions through, for example, websites that publicise such inventions and discoveries. The local science centre community has added its weight to the campaign of making the local inventions and discoveries known by publishing its first book ("The Great South African Inventions", 2010). Furthermore, work is underway within the science centre community to build the first travel exhibition on South African inventions (envisaged to be about 300 square metres in size).

Through its National Research and Development Strategy (2002) and the Ten Year Innovation Plan (2007), the Department has prioritised a range of thematic areas such palaeosciences, astronomy, marine biology, nanotechnology, 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 plans 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 geo-political importance attached to South Africa, and the fact that its science by most indicators (currently still) leads the continent. But in large part, this profile and standing is also earned by the quality and global impact of South African science, whose scientometric impact is considerably higher than the global average in a number of thematic areas. In addition, especially since the award of the SKA project to South Africa, the country's research infrastructure is increasingly attracting global attention, as is the fact of our geographic advantage for research in astronomy, marine and Antarctic research, palaeosciences, and earth system sciences. Together, these strategic advantages present themselves as a very powerful platform against which the country and the Department can leverage considerable edge in the public relations and science communications sphere – and which, arguably, are not being sufficiently exploited.

Already, the Department doubled its budget for the DST Communications division in 2012/13, but further growth in investment will be absolutely necessary to fully exploit the above advantages; and tight coordination of marketing and communication efforts and campaigns across the DST entities is a sine qua non. Moreover, the Communications division has also produced a public participation strategy (and implementation plan) and a communications strategy, in response to requirements from the Government Communications and Information Services department. These strategies should be considered complementary to this Science Engagement Framework, and they considerably strengthen DST communications 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 the 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 needs to communicate the impact of science and technology (a) across fields in which it has little or no footprint (like medicine or agriculture), and (b) where the field aligns with its mandate, the Department's ability to generate macro-level impact through its programmes is limited by the limited scale of its operations.

The above context informs the set of interventions outlined below.

Proposed interventions:

- The role of the DST Communications section in coordinating marketing and communications activities across all DST entities will be strengthened and further systematised and formalised.
- Inter-departmental science communication and marketing campaigns and structures around science councils and entities located in other government departments will be established in conjunction with those departments, and under the leadership of the DST Communications section.
- The priority area-based awareness campaigns that have been started by the DST will be sustained and expanded. The Department already leads awareness and engagement programmes in palaeosciences and astronomy, for instance.
- The establishment of a science tourism campaign will be investigated. This could be run as a standalone 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 some 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.
- Current efforts by the local science centre community involving the publicising of local inventions through purposefully made travel exhibitions and dedicated publications will be enhanced.
- Science centres will be strengthened as part of an overall communication campaign to communicate on science and DST successes and achievements, through capacity development support and coordinated integration into DST-led marketing and communications efforts.
- Periodic national science, technology and innovation events will be continued, featuring Government entities, industry, the higher education sector, and selected projects of school-level aspirant innovators.
- South Africa will be profiled 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.
- Multi-lateral platforms will be widely used to profile South African science and scientists.

- United Nations observances that have science relevance to science engagement programmes will be implemented as relevant.
- Periodic bilateral science cooperation celebrations, such as the Germany – South Africa Year of Science, should be expanded.

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 development of relevant monitoring and evaluation mechanisms and performance indicators. Success in pursuing the four strategic goals of this science engagement framework critically 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) and knowledge disseminators and communicators (such as journalists, science centre personnel, publicists, museologists, teachers, and audio-visual aid producers, and sometimes also members of communities), as well as 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, up to 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 health awareness campaigns by the Department of Health whose impact on public health may be significant, but that are perhaps never 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, present 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 and sanitation, energy) and therefore easily contextualised and communicated.

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

At the departmental level, the DST has adopted a science engagement model in which its priority areas pursue science engagement programmes related to 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 Biotech Public Communication strategy. Such existing individual strategic plans will be brought into alignment with this overarching framework in the ensuing stages of the implementation of this framework.

The management of science engagement activities within the DST will also be coordinated around this strategic framework, and the implementation plan will provide further details in this respect. For example, although the Department's Science Promotion unit is assumed the custodian of science engagement in the Department, there are no internal coordinating systems in place. The shortcomings of this include failure to centrally account for the performance of the DST-wide science engagement programmes and confusion among external stakeholders.

Interventions:

- Government-wide coordination will be pursued by the Department using the usual instruments such as clusters (science engagement belonging to the social cluster which include the former human development cluster), bilateral agreements with the relevant departments, and other government structures.
- The Science Promotion directorate of the DST will assume the internal coordination role of all science engagement activities in the Department, excluding those conceived as corporate communications and marketing initiatives (on which coordination across the DST entities will be the responsibility of the DST Communications division).
- The role of coordinating science engagement within the science system will be played by SAASTA following the incorporation of its function into the NRF Act (No. 23 of 1998).

- Higher Education South Africa will be requested to coordinate Higher Education related work, and the Committee of Heads of Organisations for Research and Technology (COHORT) 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 international comparison of science, technology, engineering and mathematics (STEM) education by the Australian Council of Learned Academics (ACOLA) established that in almost all instances, 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 (2010) is provided by Questacon, a federally funded national science and technology centre located within the Department of Innovation, Industry, Science and Research (DISSR). In the USA, several institutional variations exist for promoting science engagement, with the Centre for Public Engagement with Science and Technology contained within the American Association for the Advancement of Science (AAAS), 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 cognate organisations, a delicate balance has to be struck: the central function needs to be vested with an organisation enjoying credibility in both the national science system and the broader public base, while not 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 conflict of interest – that science engagement will become a pretext for propaganda and non-critical, purely positivist dissemination of science information.

Currently and for several years, the National Research Foundation has played a major role in implementing a variety of science engagement activities, both of its own volition and on behalf of the Department; it has effected those activities through the South African Agency for Science and Technology Advancement (SAASTA). In conjunction with SAASTA and the NRF, the Department will formalise and systematise further 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 promoting and coordinating 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 NRF's and SAASTA's function 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 participation of the network of collaborative institutions in science engagement programmes.
- Design and implement programmes that enhance the strategic aims of the framework, 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 developing a systemic way of reporting on their involvement in or support of science engagement activities.

6.3 Funding

Prior to the 2002/3 financial year, the DST had a Science and Society directorate with a dedicated annual budget allocation. The adoption of the National Research and Development Strategy (2002) resulted in the replacement of this directorate with the Science and Youth directorate 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 strategic framework, the Science and Youth directorate was converted into a Science Promotion directorate, and a dedicated science engagement budget line was established in the Estimates of National Expenditure (ENE). In the 2013/14 financial year, the budget for this function was R67 million, growing to R70 million in 2014/15, and by an annual average increase of 5% over the 2014/15 Medium Term Expenditure Framework.

It is important to stress that these amounts are 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 goals of this framework.

Interventions:

- Efforts will be made on an ongoing basis to secure significant new funding for the development of the science centre infrastructure, and current funding levels will be sustained.
- Science engagement core funding will be increased to resource the SAASTA's coordinating role and its programmatic activities, including capacity building.
- In line with several international examples, DST-funded entities will be expected to commit a percentage of their total corporate budgets to the science engagement and corporate communication work of their entities. 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 framework's implementation plan.

- The NRF will be requested 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 which collects and manages science promotion and engagement data on an ongoing basis is essential to finally 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 which stores and retrieves the essential data on science promotion and engagement. SAASTA will be requested to facilitate the establishment of a suitable system in this regard.

7 INSTITUTIONAL AND SECTORAL ROLES

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

7.1 Department of Science and Technology

In its role as the department mandated by Government to deliver the country's science engagement programmes, the DST will:

- Provide strategic direction to science engagement programmes nationally, ensuring at all times that the implementation of this framework remains aligned to the overall strategic direction of the Department and Government priorities as outlined by the NDP and the MSTF from time to time, 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, set targets for and report on all science communication and engagement programmes and activities through their compliance reporting (Performance Plans, Annual Reports etc.).
- Coordinate corporate communications across all DST entities in alignment with this science engagement framework and the DST Communications strategy.
- Manage inter-departmental relations to leverage benefits for the implementation of this framework.

- Develop an implementation plan for the framework, 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 overseas development assistance for the implementation of this framework.
- Monitor and evaluate the implementation of this framework.

7.2 The South African Agency for Science and Technology Advancement

Informed by this science engagement framework, SAASTA will strategically coordinate its implementation across the national system by:

- Establishing and implementing an effective and efficient grant management system to support 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 strategic aims of the framework, including establishing necessary partnerships with relevant institutions.
- Establishing appropriate platforms and fora that promote multi-stakeholder engagement on science and technology issues.
- Ensuring alignment of its programmes with the government policies, in general, and DST priorities in particular.
- 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 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 last decade, with science engagement taking place in both formal and informal science settings and community organisations. Various institutions are highlighted for attention, although science engagement activities are not limited to the list below.

7.3.1 Government entities

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

- To ensure alignment of their science engagement activities with the aims and interventions of this framework.
- To provide SAASTA with reliable science engagement data related to the success indicators for this framework that transcend regular PFMA and Treasury reporting standards.
- DST entities will commit a determined proportion of their total budgets to science engagement activities (as mentioned above). The usage of the top-sliced budget will be detailed in this framework's implementation plan.

In addition to the above role 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 roundtables and community organisations. In particular, research findings must be accessible to policy makers 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.

The National Research Foundation's Research and Innovation Support and Advancement division will:

- Ensure that the RISA grant applicants to the NRF are awarded a "Science Engagement top-up", from specially earmarked funds, as part of their main grant.

7.3.2 Higher education institutions

Higher education institutions should:

- Encourage all researchers to present their research work to non-specialist communities. Use the university's resources (extensive infrastructure, researchers, funding) to advance science engagement aligned to the aims and interventions of this framework.
- Establish the necessary qualifications and short-courses which will create capacity development in science communication, specifically.
- Create incentives for researchers who lead science engagement initiatives related to their research projects.

7.3.3 Network of science centres

The network of science centres (including natural science museums, zoos, aquaria and botanical gardens) is a significant part of the science engagement landscape and will support the implementation of this framework by:

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

7.3.4 Industry, non-governmental organisations and professional bodies

The role of industry science promotion and 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 technologies that have changed or have the potential to change the world. Industry's involvement is crucial in implementing the interventions which address all the aims of this framework. This involvement is equally important for the industry partners, whose research and development activities are located in South Africa.

A number of non-governmental organisations are already participating significantly in implementing science promotion initiatives. Partnerships with these organisations will be encouraged to enhance the implementation of this framework while ensuring efficiencies in so doing. 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 in numerous professional bodies. These professional bodies (including the South African Council for the Natural Sciences Professions) will be encouraged to contribute to this framework by creating incentives for their members or registered scientists to communicate their work in an effective manner to the broader society.

7.3.5 Society

The vastness of South Africa and the diversity of sources of the information and knowledge to be exchanged to achieve the envisioned society will be enhanced by voluntary involvement of various sections of the 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 framework.

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 Attitude 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). In the same context, implementation of this framework will be:

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

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

Table 1: Performance indicators

STRATEGIC AIMS	PERFORMANCE INDICATORS			
	Input	**Output**	**Outcomes**	**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 take up 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 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 people's participation in science dialogue programmes • Increased people's participation in public hearings on science and technology issues	• Development of a society that critically scrutinises key scientific issues enhanced • The chance of discourse on science and technology issues being the preserve of the scientific community and business institutions minimised • Attainment of civic scientific literacy – citizens able to independently formulate own opinions on opposing views on 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 on-going science communication capacity building programmes benefitting learners, local science communicators, journalists, scientists and researchers • Number of learners, science communicators, scientists,	• 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 trained scientists, researchers	• 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

STRATEGIC AIMS	PERFORMANCE INDICATORS			
	Input	Output	Outcomes	Impact
		researchers and journalists who benefitted from science communication capacity building programmes	and journalists • Improved relations between media and the scientific community • Environment for developing and nurturing the culture of communicating science to the public by aspiring scientists and researchers established	
To profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing its public standing	• Size of funding invested in relevant programmes • Number of science promotion institutions participating in the programmes (viz. 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 • International standing of South Africa on science and technology issues enhanced	• South Africa's scientific competitive advantage 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

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Acronyms

AAAS	American Association for the Advancement of Science
ASCC	African Science Communication Conference
ASSAF	Academy of Science of South Africa
CAISE	Centre for the Advancement of Informal Science Education
DIISR	Department of Innovation, Industry, Science and Research
DST	Department of Science and Technology
ENE	Expenditure of National Estimates
GDP	Gross Domestic Product
GM	Genetic Modification
HEIs	Higher Education Institutions
HSRC	Human Science Research Council
IKS	Indigenous Knowledge Systems
IR&C	International Relations and Cooperation
NACI	National Advisory Council for Innovation
NCCPE	National Coordinating Centre for Public Engagement
NDP	National Development Plan
NFs	National Facilities
NGOs	Non-Governmental Organisations
NRDS	National Research and Development Strategy
NRF	National Research Foundation
NSTF	National Science and Technology Forum
R&D	Research and Development
RISA	Research and Innovation Support and Advancement
SAASTA	South African Agency for Science and Technology Advancement
SABC	South African Broadcasting Corporation
SADC	South African Development Community
SET	Science, Engineering and Technology
TYIP	Ten Year Innovation Plan
UNESCO	United Educational, Scientific and Cultural Organisation