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A Comparative Perspective for Functional Application of Scientific Temper in Southern Africa

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"*… the first precondition for a history of philosophy, the first precondition for philosophy as history, is therefore the existence of a scientific practice, the existence of science as organised material practice reflected in discourse. But one must go back even further: the chief requirement of science itself is writing. It is difficult to imagine a scientific civilisation that is not a civilization based on writing, difficult to imagine a scientific tradition in society in which knowledge can be transmitted orally. Therefore African civilizations could not give birth to any science, in the strictest sense of the word, until they had undergone the profound transformation through which we see them going today, that transformation which is gradually changing them, from within, into literate civilizations.*"

Paulin Hountondji (1976:99)

ABSTRACT

In celebration of the launch of a journal in India that will be dedicated to the advancement of the notion of scientific temper, it is apt to reflect on the possibilities of the impact that such a notion is likely to have once introduced in countries other than in India.

In a country like South Africa, which has its historical, emotional as well as political links with India established through the ideas of great statesmen such as Mahatma Gandhi, one finds similarities as well as differences in its historical development and post-liberation governance practices. A striking communality is that both countries were subjugated to British colonial rule. Both countries went through post-colonial changes that required new governance structures subject to new regulations and policies. New

governance choices were made as result of visionary indigenous leaders keen to provide policies appropriate to serve the indigenous society. As a result the new policies were infused with each country's respective cultural worldviews and histories.

One similarity of action between the two countries is the idealised protection of people's indigenous knowledge systems. A striking difference, however, is the national efforts to protect people's knowledge, identified as 'scientific temper' in India, and the wide ranging, culturally embedded perception of people's inability of being 'rational' in Africa with the resultant disregard for African knowledge systems. This paper will explore this socio-political divide created through the subconscious 'acceptance' of people's apparent inability of being 'rational' in Africa against the endorsement of a nation's ability of 'being rational' through a constitutional obligation towards maintaining scientific temper in India.

KEYWORDS: Reason and Unreason, Western Science and Indigenous Knowledge Systems (IKS), Colonialism, Post-Colonial Social Movement

Introduction

Discussion about the notion and application of scientific temper is central to the larger scholarly conversation about dichotomies between science and belief systems. Embedded in this conversation are issues related to culture, religious dogma and perceptions around reason and unreason. Such (often intense) reflection on the conflicting nature of reason and unreason can be found in most European countries as well as in India and Africa. In India, reflections on issues related to reason and unreason became an established academic debate during the late colonial period. This debate was equipped with affirmation of the Indian intellectual capability, pitted against the 'colonization of the mind' which served as a weapon of oppression by the British colonizers. The project to 'colonize the mind' by the British was not unique to India. Similar tactics of racial dominance through means of (perceived) intellectual superiority were systematically applied in colonised Africa. The difference, however, lies in the seemingly continuous acceptance of intellectual inferiority of (and amongst) Africans, as argued by

Ki-zerbo (2005) and the liberating challenge by Indian intellectuals in acceptance that the indigenous population do have scientific knowledge and this knowledge must be protected and maintained (Raina & Habib, 1996 and 2004).

History has not been kind to colonised countries. In Africa, there has there been a cruel conquering and appropriation of people and their land, but, aptly stated by Mogobe Ramose (2002:464), "… one of the lines the conqueror drew is that between reason and unreason." This line between reason and unreason simultaneously assigns competencies, rights and obligations in agreement with reason and unreason — with the conqueror having the sole right to reason and being claimed sole possessor of a superior civilization. "Accordingly, the conqueror had competencies and rights against the African but without any obligation to the African. This was a one-way relationship that precluded the possibility of reciprocity. The African had only obligations towards the conqueror but no rights" (Ramose, 2002:464-465). Ramose (2002:464) further argues that there were a number of differentiated lines drawn within this notion of reason and unreason:

- The notion of the fidels (believers) and the infidels (the non-believers in line with special impact on religion)
- Cultural civilization and barbarism
- The establishment of principles governing the humanization of war (just and unjust wars)
- The Geographical rayas and amity lines — driving the unfair (illegal) appropriation of land
- The meridian line defining truth and justice, based on the notion that the conqueror has sole and exclusive power.

We can safely assume that the same principles were experienced in India during British occupation. Some differences can be observed: the rayas and amity lines were, arguably, drawn in India on cultural and even intellectual lines since the whole of India fell geographically under colonial rule (divided into

districts rather than countries). In both India and Africa, western knowledge systems held sovereign power over the indigenous knowledge systems. As Ramose (2002:468-469) argues: "…for the conqueror the logic of drawing lines served as the basis of the ideology which maintained that those on the other side of the line could not and did not have similar rights to those this side of the line…. the construction of identity and the drawing of boundaries coincide in the single, contemporaneous, and simultaneous act of inclusion and exclusion".

Scientific Temper in India

Countries seldom experience leadership under intellectual statesmen. In India, Jawaharlal Nehru, described as "… a moody, idealist intellectual who felt an almost mystical empathy with the toiling peasant masses" (Tharoor, 2003:ix), was one of the rare intellectuals who not only steered his country from British colonisation but who left a lasting intellectual legacy: the legacy of the notion of scientific temper. The notion of scientific temper comes from the writing of Jawaharlal Nehru's book *Discovery of India* (1946). He became the first president of a 'trade union of scientists' — the Association of Scientific Workers of India (ASWI), founded in the late 1940's (Bhargava, 2007:25). The aim of this organisation was to develop a national scientific temper amongst scientists. Nehru saw the role of scientific temper to assist in the progress and development of the country as a whole and introduced the notion of a scientific temper as the theoretical underpinning of a system approach towards the development of science and technology (S&T).

Nehru undoubtedly played a central role in the introduction of a process of social transformation that was initiated after Independence in 1947. He also became one of the first politicians ever who openly addressed a country's intellectual conflict between science and religious dogma. By acknowledging the existence of a *scientific temper* amongst the Indian population, Nehru introduced far-reaching programmes to

help in the restructuring of his country[1]. He appropriately formulated a five-point plan to be implemented within the first few years after the independence of India (1947) that reads as follows:

- "People should develop along lines of their own genius and we should avoid imposing anything on them.
- Tribal rights in land and forest should be protected.
- We should try to train and build up a team of their own people to do the work of administration and development.
- We should not over-administer these areas or overwhelm them with a multiplicity of schemes.
- We should judge results not by statistics or the amount of money spent but by the quality of human life that is involved" (Pachauri, 1983:3).

The promotion of scientific temper led to the development and support of a new field of research, Science Communication, which is currently situated within the Department of Science and Technology. The main objectives of science communication in India are, firstly, to popularize science and secondly to stimulate scientific temper amongst the population. To support all these activities the National Institute for Science Communication and Information Resources (NISCAIR), came into existence in 2002 with the merger of National Institute of Science Communication (NISCOM) and the Indian National Scientific Documentation Centre (INSDOC). Both NISCOM and INSDOC, the two premier institutes of the Council of Scientific and Industrial Research (CSIR), are devoted to dissemination and documentation of S&T information. NISCOM had been in

[1] Partha Bandyopadhyay drew attention to the fact that this idea preceded the incentive of Nehru. Both Roy (1772 - 1833) and Tagore (1861 - 1941) promoted the idea of popularizing science (in Journal for Science Communication, Issue 2, Volume 4, 2005)

existence for the last six decades (first as two Publication Units of CSIR, which were merged to form the Publications Division, which was later renamed as Publications & Information Directorate and in 1996, as NISCOM). Over the years, NISCOM diversified its activities, and through a host of its information products, comprising research and popular science journals, encyclopaedic publications, monographs, books, and information services, it had been reaching out to researchers, students, entrepreneurs, industrialists, agriculturists, policy planners and also the common man. INSDOC came into being in 1952 and was engaged in providing S&T information and documentation services through myriad activities such as abstracting and indexing, design and development of databases, translation, library automation, providing access to international information sources, human resource development, consultancy services in setting up modern library-cum-information centres. INSDOC was also host to the National Science Library and the SAARC Documentation Centre.

Indian scholars made sure that there was a clear understanding of the term scientific temper. It was aptly defined by Udgaonkar (1980:27) to be:

> "…the essence of scientific attitude is an active, sensitive, questioning, understanding and creative relationship between man and his environment. Not only his physical and biological environment but also his behavioural, social and cultural environment. It is a rational approach to the discovery of truth, through free and creative thinking, experimentation and objective analysis: a steadfast commitment (with humility, not arrogance) to scientifically established truth. At the same time it recognizes the tentative and continuously unfolding character of our scientific understanding of phenomena. A scientific approach involves deliberate effort to distinguish between apparent and real causes of phenomena, disentangling the different forces and motivations at work; a consistence between theory and

> practice; quantitative as distinguished from vague qualitative thinking; a spirit of adventure; a willingness to pursue a promising path or paradigm consistently and tenaciously to its logical conclusion, with built-in consistence checks, and a willingness to also give up the paradigm if contradictions show. Last, but not least, an important characteristic of a scientific approach to the solution of problems is a systems approach: analyzing the totality of a complex system into its essential components, and taking operational steps with due allowance for the mutual interactions of these components so that desired results may follow."

Most importantly Udgaonkar (1980:27) states that "… science thrives on free communication: freely available information; codification of experience; a willingness to take calculated risks; to analyse mistakes and to learn from experience; a spirit of self-confidence and self-reliance. The existence of an invisible college of peers is another prerequisite for the healthy growth of science in any country".

This definition of scientific temper that served as philosophical driver for the socio-political transformation of a society provides ground for greater admiration for the steps taken by Nehru in the years before and after India's 1947 Independence. Nehru created an infrastructure for excellence in science and technology "… which has become a source of great self-confidence and competitive advantage for the country today" (Tharoor, 2003:245)[2]. This system for the advancement of science and technology did not exclude the knowledge embedded within the social complexity of thought that has been in existence for millennia. In 1976, India became the first country to include in its Constitution 'Scientific Temper' with

[2] This support provided the space for great scientists like Homi Bhabha and Vikram Sarabhai to excel in the fields of atomic energy and space research. (Though India's Nobel prize winning scientists received their honours abroad, Har Gobind Khorana and Subramanyam Chandrasekhar had their grounding in India).

'Humanism' and a 'spirit of enquiry' as a fundamental duty of all citizens of the country (Article 51-A(h)). In the Science Policy Resolution (SPR) adopted by the Government of India in 1958 the cultural aspect of science is mentioned as follows: "… science has led to the growth and diffusion of culture to an extent never possible before. It has not only radically altered man's material environment, but, what is of deeper significance, it provided new tools of thought and has extended man's mental horizon. It has thus influenced even the basic values of life, and given to civilization a new vitality and a new dynamism" (Udgaonkar, 1980:25).

To ensure appropriate uptake of science and the advancement of scientific temper, the Indian Government initiated the process of communicating science to and amongst the population. Two strategically important streams of science communication served this purpose. The first being the structural support for science communication through the establishment of institutions such as the National Institute for Science Communication and Information Resources (NISCAIR) that came into existence in 2002 with the merger of National Institute of Science Communication (NISCOM) and the Indian National Scientific Documentation Centre (INSDOC) and the National Council for Science and Technology Communication (NCSTC) in 1982. The second thrust of developing science in India came through the establishment of Kerala Sastra Sahitya Parishad (KSSP) and the People's Science Movement (PSM) founded in the 1980's (Mazzonetto 2005, Raza, 2010). These movements were responsible for the most extensive science communication events in the world. Parallel to this second thrust of communicating science was the initiation of the Indigenous Knowledge Systems (IKS) National Program in 1982. The aim was to support the incorporation of traditional knowledge in national research incentives and to integrate IKS into the mainstream science system. This led to the realization of new directions in the philosophy and sociology of science by integrating rural communities in the research process.

In the early years after Independence (1947) a number of events and publications addressed the need for a scientific temper. In 1964, *Seminar*[3] published the full text of a statement promoting the application of a scientific temper issued by the newly founded Society for the Promotion of Scientific Temper (SPST) (Bhargava, 2007:26). This organisation was launched after an international symposium on nucleic acids, organised by the Regional Research laboratory (CSIR) at Hyderabad in 1964. All members of SPST were required to sign the following document before they were inducted: *'I believe that knowledge can be acquired only through human endeavour and not through revelation, and that all problems can and must be faced in terms of man's moral and intellectual resources without invoking supernatural powers'.* Ironically enough, this society was short lived since the majority of scientists in India were not prepared to sign this document.

The Challenge in Introducing Scientific Temper

During 1981, scientists from all over India met at Coonoor, near Ooty, to deliberate on the state of Scientific Temper in the country. Out of those deliberations was born 'a Statement on Scientific Temper', which was released on 19 July 1981. The statement was followed by an International Conference on Science Communication for Scientific Temper, organised by the National Institute of Science Communication and Information Resources (NISCAIR), CSIR, in collaboration with Vigyan Prasar, in New Delhi, India during 10-12 January 2012. The promotion of scientific temper was ratified, by means of a formal declaration, by a number of international partner institutions. This task currently serves as a challenge to South Africa to explore the possibility of introducing the notion of scientific temper as a collaborative aspect in the development of science and technology in assistance to policy development.

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[3] Edition No. 55 Pp 10-11.

The primary aim of the New Delhi conference in 2012 was to introduce the notion of scientific temper as a driver for a second 'Indian Renaissance'. This aim echoes well with the expressed need for an African Renaissance — an idea introduced by Thabo Mbeki, the second president of South Africa after its independence in 1994. The notion of an African Renaissance is not new in Africa. By mixing the origin of what is referred to as Universal Knowledge with the development of the Egyptian kingdoms, Dani Nabudere (2012:15) refers to the first text known as the Shabaka Text or Memphite Theology that was presented by Pharaoh Shabaka as the first 're-memorised' African Renaissance during the Egyptian twenty-fifth dynasty (770-657 BC). We get, through these traditional (cyclic by nature) African Renaissance texts, originating from Egypt, an obscured message of confusion between what constitutes myth, what is simply the positioning of archetypes and what is approached as science. According to Nabudere (2012: 15) reference to the archetypes of Egypt can be considered as being specific to Africa (Egyptian mythos) and not necessarily applicable as 'universal types'. These archetypes, throughout the ages, contributed to

> "… present day dilemmas in which knowledge, as originally conceived in the Cradle of Humankind, has been intermixed with other forms of knowledge in other cosmologies, creating the kinds of complexity that are behind today's dilemmas in human relationships. The understanding of how archetypes were first formed and made manifest through the collective memory of the people of Africa must inform our understanding of the process of how this knowledge was communicated and shared between different communities must be the result of an historical study of those societies in their relationships and contacts with the African societies"(Nabudere, 2012:15).

The task of promoting the notion of a scientific temper in Africa therefore positions researchers within a collective global

responsibility to firstly understand the intellectual knowledge originating from within Africa and then to frame this collective wisdom into a modern system of knowledge. This is no easy task. In the African context this task is mostly assigned to the philosophers and historians. The task becomes complex when one considers the kind of foundational framework structured by western philosophers of science whereby Richard Boyd (1991) defines scientific realism as a doctrine:

i. Theoretical terms in scientific theories (i.e. non-observational terms) should be thought of as putatively referring expressions; scientific theories should be interpreted 'realistically'.

ii. Scientific theories, interpreted realistically, are confirmable and in fact often confirmed as approximately true by ordinary scientific evidence interpreted in accordance with ordinary methodological standards.

iii. Historical progress of mature sciences is largely a matter of successively more accurate approximations to the truth about both observable and unobservable phenomena. Later theories typically build upon the (observable and theoretical) knowledge embodied in previous theories.

iv. The reality which scientific theories describe is largely independent of our thoughts or theoretical commitments" (Boyd, 1991:195).

Hence, we create paradigms feeding upon itself internally with little relation to our personal thoughts and theoretical (ideological) commitments. Taking the quite powerful epistemological rejection of the notion of a paradigmatic scientific realism by antirealists like Thomas Kuhn (1962) into a discussion around the validity of scientific temper, will be the challenge to all those science communicators who try to make sense of the fault lines that exist between science and IKS.

Africa Knowledge Systems

An appropriate framework for the establishment of a scientific temper is a necessity in countries newly introduced to this idea. Using science communication as a vehicle, such a framework requires interdisciplinary collaboration and a transdisciplinary approach. Condensed into a framework consisting of four main approaches, Michèle Gellereau (2012:111-112) provides the complex scale of such a framework:

- The development of linguistic sciences and their increased interest in social customs and in specific kinds of discourses issuing from different social worlds, including the world of science.
- The rise of sociology and anthropology of scientific activity (to provide the social and political dimensions of research).
- The theorising of popularization (as a means to generate reflexivity and challenging the irreducible heterogeneity of the production of knowledge).
- The critique of the political role played by science in social life (looking at the links between so-called legitimate forms of knowledge production and ideological frameworks supported by literature and the media).

These points could serve as guide to establish the manner in which knowledge of science and knowledge of indigenous practices plays a role in what society applies for survival.

There are many dimensions related to the question on African knowledge systems. The early Pan-Africanists like Joseph Ki-Zerbo (2005) saw the solution to the crisis of rationality (and culture) in the 'discovery' of authentic African knowledge in the form of ideas and thought systems uninfluenced by outsider accreditation. This gave birth to concepts like Negritude and African Socialism. Some African philosophers argue about the existence of an African science prior to western contact (Gyekye, 1997) (Wiredu, 1975, 1976,

2000). Others, like Enyichukwu Offia (2009), criticize these various responses in their efforts to affirm and construct African knowledge (rationality) by stating that none of the African indigenous concepts are particularisable — therefore nothing about them is peculiarly African. Also, Africa has not yet experienced real pragmatic applications of these ideas, and sadly, Africa could be said to be in a state currently worse off than it was prior to colonial rule! Blame is placed on the reluctance of African communities to change traditional mind-sets without defining with clarity what these mind-sets are (Geyekye, 1997). Fear of change, lack of technology, inability to implement new policies and lack of vision are mentioned as further reasons for Africa's perceived inability to modernise (Hountondji, 1997; 2002).

Ngugi wa Thiong'o (2005: 159) talks of the subjugation of the colonised to Europe's memory. This subjugation includes Africa's conceptualisation of the world, its notions of democracy, commitment to the state in the form of a nation-state and even its notion and definition of rationality and epistemology. Africa's organisation of knowledge, which includes western methods for interpreting and coding, is the result of western colonisation and the deliberate scientific neglect of traditional knowledge systems and practises. Offia (2009) ambitiously cautions that:

> "… Africans would want to ensure that their religious and cultural differences do not continue to form the basis for hatred, violence and insecurity; rather to be a strong force that would ensure that they fly high above the bumps of ethnicity and ethnic consciousness, overcome hunger, poverty, corruption, war, strife, disease, desertification, political and economic instability. Whatever political and societal values, policies, laws and practices that would ensure freedom, justice, equality, equity and total development of Africa would be instrumental in achieving our desired goals in Africa.

> Anything short of this would be adjudged as irrational in Africa by Africans".

However, to better understand the African perspective we need to reflect on the contributions of African philosophers such as Dani Nabudere (2011). Nabudere (2011:1) developed the term 'Afrikology' in an attempt to capture the spirit of ancient African wisdom that was embedded in "… an epistemology of knowledge generation and application that has roots in African Cosmology". Nabudere (2012: 78) argues that Afrikology consists of:

> "… an epistemology of knowledge generation and application that has roots in African cosmology and worldviews. It is a universal epistemology, precisely because it recognizes that knowledge is created by different languages. Afrikology is therefore universal because it can help us to integrate human knowledge. It seeks to retrace the evolution of knowledge and wisdom from its source in the Cradle of Humankind in Africa, up to the current scientific epistemologies and to try to situate them in their historical and cultural contexts".

For Nabudere (2011:68) the African response on the colonial attitude about 'scientific reason' turned " …into a form of metaphysics that militated against science being at the service of a few and not the entire society". The western exclusiveness of a worldview fragmented knowledge systems and provided a barrier to the positive development of knowledge production. As a result the struggle against western epistemological arrogance and prejudices became a necessity. Nabudere (2011:69) sees this as a process whereby "… we have reached a point at which a dialogue between Western epistemology is crucial to the advancement of human knowledge if this prejudiced one-sidedness is to be fully eradicated. The central issue in the dialogue is to what extent scientific knowledge can be said to be a product of 'reason' alone, and why human experience is underrated as a source of knowledge".

According to Nabudere (2012:74) we are now at a time where science must acknowledge, without reservation, that all societies are knowledge producing societies, capable of producing all kinds of knowledge. To illustrate this point Nabudere (2012:76-77) used the following example to demarcate the diversity of the scientific knowledge field in its intersection with society:

> "… its conceptual and organisational categories such as State, Society (Culture) and Science became increasingly permeable and even transgressive, as the value systems on which they were crafted became ' fuzzy'. Secondly it became evident that the external contexts that scientists worked in were becoming intensified and 'unmanageable'. This meant contexts and other sites of knowledge production (including the non-science ones) kept on expanding inexorably and exponentially into contextualised socio-cultural knowledge fields. As 'contextualisation' moved from 'weak' context to 'strong' ones, even the boundaries between disciplines became exposed and porous. Thirdly, as the socially contextualised knowledge became stronger the knowledge produced became 'robust'".

The effect of acknowledging the social robustness of science further implies a trans-disciplinary approach whereby, according to Helga Nowotny (2001), we can safely argue that knowledge is relational and not relativist as previously claimed under a uni-linear (western) science. It is argued that the social robustness of knowledge is being judged in specific contexts. Social robustness is a process capable of attaining a certain stability of its own and is capable of dealing with the unknown and unforeseeable contexts since it is normally infiltrated by social knowledge and is based on a strong open-ended empirical dimension.

A lucid and clear argument towards the introduction of a scientific temper in Africa comes from the philosopher Kwasi Wiredu in his work: *Philosophy and an African culture* (1980).

Using the development of philosophy as the base of his argument, Wiredu looks at the position that traditional philosophy occupies in nations and argues that these philosophies are globally considered to be pre-scientific. According to Wiredu it is necessary to differentiate between knowledge and wisdom, formal education and common sense and codes of ethics stemming from global perspectives and those that are home-grown according to belief systems. In Africa, industrialisation introduced formal scientific education and the radical introduction of Christian fundamentalism. This is what Wiredu (1980:30) has to say:

> "Christianity, a comprehensive metaphysic with an associated ethic, has itself been in historic conflict with science. In the intellectual outlook of those people whose evangelists carried it into our lands it usually survives in co-existence with the scientific temper only by making accommodations of varying degrees of subtlety and candour. Thus the African, converted to Christianity but with some roots in his own past, or born into a 'converted' family, as a rule has been inculcated with elements of traditional religion and world view, the teachings of fundamentalist Christianity, and smatterings of science or bits of vaguely science-orientated information. These elements persist in mutual incompatibility, and become selectively operative in the various circumstances of life."

For the African the consequence of this way of life is the creation of an unthinking scepticism and cynicism and often leads to an attitude of, as Wiredu (1980:30) aptly describes it, 'grab what you can get, no holds barred'. Wiredu (1980:32) identifies the need for two restorative actions: in the first place science is to be positioned as a crucial factor in the transition from the traditional to the modern world by introducing habits of exactness, methodological actions, the pursuit of systematic coherence and an experimental approach. To achieve this goal the philosopher, as a second course of restorative action, is to

precipitate the desired revolution in intellectual habits, taking into account the impact of language, culture and the growing need to record, reconstruct, interpret, and correct false interpretations.

We can safely assume that there is strong indication that the introduction of the notion of a scientific temper amongst African society is not only a desirable action towards understanding the past, but a necessity for embracing the future. It is clear how "in every society people employ both scientific and non-scientific explanatory models in accounting for their world of common sense. Whatever contradictions there may be in the models applied should be seen as internal contradictions within a given culture rather than features for distinguishing between one culture and another". Rationality, pursued within all cultures, should be considered as a process of validation and logical inference and not as a truth and false proposition. If we overcome past restrictive perceptions, accept that all societies are acting in a rational manner in their 'right to life actions', we have the foundation for promoting a scientific temper amongst all nations.

Concluding Remarks

The argument towards the need and necessity of introducing the notion of scientific temper in Africa served as inspiration for this paper. The question addressed was whether such an introduction is a possibility. Since African knowledge systems have been related to an interpretation of 'being incapable of reason' as we encounter in the ethnological work of Lévy-Bruhl (1910) and Lévi-Strauss (1966), the question regarding the possibility of introducing a scientific temper is so much more pertinent to the people on this continent. South Africa is probably ready to grapple with the complexity of introducing a notion such as scientific temper.

In conclusion, we can refer to the words of Ben Ngubane, the previous African National Congress (ANC) Minister of Arts, Culture, Science and Technology who stated the following

during a speech at a UNESCO seminar on '*Science and Technology for Sustainable Development in Africa*' that took place on the 8th of November 2001:

> "…With the publication of key reports such as the UNDP 2001 World Human Development Report, it is becoming clear that the relationship between science, knowledge and the availability of human capital to address the issues of sustainable development is crucial. This is a very different approach from the traditional and narrow thinking of development economics. Few, if any, future scenarios for Africa talk about the contributions of African science and technology to the sustainable development of our planet. This is surely not right. Perhaps we have convinced ourselves that Africa cannot be a player in the knowledge economy. I believe that it is this mind-set that needs to be fractured and removed from our consciousness" (reported in the *Sunday Times*, November 11, 2001).

The words of Ngubane still ring true. Science and technology are often seen by policymakers as instruments that have well-defined functionality. Under these conditions, science and technology becomes the handmaiden of greater goals such as economic development or quality of life. This instrumentalist approach does great damage because it does not recognise the potential of people trained in science and technology as problem solvers, innovators, entrepreneurs, business people, community leaders and artists. In conclusion, it is clear that the introduction of the notion of a scientific temper in Africa is a necessary step towards the formation of national identities and the application of science in service to society.

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