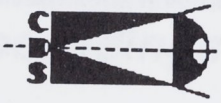
Towards a Technology Policy for South Africa

AFRICAN NATIONAL CONGRESS

Interim Science and Technology Group

24 November 1990

Published by the:
Centre for Development Studies
University of the Western Cape
Private Bag X17
Bellville
7535
South Africa
Tel: -21-9592151
Fax: -21-9592317



ISBN: 1-86808-076-5

PRINTED & BOUND BY ESQUIRE PRESS (PTY) LTD
VANGUARD DRIVE, ATHLONE INDUSTRIA 1
TEL: 637-1260/1

Table of Contents

Part One: ANC Conference Proceedings

Part Two: Position Papers

Part One

ANC Conference Proceedings:

Towards a Technology Policy for South Africa

edited by Ania Grobicki, Conference Convenor

Introduction

Issues relating to technology do not yet have a high profile in progressive politics. The shortage of technically qualified people in South Africa, linked to the poor quality of education; environmental problems; electrification; the role of the large industrial corporations; these are all topics which are occasionally raised, but not dealt with in a systematic manner. No democratic society can afford to leave technical decisions in the hands of technocrats, since they often affect the quality of life of large numbers of people. A coherent and democratic approach to the development of technology policy is required.

The questions which the ANC Interim Science and Technology Group are asking include: what kind of structures are needed to affect policy decisions? Should community groups and trade unions be involved, and if so, how? How can the needs of industrial development and environmental regulation be reconciled? What steps must be taken to build a strong indigenous technological base? At this crucial stage in South Africa's history, it is important for the ANC to begin to frame a possible policy within which these questions may be contained.

*The Interim Science and Technology Group was formally set up under the ANC's Political Committee, and mandated to gather information and advise the NEC on forming a science and technology policy for a non-apartheid South Africa. The ISTG organised this conference on 24 November 1990 as a part of the process of discussion and consultation. Much of the day's proceedings comprised eight workshops, each addressing a particular issue relevant to a science and technology policy. These were: energy policy, environment policy, new technology, rural technology, industrial restructuring, technical education, research and development, and democratic policymaking structures.** ***

The objectives of the conference were formulated as follows:

1 . To bring together supporters and members of the ANC who have an interest in these issues.

2. To develop an agenda of areas of technology policy which need to be urgently addressed .

3. To define structures within which technology policy can be debated and decided .

4. To work out how best to build up capabilities for dealing with issues of technology policy within progressive organisations.

---

* A small group of scientists and engineers who are also ANC Members came together to produce the position paper on Science and Technology included in this volume, which was made public in October 1990.

** Many Conference participants and speakers are not ANC members. Hence the workshop papers included in these proceedings cannot be seen as in any way reflecting ANC policy. They represent merely , the first step in a democratic and consultative process of policy formulation in which issues are openly discussed and publicly debated.

*** The policy papers included in Part Two were presented in plenary sessions at the Conference. These do not represent ANC policy.

5. To bring together industrialists, unionists, academics, and politicians to discuss aspects of science and technology policy.

When looking at the process of policy formulation, it is important to begin to engage with the existing structures, to analyze flaws and to grasp the possibilities for change. At the level of the state, the structures that shape technology policy in this country at present are extremely fragmented. Technology is dealt with by the departments of Trade and Industry, National Education (Science Planning Directorate), Mineral and Energy Affairs, Environment Affairs, Water Affairs, Transport and Public Works, and Agriculture. There are a number of councils which are relatively autonomous, but hugely influential in decisionmaking around science and technology. These include the Council for Scientific and Industrial Research (CSIR), the Foundation for Research Development (FRD), the Council for Mineral Technology (Mintek), and the Atomic Energy Corporation (AEC). There are also the parastatal organisations such as Eskom, Sasol and Iscor, which were established as part of a government strategy to control certain technical sectors.

Following the success of this Technology Policy conference, the ANC Interim Science and Technology Group has gone on to begin a detailed critique of the state's industrial strategy (emanating from the Department of Trade and Industry) and its science policy (emanating from the Department of National Education). We have also established commissions in each of the areas covered by the conference workshops, as well as in electronics, telecommunications and information technology, mining and minerals, water resources, and urbanisation. There are now 12 commissions in all.

We believe that the establishment of a future Department of "Research and Technology" or "Science and Technology" (as outlined in the commission on Democratic Policy-making Structures) is an important task in developing a new South Africa. When technology remains on the margins of discourse, its hidden power can be turned to undemocratic purposes. In embracing technology we can render its use fully democratic and turn it to the service of all the people of South Africa.

You can Contact the ISTG by writing to us at:
P.O. Box 27862
Yeoville
2143

Energy Policy

Speakers[1] *: Anton Eberhard*
Jaap van Deventer

While there is no shortage of energy in South Africa, its distribution is highly skewed. For example, South Africa produces half of the electricity in Africa but two-thirds of its own population do not have electricity and rely either on wood or other costly and inconvenient fuels such as coal, paraffin, gas, candles and batteries.

The changing political and economic context in South Africa makes the development of new energy policies urgent. There is a growing political demand for more equal access to affordable infrastructure and services including electricity. The provision of adequate housing and electricity to all is also seen as an important aspect of an economic policy which seeks to stimulate growth through redistribution.

The workshop participants agreed that the key energy policy issue is the provision of power for growth through adequate and affordable energy for all.

The workshop was informed about a comprehensive and large research project, based at the University of Cape Town, which would address these issues. The development of an integrated energy policy is a complex process which relies on an understanding of a range of related areas. For example, a national electrification programme will need to link into a national housing policy. It would require an understanding of the significance of the electricity supply industry which plays an enormous role in the economy in terms of assets, capital requirements, foreign debts and employment. Another example is rural areas where a large-scale afforestation programme would require an understanding of land and rural de-

1 NB: Workshop Summaries are a summary of the views of all the participants, not only of the speakers.

velopment policy issues. It is thus important that research is undertaken around these issues.

The objective of the project is to identify and clarify critical policy issues and to develop a coherent framework which could be used as a resource in the formulation of energy policies which would enable the provision of adequate and affordable energy supplies for all South Africans.

The sectors to be studied include:

- *Demand projections for underdeveloped areas*
- *Energy for rural development*
- *Energy and small-scale agriculture*
- *Domestic energy supply options in rural areas*
- *Afforestation and woodland management*
- *Domestic energy supply in urban areas*
- *Energy and informal sector production*
- *The electricity supply industry*
- *Energy efficiency and conservation*
- *Energy and environment*
- *Energy linkages in Southern Africa*
- *Electricity generation options*
- *Energy and mass transportation*
- *Investment requirements*
- *Pricing*
- *Institutional analysis*

The research project will lock at each of these sectors and integrate them into a coherent policy framework.

Environmental Policy

Speakers: Graham Noble
Henk Coetzee

It is essential that an ANC government take the responsibility for correctly managing the Economy/ Quality of Life/ Environment system. The situation today is that we are paying environmentally for past irresponsible political and economic decisions. We must therefore decide to face these issues now, however painful and unpopular this may be rather than risk creating a more serious problem for future generations.

An environmental policy must involve economic issues and policies concerning population. The latter concerns not merely the overall numbers of people, but also consumption patterns of the rich versus the poor. Economic considerations include rural, agricultural and industrial policies.

Poverty and overpopulation, the lack of education and social awareness, and unrestrained industrialisation are elements which have previously combined to the detriment of the environment. It follows therefore that the conflict between industrial and economic development and care of the environment must be acknowledged. The way out of the vicious circle is through democratisation.

Environmentally-friendly technologies must be identified, researched and implemented. However, the material needs of poorer people must be taken into consideration. An example: if coal scrubbers were fitted to all thermal power stations, the price of electricity may rise out of the range of significant numbers of people. Impact studies must be done prior to implementing technical change or development projects. Both environmental and social implications should be addressed.

There are opportunities for environmental friendly exports - indeed, strict regulations are being imposed by some major markets (e.g. EEC & US). The aggressive taxation system needs to be reformed, and a pollution tax introduced so the pol-

luter pays for cleaning up. This requires government intervention (by a body with teeth) funded from taxation.

Environmental damage to rural areas due to overpopulation and resulting overgrazing and injudicious farming practices should be identified, and environmental management should be a part of the land reform initiative.

We should aim for an integrated, and therefore flexible, environmental management policy. This will cover all changes in land use, industrial and agricultural.

There is existing environmental legislation, but it is fragmented and inefficiently managed/maintained. It needs to be pulled together and reviewed.

Recommendations

- *The Environment should enjoy constitutional protection.*
- *Worker participation is an essential part of the democratisation process.*
- *A pollution tax should be introduced.*
- *Environmental and social impact studies are essential.*
- *Public education and open access to information is essential to the workings of policy.*

New Technology

Speakers: Brian Clark
Pieter Burger

*H*igh priority technologies now are information technology, biotechnology, new materials and advanced production technologies. All of these have the potential for major breakthroughs, and for a broad impact on society.

*D*eveloped economies tend to have a multifaceted approach in their technology push. Research is done across a continuum of topics, with long-term objectives being the principal focus. Developing economies, on the other hand, tend to have a problem solving approach. Due to the limitation of resources, research is often focused on specific areas, with short-term objectives.

*F*or instance, in South Africa the debate around new technologies cannot be detached from urgent national priorities: education, employment, urbanization, health care and rural reconstruction. These priorities necessitate the development of "inwardlooking" technologies for housing, transport, energy, water and the environment.

*A*t the same time South African industry needs to be export oriented and competitive in world terms. This can only be achieved by finding specific niches for high quality exports in new technologies and in minerals processing technologies. The development of novel applications can also be regarded as new technology .

*I*t was pointed out that for this to be achieved, access to new technology from developed countries was essential, and that the technology can then be adapted to South Africa's needs. However, this process will only be successful if the skills exist to make use of the technology, which implies that training agreements must be built into contracts. It is also important that the technology imports can be made without any export restrictions. Here the state could play a role in the bargaining process, by providing information about previous agreements and by backing the South African company. It may be helpful to institutionalise the process of technology transfer, to ensure the best conditions.

Importing plant and equipment may in effect be importing old technology. There is more risk involved in importing technology closer to the research stage, but at the same time there are also more benefits. Here it is even more important that the expertise should exist to understand the technology, otherwise there is the danger that imported new technologies may not be applicable or useful in South Africa .

Enabling new technologies which are of most importance in South Africa are telecommunications, minerals processing, biotechnology, food technology, new materials, and organisational technology. The basic question is not whether South Africa needs to invest in these technologies, but how. The choice can perhaps be made by identifying niches in the export markets, and then choosing the technologies which those niches require.

The way of deriving maximum benefit for society from developing new technologies is by ensuring the intellectual property rights to the technology, together with maximum disclosure. There needs to be a wide spread of protective rights, which will give strong incentives to new developments and adaptations in products and processes. An enabling environment for innovation must be created.

A balance needs to be found between investment in new technology, and in the "inward-looking" technologies that are needed for development. In both cases, a problemsolving approach is necessary, choosing a specific technology to achieve a specific objective. The funding of research across a broad spectrum is not a realistic approach. The new technologies imported and developed must provide products for the export market, and must also integrate into the development needs of the country.

Recommendations:

- *Technical training is essential to develop new technology and to make the best use of imported new technology.*
- *A wide spread of protective rights over intellectual property must be ensured, to provide an enabling environment for innovation.*
- *The emphasis in the export market must be on high quality goods, concentrated in specific niches of the market.*
- *The state should advise on the importation of*

technology, to ensure that agreements are reached on good terms regarding training and export licences.

- *Research into the new technologies of information technology, biotechnology, new materials, advanced production technology and minerals processing must be funded, in the specific areas which may be useful in providing products for export and for domestic development.*

Rural Technology

Speakers: Rob McCutcheon
John Abbot

Mr Abbott considered priorities for rural development, and stressed the need for an integrated policy which would combine agricultural development with use of local resources to create jobs on a large scale. This would only be achievable through a new institutional framework agreed by democratic participation both in decision-making and implementation. An important principle to recognize was that appropriate technology did not mean lowlevel technology. This was especially the case in the area of communications.

Prof McCutheon returned to some of these themes in his presentation, and emphasized that economic growth of the rural areas depended on productive employment creation. Emergency job creation programmes were not the answer (e.g. drought relief, food for work programmes). It was clear that the construction industry could not alone absorb the mass unemployed. Rural development needed a long-term view, perhaps ten years or more, and had to be based on community participation with appropriate institutional support. Without these, experience pointed to failure.

In the ensuing discussion, a number of points emerged:

a. Current plans for economic development for South Africa tended to look toward the industrialising countries as role models rather than toward the newly industrialised countries. Although South Africa competed internationally, it was underdeveloped internally, and there was a tension between these two drives.

b. Primary wealth could be created through agriculture if land was used effectively,

c. The reasonable expectations of tne rural

poor had to be considered in determining what was appropriate and acceptable,

d. Education, and a political desire for change were required .

The participants agreed that any national science and technology policy should emphasize the importance of the rural economy, and that a fully integrated policy was necessary. Agriculture was to be seen as but one component of the rural economy, therefore rural industrialization should be promoted. Above all, productive activity had to be stimulated through "enabling technology". It had to be recognized that the major determinant of success related to the "software" dimension, namely education, training, attitudinal change and political consciousness, research and implementation strategies. A prerequisite for rural development was the provision of a basic infrastructure of dams, roads, clinics and schools, and the sustainable exploitation of local resources.

A fundamental commitment to universal primary education was needed Employment creation should be understood as a basic goal, and not a social service. Overall, long term planning and political commitment would be needed if the rural economy were to become viable. Participants expressed a wish to reconvene at a later date for more extended discussion.

Recomendations:

- *Rural industrialisation must be promoted*
- *"Enabling technology" stimulates productive activity.*
- *The importance of education, training, attitudinal change and political consciousness must be recognised*
- *The basic infrastructure: roads, dams, clinics, schools must be provided as a matter of urgency.*
- *Long-term planning and political commitment to employment creation are essential.*

Industrial Restructuring

Speakers: Peter Glenshaw
David Kaplan
Piroshaw Camay

Industrial restructuring is perceived desirable if the current socio-economic systems are not delivering the goods in acceptable quantities of an acceptable standard and at acceptable prices.

South Africa industry at present is characterised by:

- *general reliance on technology transfer from abroad*
- *being badly placed, with respect to R & D, in low technology industries rather than in the more sophisticated ones*
- *where there has been indigenous innovation, it has been skewed to a very few strategic industries*
- *overprotection and concentration.*

Raw materials and direct labour are becoming less important components of manufacturing cost of products on the world markets. Thus South Africa's former comparative advantages, where these had existed (relatively cheap materials and labour), are becoming less helpful maintaining our competitiveness on world markets. Indeed, South Africa's share of world exports (particularly of manufactured exports) have declined significantly.

If South African industries are to compete in markets abroad, they must find advantageous niches for themselves, for example SA chemicals industry into "commodity chemicals" and SA telecommunications industry into appropriate products for the local lower income market. If South African industry can manufacture products of appropriate standards and price to suit the lower income market within our borders, it will find that there is a huge market for these same products north of our borders.

The successful technology based economies of the East have largely been successful because of the State correctly prioritising, in sequence, specific technological training, the picking of winners, and giving these winners specific assistance.

Market needs have shifted. A higher premium is now placed by consumers on response time, variety and quality (in addition to price, which is still of paramount importance). In-house R & D was essential, if the manufacturer was to have hope of competing in respect of response time, of variety and of quality.

The question was then addressed as to how the benefits of technology could filter or be directed to the lower income people of South Africa. The role of government should be to identify those industries with the potential to generate spinoffs and then to provide incentives to the private sector to direct its resources to the lower income market (an example was housing). The correct identification of appropriate standards and technologies was vital. Markets could sometimes restructure themselves (e.g as the SA fertilizer industry did after overproduction).

The needs and cautions expressed were

- *that the investment policy be socially responsible*
- *that there be worker participation*
- *that there be affirmative action to provide equal opportunity*
- *that whatever restructuring take place, it not be at the cost of the rights of the workers.*

It was noted that a shortage of technological manpower had the potential to limit national growth.

It was agreed that it was also necessary to find means whereby government could prevent established business from making it difficult for new manufacturers to enter the market, and also that it was necessary to encourage the growth of subcontracting and for big firms to enter partnerships with smaller ones.

Restructuring should be a continuous process, responding to the continuing internal and external challenges.

Recommendations:

- *Industrial restructuring is neccessary to enable SA industry to deliver goods in acceptable quantities of an acceptable standard, at acceptable prices, to suit the domestic and export markets.*
- *Advantageous niches for exports must be formed.*
- *Manufactured goods for the domestic market will find a huge market north of our borders.*
- *Government has a role to play in picking "winning industries" and providing incentives.*
- *In-house research and development should increase.*
- *Restructuring must not take place at a cost to workers' rights.*

Technical Education and Training

Speakers: Lindelwe Mabandla
Marisa Rollnick
Cliff McMillan

The aim of any education system should be to bring out the best in the pupils being taught. Talents must therefore be encouraged and nurtured, and pupils should be inspired with the moral and cultural values consistent with a multi-racial and multi-cultural society.

The crisis in South African education generally, and technical education in particular, is an integral part of the human resources catastrophe in South Africa. Any policy recommendations should apply not just to the young, but also to adults who require access to the educational facilities of the country. Teachers are poorly qualified and enjoy a low status, and science is therefore maintained as a difficult subject. The system therefore perpetuates itself.

In developing a policy, we must identify what is good about the present system and what is bad, then retain, improve or replace where necessary. In this way science education can be overhauled. In addition, we must recognise that success in science education is not just a matter of integrating our schools. We must encourage a people's science rather than a science for the scientists. This will do much to rid us of the elitism inherent in science.

We should attempt to train a scientifically literate population who can understand natural phenomena and the technology which affects their lives. This will democratise science and permit our population to decide on important matters in science policy.

We should aim for a science for all squatter camps, rural areas, townships - which is context-relevant and applications based. The students should be encouraged to ask questions about the world around them, and we should have a science curriculum to answer these questions. Emphasis should be placed on problem-solving, where the pupils' opinions and ideas are

important. The source matter for experimentation should be from their own experiences as much as possible.

English is the common language across the fabric of South African society. It is also the international language of commerce and science and technology. The technical education system in South Africa must therefore be taught in the medium of English. The dynamics of science and technology necessitate a single, centralised system that is available to everybody.

The main practical problems are the availability of trained teachers. Teachers should be trained adequately, and paid well. There is a fear of the danger of the lowering of standards through a huge expansion of the school system. This problem may be approached in the short term by rapidly training teachers up to diploma levels and continuing their training in service over several years.

Policy-making must take account of the needs and the initiatives of business and the unions. The close link between technical education and prosperity must be recognised.

Recommendations

- *A centralised science and technology education system is essential.*
- *Science education should take place in the medium of English.*
- *Science education must be available to all sectors of the society.*
- *Teacher training in science is the basis. In-service training must be provided.*
- *The emphasis must be on problem-solving, working with students' own opinions and experiences.*

Research & Development

Speakers: Reinhard Arndt
Hank Miller

The discussion in this commission was characterised by a high degree of consensus. This may be because the participants are all active in the R&D sector, and, although their political views may differ, they therefore speak a common language .

An enabling environment is essential for the R&D effort to prosper, rather than a policy embodying a set of principles or guidelines, which would almost certainly be ignored by researchers. This enabling environment would be characterised by networking between individuals and groups from the universities, industry and the state. Currently there is ignorance in all these sectors concerning the potential for beneficial relationships between them. Networking is likely to be far more effective as a means of spurring on research than the creation of "centres of excellence".

Research and development must be situated within an overall vision of technology, the economy and South African society. However once scientists have been provided with an overall set of goals, it is up to them to decide how to achieve these goals. In particular, scientists have discovered to their detriment that the terms "pure" and "applied" science are often misunderstood by lay people (i.e. that pure = useless, applied = useful). It should be the responsibility of scientists themselves to determine the relative weight of "pure" and "applied" components needed to achieve a given aim.

It was agreed by most present that neither the current government nor the private sector were spending enough on R&D. It was suggested that total R&D spending should be raised incrementally from the present level of about 0.88% of GNP (compared with about 2.9% for Japan) to well above 1%. Foreign companies spend on average twice as high a percentage of their budgets on research in South Africa as compared with South African companies, despite the fact that foreign companies do the bulk of

their research back home. Participants felt that this underscored the need for R&D professionals to network more effectively with industry in South Africa. Tax incentives for local companies to support R&D are also necessary.

The opinion was expressed that scientists in particular and technical people in general were not given sufficient credit in industry for their work. The credit is given instead to the managerial staff. Hence R&D is not perceived as a rewarding career, which therefore creates a shortage of scientific personnel. Although 47% of science graduates in South Africa are women, R&D is largely dominated by men. Women often become disillusioned and leave the area of research. More must be done to encourage women to stay in R&D.

However it was clear to all that the system of apartheid has been the principal culprit in producing a shortage of scientists. Equal educational opportunities, with comprehensive bursary schemes for disadvantaged students, are probably a better solution than affirmative action. The building of a culture of science (i.e. a culture in which scientific questions are considered interesting and important) should be a goal. It is not clear how this goal can best be achieved. South Africa may be able to learn from the culture of science that exists in Germany and some of the Pacific Rim countries.

R&D is not sufficiently addressed to the problems of rural technology. There is often a tendency to assume that rural technology is low technology, when this is not necessarily the case. Few R&D professionals have experience in the area of rural technology. Possible rural applications of high tech research need to be investigated .

Recommendations:

- *An enabling environment must be created for research and development. This includes networking rather than the creation of "centres of excellence".*
- *Both pure and applied science are necessary, useful and should be pursued.*
- *Government and the private sector should invest more money in R&D, to push R&D spending over 1% of South Africa's GNP.*

- *Credible career paths must be available for scientists, particularly in the private sector, in order to attract more people into science.*
- *Women must be encouraged to stay in science.*
- *The skill shortages caused by apartheid may be best remedied by provision of equal educational opportunities, with comprehensive bursary schemes.*
- *We should aim to develop a science culture in South Africa.*
- *Rural applications of R&D must be investigated.*

Democratic Policy-Making Structures

Speakers: Geoff Schreiner
Hans Pornschlegel
Mohamed Valli Moosa

Policy-making must include the processes of education, consultation and participation in order to be effective. Speakers agreed that in every area, abstract policies need to be derived from concrete issues, in order to involve people at all levels. However, time is always a limiting factor in the extent of consultation and feedback which can take place before a given policy is implemented.

Given the broad scope of technology policy, many different agents need to be involved in policymaking. Structures are needed at community, regional and national levels. In addition, these structures must reach out horizontally to include state or municipal bodies, industry (both public and private sector corporations), trade unions, academics, professional societies, small businesses, research organizations, community groups and school teachers. All these agents play important roles in the establishment of a technological culture.

The development of policies through these structures would be a multipartite consultative process. It was debated what the role of parliament could be in such a process, but it was agreed that this was a constitutional issue which could not usefully be taken further until the political situation in South Africa had crystallised. However, a Ministry of Research and Technology would provide a focus at national level to ensure that technology issues received attention.

Problems which were raised in the workshop included people's perceptions of technology, i.e. pressure groups and community groups with an "anti-technology" focus. Many sectors of the population have historically been excluded from technology. Hence the process of education becomes vitally important, to enable people to make an effective contribution in decision-making. Another problem was the typically short-term, profit orientated view which industry often takes. It was pointed out that politicians also frequently take a short-term view, as far as the next election. The multipartite process

would enable long-term visions to be developed.

Conflicts of interest would inevitably emerge within such democratic policy-making structures, but ideally it would be possible to reach consensus on a particular issue by open debate. Conflicts are heightened by the process of exclusion, which is a feature of the present policy-making structures of the state. It was suggested that there are essentially three groups with very different stakes: "experts", "players" and "affected people". Technology assessments could be carried out by a nonaligned body of "experts", such as the Office of Technology Assessment (OTA) in the United States. These assessments would provide the information needed for the processes of education and consultation.

Recommendations:

- *A multipartite process of consultation must develop.*
- *Education and participation at all levels are necessary.*
- *Decision-making needs to take place at community, regional and national levels.*
- *At national level, a Ministry of Research and Technology, and a politically independent Office of Technology Assessment should be established.*

Part Two: Position Papers

Part Two
Position Papers:

A Draft Position Paper on Science and Technology Policy

INTRODUCTION

Science and Technology (S&T) play a major role in supplying the material needs of the citizens of any modern society. S&T do this through many different mechanisms. For example they generate wealth when new products are placed on world and domestic markets. S&T help feed people by perfecting crop growth and animal husbandry. And S&T contribute towards a healthy nation by ensuring adequate supplies of high quality medical goods.

South Africa needs to establish a policy which will set and guide national objectives for Science and Technology. The policy should link state and private sector activities into an effective thrust to meet local needs and to compete on world markets. And it will include integrated policies for Research and Development (R&D) and S&T. The ANC does not pretend to have ready answers to the complex issues raised in this chapter. At this stage it is more important to present various perspectives within the broad principles of our movement, in the hope that this will stimulate debates, both in public and in activist circles. It should be stressed that a substantial amount of public money is spent on both R&D and S&T. Any political organisation that is serious about assuming the reins of government needs to formulate credible S&T policies.

What is Science and Technology?

The majority of South Africans, of all racial groups, are ignorant of what Science and Technology are, let alone of what might constitute an effective S&T policy. S&T are regarded as specialist activities, incapable of being understood by the average person, and not often discussed in public, even at election times. This is particularly true in South Africa, where the issue of apartheid has thrust aside most other topics in the arena of public debate. In fact the recent tabling of the new R&D Bill in Parliament hardly received a mention in the popular press. We need to describe what the terms Science and Technology mean to us. And how our success (or failure) in harnessing S&T can affect the lives of South Africans.

We begin by making the bold and general statement that S&T represent the striving of humans toward understanding and controlling our environment.understanding is really the understanding of how things work. And technology is the application (hopefully beneficial but regrettably often not) of the understanding which flows from scientific discoveries. Technology includes the full range of activities from research through design, development, production, operation and maintenance.

The history of human development is inextricably linked to the history of S&T. Examples of these are too numerous to list. We simply state that they date from the taming of fire and the smelting of ores by our ancestors, through the development of sailing ships, gunpowder, the telescope, steam power, wireless and ultimately the electronic computer and the microchip in the second half of the 20th century. Moreover we assert that it is those countries which are able to create and use technology effectively which are able to provide for their citizens' well-being. It is only by means of technology that an underdeveloped country may break its reliance upon the export of raw materials. Technology enables a country to draw full benefit from its raw materials instead of exporting them in an unfinished form for others to get rich. A properly developed technology can go yet further: it may enable a country to utilise its human resources to overcome a lack of natural resources. Japan, for example, has no significant physical resources to speak of, yet it leads the world in electronics and its citizens enjoy a high standard of living on average.

The Situation in South Africa

What is the state of S&T in South Africa today? The backbone of the South African economy is the mining sector, with gold and coal being our most important exports. Around mining grew an industrial sector which either provides the mines with the low technology wherewithal (e.g. machinery, explosives and chemical reagents) to extract the minerals or adds minimal value to the raw minerals (e.g. iron and steel industries). We export iron and steel to Japan and import back machines made from iron and steel. Where high technology goods are manufactured locally (e.g. motor vehicles) the designs usually come from abroad, as well as the more sophisticated components. For example, the multinationals with subsidiaries in South Africa have their R&D departments abroad.

There are exceptions to these trends. South Africa even leads the world in some aspects of design (e.g. Sasol and Atomic Energy Corporation). But, broadly speaking, our economy is geared towards exploiting minerals which are largely beneficiated by other technologically more advanced countries. Our record in pure science is less obviously disastrous. We have made contributions in various areas, particularly, botany, zoology, geology, archaeology and astronomy. But we ache to think what might have been achieved had all our citizens had access to scientific knowledge and not just the white minority.

Solutions to the Problem

A scientifically and technologically backward country will find it impossible to achieve acceptable economic growth. While South Africa does have limited, and in some cases highly skilled, technical competence, it is generally technically backward. We now need to point to pathways out of this situation.

The first requirement is the development of a National Science and Technology Policy which will allow the country to make rational, structured, and well coordinated development decisions. Secondly, in order to support such a policy, we need more artisans, technicians, technologists, engineers and scientists. By the end of the century South Africa will need to provide 9 million more jobs. In particular, the artisan career path is likely to offer rapid job creation possibilities. Thirdly, we need to direct, rationalise and properly fund our R&D so that our efforts are optimised and not diffused among projects which are uncoordinated, too small to attain critical mass or irrelevant to the interests of the people of this country.

National Science and Technology Policy

The problem of establishing a National S&T Policy is that of striking a balance between rigid bureaucratic control and the haphazard and wasteful stopstart approach to technical which South Africa has adopted in the past. To be successful such a policy must involve and obtain the commitment of industrialists, trade unions and academics. It should define and assess desirable state projects and provide guidelines for private sector developments and support to meet a set of established national

Research and Development

Research and Development is part of S&T. Without R&D new S&T cannot be discovered and growth will not be possible. The aim of the overall R&D effort should be to improve the lives of all South Africans. To this end we advocate close cooperation between the universities and technikons, which produce S&T specialists, the industrial and agricultural sectors which employ them, and the organisations of the people, which represent those who consume the products of technology.

Our overall research effort needs to be carefully rationalised. At present most pure research is done by universities and applied research by institutes like the CSIR and by large industrially based companies. We shall examine the role of pure research first. Until now we have emphasised the role of applied science and technology rather then pure science because of the more directly positive link between the former and the economy. Although we are convinced that this is the correct emphasis this does not mean that the ANC will maintain a mechanical bias towards applied research.

We believe that it is extremely important to maintain a nucleus of high quality pure research for several reasons. Firstly it is important to have a reservoir of people in tertiary education who have a deep understanding of basic phenomena. Because such phenomena underlie all applications of science it is important that our technologists and engineers have an excellent grounding in pure science too.

Secondly, it is seldom possible from the outset to know what applications, if any, will result from a given piece of pure research. The most important practical applications may come unexpectedly. For example, transistors from quantum mechanics, nuclear power from special relativity. It can therefore be a mistake to require scientists to provide narrow justifications of the usefulness of their projects.

Thirdly, we believe that pure scientific thought is one of the highest expressions of the human intellect and spirit, on a par with music, art and literature. In the words of the Freedom Charter, "The doors of learning and culture shall be opened." Full human life implies trying to understand the deeper implications of science (e.g. where we come from, how life developed, etc.) because this is an important part of our understanding of our position in the universe and the nature of our lives. If we were to give no encouragement to such thought this would be a statement of our views on South African people: that we are incapable of rising to the heights other nations have achieved.

What of the State research institutes like the Council for Scientific & Industrial Research (CSIR) and funding bodies like the Foundation for Research and Development (FRD)? Many scientists are of the opinion that the state attempted to rationalise research and development several years ago by restricting the CSIR to applied research. We have nothing in principle against rationalisation, but feel that an integrated approach of theoreticians and applied researchers working together on projects might be more effective and it is encouraging that the current management of the CSIR declares that it shares this viewpoint. More important are the decisions about what research to fund. We believe it would be advantageous if such decisions were influenced by much more broadly based opinion than at present. This is not to day that we would overcrowd scientific bodies like the FRD with non-scientists telling scientists how to do their jobs. But it seems essential to us, for example, that workers have a say in what research should be done on technology which concerns them. We advocate, therefore, that trade unions be represented on the National Science and Technology Policy Council. S&T should serve ordinary people and can only benefit from the popular perception that it does so.

Criteria for a National S&T Policy

We have mentioned earlier that developing an S&T policy involves deciding how much control government should exercise and exactly where that control should be applied. We believe that a balanced policy would best be arrived at by a rather broadly based National Council for S&T. It would be composed of representatives from industry, the trade unions, agriculture, the technikons and the universities, funding bodies like the FRD and the Academy of Science. The National Council would decide on basic strategies to promote progress in development and appli-

cation of S&T, leaving detailed work to bodies like the FRD.

Without wishing to preempt the deliberations of a Future National Council, we offer some thoughts on how a policy could be arrived at. Two basic questions need to be answered before we can proceed. Firstly, what urgent needs of South Africans can be met by an application of existing or attainable technologies? And secondly, what combination of S&T programs will result in an optimal generation of wealth for South Africans?

An example of an urgent need which can be satisfied by existing technology is the provision of electricity to all South Africans. We regard this as a priority for several reasons. Firstly, chronic health problems are directly caused by the high level of wood smoke pollution in townships. This far exceeds the negative effects of sulphur dioxide pollution from coalfire power stations in the Eastern Transvaal, although we do not wish to ignore the health risk these present either. Secondly, the electric light facilitates study and intellectual activity, thus contributing indirectly to the alleviation of the skilled manpower shortage. And thirdly, the collection of wood for fuel is a time consuming and ecologically unsound activity. The provision of electric power for all would free poor people, particularly women, from this drudgery as well as preserving the environment. Current estimates are that it would cost R6billion to electrify all South African townships and this would not involve the erection of any new power stations because we already have a 30% overcapacity in electricity generation.

To develop an effective wealth generating S&T program we need to answer another fundamental question: is it better to allow relative freedom to industrialists, providing incentives across the board for beneficiation of raw materials? or, should we constrain them to focus on particular products which we believe have a better chance of being competitive on world markets? We briefly examine two case studies, Japan and the United States to clarify this issue.

In Japan the central government agency responsible for directing the bulk of research does not have the word science in its name, but is called the Ministry of International Trade and Industry (MITI). Today Japan is not known for its Nobel laureates but for high quality manufactured goods which are exported worldwide. In recent years MITI has engaged in high risk projects, hoping to secure the longterm strength in technology which it has so carefully nurtured. The transfer of technology back to industry via both training and collaborative programs is important and the majority of big research programs are arranged jointly between MITI, industry, and

the organised labour movement, although the latter certainly plays a less important role. None of this would be possible without R&D expenditure. In 1990 Japan will spend about 2,9% of its GNP on R&D. Of this, 96,5% is civil research and about 70% is financed directly by industry.

The United States on the other hand, will spend 2,5% of its GNP on R&D of which only 25% is civil research and 50% is financed directly by industry. This emphasis has not been as effective for the United States, probably because military projects generate less wealth. Moreover there is a comparative lack of direction in civil R&D in the US. Research programs are rarely joint actions taken by industry, academia and government, and never include worker organisations. The National Science Foundation (amongst others) administers an annual budget which is allocated in small parcels to individuals or groups of individuals. Programs are thus relatively shortterm (and hence very intense) but lack a sufficiently applied character. The result Nobel laureates bloom, as does pure science, but the manufacturing sector lags behind.

We believe that these two examples illustrate the need for firstly a well devised national industrial strategy and secondly a well coordinated manpower development program. Thus the national strategy should be directed towards perfecting:

1) what we are good at, and

2) what we need.

For example [in respect of (1)] we should not try to develop a rival silicon valley in the Western Cape, for example. Instead we might put our efforts into expanding our half-formed capability in materials, both metal alloys and ceramics. In respect of (2) we should aim to produce, say, lowcost housing units rather than casspirs.

Conclusion

We have written this chapter with the ANC policy of a mixed economy containing both strong state and private sectors in mind. The roles of both sectors must continually be reviewed in the light of how effective they are in providing for the needs of South Africans. In the past the funding and policies of S&T in South Africa have always served the interests of the apartheid government and big business. In the future, S&T should serve the interests of all the people, not just a rich elite. The full benefits of S&T can only be realised when the mass of people can make political decisions. The wealth of this country has been produced by workers and S&T has developed partly as a result of workers' labour too. Therefore the struggle for a

science policy that serves the people of South Africa is part of the struggle for democracy.

Science and Technology will prove decisive in the battle to achieve material security for all the citizens of this country. We see it as an urgent priority to develop effective indigenous technologies which will give South Africans greater control over the beneficial utilisation of our country's resources. To this end we advocate the integration of an increasing number of South Africans into Scientific and Technological Fields.

Towards a Technology Policy for South Africa

Mohammed Valli Moosa

OVER the past few weeks many people have approached me with a perplexed look on their faces. Is the ANC really organising a science and technology conference, they asked in disbelief. I am quite certain that if such a conference was held by the UDF during the State of Emergency, the security police would have deployed every kind of intelligence technology available to it inside and outside this room. They would have been convinced that our science and technology discussion is actually about timing devices, fuses and anti-Caspar technology.

Friends, and comrades, yes, the ANC is genuinely interested in science and technology, more particularly in the development of a national science and technology policy that will serve the people of this country.

As a liberation movement we are as interested in the drafting of a democratic constitution for South Africa, the development of a Bill of Rights and the restructuring of the economy as we are in a national science and technology policy.

The apartheid policy has been much more than a denial of the franchise to the majority of South Africans and much more than segregated residential areas. It is a policy that infected every aspect of life be it the economy, educatlon, culture, religion and indeed even the development of science and technology.

In attempting to rid this country of the injustices of apartheid our goal should be not simply to replace the present white minority government with a democratically elected non-racial government.

For the ANC the struggle against apartheid is a struggle for freedom in all spheres of life. One cannot overstate the fact that in SA the advantages of technological progress are being enjoyed only by a small elite.

Mohamed Valli Moosa -November 1990-

Our vision is to build a strong technological base as a means of improving the living conditions of all South Africans as a means of combatting illiteracy, homelessness, escalating unemployment, hunger and disease.

SA would find it impossible to achieve acceptable economic growth as long as it remains a scientifically and technologically backward country. We are acutely mindful of the fact that economic growth is to a great measure driven by advances in technology.

The ANC is of the view that the political transformation of SA must be accompanied by an equally comprehensive transformation in the fields of science and technology.

For the new South Africa we need to develop a national science and technology policy that is indigenous and one which is geared to meeting the needs of our people.

At present science and technology are grossly neglected. There is a serious shortage of technically trained people. This shortfall is deeply rooted in apartheid. Scientists and engineers are almost exclusively dra~n from among the white population.

The disturbing reality is that 96% of all engineers and 89% of all scientists in SA are white. This is largely due to a school education system which produces one maths and science matriculation exemption for every 10 000 black school entrants.

Minister of Trade and Industry, Kent Durr's, report on technology policy released this week talks about "reorientating the education system towards a more technological inclination". This is welcome but it will achieve little lf the racial inequalities in education remain.

Compared to developed countries our science and technology human resources lag sadly behind.

At present only 1 225 engineers graduate annually in SA. This represents about 35 engineers per 1 million population. The figures for Japan and the US are 600 and 360 respectively.

SA has proportionately only 10% of the number of sclentists and engineers that North America has. And whereas the USA has 13 doctoral degrees in science and engineering per 10 000 population, Germany 22 and the UK 11 SA has only 0,18.

The figure for the number of technically trained women are just as dlsmal. According to statistics only 8 percent of all first year engin-

eering students at SA universities during 1989 were women.

In our view, South Africa is a technically backward country and it serves us no good in the long run to smugly compare our technical competance with that of our neighbouring countries. The fact of the matter is that the SA economy relies heavily on the export of raw materials (like coal and gold) and on the import of high tech equipment, machine tools etc.

Although motor vehicles are manufactured locally, the R&D departments of the multinationals controlling the motor industry are abroad.

Of course there are exceptions to these trends, like Sasol, the Atomic Energy Board and perhaps Armscor. Some of these projects were motivated by the machinations of an apartheid government in a state of war with the neighbouring countries and even the people of SA itself.

So that the extent to whlch there has been technological advances these have been skewed. In our view it has been skewed ln order to suit the political and ideological persuits of a white minority.

The strategic choices have been for projects like Sasol which run at a huge loss rather than projects to electrify the townships. The cholces have been for the development of an arms lndustry rather than developing technology which could serve to redress the imbalances between urban and rural life. In general our technological development has been too urban orientated.

The development of a national science and technology policy must involve the participation of a broad range of South Africans, including trade unions and other mass organisations. Work on such a policy must also involve the participation of universities, research institutions and industry. It is just not good enough to appoint as the government has done a Scientific Advisory Council composed of fourteen experts.

We are pleased that this very first science and technology conference organised by the ANC has attracted such a wide range of participants.

Science and technology issues need to be simplified so that they become accessible to the layperson. In this way the strategic choices we make will begin to involve the participation of a broad layer of South Africans. The ANC is committed to striving for a democratic method of policy making.

Mohamed Valli Moosa -November 1990-

Bearing these points in mind how can an acceptable policy be arrived at?

Clearly the development of a science and technology policy involves deciding how much control government should exercise and exactly where that control should be applied.

According to an ANC discussion paper on the issue, two basic questions need to be answered. Firstly, what urgent need of South Africans can be met by an application of existing or attainable technologies? And secondly, what combination of S&T and programmes will result in an optimum generation of wealth for South Africans.

An example of an urgent need which can be satisfied by existing technology is the provision of electricity to all South Africans. We regard this as a priority for several reasons.

Firstly, chronic health problems are directly caused by the high level of wood smoke pollution in townships. This far exceeds the negative effects of sulphur dioxide pollution from coalfired power stations in the Eastern Transvaal, although we do not wish to minimise the risk these present either.

Secondly, the electric light facilitates study and intellectual activity, thus contributing indirectly to the alleviation of the shortage of skilled human resources.

And thirdly, the collection of wood for fuel is a timeconsuming and ecologically unsound activity. The provision of electric power for all would free poor people, particularly women, from this drudgery as well as preserving the environment.

Current estimates are that it would cost R6 billion to electrify all South African townships and this would not involve the erection of any new power stations because we already have a 30% overcapactiy in electricity generation.

To attempt to arrive at an effective wealth generating set of *S&T* programs we need to answer another fundamental question: is it better to allow relative freedom to industrialists, providing incentives across the board for beneficiation of raw materials or, should we constrain them to focus on particular products which we believe have a better chance of being competative on world markets?

In its discussion paper the ANC looked briefly at two case studies: Japan and the United States.

Japan is not known for its nobel laureates but for high quality goods which are exported world wide. The Japanese government through its Ministry of International Trade and Industry (MITI) has engaged in high risk projects hoping to secure the long term strength in technology which it has so carefully nurtured. The of technology back to industry via both traininq and collaborative programs is still important and the majority of big research programmes are arranged jointly between MITI, industry and the organised labour movement, although the latter certainly plays a less important role.

None of this would be possible without R&D expenditure. In 1990 Japan will spend about 2,9 percent of its GNP on R&D. Of this, 96,5% is civil research and about 70% is financed directly from industry.

The United States on the other hand, will spend 2,5% of its GNP on R&D of which a mere 25% is civil research and 50% is financed directly by industry. This emphasis has not been as effective for the US probably because military projects generate less wealth proportionately. Moreover there is a comparative lack of direction in civil R&D research programmes are rarely joint actions taken by industry, academia and government.

The National Science Foundation in the United States adminlsters an annual budget which is allocated in small amounts to individuals or groups of individuals. Programmes are thus relatively short-term (and hence very intense) but lack a sufficiently applied character. The result nobel laureates bloom, as does pure science, but the manufacturing sector lags behind.

This illustrates the need for, firstly, a well devised national industrial strategy and, secondly, a well coordlnated human resources development programme. Thus the national strategy should be directed towards perfecting

i) what we are good at, and

(ii) what we need.

In respect of (i) we should not try to develop a rival silicon valley in the Western Cape, for example. instead, we might put our efforts into expanding our half-formed capability in materials. In respect of (ii) we should alm to produce lowcast housing units rather than Ratels.

In conclusion, we believe that vigorous debate needs to take place around these issues - this conference must be seen as part of the debate which would lnform the ANC.

Mohamed Valli Moosa -November 1990-

This conference becomes part of the struggle and search for a greater freedom for all South Africans. A humane political system will free our people from the bondages of apartheid. Advances In science and technology are crucial to improving the overall well-being of our people.

Finally, technology can be developed in many directions. There are often many choices and what emerges is usually historlcally determlned.

Let us make the rlght choices so that the country may prosper and the creatlve potentlal of our people flower. ❑

An African Perspective on Technology

Prof. Chodziwadziwa C. Mjojo

President, Network of African Scientific Organisations

"Science and the pursuit of knowledge are given high priority by successful countries not because they are a luxury which the prosperous can afford but because experience has taught us that knowledge and its effective use are vital to national prosperity and international standing."

Margaret Thatcher

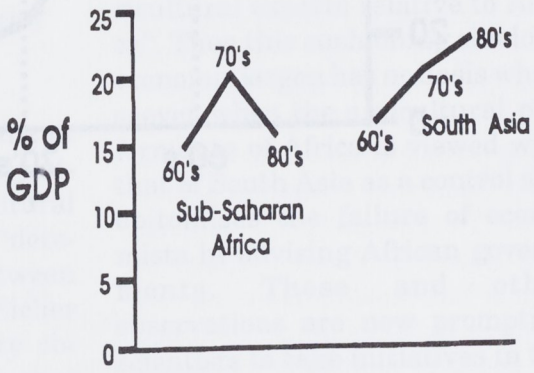
But research and development in science and technology has been treated as a luxury and given the lowest priority in African nations. This paper attempts to summarise the pathological indicators in economic performance of African states which have arisen inadvertently by following policies contrary to the prescription of the Prime Minister of Great Britain cited above.

The analysis also gives a grim introduction to the realities of being African. These are realities which the New South Africa inherits at her birth and provides new challenges to overcome in the process of transforming the continent for a better place to live. it also shows what the New South Africa can become if it is lured into following the paths taken by African states.

The Pathological Indicators in Economic Performance

Decline in investment rate

Investment Rate

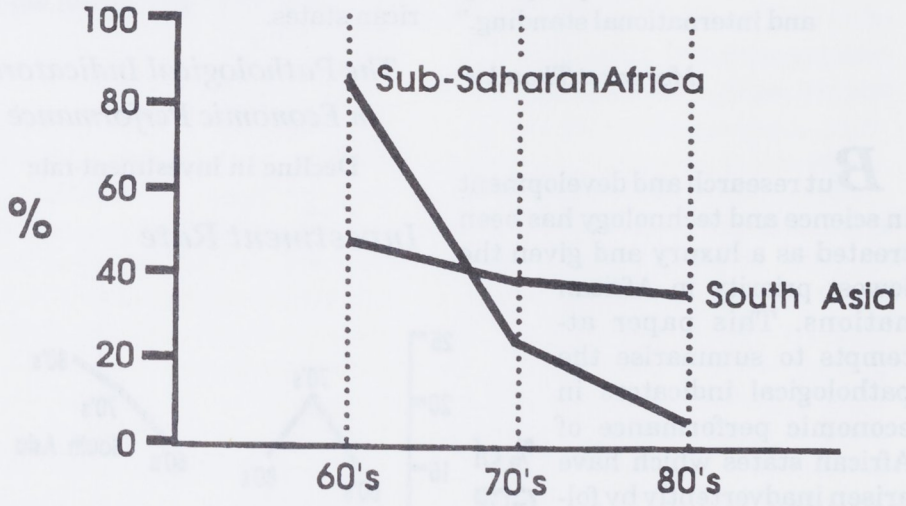


Sub-Saharan Africa enjoyed a competitive investment rate growth which was even superior to that of South Asia between 1960 and 1970. The investment rate suffered an abrupt decline from 1970 onwards whereas that of South Asia shows consistent growth.

During the early sixties Sub-Saharan Africa provided a superior net rate of return on investment relative to that of South Asia. Sub-Saharan Africa now has the most inferior net rate of return on investment on the globe. This accounts for the rapidly deteriorating investment rate.

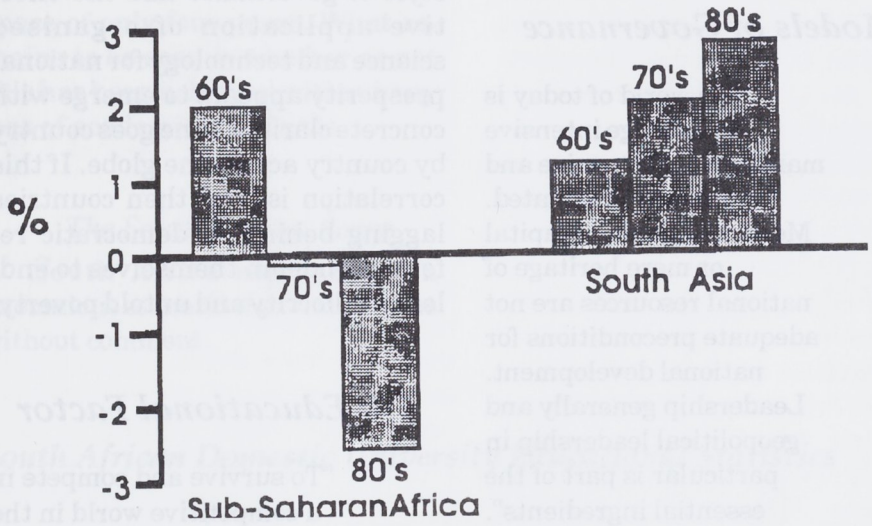
Declining net rate of return on investment

Net Rate of Return



- *Adverse per capita GDP Growth*

Per Capita GDP Growth



The per capita GDP growth shows a dramatic deterioration relative to that of South Asia.

Poor Agricultural Export Performance

Economic advisers to African governments have consistently attributed Africa s poor agricultural export performance to the "deteriorating terms of trade" between the North and South. Carl Eicher of Michigan State University observes: "The unhappy truth is that although Asia and Africa competed in the same world markets and received the same export price over the past two decades Asia has gained world market shares in agricultural exports relative to Africa". Thus this cushioning shield of economic jargon has no basis whatsoever when the agricultural performance of Africa is viewed with that of South Asia as a control and epitomises the failure of economists in advising African governments. These and other observations are now prompting scientists to take initiatives in the

policy making arena of the continent. African leaders must now begin to use scientific advisers as their counterparts in the industrial world commonly do.

Models of Governance

"The world of today is knowledge intensive management intensive and technology dominated. Mere possession of capital or mere heritage of national resources are not adequate preconditions for national development. Leadership generally and geopolitical leadership in particular is part of the essential ingredients".

T.R. Odhiambo

The prescription by the President of the African Academy of Science is clear and bears profound implications. His observations are in good company. The recently published report by the World Bank ("Sub-Saharan Africa: From Crisis to Sustainable Growth") also makes strong allusions to the role of the state and economic performance. The International Development Research Council (IDRC) of Canada has recently issued a consultative publication which hints at a possible linkage between the effective application of research and development in science and technology for national development on one hand; and the democratisation processes on the other hand. The correlation between the style of governance and the effective application of organised science and technology for national prosperity appears to emerge with concrete clarity as one goes country by country across the globe. If this correlation is true then countries lagging behind in democratic reforms condemn themselves to endless mediocrity and untold poverty.

The Educational Factor

"To survive and compete in a competitive world in the 21st century Africa will require not only literate and numerate citizens but also highly qualified and trained people to perform top—quality research formulate policies and implement programmes essential to economic growth and development"

World Bank

The Kenyan Experience

Kenya is an excellent example of a Sub-Saharan African country which has taken bold steps in ex-

panding university education. With an estimated full time equivalent (FTE) enrolment of about 8000 university students in 1988 the projected enrolment of 35000 FTE for 1991 represents at least a four-fold expansion within the space of only four years. What remains to be seen is whether or not this has been achieved without any loss of academic standards.

- *The South African Scene*

South Africa represents an anomalous scenario that cannot pass without comment.

South African Domestic University Educational Statistics

Population Group	FTE (F)	% Popul. (P)	RHF
Black	23	69	67
Coloured	3	11	70
Asian	7	3	-138
White	67	17	-291

$$RHF = \frac{P-F}{P} X100$$

RHF = Relative Handicap Factor

RHF = 0 for an equitable distribution

Prof. Chodziwadziwa C. Mjojo -November 1990-

The relative handicap factor (RHF) measures in a single variable the extent to which a population group is receiving an equitable share of educational opportunities at the national level. A negative RHF implies a most favourable and promotive environment. A positive RHF is disadvantageous. The educational imbalances do not correlate with intellectual capacities of the population groups. SubSaharan African students account for 20% of total FTE (foreign and domestic) in European and North American universities. This represents a considerable share of educational opportunities on the globe; particularly as this is over and above those enrolled within their national universities on the continent and other non—European countries such as Japan and Russia. South African blacks would have to be different from Africans across the border if the imbalances were intrinsically justified. The new South Africa will understandably demand that the distribution of educational opportunities be normalised over and above responding to the implications of the World Bank prescription above.

Continental Scientific Renaissance

As alluded to elsewhere African scientists have decided not to remain indifferent to developmental issues of the continent. They have decided to expand their field of operation beyond the confines of their laboratories. Their analytical knowledge represents a vital pool of expertise hitherto very much underutilised particularly in view of the limited scientific resources at their disposal as a result of the low priority awarded to R & D operations in their fields. There have been a number of serious ministerial conferences leading to important declarations which unfortunately have yielded no measurable impact at the implementation stages. This explains the birth of a number of scientific organisations during the last five years as summarised below together with their fields of competence.

The Scientific and Industrial Infrastructure of Africa

• *The Network for Scientific and Technological Institutions (ANSTI) (1974) NAIROBI UNESCO ROSTA*	*Academic and professional exchanges textbook writing and scientific meetings.*
• *The African Academy of Science AAS (1985) NAIROBI*	*Science and Technology Policy and general developmental issues.*
• *Network of African Scientific Organisations NASO (1989) NAIROBI*	*Industrial and technological development of Africa.*
• *Panafrican Union of Science and Technology PUST (1990) BRAZZAVILLE CONGO*	*Science & Technology Policy with emphasis on scientific research and education.*

A new and important development has been the creation of a think—tank organisation based in Nairobi called the Future Actions Committee on the Management of Science and Technology for the Development of Africa which is chaired by the renowned Nigerian soldier and statesman General Olusegun Obasanjo. A particularly interesting innovation has been the creation of a Presidential Forum through which the Future Actions Committee intends to sensitize African Heads of State to the centrality of science and technology in the development process. To imbue them with the need to give absolute priority to science and technology to the point of taking personal charge of science and technology policies on the same footing as national security. President Moi has kindly agreed to host the first such Presidential Forum in Nairobi.

Conclusion

The move by the ANC to include science and technology policy on the agenda for political reforms during the transition period is unique and highly laudable. This matter was never an issue at the negotiating table for independence in African states. This initiative which recognises the central role of science and technology in national developments and the democratic form by which the consultative meeting has been organised gives

a positive signal of the style of governance envisaged by the ANC. It is an assurance that the New South Africa is a sciencedriven high-tech country.

It is also clear that a proper strategy for transforming the continent will involve net-working of scientific and technological infrastructure across national borders. The building of such infrastructures takes time. This fact is recognised by scientists across the continent but are keenly awaiting the green light from the ANC for such processes to start with hopefully this part of the continent making a leading contribution.

Towards a Technology Policy

Some Propositions for Discussion

Prof Hans Pornschlegel

Sozialakademie Dortmund, Dortmund, Germany

1. Talking about technology policy, the term might imply different meanings for goals, measures and time spans involved, e.g. concerning the reach of such a policy;

- *just the economic promotion of certain industries with certain (basic or high tech) technologies, possibly limited to certain company sizes and types of ownership, by different incentives like tax holidays, financial incentives, grants for investments, additions to wages;*

- *a further reaching promotion of certain technologies, including the educational and physical infrastructures, as major parts of a future oriented socio-economic policy of "modernisation";*

- *an overall promotion (as before) but with the inclusion of relevant research, development and possibly technology transfer activities.*

(The author favours the latter concept, following the German line).

2. There might be also specified goals to promote technologies, e.g.

- *just R&D promotion*

- *support of market introduction*

- *introduction of mature technologies into new sectors as technology transfer, to achieve synergic effects*

- *supporting technology introduction into existing markets (e.g. energy saving technologies in*

households, in industry, sewage disposal, by subsidies or tax reliefs).

3. Any type of technology policy will, of course, depend in its objectives and instrumentation on the basic options towards a more market oriented or a more publicly controlled economy, or towards forms of a mixed economy following some European patterns (e.g. Sweden, Germany). It will consequently depend on its approach and structures on the economic theory underlying the decisions.

4. Any technology policy should be directed to unsatisfied public or private needs or demand which appear to be of public interest for social or economic reasons (e.g. improvement of living conditions in townships by improving infrastructures).

5. Any future technology policy will depend on the political and constitutional framework in a state liberated from apartheid. Apartheid seems so far to shelter segmented labour markets and therefore strong income differentials with repercussions on the structure of production and services as well as on the income levels of the black and coloured population. With apartheid removed, a process of lowering labour market barriers and levelling of incomes for the working class can be expected, setting free new economic forces and creating a changing environment for competition within and outside the state.

6. With scarce resources and a critical overall economic situation to start from, fundamental political decisions will be between a strengthening of market forces vs. state regulated fields. This will influence the generation and redistribution of incomes but also the role of production and services. There will be repercussions e.g. in the fields of education and vocational training (e.g. state funded systems vs. private sectors). The options chosen will affect future technology policy by influencing production and qualification structures in the medium and longer term.

7. Market oriented economies allow a better feedback and therefore objectified control of promoted R&D as centrally controlled economies. It helps to avoid the build-up of "ivory tower technologies". At the same time, the support and promotion of technologies which cannot soon survive unsupported on the markets, has to be watched with extreme care (exceptions might be politically justifiable in cases of ecological and job conservation measures).

8. Within the framework so defined, technology policy must have a vision, a scenario:

- *What should be the role and rank of technology policy amongst other major policy fields of a state, (e.g. social and health policy, educational policy, defence policy) - how should their combined implementation affect living and working conditions of the people within five, ten or fifteen years hence?*

- *What future mix of industries and services of the country is envisaged under such time horizons?*

- *Which technological levels should be achieved, by own resources only, by using foreign expertise, by joint ventures, by promoting the growth of foreign companies with special emphasis on high-tech and adequate research?*

- *How can such a policy be linked up with providing the necessary human resources with adequate qualifications at the times needed?*

- *How can necessary measures of educational and labour market policies be geared accordingly?*

9. The questions mentioned here indicate the need for a systemic approach in which the interdependence of the different policy areas is the logical starting point. A systematic approach also means that the systems and sub-systems to be influenced change over time in their interrelationships: Dynamic approaches and models are needed which allow adaptation to sometimes quick changes (e.g. in international markets).

10. There is little doubt that Republic of South Africa has a high potential to become a stronger economic force if it will find an optimum combination of;

- *utilizing its raw materials on the one hand as scarce goods and at the same time at relatively high world market prices,*

- improving the productivity of farming at competitive and profitable price levels, again on the world markets,

- developing its services, especially tourism, possibly in a "soft" and ecologically acceptable version,

- developing niches for specialized and high-tech industries for Africa and the world (where there was an international base before the boycott wave).

It seems essential to analyse and evaluate potentials for technology development in all these fields (e.g. mining, farming technologies, new organisational patterns for tourism).

11. The RSA has - in some cases as a result of boycotts - reached a very high level of technology, e.g. in the liquefication of coal. The high tech armament industry offers a lot of potential for future civil uses supported by a conversion policy.

12. Scenarios and visions are certainly not sufficient to develop a viable technology policy for a nation. As with any other area, a thorough analysis of the economic (i.e. also market situations), technological and manpower situations must be another starting point.

13. A major question will be the quality and volume of the data available from existing statistics, enquiries and surveys. If they are severely deficient, then the planning process and the decisions following them will carry forward such defects.

14. Any analysis and evaluation will be the more effective if it is guided by clear goals of their uses and by a good know how about markets in order to formulate a framework for future policies. Therefore a set of goal and market oriented criteria is needed which reflect the variables and the behavioural patterns to be affected.

15. Part of the analysis must be a status of research and development capacities already existing in the hands of the state, to other public agencies, of universities, of commercially operating institutes and of the companies. Due to their commercial interest, the latter carry the major part of R&D costs in most Western countries.

16. Analysis must be followed by an evaluation of the findings under the same criteria.

17. This process is the point of departure to formulate policy options to be pursued as to:

- *goals and objectives*
- *subjects and areas to be covered*
- *duration*
- *measures*
- *conditions of granting*
- *financing*
- *control instruments*
- *legal status of measures*

18. Another important strategic question is which areas beyond the purely industrial ones should be pursued in the national interest by a technology policy supported by research and development (e.g. service sectors, technical education, ecological questions, energy conservation, transportation and traffic systems, materials and substances, production and process technologies).

19. As in most other countries, a decision has to be made in principle which roles the different "agents" and institutions should play in technology development and now.

20. A basic decision by a national government will therefore be whether and possibly with which division of labour technology, technological and accompanying social research, development and promotion will be the responsibility;

- *of a centrally responsible ministry or of several ministries resp. government departments;*
- *of other public institutions, regional or local using;*
- *financial incentives (taxation, subsidies, grants etc.)*
- *or private capital.*

21. For technology to be used for the improvement of industries and services, a system of graduated incentives and subsidies would have to be (further) developed, with a special emphasis on creating effective research facilities and capacities with high calibre personnel. It must respect the functioning of markets as well as the subsidiary need to assist in getting access to markets with new and intelligent products until they can be left to the play of market forces.

22. To assist in removing the so far existing legal and factual discrimination by apartheid, policies and concepts for technology promotion could and should include special measures favouring investment and qualifications for the so far disadvantaged groups.

23. Even if market oriented approaches are chosen, the danger of biasing investment options and "take-with" effects are a massive danger. Any intervention even of the "milder" kind has some unwanted by- and side effects.

24. With limited means at disposal for a national budget, the fight for priorities will take place between lobbies and political factions. There is still room for regional and even local technology policies within a national framework.

25. Since multinational and large national companies need relatively less assistance - if any - for their own "technology policies", ways and means must be found to foster the innovativeness, creativeness and flexibility of medium and small businesses by adequate and flexible forms of promotion.

26. The implementation of any technology policy usually has strong repercussions on the industrial relations' scene at branch, company and plant level. Therefore the participation of the labour market parties in the formulation and implementation of the labour market parties in the formulation and implementation of technology policy should form an indispensable part of the concepts to be developed. Workers' representatives should be participating in the planning and implementation of measures at plant level. Such an approach will strengthen the industrial relations' network and at the same time promote acceptance and implementation of new technologies. Industrial health and safety concepts as well as far reaching qualification measures should be part of such parcels. Such an approach would help to stabilize the structures of a non-apartheid democratic safety.

27. The German and Swedish national programmes provide special activities for research and development of work and technology for the improvement of working conditions. In a nation growing together after very deep racial conflicts, such a special technology programme might assist in modernising the industrial sector and creating working conditions compatible with the democratisation of the political sector of society.

28. For the RSA, the improvement of living conditions of the so far disadvantaged groups of the population might have equal rank. Technology programmes could focus e.g. on improved building technologies, house heating, communication etc.

29. As a parallel activity at national level, but also accompanying sectoral programmes, a process of well-organized technology assessment is most desirable where an iterative prognostic and accompanying approach appears adequate.

30. A constant feedback is needed between technology policies and programmes and of educational policy, especially in planning and providing capacities, personnel and finances for adequate measures of basic and further vocational training but also for education at institutions for higher learning. Here again, active countermeasures against discriminations by apartheid seem indispensable (cf. experiences of developed industrial countries).

31. It is common opinion in our countries, that such a policy should aim to build and strengthen those features of qualification:

- *systematic theoretical know how of technologies and systems;*
- *sufficient practical skills for the technologies to be applied;*
- *competence for problem solving of complex issues within wider spans of discretion;*
- *"social competence" for working with and communicating in teams, with customers and suppliers and for pursuing own and group interests.*

32. A RSA liberated from apartheid should regain the support of the free world in such a process of developing adequate technology programmes. Cooperation and assistance could be expected in bilateral, multilateral and international networks, in such programmes, but also in the essential field of technology transfer.

Mastering Technology as a Political Challenge -

German Experience and Perspectives

Prof Hans Pornschlegel

Sozialakademie Dortmund, Dortmund, Germany

A. Germany - a theater of antagonistic concepts of technology policy

1. "We are the people" - this was the motto of a peaceful revolution without bloodshed which started the process of unifying two Germanies with antagonistic philosophies in nearly all major areas of political life. A self-proclaimed "socialism existing in reality" broke down. A state disappeared with its formal structures by joining the Federal Republic of Germany, in many fields leaving back disorganized and sometimes chaotic conditions.

2. The change in structures affected fundamentally a so far largely centrally planned economy which was governed by qualitative and quantitative goals defined by the ruling party - in fact by rather arbitrary decisions of hidden bureaucrats. The lacking international competitiveness and relatively low productivity of the old combines made an easy transition into a market economy largely impossible.

3. Like the whole economy, science, technology and research were centrally planned, accordingly organized and carried out in the former GDR. Huge and well-staffed institutions like the "Academy of sciences" with approximately 25,000 employees and about the same number of persons in other research organisations there lacked, in spite of good formal qualifications, the innovativeness, creativity and productivity of their West German counterparts. Here, relative to the population, only one third of personnel was employed, and they were more successful in most respects - for a variety of reasons.

4. So a formerly centrally planned economy under an East Bloc oriented, socialist leadership is under transformation into a "social market economy" within a pluralist society - a gigantic undertaking without historic parallels. This is fully reflected in the reshaping of structures in the fields of research and technology which are now governed by:

- *freedom of science, research and teaching, a constitutional right and thereby a constituting factor in the field,*
- *scarce private and public funds,*
- *parliamentary decisions on the focuses of relevant legislation and budgeting for publicly funded research and development,*
- *market factors determining supply and demands of research and development capacities,*
- *a relatively high competitiveness amongst researchers and research institutions for money, personnel and projects, to mention the most important features.*

5. The technology gap of the East Bloc countries, including the relatively well situated former GDR, against advanced Western standards (e.g. about ten years time lag in computer standards and application) appear to be the result of basically wrong and inefficient guiding principles of "monolithic", centrally planned and controlled societies.

6. Inspite of certain structural weaknesses, there is not doubt that the developed structures of the "old" Federal Republic of Germany provide a framework, but also principles, policies and a financing which offer very good chances to reshape slowly but efficiently the East Germany structures and technology.

7. Inspite of a basic market orientation and the pursuit of "capitalist principles" of profit maximation by business, the federal German state has a very strong role in the redistribution of GNP which is largely governed by social principles. The state quota is still over 50 pc. In this respect, Germany represents a mixed economy with strong interventionist traits.

8. The new five Länder not only became immediately part of the Federal Republic; they also entered the European Community. Euro-

pean policies have an increasing impact on research and technology promotion by pursuing a respective Community policy in accordance with its member states. There are therefore competing European, national and regional programmes. In some cases there is also an overlapping with regional and sectoral economic promotion programmes.

B. Federal structures for science and education - constitutional pillars of policies concerned

9. The provisional German constitution, the Basic Law of 1949 with its amendments, not only contains inalienable human rights, but also defines the base of a federal state with checks and balances consisting of 16 Länder (federal states).

10. The freedom of arts, science, teaching and research is also defined as a basic right (art. 5.3); these rights are widely interpreted. This provision has strong consequences for the system of higher learning and research as well as for the relative autonomy of such bodies. It has repercussions on technology policy too.

11. Education and science is basically Länder affair in their legislation and budgeting. The Länder cooperate e.g. in the Permanent Conference of Ministers of Education and Culture, regulating e.g. requirements for certain studies, also in cooperation with the Federal Minister of Education and Science with very restricted competences in this field.

12. The promotion of research, like legislation concerning the economy and labour law and social insurance schemes are constitutional part of the competing legislation. The Federal state has made wide use of these provisions, which form part of the framework for a technology (and research) policy. this leaves sufficient room for Länder and municipal activities and institutions.

13. This also is true for legislation concerning basic and further vocational training (and labour promotion) which are considered as parts of economic and labour legislation. In our "dual system" of vocational training, the federal state is legislator, the schooling is provided by the Länder which coordinate the curricula amongst each other and with the Federal Institute of Vocational Training. These fields are again closely interrelated with technology policy and research fields.

14. The Basic Law (constitution) was enlarged by "joint tasks" (Gemeinschaftsaufgaben) "where the federal state participates in the fulfillment of Länder tasks if these tasks are relevant for the whole and the participation of the federal state is necessary to improve living conditions..." (art. 91a). As part of these joint tasks the enlargement and new construction of institutions of higher learning (Hochschulen) and adjoined clinics became part of the parcel, together with the improvement of regional economic structures and agrarian structures as another component. A 50% financial participation of the Federal Republic is the rule. Such joint tasks require respective legislation and budgetary measures by consensus between the Federal Republic and the Länder.

15. This fairly complicated structure has led to a similarly complex structure of formalised and informal cooperation between federal state and Länder, between all institutions in the field and of the private economy. Statutory bodies form an intermediate level (e.g. chambers of industry and commerce). There is also a close interaction between the fields of technology and research promotion in conjunction with regional or sectoral (structural) policies.

C. Some principles and approaches of research and technology policy in Germany

16. With some variations due to changing government, the integrated research and technology policy of the Federal Republic was guided by some common principles:

a) R&D in technologies is, together with the qualification of the people, the essential resource and source for national survival and economic development in accordance with the living and working conditions already achieved and aimed at.

b) Under our constitution the promotion of personal development and of qualification is a primordial public function (e.g. free education, even at University level). Therefore e.g. universities with (some essential) research functions are state financed and form an integral part of a research and technology policy concept.

c) Depending on the interpretation of proper state functions these will possibly require own research

capacities or the maintenance of state funded, though (relatively) autonomous institutions. The Federal Republic or Länder creates, organizes and finances such institutions (e.g. Federal Health Office, Federal Ecological Office, many federal research institutions, Länder institutes for ecological affairs).

d) Research and technology policy is aiming at strengthening the competitiveness of the private sector of the economy where this is in the national interest. This assumption presupposes major contributions to R&D from the private sector. Such aims can be pursued e.g. by special programmes and fundings for technology innovation and research (and other forms, e.g. in microelectronics, in production and process technologies).

e) R&D policies should be governed by the principle of subsidiarity: what can be decided and done by smaller and autonomous units, e.g. companies, autonomous research institutes, should not be undertaken by the state. The state only comes in if, when and where those capacities appear insufficient to do so (e.g. smaller and medium companies in getting access to CAD/CAM, CIM).

f) All programmes in this sector are in principle "aid to self-aid". With the assistance given, the technologies, industries and products promoted, should eventually find their unsubsidized access to the markets.

g) There are always dangers of distorting markets and market developments by such "benevolent" interventions in form of subsidies, R&D grants, general investment promotion programmes.

- by "take-with" effects of companies and institutions which would have undertaken the necessary steps anyway and out of their own financing; in such cases they provide extra revenues and profits;

- by the subsidizing effects for the companies concerned which strengthen their profitability vs. those operating without public support for technology and research;

- by shifting market positions and power of promoted companies and research institutions by strengthening their innovative potentials and capacities against competitors;

- by making the powerful ones more powerful (e.g. technology promotion of multinational combines).

h) International and European technological developments are becoming more and more important for national policies and their integral parts. In this respect, national technology policies are becoming more and more "regional programmes" of an economically united Europe of 12, possibly on its way to a confederation as United States of Europe around the turn of the millennium.

D. German structures and patterns of research and technology policies (former FRG)

*D.*I Some indicators for R&D and technology policy in Germany (former FRG);

*D.*II International position of German R&D by indicators;

*D.*III Major areas of R&D in Germany;

*D.*IV Some organizational structures.

A short description will be given verbally, with some transparencies assisting.

Acknowledgement:

*T*he author used for the preparation of the papers official documents and some internal papers of the BMFT (Bundesminister fÜr Bildung und Wissenschaft, Federal Minister for Education and Science), of the Christilich-Demokratische Union and the Grundgesetz (Basic Law), all in German.

Sources can be given at request.