SCIENCE POLICY: A NATIONAL RESPONSIBILITY ONLY? [1]

J.S. Wessels [2]

Opsomming: Wetenskapsbeleid: Slegs die verantwoordelikheid van die nasionale owerheid?

Een van die vernaamste take van 'n grondwet vir Suid-Afrika is waarskynlik die toedeling van funksies aan die onderskeie owerheidsvlakke. Een van die funksies wat vir die professionele amptenaar en die akademikus van wesenlike belang is, is die bepaling en uitvoering van wetenskapsbeleid. Waar die proses om Suid-Afrika se finale grondwet op te stel reeds in alle erns begin het, is die doel van hierdie artikel om die faktore te identifiseer wat gebruik kan word om 'n antwoord te vind op die vraag na die ideale owerheidsvlak vir die bepaling van wetenskapsbeleid in Suid-Afrika. Die volgende faktore word onder meer vir dié doel geïdentifiseer:

- Die geldigheid van die redes wat aangevoer word waarom wetenskapsbeleid op 'n hoër as die laagste moontlike owerheidsvlak gemaak moet word.
- Die mate waarin dit internasionale betrekkinge raak.

1 Based on a research project for the Centre for Science Development of the Human Sciences Research Council, under the guidance of the former Head of the Division for Public Administration Research, Mr A. Viljoen

2 Dr Wessels lectures at the Department of Public Administration, UNISA

- Die gewig wat wetenskapsbeleid dra, relatief tot ander owerheidsfunksies.
- Die beperkinge op openbare hulpbronne wat nodig is om daaraan reg te laat geskied.

INTRODUCTION

The writing of a final constitution of South Africa comenced in real earnest at the beginning of 1995. One of the main stipulations of the new constitution will be the assignment of functions to the various levels of government. At this stage it is quite clear that, according to the 1993 Constitution, the present arrangments in this regard will not necessaraly be retained in the new constitution – the result may even be totally different.

All public institutions are responsible for the formulation and execution of policy of their particular line functions. One of these functions which is of equal importance to professional officers and academics, is the determining and execution of policy regarding science and technology. Presently it is the responsibility of the central government. The question that comes to mind is whether this is the most suitable level, especially for policy-formulation. The purpose of this article is not to give a decisive reply to the question, but rather to identify factors which could be used in finding an acceptable solution.

One of the key factors in finding a solution, is in all probability the specific nature of policy. As numerous definitions of and views on the concept of science policy exist, a brief conceptual analysis followed by a broader contextualisation of state functions and organisation will be given first. After that, the systems of policy-formulation and execution will be examined. The last part of the article concludes with a discussion on criteria for determining the hierarchical position of the function of policy-formulation and execution with regard to science and technology.

CONCEPTUAL ANALYSIS

Before the issue of science policy in the context of state functions and organisation is discussed at length, the concepts public policy, science and science policy are analysed briefly.

Public policy

Roux (1968: 142) and Dror (1968: 12) describe policy as a complex and dynamic process that determines and details goals and lays down major guidelines for action. Both Friedrich's (1971: 7) and Anderson's (1994: 5) definitions of policy link up with the foregoing in that they describe policy as a proposed course of action. Steyn (1971: 7) sees policy also as a declaration of intent, a specification of objectives and a broad description of the different ways in which particular objectives will be pursued. Public policy, an important variant of policy, is seen by Palumbo (1988: 9) as a constantly changing series of intended actions and behaviours of many government agencies and officials. As a guiding principle behind regulations, laws and programs (Palumbo 1988: 10), it usually entails future action, outlined in a policy document, for example a White Paper (cf South Africa 1993).

The formulation of public policy is by implication a function of the state. It aims to satisfy the real needs and expectations of society. The process of policy-formulation can be analysed in terms of,

- the process with its distinguishable stages (e.g. initiative, advice, formulation, execution and evaluation) (Anderson 1994: 37);
- the actors (e.g. the legislature, political executive office bearers and government departments) involved in the process (Anderson 1994: 55-61);
- the various dimensions of policy (e.g. substantial policy and procedural policy) (Anderson 1994: 10; Lindblom 1980: 64-65); and
- the different levels of government (e.g. central, provincial and local) where policy can be formulated and executed.

Science

For the purpose of this article science is regarded as,

- symbolising man's ability to interpret, to understand and to control through increased understanding (Garbers 1992: 1);
- the sum of the knowledge of facts, natural laws, and phenomena that have been verified through observation, experimentation and logical thought (Department of National Education 1988: 21); and
- a system of knowledge that can serve as a theoretical basis for the development of practical techniques, or technology (Loxton 1992: 135).

Science policy

Science policy can be regarded as a facilitatory or enabling instrument employed by the government to reconcile the logic of science with the needs of society (Garbers 1992: 1). This reconciliation process consists of proper guidance in the area of research and development (R & D) to ensure the achievement of broad national aims through contributions from science and technology (Loxton 1992: 142). This would include planning the development of a national system and infrastructure for the effective generation of R & D knowledge, determining national R & D priorities, and monitoring the national science effort and the functioning of the system (Loxton 1992: 142).

Conclusion

Science policy is the declaration of the goals and the detailing of major guidelines of government bodies for future action in connection with the sum of the knowledge of facts, natural laws and phenomena that have been verified through observation, experimentation and logical thought. This study will focus on the formulation of science policy by the various actors and their specific roles, and the possible levels of policy-formulation and policy execution.

STATE FUNCTIONS AND ORGANISATION

As science policy-formulation is an activity of government bodies, it has to be seen in the context of state functions and public policy in general. Loxton's (1992; 1994) findings are fundamental to this deliberation on state functions and organisation as context for science policy (see Figure 1) in decentralised states. They will be paraphrased briefly in the following paragraphs.

The purpose of the state

The state originated as a response to man's social nature. It does not exist for its own sake but solely to enable every individual to attain a life of temporal happiness and natural perfection. However, since man can only find the means for living a proper life and developing his mental and moral faculties within society, the ultimate end of the state is not simply the personal good of individuals but the welfare of society as a whole – in other words, fulfilling the various needs of society (Cf. Garbers 1992: 1).

The primary functions of the state

The functions of the state can be listed in three categories, i.e. protective, promotive and supportive.

Protective: The state is concerned in the first place with the removal of all hindrances that could harm the community and with safeguarding the nation it from the harmful effects of that such hindrances (Figure 1).

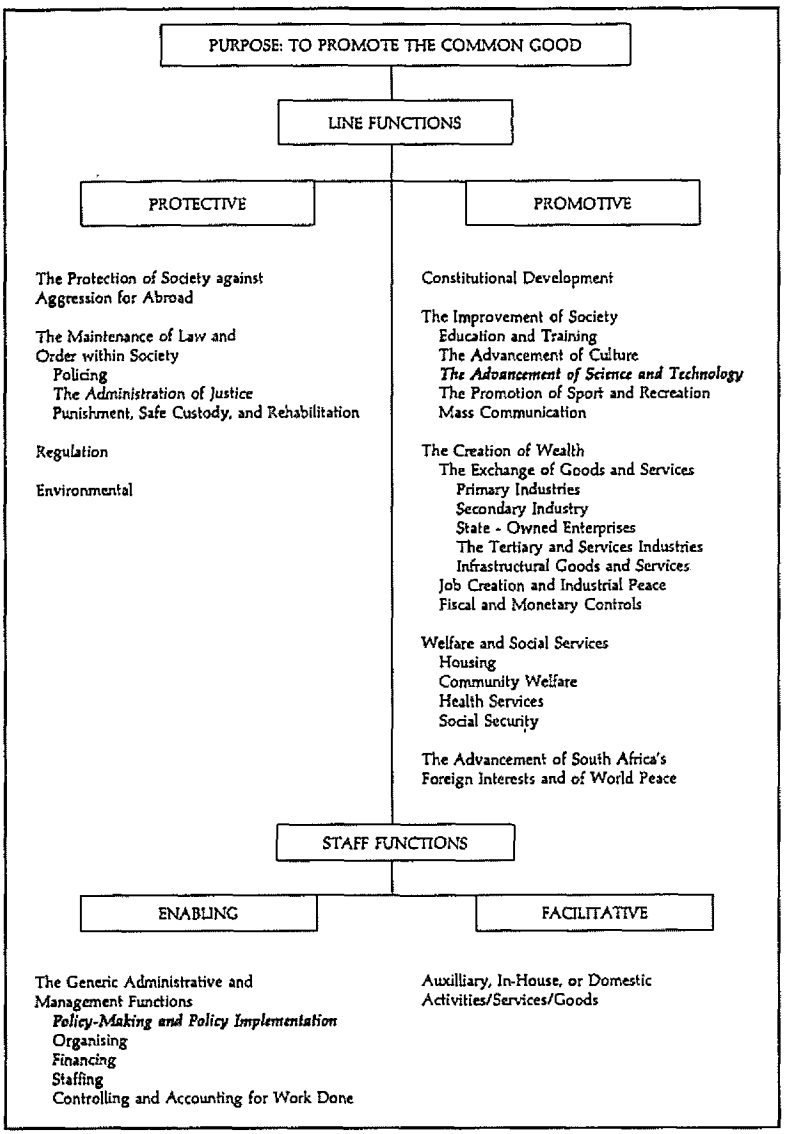
Promotive: The state is not only committed to the protection of society, but also to its promotion through the positive development of both state and community. The advancement of science and technology forms part of this second category of functions (Figure 1).

Supportive: Apart from the above of operational or line functions to which the state is committed and which it undertakes as ends in themselves, there is a third order of supportive functions, namely staff functions which may be perceived as being of either an enabling or a facilitative nature. Policy-formulation is part of this order of functions (Figure 1).

The advancement of science and technology as a function of the state

The five functions aimed at the promotion of society are: constitutional development, the creation of wealth, welfare and social services, the advancement of a country's foreign interests and of world peace, and the development/improvement of society. The latter function can be regarded as

FIGURE 1: A taxonomy of the kinds of functions that the state usually undertakes (Loxton 1992)



the common aim of education and training, the advancement of culture, the promotion of sport and recreation, mass communication and the advancement of science and technology (Figure 1).

The promotional character of the latter is strikingly illustrated by the Technology Policy Statement of the Indian Government (1983) which states that science and technology must unlock the creative potential of the people, that science requires of trained and skilled manpower, and that special attention should be given to the promotion of the technology base of specific frontier areas.

The system of science and technology in democratic societies generally consists of four subsystems of which the first is located in state departments and institutions (to "unlock the creative potential of the people"), the second in specialised statutory research bodies (to promote the "technology base"), the third in educational institutions (training the "skilled manpower"), and the fourth in the private sector.

As a result of the generally recognised failure of the market mechanism to achieve revolutionary and long-term innovation (Directorate Policy Studies 1992: 4), the government of a country has no option but to take the initiative and to assume responsibility for the country's research and development (Loxton 1992: 141). Five functional areas can be identified for state involvement in the advancement of science and technology:

- Policy formulation and direction
- The generation, exchange and utilisation of knowledge
- The provision of an adequate infrastructure
- Encouragement and support
- Co-ordination and co-operation.

Government involvement in these functions requires both the authority and the legitimacy that only the state can command. The measure of involvement is determined by the priority or weight that the government of the day accords a particular function relative to all of its other functions, and the limits of the public resources that can properly be devoted to the provision of any given public service or good (Loxton 1992: 71-72). The scientific development of nations appears to be the consequence of their economic development rather

than its cause. This makes research look like a luxury that can be afforded only by those who have already overcome the problems of poverty (Spaey et al. 1971: 107).

Policy-formulation and policy implementation as functions of the state

A distinction was drawn in figure 1 between, on the one hand, the line functions of the state, i.e. the protective and promotive functions, and on the other hand, the staff functions of the state, i.e. the enabling and facilitative functions. The formulation and implementation of public policy, which are enabling functions of the state (Figure 1), originate with political parties and are given substance when the government of the day translates party policies into government policies by entrenching them in legislation. Once approved by the legislature, the legislation requires skilled public servants to assist in formulating executive implementation policy, which finds expression in the establishing of priorities, in the planning of programmes of action, and in the practical measures needed to give for giving effect to executive policies. What is important in policy-formulation and policy implementation in decentralised states, is the question whether one or both of these dimensions can be decentralised to lower levels of government. This issue will be dealt with in the section below.

Conclusion

The advancement of science and technology is an integral part of the state's function to promote the personal good of individuals and the welfare of society as a whole. The formulation of policy is part of the enabling and supportive function of the state. The formulation of science policy and the advancement of science and development, as functions of the state, manifest themselves on potentially more that one level of government.

THE FORMULATION AND EXECUTION OF SCIENCE POLICY

In the previous paragraphs it was shown that the state is responsible for the formulation of public policy and for the advancement of science and technology – and, by implication, for the formulation of science policy. It is now appropriate to consider briefly the process of formulation and execution of science policy, the role of the actors involved in the process, the dimensions of science policy, and the possible different levels of government where science policy-formulation and execution can take place.

The process of formulation and execution of policy and the policy-makers

The formulation and execution of public policy, and by implication also science policy, are part of a dynamic process. Various phases in the process can be distinguished, i.e. the initiation of policy, policy advice, policy-formulation, execution of policy and policy evaluation.

Each phase involves specific activities by the actors concerned. One can differentiate between two categories of actors or policy-makers: the official policy-makers and the unofficial policy-makers. Official policy-makers have legal authority to formulate public policy (Anderson 1994: 6), while unofficial or indirect policy-makers (Anderson 1994: 6) do not have the legal authority to make binding policy decisions but can at least initiate policy or give advice on policy.

Official policy-makers include legislators, executive office bearers and administrators. They each perform policy-formulation tasks that are somewhat different from those of the others (Anderson 1994: 6). For example, in South Africa, as in most of the democracies of the world, the system of parliamentary government provides for (Loxton 1992: 299):

- a representative legislature whose purpose it is to give expression to the will of the people through the formulation of policy in the form of Acts;
- a political executive whose responsibility it is to formulate the government's policies for meeting the needs of society; and

- a central and politically neutral bureaucracy, or administrative executive, dedicated to the task of professionally and impartially advising the government of the day on the process of policy-formulation and carrying out policies under the direction and control of the political executive.

Unofficial policy-makers include interest groups, political parties, advisory councils and individual citizens. Garbers (1992: 2) points out that the government can create policy advisory instruments, such as the Scientific Advisory Council. These indirect policy-makers make it possible, for example in the case of science, to base policy on an intimate knowledge of science praxis and utilisation (Garbers 1992: 2).

Like state department's or any other kind of state institution, advisory institutions should be established in terms of legislative enactment. Their purpose, functions, field of operation and responsibilities, as well as their powers and authority, should to be clearly demarcated and circumscribed in order to define their functional and its structural relationships with the parent department and its political head (Loxton 1992: 312). In many countries, however, these policy advisory structures are more geared to executing policy than giving advice on policy rather than for advice only (Directorate Policy Studies – CSIR 1992: 11-16). The reason for the hierarchical policy-formulation structures, including the direct and indirect participatory institutions, is to democratise the process and to involve expertise from all spheres of society (Directorate Policy Studies – CSIR 1992: 15-16).

In most modern political systems, public policy is implemented primarily by a complex system of administrative departments or agencies (Anderson 1994: 189). These institutions perform most of the day-to-day work of government and thus affect citizens more directly than do any other government bodies (Anderson 1994: 189; Palumbo 1988: 17-18). Specialised state institutions are usually established to execute science policy aimed meeting all of the essential R & D needs of the public and private sectors (Loxton 1992: 334). Loxton (1992: 334-335) identifies the following five common characteristics of these institutions:

- Their readiness to undertake contract research and development projects for both the government and private sector;

- Their aim to make the research and development they undertake self-financing within reasonable limits, and to allow the price and quality of their services and products to be regulated by market forces, with the ultimate aim of reducing state support to a minimum by operating at a maximum level of self-sufficiency;
- Their need to establish private companies or joint ventures in order to render more effective and profitable research and development services, to exploit knowledge and expertise optimally, and to produce systems developed by their research and development efforts;
- Their operating as prestigious, semi-autonomous parastatal bodies is more likely to attract functional and financial co-operation from the private sector than if they were perceived as a normal part of the executive machinery of the government of the day; and
- Their freedom from direct ministerial or state control ensures non-interference in the setting of their priorities, as well as the objectivity that is required in research.

To conclude: science policy originates in a dynamic process of initiating, advising, formulating, executing and evaluating. Two categories of policy-makers are involved in the process, namely the official policy-makers and the unofficial policy-makers. The formulated policies are implemented through one or more state departments under the supervision of one or more political executive office bearers, and through specialised state institutions with distinguishable characteristics.

The dimensions of public policy

Various dimensions of public policy are identified in the literature on the subject. For the purpose of this report only two broad dimensions will be discussed: substantive and procedural (Anderson 1994: 10). Substantive policies involve what government is going to do (Anderson 1994: 10) and is usually advocated by the governing political party (Hanekom 1991: 10). Procedural policies, in contrast, pertain to how something is going to be done and who is going to take action (Anderson 1994: 10). So defined, procedural policies include administrative matters (Anderson 1994: 10) and is the result of the transformation of substantive government policy into practical directives

through the development of a specific implementation strategy (South Africa 1993: 23). It is therefore of a more specific nature than substantive policy, as it is concerned with the details of various aspects incorporated in a policy, with the setting of priorities and with the drawing up of the budget.

Various actors are involved in the different dimensions of science policy. For example, a non-official actor such as an interest group can initiate, depending the particular policy issue, substantive and procedural policy. An interest group can also be formally approached for advice on a government or executive policy issue. The role of political parties is largely limited to the initiating of government policy. Advisory institutions give advice at the request of the actual policy-makers on the formulation of government policy as well as executive policy. They also help with the evaluation of science policy. Legislative institutions are involved in the formulation of government policy. The government of the day, which has to implement the laws passed by the legislature, is responsible for the initiation of both dimensions of policy. State departments responsible for the advancement of science, are mainly involved in the formulation of procedural policy to be executed by research institutions.

The formulation and execution of science policy at various levels of government

Substantive and procedural policy can be formulated and executed at both the central and the regional level of government. The formulating and executing of substantive as well as procedural policy can take place partially or entirely at one or more levels of government. A comparison of the systems of science policy of five selected federal-type states (USA, Canada, India, Belgium and Germany) shows that although the formulation of science policy occurs in all five states in one or other way at both central and regional level, in practice it differs considerably. Even the USA and Germany, which are regarded as ultimate examples of decentralisation with regard to the formulation of science policy, show signs of centralisation in the process of policy-formulation. Although highly centralised in many respects, science and technology endeavours in Canada still manifest a strong federal influence. The science system in India, the only example of a developing state among the selected five

states, is structured in a highly centralised way. Substantive policy-formulation on science and technology is still highly centralised in Belgium, while procedural policy-formulation and execution are being decentralised.

CRITERIA FOR DETERMINING THE HIERARCHICAL POSITION OF THE FUNCTION OF SCIENCE AND TECHNOLOGY

The different hierarchical positions of the function of science and technology in South Africa, as in the selected five federal-type states, can be understood and explained by considering:

- The rule of subsidiarity;
- The criterion of extra-territorial status;
- The criterion of relative functional weight, and
- The criterion of public affordability.

The rule of subsidiarity

The essence of the rule of subsidiarity in this context is that there is no valid reason for a higher institution or level of government to appropriate to itself functions or services that can satisfactorily be undertaken by smaller and lower bodies or levels of government (Loxton 1992: 64; Loxton 1994: 103). Thus the central government ought to handle only matters that need to be dealt with on a national scale and by a central department or agency. In all the selected federal-type states, the formulation of public policy on science and technology is done on the central as well as the regional level. What is necessary here, is to establish what particular aspect of policy-formulation cannot be handled satisfactorily on a lower level, and why this is not possible.

In the USA the central government started centralising and co-ordinating science policy when it became clear that the USA's technological lead had been substantially eroded in many of its established industries and that only centrally directed initiatives would stop the process of erosion (Knezo 1993: 5; Prinsloo & Pienaar 1993: 98). Although German science policy states that science, research and teaching shall be free, the freedom exists within the

policy framework created by the federal government and individual states (CSIR 1991: iv). The main reason for the central and regional policy frameworks is that individual research institutions cannot render satisfactorily results without financial assistance from institutions on the regional and central level of government. Funding by government institutions on these levels requires the formulation of policy on science and technology on each level of government. These policies do not necessarily go into the details of procedural policy – they are usually government policy that gives the broad policy outlines to be followed by the executive institutions on the lower levels of government in order to maintain a satisfactorily standard of research and development. In comparison with the highly centralised policy-formulation process in India, as a example of a developing state, policy-formulation in the other states, as examples of highly industrialised states, is to a large extent highly decentralised. It seems that more aspects of the formulation of science policy can be handled satisfactorily on the regional level.

The criterion of extra-territorial status

In terms of the criterion of extra-territorial status, the state is regarded as the only legitimate authority capable of dealing with any matter that involves the relations between states, irrespective of whether that matter arises from an official or a private affair (Loxton 1992: 67; Loxton 1994: 105). In the context of science and technology policy, it follows thus that only the central government can sign agreements on behalf of the nation as a whole. It alone can act to integrate science policy with other national policies, and it alone is capable of formulating and implementing a science policy for the benefit of society as a whole (Loxton 1992: 141).

In Germany, for example federal support for information technology has received a boost in the form of a coordinated programme covering several ministries and including European projects. Germany participates in most EC research programmes, as well as in the European Space Agency (ESA), CERN, and many other European and international R&D organisations and programmes. German contributions to the research expenditures of international organisations in 1989 amounted to 1,2 billion DM. In addition, international projects received 53,1 million DM in support. The two items

together represent 8,9% of Germany's total federal R&D budget. All the above international programmes are sanctioned and in some way directed by federal policy (Biesenbach 1993; Deutscher Forschingsdienst 1987; Prinsloo & Pienaar 1993: 57). Belgian science policy has also been merged into the framework programme adopted by the EEC (Prinsloo & Pienaar 1993: 17). This decision was taken centrally by the cabinet at the instigation of the Minister for Science Policy. It is thus especially these two European federal-type states that are formulating many policies on international co-operation on science in technology in the European Community.

It seems that this criterion differentiates in the abovementioned states between the relative priorities of central and regional governments, and between the relative priorities of the various regions or states. On the central level, science as a whole has to compete with all the other central government functions. Regionally, science policy is determined by the specific needs, abilities and resources of the region, which may be totally different from those of neighbouring countries.

The criterion of relative functional weight

The extent to which government, central or regional, can be expected to assume responsibility for policy-formulation regarding the function of science and technology, will depend on the priority or weight that the government of the day attaches to that function relative to all its other functions (Loxton 1992: 72; Loxton 1994: 106). It also depends on the emphasis that it places on any particular activity(ies) constituting that function at any given time (Loxton 1992: 72).

The latter is illustrated by the fact that since each state in the USA has different scientific needs, public policy varies accordingly (Prinsloo & Pienaar 1993: 102). At the local level, science policy is developed and pursued independent of central government. In Canada, the diversity of federal, provincial and territorial priorities in science and technology and their importance to regional development relative to other government-sponsored programmes, is being recognised. Although the provinces and territories have

their own structures for the formulation of science and technology policy, science policy programmes and initiatives tend to be co-ordinated at the federal level (Prinsloo & Pienaar 1993: 37).

The trend in Canadian science policy is to re-evaluate and seek greater coordination of national, regional, industry and university science and technology priorities and programmes. In seeking greater coordination, the federal government is increasing its use of multi-agency advisory groups and task forces to enhance its ability to meet national science and technology priorities. In this respect Canada is following the trend of other developed nations in looking for effective models from which an effective and efficient system of science and technology research and development might be realised.

The difference in priorities of the central government versus the regional government, is illustrated by the example of India. In the first instance, the research institutions of the central government agencies are the principal users of the national funds for research and development. In the second instance the division of funds between specific research programmes of the central government during the three-year period 1985-1988, indicates different sets of functional priorities for the state governments vs. the central government.

As shown in Table 1, the central government priorities in India contrast sharply with the relative functional weight of the 22 states and the nine Union Territories which use up to 95 % of all their research and development funds for agriculture, fisheries and forestry (Prinsloo & Pienaar 1993: 89). Of the 31 regional entities, 15 report no expenditure on research and development – thus, relative to other government functions, research and development has limited or no value at all.

In Belgium, where there is a difference in the level of development between Flanders and Wallonia, a regional infrastructure is regarded as essential. Provision has been made inter alia for the relative functional weight each region attaches to the improvement of science and technology in general or just a specific aspect of science and development, by setting up a special fund (Funds for Industrial Renovation, FRI), centrally funded, to give financial support to specific projects recommended by the regions (Prinsloo & Pienaar 1993: 28).

The criterion of public affordability

The criterion of public affordability with regard to science policy, establishes the limits of the public resources that government can properly devote to the promotion of science and technology (Loxton 1992: 72; Loxton 1994: 106). In Germany, for example, the policy frameworks created by the federal government and the governments of the individual states make provision for various types of affordability or funding criteria for scientific organisations funded directly by government and by foundations (Biesenbach 1993; Prinsloo & Pienaar 1993: 58).

TABLE 1: R&D expenditure in India by objective from 1984-85 to 1986-87 (% of total)

OBJECTIVES	CENTRAL GOVERNMENT			STATE GOVERNMENTS		
	1984-85	1985-86	1986-87	1984-85	1985-86	1986-87
Earth, seas, atmosphere	2.75%	2.49%	2.26%	1.67%	1.55%	1.51%
Space	9.37%	9.69%	10.83%	0	0	0
Agriculture, etc	11.09%	10.56%	9.25%	93.77%	94.82%	95.02%
Industrial development	12.70%	14.37%	12.42%	1.25%	0.52%	0.60%
Energy	13.40%	10.49%	9.55%	0.28%	0.43%	0.77%
Transport and communication	4.02%	4.24%	4.40%	0.05%	0.05%	0.04%
Education services	0.08%	0.08%	0.07%	0.01%	0.02%	0.01%
Health services	3.19%	3.91%	3.52%	1.58%	1.54%	1.25%
Socio-economic services	0.66%	0.79%	0.78%	1.23%	0.94%	1.05%
Environment	3.70%	4.29%	5.05%	0	0	0
Knowledge	6.87%	6.49%	6.56%	0	0	0
Other aims	5.87%	4.10%	3.79%	0.14%	0.13%	0.12%
Defence	26.32%	28.50%	31.51%	0	0	0
Total (Rs00 000)	**119120.2**	**138259.3**	**180007.2**	**12611.39**	**16277.52**	**19115.98**

(Source: Prinsloo & Pienaar 1993: 89)

In Canada, as with the U.S.A. and other leading technology-driven economies, science and technology policy and programmes are being re-evaluated owing to economic and fiscal constraints, i.e. the public affordability of specific programmes. The trend in Canadian science policy is to seek models from which an effective system of science and technology research and development can be realised (NABST 1992: A1-1, A1-12,5; CR&DM 1992b: 1).

In India (Cf. Prinsloo & Pienaar 1993: 70-93) the central government is the main source of funding for research and development. The private sector provides for only 10-11 % of the total expenditure on research and development. Bearing in mind India's problems of poverty, urbanisation, high population growth, illiteracy and low economic growth, research and development can easily be regarded as a luxury in comparison with other needs. The dominant role of the central government in the formulation of science policy can be seen as an attempt to ensure that spending on science and technology remains publicly affordable and accountable in comparison with the other needs of society.

In 1976 the Belgium Science Policy Office was charged with establishing the scientific and technological requirements of the markets. Its aim was to ensure that national research programmes were market oriented – affordable to the public. It was also government policy not to enter into the required fields of new technology without being aware of the social and economic changes engendered by them. Their affordability in terms of the social environment had to be gauged.

CONCLUSION

Formulating government and executive policy on the advancement of science and technology, which involves various actors on the different levels of government, is an integral part of a state's functions in general. The advancement of science and technology is aimed at the promotion of society, which in turn serves the personal good of individuals and the welfare of society as a whole. The priority of the promotion of science and technology relative to all other state functions, is embodied in the policy and budget proposals of the particular central or regional government.

The two dimensions of science policy, i.e. substantive policy (concerning the what) and procedural policy (concerning the how and the who, and including administrative policy), originate in a dynamic process of initiating, advising, formulating, executing and evaluating. Two categories of policy-makers are involved in the process: the official policy-makers and the unofficial policy-makers. The formulated policies are executed through one or more state departments under the supervision of one or more political office bearers, through specialised state institutions with distinguishable characteristics on one or more levels of government.

The five selected federal-type states were analysed to establish the most suitable level for the formulation of policy for science and technology: the central or regional level, or both. Although government policy is formulated on the central as well as the regional level in the USA, Canada and Germany, there is a noticeable tendency towards centralisation in all three.

In the USA and Canada this is mainly for economic and fiscal reasons (cf. the criterion of public affordability). It is believed that the return on government spending on research and development can be increased by centralising policy-formulation and control. The extent of the centralisation of government and executive policy observed in Germany, is probably due to Germany's efforts to become more competitive internationally. Although executive policy is formulated and executed on both central and regional level in above three states, the regional level received greater emphasis.

In Belgium, which is in the process of decentralising, the formulation of science policy was initially highly centralised. Although the formulation of government policy is still highly centralised, the formulation and execution of procedural/administrative policy take place increasingly on the regional level.

From the a above it is clear that it is not possible to identify a clear-cut pattern for the hierarchic division of the policy-making function regarding science and technology. However, different variations are possible of which the following are a few examples:

- Division by dimension: substantive policy is formulated mainly on the central level, and procedural/administrative policy on the regional level (for example, India);

- Division by phases: policy-formulation (substantive and procedural policy) and some policy execution occur on the central level, while only the execution of policy occurs on the regional level;
- Division by sector: the formulation and execution of policy regarding specific sectors of science and technology (for example the promotion of space and nuclear research) occur on the central level, and the formulation and execution of policy regarding other sectors (for example agriculture) occur on the regional level;
- Complete division: central and regional governments accept equal responsibility for the determination and execution of policy on the advancement of science and technology with, inter alia, the accepting of concurrent funding formulas.

The hierarchical position of policy-making on the advancement of science and technology or any other state function is determined by,

- the validity of the reasons presented for a particular function to be determined and executed on a specific level; the extent to which a function involves international relations;
- the weight or priority attached to a specific function relative to other functions; and
- the limits of public resources that can be devoted to the promotion of a specific function.

In short, the hierarchical position in a state of science policy is determined by national and regional priorities as well as political, economic and administrative realities.

Literature

Anderson J.E. 1994. *Public policymaking*. Second Edition. Boston: Houghton Mifflin Company.

Biesenbach, R.A. 1993. *Science policy in Germany*. Bonn: CSIRIS.

CSIR. 1991. *Science and technology policies and economic development: A review of international experience*. Pretoria: CSIR (CSIR Policy Studies No. 1)

CR&DM. 1992b. Proposed R&D data network is upgraded to gigabit speed. *Canadian Research and Development Manager*, 1(19), 1.

Departement Nasionale Opvoeding. 1988. *Die wetenskapsbeleid en stelsel van die Republiek van Suid-Afrika*. NASOP 11-005.

Deutche Forschungsdienst. 1987. *Forschungspolitiek fur die Bundesrepubliek Deutschland*. Bonn: Deutsche Forschungsdienst.

Directorate Policy Studies (CSIR). 1992. Report to the Department of National Education. Subject: *An audit on "The science policy and system of the RSA": Nated 11-005* (88/06).

Dror, Y. 1968. *Public policy-making reexamined*. Chandler Publishing Co. Scranton.

Friedrich, C.J. 1971. Political decisionmaking, public policy and planning. *Canadian Public Administration*, 14(1).

Garbers, J.G. 1992. Opportunities and constraints in science policy in South Africa. *Africa 2001*, 1(1).

Hanekom, S.X. 1991. *Public Policy – Framework and Instrument for Action*. Halfway House: Southern Book Publishers.

Knezo, G.J. 1993. *American science at a critical crossroads*. (Issues Brief IB 92016 February 12.)

Lindblom, C.E. *1980. The policy-making process*. Second Edition. New Jersey: Printice-Hall.

Loxton, A. 1994. Public functions and public institutions: A Criteriological approach to the functional structure of central government administration in a liberal democracy, with particular reference to South Africa. *SAIPA – Journal of Public Administration*, 29(2): 86-147.

Loxton, A. 1992. *Criteria for determining the functions and organisation of central government administration in South Africa*. Report PAN-4A. Pretoria: Human Sciences Research Council.

NABST. 1992. *Committee on Technology Acquisition and Diffusion Report*. Canada: National Advisory Board on Science and Technology. Report No. 10, Vol. 1, October 1992.

Palumbo, D. J. 1988. *Public policy in America: Government in action*. San Diego: Harcourt Brace Jovanovich, Publishers.

Prinsloo, R.J. & Pienaar, M. (eds) 1993. *Science & Technology policy in five decentralised states: Belgium, Canada, Germany, India, USA*, Pretoria: HSRC.

Roux, B. 1968. The planning process – a generic view provisionally stated. *SAIPA*, 3(3).

South Africa. 1993. Department of Environment Affairs. *White Paper: Policy on a National Environmental Management System for South Africa*. WP 13-1993. ISBN 0-621-14368-0.

Spaey, J. et al. 1971. *Science for development – An essay on the origin and organisation of national science policies*. Paris: Unesco.

Steyn, W.I. 1971. *Die beleid van die Staatsdienskommissie in sake opleiding met spesiale verwysing na die taak van die departementele opleidingsbeampte*. (Referaat gelewer tydens 'n seminaar oor opleiding op 9 Augustus 1971).

- Division by phases: policy-formulation (substantive and procedural policy) and some policy execution occur on the central level, while only the execution of policy occurs on the regional level;
- Division by sector: the formulation and execution of policy regarding specific sectors of science and technology (for example the promotion of space and nuclear research) occur on the central level, and the formulation and execution of policy regarding other sectors (for example agriculture) occur on the regional level;
- Complete division: central and regional governments accept equal responsibility for the determination and execution of policy on the advancement of science and technology with, inter alia, the accepting of concurrent funding formulas.

The hierarchical position of policy-making on the advancement of science and technology or any other state function is determined by,

- the validity of the reasons presented for a particular function to be determined and executed on a specific level; the extent to which a function involves international relations;
- the weight or priority attached to a specific function relative to other functions; and
- the limits of public resources that can be devoted to the promotion of a specific function.

In short, the hierarchical position in a state of science policy is determined by national and regional priorities as well as political, economic and administrative realities.

Literature

Anderson J.E. 1994. *Public policymaking*. Second Edition. Boston: Houghton Mifflin Company.

Biesenbach, R.A. 1993. *Science policy in Germany*. Bonn: CSIRIS.

CSIR. 1991. *Science and technology policies and economic development: A review of international experience*. Pretoria: CSIR (CSIR Policy Studies No. 1)

CR&DM. 1992b. Proposed R&D data network is upgraded to gigabit speed. *Canadian Research and Development Manager*, 1(19), 1.

Departement Nasionale Opvoeding. 1988. *Die wetenskapsbeleid en stelsel van die Republiek van Suid-Afrika*. NASOP 11-005.

Deutche Forschungsdienst. 1987. *Forschungspolitiek fur die Bundesrepubliek Deutschland.* Bonn: Deutsche Forschungsdienst.

Directorate Policy Studies (CSIR). 1992. Report to the Department of National Education. Subject: *An audit on "The science policy and system of the RSA": Nated 11-005* (88/06).

Dror, Y. 1968. *Public policy-making reexamined.* Chandler Publishing Co. Scranton.

Friedrich, C.J. 1971. Political decisionmaking, public policy and planning. *Canadian Public Administration,* 14(1).

Garbers, J.G. 1992. Opportunities and constraints in science policy in South Africa. *Africa 2001,* 1(1).

Hanekom, S.X. 1991. *Public Policy – Framework and Instrument for Action.* Halfway House: Southern Book Publishers.

Knezo, G.J. 1993. *American science at a critical crossroads.* (Issues Brief IB 92016 February 12.)

Lindblom, C.E. *1980. The policy-making process.* Second Edition. New Jersey: Printice-Hall.

Loxton, A. 1994. Public functions and public institutions: A Criteriological approach to the functional structure of central government administration in a liberal democracy, with particular reference to South Africa. *SAIPA – Journal of Public Administration,* 29(2): 86-147.

Loxton, A. 1992. Criteria for *determining the functions and organisation of central government administration in South Africa.* Report PAN-4A. Pretoria: Human Sciences Research Council.

NABST. 1992. *Committee on Technology Acquisition and Diffusion Report.* Canada: National Advisory Board on Science and Technology. Report No. 10, Vol. 1, October 1992.

Palumbo, D. J. 1988. *Public policy in America: Government in action.* San Diego: Harcourt Brace Jovanovich, Publishers.

Prinsloo, R.J. & Pienaar, M. (eds) 1993. *Science & Technology policy in five decentralised states: Belgium, Canada, Germany, India, USA,* Pretoria: HSRC.

Roux, B. 1968. The planning process – a generic view provisionally stated. *SAIPA,* 3(3).

South Africa. 1993. Department of Environment Affairs. *White Paper: Policy on a National Environmental Management System for South Africa.* WP 13-1993. ISBN 0-621-14368-0.

Spaey, J. et al. 1971. *Science for development – An essay on the origin and organisation of national science policies.* Paris: Unesco.

Steyn, W.I. 1971. *Die beleid van die Staatsdienskommissie in sake opleiding met spesiale verwysing na die taak van die departementele opleidingsbeampte.* (Referaat gelewer tydens 'n seminaar oor opleiding op 9 Augustus 1971).