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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Assistance to Ministry of Science,
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SCIENCE AND TECHNOLOGY POLICY ACTION PROGRAMME

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SUMMARY

Formal government support for a comprehensive national science and technology (S&T) policy is close at hand. A S&T policy framework document is currently being considered by the Ministry of Science, Technology and Vocational Training (MSTVT). To complement the comprehensive framework, the MSTVT has also requested a program of action. This report presents the program of action

Implementing the policies sketched out by the comprehensive framework requires prioritization and further elaboration. In order to select the most important investments, this report begins with a careful analysis of background material on the nature of S&T Policy and the situation relating to the production and use of S&T in Zambia. Next, this report recommends a prioritized program of policy action, with project descriptions, justifications, budgets and timetables.

In designing this program of action, it has been recognized that supporting S&T entails significant costs. The benefits of S&T often come only in the long term. The benefits are sometimes difficult to trace back to a particular investment. Like many other African countries, the Government of Zambia finds it difficult to choose what kind of S&T to invest in and to divert funds from other pressing needs to support S&T.

Given present economic and social realities, it is essential to focus on the kind of S&T that will bring benefits in the short and medium terms. This means focussing on linkage of S&T to the industrial, or productive sector. It means developing mechanisms to encourage industry, large and small, to ask the S&T organizations in Zambia for help in upgrading their products and processes to make them more competitive. Once the economy begins to grow and it is clearly proven that S&T have been instrumental in helping this growth, then resources can flow into the other areas of S&T where benefits are much more diffuse and long term.

The new MSTVT is the group that will ensure most of the activities take off. Given the inherent limitations that all governments face in promoting industrial development, the MSTVT needs to help set up strong, independent organizations outside government that will be better able to link S&T to industry and respond to market signals.

The actions recommended in this report involve:

- strengthening the department of S&T within MSTVT
- designing a comprehensive funding mechanism

- linking government R&D labs to their clients
- creating a S&T Promotion Council
- creating Technology Business Service Centres
- creating a Product and Process Engineering Centre
- creating a Technology Venture Capital Fund
- creating university courses in S&T Policy and Management
- enhancing public awareness on technology-based business opportunities
- gathering and disseminating technical and business information
- developing supporting policies and legislation to ensure the above projects function properly
- training in all aspects of S&T Policy and Management related to the above recommendations.

When implemented fully, the action program proposed here will require the Government of Zambia to increase its initial investment in S&T, by an estimated total of $US 56 million for a five year program. However, many of the projects are eligible for donor assistance. The donor component could amount to $US 11 million per year in a combination of preferential loans, outright grants and in-kind support. This would reduce the estimated total investment required from the Government of Zambia to $US 44 million. (Note that these figures assume an annual inflation rate of 20%.)

The budget requirements have been scaled to fit under a ceiling of $US 10 million per year. The maximum average inflated investment required is $US 11 million per year, without donor support. This translates to a first year investment of $US 7.5 million. If donor support is obtained as targeted, this first year indicative minimum cost is only $US 6 million.

It is crucial to note that this report describes a complete program of action to illustrate the kind of investments that are necessary, but that implementation of this program need not make all the investments at once. The first action to undertake is to get dynamic and competent individuals in place to promote and start up each of the project areas. Once they have begun to define the needs and potentials of their organizations, then they can work to further define the resource requirements and seek additional funding. Working in this manner on all projects at once, but with only the key individuals, allows the laying of stronger foundations, the design of better organizations, the minimization of scarce government expenditures and the beginning of action as soon as possible. In fact, the expenditure required for a year's work of implementation, before the main investements need to be made, is only about $US 184,000.

TABLE OF CONTENTS

1. OBJECTIVE

The Government of Zambia is currently considering a comprehensive framework of policy action for S&T. The objective of the present document is to lay out a program of action that gives life to the broad policy framework and to support that program of action with careful analysis of S&T Policy within the Zambian situation. Working within the policies of the overall framework, this document describes a set of projects for the MSTVT to undertake. Once approved by the stakeholders, this document will lay out the work for the MSTVT for at least a year.

This document begins with a discussion of the role of science and technology in development, and shows how to manage science and technology for maximizing competitive advantage within the present situation in Zambia. Considering the principles of this background material allows prioritization of the large number of policies presented in the framework document. A small set of the most important projects to undertake is chosen and described.

The projects for immediate implementation form an interrelated set that should be considered as a group, not as isolated actions. Deleting any from the group weakens the effectiveness of those that remain. Building a dynamic "techno-industrial" system is the underlying aim of the policy and the program of action. A techno-industrial system is an interrelated group of organizations producing goods and services, regulating business, financing new investment, creating new technological innovations, undertaking research and development, setting up new, technology-intensive enterprises and trading competitive information. It is a complex, dynamic system of interactions. No one element in the system is sufficient to make it work, or to function as an individual player on its own.

Zambia can harness the power of science and technology in exactly the same way that developed countries do to generate wealth. By following the plan of action set out in this document, within a year, Zambia can have in place the basic organizations that will begin to produce, transfer and commercialize technology in an effective manner. Doing this will have widespread positive impacts on the productive sector - more industrial output, more exports, more jobs, more higher-skilled jobs and better lives for ordinary people. If the program of action is supported assiduously, these positive benefits will be readily apparent by the year 2000.

2. BACKGROUND

2.1 Preceding Work

The Government of Zambia has been concerned for the last few years to increase the emphasis given to the effective utilization and development of S&T in the nation. After the formation of the Department of Science and Technology in the Ministry of Science, Technology and Vocational Training (MSTVT), a workshop on National Science and Technology Policy[1] was held in 1993. The ministry now has a budget allocation to realize its new mandate, a requirement to develop policy and coordinate policy for S&T within government. The ministry has the authority to hire staff and is in the process of seeking a director.

As part of this ramp-up, MSTVT requested UNESCO for assistance. In 1987, UNESCO conducted a study of the issue in Zambia as part of UNESCO's larger CASTAFRICA series of initiatives to promote S&T for development in Africa[2]. UNESCO has also assisted groups such as the Research and Development Forum for Science-Led Development in Africa (located in Nairobi), known as RANDFORUM. The MSTVT has attended S&T policy events in Africa such as a recent RANDFORUM presentation,[3] and has studied other documentation dealing with S&T policy in Africa. The MSTVT sought further advice from UNESCO which fielded a mission in June 1994. After this mission, UNIDO offered to assist as well and full policy development projects were launched by both agencies in August 1994.

This Action Program document is the current cumulation of the previous work and is designed as a companion document to the Draft National Policy on Science and Technology[4] as a major new initiative of government investment in applying S&T to national development.

2.2 What is Science and Technology Policy?

There is widespread interest in the general concept of using S&T to stimulate national development in Zambia. To do this, the Government needs both policies fo. S&T and organizational capability to develop and apply S&T Policy. As the first step in designing these organizations and policies we need to be very clear about the goals of S&T Policy for Zambia.

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[1] National Workshop on Science and Technology Policy held at Livingstone, Zambia, 8 - 11 February, 1993. MSTVT, Lusaka.

[2] Castafrica II National Report: Zambia. UNESCO, Paris, 1987.

[3] Odhiambo, Thomas, Redefining Africa's Priorities for the 19990's: An Agenda for a Science-Led development Strategy for Africa. The Second Presidential Forum, 21 - 22 July 1994, Maputo, Mozambique.

[4] Draftion National Policy on Science and Technology. Lusaka, MSTVT, October 1994.

Science and Technology Policy for Zambia is about development, employment, wealth and production. It is about how to use science and technology to meet human needs and maximize competitive advantage in the marketplace.

The best way to explain what S&T Policy is and why it is important, is to refer to several real stories about S&T in Zambia.

In the 1980's, the National Council for Scientific Research initiated a research and development project to utilize locally-grown guava fruit in the production of a bottled beverage under the TipTop label. The formula was sold to a local producer, the beverage was produced and widely marketed. This was a clear demonstration of the power of Zambian scientists and engineers to contribute directly to Zambian economic and industrial development, creating jobs for small-scale farmers, transporters and manufacturers.

Unfortunately, during the Structural Adjustment Program market liberalization activities, the company producing the beverage was sold to a multinational firm which decided to use its own international formula, using imported raw materials. Local producers of the raw materal inputs lost out as well as the National Council for Scientific Research, which stopped getting a royalty on the technology.

The lessons from this story? Zambians can use S&T to produce economic, social and industrial benefits. However, sustaining these benefits requires vigorous attention to the industrial or productive sector. S&T Policy is an essential component of industrial and trade policy.

Now consider a second story. A visitor to the Technology Development Advisory Unit at the University of Zambia will see an impressive display of prototypes of appropriate technology ranging from bicycle powered pumps to efficient charcoal braziers and powerful, hand-operated grain dehullers. The same kind of displays can be seen in many other such labs across Africa. These new products clearly show the significant technological capabilities of engineers and the potential of such people to contribute to national development. Unfortunately, very few of these prototypes are actually used. Emphasis is only put on technical feasibility of the concept and once it is fully proven, there is very little work put into marketing the innovation. Experience around the world shows it is extremely difficult to market such prototypes and that intense efforts right from the beginning must be made to understand the market and involve a potential manufacturer. Until the

product is mass produced, marketed, widely sold and serviced, the costly investment in new technology has no economic benefits whatsoever - it is just a cost to the country generating no return.

The lesson from this second example is that science and technology policy is not about supporting research or design by themselves, but more about fostering linkages among research, manufacturing and marketing activities. Scientific research and engineering design by themselves are important activities, of course. They have an important cultural component and bring benefits in the long term. However, in the short term, they cost the economy heavily. Such expenditures are difficult to justify by politicians when there are competing demands on the public purse which can demonstrate immediate benefits to large numbers of voters. Until S&T Policy focusses on the task of developing the productive sector, science and engineering will always suffer from insufficient funding and have only marginal relevance to Zambian society.

Opportunities for industrial development linked to S&T lie everywhere in Zambia, waiting only for the appropriate institutional mechanisms to bring them to life. Consider a third story. A Zambian manufacturer of paints is having trouble importing expensive pigments. The pigment causing the firm the most trouble is titanium dioxide. Can titanium dioxide be produced locally? The owner of the company is not technically trained. He knows nothing about the National Council for Scientific Research (NCSR) or the Geological Survey, two organizations that might be able to answer this question. Nor does he know anything about the process of technological innovation. Unfortunately, he has never been visited by a technology extension officer from the NCSR to explain how he might optimize his production line or substitute imported inputs for more economical local ones. The opportunity is there, but neither party knows about it yet. Suppose, though, that the manufacturer did wish to use local titanium dioxide and knew how to initiate the process, using public S&T resources. This innovation project could be extremely expensive, yet in doing it, the company would receive no support from the state. His counterparts in North America, Europe or Japan, however, doing the same thing, would benefit from extensive subsidies from the state for this Research and Development (R&D) work. The Zambian manufacturer is trying to compete in an international marketplace, yet he is placed at a double disadvantage.

S&T Policy is about pulling directing R&D from the private sector, paying fair market value for it and encouraging industry to be in the driver's seat.

To develop the S&T Policy and achieve the attendant benefits, the role of the new Ministry of Science, Technology and Vocational Training is critical. Since the ministry cannot be expected to do everything itself, it needs to work in close cooperation with other organizations concerned with scientific research, teaching, engineering design, manufacturing, marketing, venture capital funding and public awareness. Together, these groups will make the productive sector larger, more diverse and more efficient. In our view, this is the crucial first phase of investment. Once S&T-led development takes root and begins to expand the economy in the short and medium term, then the focus can enlarge to optimizing those many other areas of science and technology that will bring the long-range benefits.

2.3 Guidelines for Designing S&T Policy

The second step in designing appropriate policy and organizational structures for S&T in Zambia is to take the lessons from the stories told in the preceding section and formalize them into a set of guidelines. Here, we will lay out some basic principles on what S&T can do, how it can be harnessed and what support is available for doing this.

Funding is Scarce for Public Sector Projects

The recommendations in this report are underlain by a realization that international development funding for public sector projects is extremely scarce. Projects involving creation of large, new public organizations will not likely be fundable.

The Role of Government is Limited

The role of government in the economy should be focussed on supporting competitive market structures. Institutional development and strengthening should not occur only the government sector, because government cannot undertake all the required tasks by itself. Fortunately, the Government of Zambia recognizes this already. Therefore, this report deals with institutional development primarily in the private and university sectors. These new institutions will work in partnership with government.

Action is Needed- Not Words

Too often in the past in many African countries, there has been an emphasis on elaborating complex plans and organizational mandates for S&T ministries and public R&D labs. In most cases, the organisations look powerful and impressive on paper, but the reality is usually far different[5]. It is

[5] See, for example, the "Performance Review of Science and Technology Policy Institutions in Madagascar, Malawi, Senegal, Sierra Leone, Zimbabwe and Gambia", UNECA, 1991.

not the charts and mandates on paper that determine how well public S&T organizations work, but how well they serve their clienteles - those groups in the productive sector that will use the technical knowledge to improve their profitability and pay back the public research system, either by direct contract or by taxes.

Private Sector Investment in S&T is Essential

Government investment alone in S&T cannot ensure national development. There is a direct correlation between the economic prosperity of countries and the proportion of S&T activity conducted in the private sector, by industry. The more industry conducts its own research and development (R&D), the more prosperous the country. In developed countries, the role of the public sector focusses on standards, regulation, large-scale infrastructure and long-term investment projects. In developing countries, it is usually necessary to use the public system in a broader way to begin national development and to expand a S&T "culture" into particular industrial sectors. Therefore, the Government of Zambia should strive to promote industrial R&D; building up a public system to do industrially-relevant S&T is only a temporary substitute. However, the objective should always be to continually expand the involvement of the private sector in S&T until the public component is a minor one.

Government S&T Policy Sets the Climate and Direction

Governments can promote the development and take up of S&T within the productive sector by a whole range of public policies. At the broadest level, social and macroeconomic factors promoting general business growth are essential. There are many other public policy issues influencing the success of S&T policy which, at first glance, might seem extraneous. For example, immigration policy is an essential element. Laws making it difficult for technically skilled immigrants or investors to come and live in the country are exceptionally counterproductive for technology transfer. Specific to S&T policy are considerations for the private sector such as:

- tax rebates for R&D
- partial R&D funding grants for targetted industrial growth areas
- subsidized R&D extension services to get public lab experts into the companies that need their knowledge
- public procurement of innovative, unproven products.

Coordination Includes Agressive Leadership

Although we strongly emphasize market driven policies, we stress that there is still a legitimate responsibility for government to take direct and agressive intervention in particular circumstances. No governments in developed countries abandon the public or even the private interest in S&T entirely to

the marketplace. Policy interventions in taxation, tariffs, procurement and other subsidies, both direct and indirect, as well as regulatory requirements are all legitimate methods of promoting the growth of technology-based business. The only danger in their use is that they become a permanent crutch to prop up uncompetitive industries. To avoid this, such policy supports should always be time-limited and require co-investment.

Sustaining the Right Balance is an Ongoing Exercise

Optimizing the path between the opposite approaches of intervention and climate-setting is difficult. All the situations that may arise cannot be predicted in a single policy. Finding the optimum path requires ongoing analysis. Take the example of controlling technology transfer as one example that has been widely discussed in the Third World. The aim, to disaggregate technologies embodied in imported products and processes, and substitute some of them with more appropriate, local technologies is laudable in principle. But experience shows that governments cannot do this effectively. A new scientific bureaucracy will be required and it will never big or skilled enough to keep up with the work load. Lengthy bottlenecks in foreign investment can be created by such insitutions and many investors are discouraged from following through.

Where this strategy works extremely well - and indeed, it has been the basis for spectacular growth in Japan, Hong Kong, Singapore, Taiwan and Korea - is for the technology importation to be controlled largely by industry itself, with the state playing a background supporting role, not the role of gatekeeper. This is a market-oriented strategy where private firms purchase imported products, take them apart and reproduce them at lower cost. This often starts out by producing inferior quality goods, but successful imitators doing this reverse engineering can often climb the quality ladder by investing in R&D to become world-class producers.

Starting from a very weak techno-industrial base makes such a market strategy of transferring technology difficult to start. Government should reserve the right to intervene in certain cases without causing market disruption. Often, imaginative technological solutions can be found benefiting both sides of the investment. General monitoring by government- but not standardized bureaucratic requirements - may be the best approach here.

The Role of Development Aid is Limited

The Government of Zambia must use offers of development assistance with great discretion. Waiting passively for development assistance to be given can take control out of local hands, diminish local entrepreneurship and

engender a climate of powerlessness. Bilateral assistance can introduce too much of the donor's political or commercial agenda into the host country. Development assistance will only be a powerful stimulus if the host country takes vigorous, independent initiative to lead the way in a carefully thought program that is under its own control.

2.5 Justifying Support to Science and Technology

The third step in this project is to be extremely clear about why S&T should be supported. It is too often perceived that S&T is only a costly claim on limited financial resources with little short term economic justification in the face of other pressing development needs. In some cases, this is entirely correct - but in other cases, it is completely wrong. Only by disaggregating the very different kinds of S&T can we lay out which kinds are cost items, which are revenue generators, what kinds of benefits derive from them and in what time frame. This section defines the functions and the section that follows afterwards prioritizes them.

There are many different functions for S&T - or reasons for a country to invest in S&T- as follows.

Generation of New Knowledge

Science is most known for its ability to generate new knowledge through the process of R&D. Scientists the world over state that pure research must be supported by the public because of the benefits that will ensue. However, most advances in science have only limited impact on economic and industrial development. It is extremely difficult for a group that pays for long range, fundamental advances in science to recoup the economic benefit. In many cases, other groups will benefit just as much or more, or humanity as a whole.

In most cases, doing pure research to generate new knowledge is a luxury poor countries cannot afford. There may be a few exceptions in specific areas where a country has unique resources or opportunities essential to harness and it cannot rely on other countries to do the work.

International Prestige

Nations will invest in science purely because of the prestige value of belonging to a select international club. The number of Nobel prizes won by a country, for example, is often trotted out to prove the quality of the national scientific establishment and by extension, the worth of the whole

nation. Trips to international scientific congresses in developed countries are often costly means of generating prestige by Third World scientists.

Power

S&T are major contributors to the exercise of national power, usually military. The United States, for example, spends more than 60% of its public S&T funding on military R&D (although this is declining after the end of the Cold War). It is not likely that Zambia would wish to devote scarce resources to such an end.

Enculturation

A fundamental premise of Marxism was that scientific socialism would gradually break down class and ethnic divisions in society, leading people to a more rational and humane state. While this political philosophy is decidedly out of favour now, the underlying conviction about the long-term, positive benefits of a scientific culture is still correct. The study and application of science by the general populace is important for the long-range, transformitive impacts it has on societies. It is the essence of "modernization". It helps to bring very different groups into contact with each other on grounds they can understand and cooperate, and helps to bring traditional, local cultures into contact with world-wide culture.

Socio-cultural Development

The social sciences (eg psychology, sociology, anthropology) are extremely important to understand elements of national culture and help modify it towards more desirable forms. Too often they are ignored by national S&T Policy which focusses on hard science and engineering.

Direct Human Needs

S&T can have major impacts on human health and well-being. Research that brings a cure or immunization against AIDS will bring incalculable human and economic benefits to Zambia. However, whether Zambia can afford to participate in this research, except in the sociological and epidemiological parts, is another question entirely, given the extreme cost, sophistication and risk of the S&T investments required. Pharmacological research using indigenous plant species, perhaps in joint ventures with international pharmaceutical companies, on the other hand, may be a good investment.

Environmental Protection

Many sciences and technologies give a country the capacity to understand, protect, clean up and safely modify the natural environment. Benefits from

investing in environmental S&T tend to arrive in the medium term and be widely dispersed, making it difficult to fund the S&T required.

Regulation

Governments have a requirement to promote industrial regulation by providing standards and protection for patents and trademarks. Standards for weights and measures, and testing quality of products, especially foodstuffs, is an essential role of government. Much of the cost of regulation can be recovered by direct user fees.

Resource Inventories

A great deal of scientific effort is spent on resource inventories and catalogues. Mapping agricultural soils distribution, water reserves, plant species, minerals, numbers and distribution of scientists are all examples of inventories. This knowledge is routine data collection, analysis and publishing, but it provides important baselines for policy development or private sector investment.

Long Range Resource Creation

S&T are often used in long term projects to discover ways of making natural resources exploitable. For example, a copper-bearing ore may be uneconomic to mine and refine because no appropriate process exists. Large, expensive investments in S&T over many years may be required to discover ways of economically treating the ore body. It is entirely possible that the whole R&D program will fail to produce economically or technically feasible solutions with the result that most of the investment will be wasted.

Appropriate Technology

Throughout the Third World, public R&D labs and universities have invested heavily in engineering prototypes of simple machines and processes that will improve farming, food handling and general livlihood of poor people in rural and urban areas. While there are some cases where the prototypes have made a real impact, in the vast majority of cases, the prototypes sit unexploited on the shelves of the S&T institution that developed them. The common problem is that there has been no or little attempt to market, manufacture, sell and service these prototypes. Scientists and engineers commonly feel that the important work is just to create the machine. Once created, its benefits will be so self-evident that nothing else needs to be done to sell it. Increased effort on the commercial end of these projects will make the innovative prototypes more salable, but it should be noted that these appropriate technology markets are often difficult to penetrate because of traditional social practices, high dispersion of customers, low literacy, high marketing costs and limited purchasing power.

Industrial Development

S&T can be made immediately useful to enhancing the competitive strength of companies in the productive sector. By productive sector, we mean industrial organizations that are involved with the creation, transformation and distribution of goods and services, in any sector. Because of the short and medium-term gains in competive strength provided by improvements in products and processes, companies will pay for S&T. This is the most important way for S&T to promote economic development and the most important way for S&T to generate financing for its own operations.

2.6 Prioritization of Needs

As has clearly been shown by the previous section, S&T are essential inputs to an extremely wide range of national needs. However, supporting the S&T involved in many of these categories involves huge financial investment with payback only over the long term, in very uncertain and indirect ways. ***Only one application of S&T, applied to industrial development, leads to generation of significant revenue in the short term.***

Therefore, it is essential to categorize these separate functions and prioritize them as the fourth step to developing a policy framework and organizational infrastructure that Zambia can afford. The table on the next page summarizes the prioritization.

The top priority is to invest in S&T for the purposes of industrial development. This has the great advantages of stimulating industrial production in the short and medium term, and providing a source of funding independent of the public sector.

The next priority is to keep working on appropriate technology products. Although the funding source is public and the marketing is difficult, it is likely that significant increases in success can be realized by focussing more and more effective effort on the marketing, manufacturing and distribution aspects.

The third priority is to support the analysis and optimization of the regulatory framework within which business operates, R&D is done, payments are made and technology is bought and sold. In addition, it is essential at this third priority level to support enculturation and public awareness - but only insofar as it relates to direct support of the top priority

Summary of Prioritization

Priority	Function	Cost of Development	Cost Source	Liklihood of Benefits	Benefits Timing	Benefits to Funder
Level 1	industrial development	small to large	private firms	very high	short, medium	precise
Level 2	appropriate technology	small	public	medium	short, medium	precise
Level 3	regulation	can generate revenue	private firms	high	very short	precise
	enculturation	indeterminate	public, private	high	long	diffuse
	socio-cultural development	small	public	high	long	diffuse
	direct human needs	small to large	public	high	short, medium	precise
	environmental protection	small to large	public	high	short, medium	general
	resource inventories	medium	public	medium	long, very long	indirect
	long range resource creation	very high	public, private	very high	long	fairly direct
Level 4	generation of new knowledge	medium to large	public	very high	long	very indirect
	international prestige	medium	public, private	low	long	diffuse
	power	very large	public, private	medium	medium, long	national

items of industrial production and industrial manufacture of village products.

In this prioritization, we stress that it is better to devote intense effort to a small number of areas to ensure they succeed, rather than attempt to carry out many initiatives at once with insufficient financial, intellectual and manpower resources. The former strategy is a certain formula for success that can be continuously extended; the latter strategy is a recipe for certain failure.

This prioritization has been made by taking into account the present difficult straits of Zambian industry as the country makes the transition to a market economy. We fully recognize the importance of supporting all the other functional areas of S&T. We recommend, however, just maintaining current levels of support in these other areas for the present, until the S&T investments for the productive sector begin to pay off.

3. ANALYSIS OF THE SITUATION

Now that the basic functions of S&T have been laid out and investment in them prioritized, we can proceed to the next step, analysing the specific situation in Zambia. Then we will be able to proceed to recommendations for action.

3.1 S&T Activities

A good deal of study has already been made of the S&T structure in Zambia and detailed descriptions of institutions and mandates exist in written form[6]. We will not repeat it here, merely summarize the situation to give an overview.

Research

Research is carried out to a limited extent by professors and graduate students at the University of Zambia. The structure of research at the University of Zambia is now the subject of detailed investigation by a group of bilateral donors. We did not look at university research in detail. The Copperbelt University does not have graduate programs and is only now developing a degree program in engineering. University research is funded through university committees with grant envelopes from the Ministry of Education.

Research is also carried out by various line ministries, principally Agriculture, Mines, Energy, Forestry and Fisheries.

The National Council for Scientific Research is the biggest and oldest research performer in the country. The NCSR has some labs in agriculture and forestry, but focusses on transformation of resource products and industrial product research.

There are no statistics on this research effort in Zambia. Nor are there any statistics on private sector research and development.

Testing and Quality Control

While it does not appear that the productive sector carries out any research, a few of the biggest firms undertake routine, scientific product testing for quality control and resolution of simple production problems.

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[6] For example, the National Workshop on S&T Policy mentioned before, and the Directory of Scientific Research Organisations in Zambia published by the NCSR in 1975.

New Product and Process Design

Professional faculties in the universities and the various government labs do a good deal of new product design, and very little process design. This work tends to stop at the prototype stage. Industry does very little, if any new product and process design. New technology is either imported already fully embodied in a product, or as components of an industrial process.

Management of the S&T System

The National Council for Scientific Research currently has the mandated responsibility for direction-setting, coordination, promotion, international liaison and industrial linkage. Industrial linkage and promotion receive less attention than the other management functions.

Policy

As of now, there is no comprehensive S&T Policy for Zambia in operation. This is not necessarily a negative statement, for many developed countries do not have such a fully articulated policy statement either. As well, there are many S&T institutions and related policies that taken together, do constitute a de facto national S&T policy. The problem seems to be more that there is little formal S&T policy at different sectoral levels to substitute for an overall national policy. As mentioned earlier, though, the MSTVT has now created a national policy framework and is preparing it for Cabinet approval along with the present action program. In addition, the Ministry of Commerce, Trade and Industry has generated an extensive policy document which makes strong statements on S&T, and it is expected to be dealt with soon in Cabinet.

3.2 Problems with the Zambian S&T System

In this section we present a consolidated overview of the problems. Chapter 4 discusses in more detail the specific problems we hope to resolve. It should be noted that the following points are universal, in that similar problems are found to a greater or lesser degree in most countries. The details, of course, are specific to Zambia. We document these problems not to lay blame, but to design ways of overcoming them and realize the development opportunies that are at hand.

S&T Producers

S&T Producers refers to those people who conduct R&D, new product design, testing and regulation. In Zambia, they are almost entirely within the public sector.

Funding for salaries, research and infrastructure is very limited. Funding actually allocated to many institutions seems to be only a fraction of what is indicated on paper. Funding has increased steadily in the past three years, but when inflation is taken into account, there is probably no real increase and perhaps even a real decrease. These funding shortages are crippling. Yet we hesitate to call this a problem; it is more a symptom resulting from other problems, problems of providing valuable and remunerated services to industry.

The real problems of the S&T producers are related mostly to their isolation from the productive sector. While it is stated in formal documents that S&T are to be carried out in service to the nation, in practice, S&T tend to become an end or an activity in themselves, with insufficient reference to the groups who will take up the technologies. There is insufficient orientation to serving the direct needs of clients, marketing services to clients, understanding the needs of the productive sector and knowing what can be sold and how. Instead, there is a common attempt to assume the researchers know best how to solve a class of industrial problems and proceed to work on a solution without reference to specific industrial stakeholders. Not surprisingly, the individual industrial stakeholders are rarely consulted for their views and rarely even told about the technological solution, with the result that the isolation is maintained.

Even when there is a realization of the need to involve the customer, the reaction tends to be too little too late. For example, the NCSR has a formal marketing group, but the efforts to market skills, infrastructure and products is extremely weak. Part of this problem is universal among scientists and researchers in labs around the world. The National Research Council of Canada, for example, was founded in the very early 1900s with the mandate of improving the functioning of industry. However, it was not until the mid 1960s that it was noticed that there was very little interaction with industry and that most technology stayed on the shelf. Turning around the lab system to a more fully client-oriented sevice centre has required a constant effort over the intervening thirty years.

In Zambia, S&T have been provided as public services. The results (research services, designs, prototypes and testing) have nearly always been simply given away or sold for the cost of some consumables. One result of this was that clients tended to place little value on the S&T they received since it cost them nothing. Perhaps if the beverage company making the TipTop drink out of local guavas described in Chapter 2 above had paid a hefty sum for the technology, the formula might not have been discarded so easily after the takeover. As the whole country moves to a market system, so must the lab

system do as well. The market value of the labs' R&D services needs to be discovered and set. The NCSR, for one, could make a great deal of money just out of standard regulatory and testing services delivered to industry.

S&T Users

S&T Users refers to the group of people whose concern is to take technical knowledge in any form and use it to create marketable products, processes and services. In developed countries, such people are found largely in private sector firms. In Zambia, there is very little indigenous use of S&T either in private firms or parastatals. Equipment, products and services are nearly all standard and mature, imported from abroad in a fully functional form and used in a routine manner for production.

While the S&T community tends to be isolated from industry, so industry tends to have little to do with the university or the research labs. There are exceptions, of course, but as a whole, the users of S&T neither invest in S&T on their own nor commission R&D or product development work of the public groups that are supposed to offer their services in this area. There are several reasons for this. One is that there are no tax incentives to support this costly interaction. Another is that industry simply does not have a S&T culture and hence cannot easily articulate technological solutions to production or market problems. Industry's ability to articulate solutions to public policy questions involving S&T is even more limited.

S&T Regulators

S&T Regulators are people who work in the public sector to develop and monitor policy regarding S&T.

In the Government of Zambia, there is very little discussion of S&T Policy because it tends to be seen as an activity with very limited relevance to pressing probems of the moment and as a highly expensive activity for the society to support. Within the Government, it is not well understood how S&T can be made a strong input to production, despite the general desire to do this.

While it is often heard that there is a problem of coordination among the government R&D labs and agencies, we found no evidence of this. In fact it seemed to us that coordination issues were being fairly well handled. The problem seems to be more one of setting major directions for S&T to work in the national interest. There is little discussion of S&T for national development outside the cloistered environments of university and the government labs. The perception of how to use S&T for national

development is rather uninformed and oriented, not surprisingly, towards the perceptions of S&T producers.

There is no injection of the S&T viewpoint into government policy-making and regulation relating to industry, natural resources, finance, health and education in a sustained or forceful manner. The MSTVT recognizes this and its desire to strengthen the Ministry with staff and a policy platform reflect this recognition. However, despite the widespread support in principle for improved S&T policy making, getting staff on board in the new Department of S&T is proving to be an extremely slow process. Until a director and staff have been put in place, there will remain no effective central voice for S&T in government.

Compared with senior departments like Finance and Mines, MSTVT has less influence on government policy because its budget envelope is smaller its mandate less immediate and clientele less powerful . While the mandate of the Department of Science and Technology within the MSTVT is crucial to the country's future, it affects only a small professional elite in the immediate term - highly educated scientists and engineers, and modern, locally-controlled industries. Rarely will S&T be at the top of any politician's agenda, not only in Zambia but in all except the most advanced countries.

S&T Educators

S&T Educators are those in universities and colleges who teach science, engineering and related technical professions.

We have not undertaken a comprehensive study of S&T education. There is currently a study underway in the MSTVT on technical training and another study of the University of Zambia. Our investigation of S&T Educators focussed only on training related to the interaction of S&T with business.

Engineering at the University of Zambia is perceived in a very "classical" manner whereby the engineers are turned out as very narrow technical specialists. This training makes it difficult for engineers to move into management positions and to consider taking entrepreneurial approaches to business, such as setting up their own companies.

3.3 Improving the Zambian S&T System

While there are numerous - and severe - problems with the Zambian S&T system, there are enormous opportunities for S&T-pulled development in the productive sector. Appropriate investment support policies could yield great benefits in the short term.

First is that so little potential has been tapped yet that there can be a flood of long-overdue innovations and product improvements hitting the market in the short term at low cost.

Second, the whole SADC region is becoming more open, providing markets for Zambian products. South Africa is seen as the regional giant, but it should not be forgotten that the great majority of South Africans live and produce at an economic level not much different from Zambians. South Africa is a new market, not just a source of technology and imported products.

Third, there seems to be a broad consensus within government at both the political and bureaucratic levels that support for S&T in Zambia needs to be increased.

The key in realizing these opportunities is, as we have emphasized throughout this report, to focus on helping the productive sector use S&T. In terms of institutions and policies for S&T this means creating linkage mechanisms among the various stakeholders so that the forces of supply and demand can operate more freely over channels of information and investment.

There are two central linkage mechanisms that need to be built. First, linkage is needed among S&T users, regulators and producers at the policy level whereby broad S&T directions can be set and action at a national level implemented. Second, linkage is needed among S&T users and producers at the level of the industrial firm whereby new products can be designed, manufactured and sold. All the other projects suggested in this report work to support the operations of these two central linkage mechansims. Together, these projects will begin to overcome the debilitating problems of isolation, insufficient funding, lack of client orientation in a competitive market system and awareness by the stakeholders of the potentials for S&T-driven development.

3.4 Sectoral Support

Two sectors require special mention for support, mining-minerals and agro-industry.

The key to Zambia's development is most likely to be the mining-minerals complex. It's role in the economy is overwhelming. It has modern technology, financing, employment practices, management and an international scope. It is essential to ensure that S&T policy support the development of this sector and its interlinkage with the manufacturing and service sector. Mining-minerals can, if proper policy support exists, drive intensive development in both manufacturing and services. The role of S&T policy in supporting this development is critical.

The agro-industrial complex is vital for health, cultural, political and economic reasons. There is great potential for development in this sector, although limited by social factors. S&T policy for this sector will bring significant benefits.

There is also a need for Zambia to begin making investments in advanced technology areas like biotechnology and information technologies. There is a natural linkage between these technological areas and the two major industrial sectors of mining-minerals and agro-processing.

4. RECOMMENDATIONS FOR PROJECTS

Now that we have considered the basic principles for project design, prioritized the types of S&T to support and analysed the key problems in the Zambian S&T system, we can create a series of proposals for taking strong action that will bear fruit in the near future.

Our recommendations include organizations in Government, but focus on the private sector. The private sector organizations we recommend will augment the government work in S&T Policy, by performing specific functions more effectively because they are within or closer to those groups actually producing goods and services.

The projects recommended do not promote one sector over another. Our approach has been to create and strengthen the institutions first and let them make sectoral choices as they carry out their work in the future.

It is essential to note that the following projects are designed as part of an overall package that attempts to support industrial innovation systems. There is a close relationship among all the elements that follow. Treating them as individual, separate projects that can be put in place without reference to the others will weaken the entire concept. The following table summarizes the project proposals and displays their essential interrelationships.

Project Initiative	Function
MSTVT	make public policy for S&T
S&T Promotion Council	initiate major S&T projects & institutions
Funding Mechanism	ensure adequate & targetted funding
Policy Support	ensure appropriate policy (eg tax breaks to firms for R&D)
Product & Process Engineering	take innovations from lab to industrial scale production
Venture Capital	fund new technology-based enterprises
Client-Driven Labs	allow market needs to direct R&D labs' work
Technology Business Centre	help set up new technology-based enterprises and get lab S&T into new products
Information Service	circulate technology and business information to users
Public Awareness	raise public appreciation of S&T-based business
University Technology Policy	train academics and technology professionals in Technology Management

The project descriptions presented in this chapter are made to a prefeasibility level and costed to an approximate degree only. The important step now is to get approval from government as to the overall program of action. Our recommendation for implementation is strongly that each project begin by hiring a dynamic and capable director. These directors should begin work immediately in their project areas with only the barest levels of support. As they demonstrate the importance of their project areas, then they can define the business plans more fully and seek required resources within the general framework already established by the S&T Action Program and approved by Government. This plan has the advantage of minimizing initial expenditures, making it easier for Government to approve the investment. The alternative would be for a much bigger investment in year 1, preceded by a lengthy period of getting formal approval and executing of design studies, mostly by foreign consultants.

All costs presented in this report are in $ US.

4.1 Set up the DST within MSTVT

The current design approved for the S&T department within the MSTVT[7] is for 8 professional staff in two branches. No functions have yet been specified except for a broad separation between the science, research, education side and the technology for development side.

Recommendations for Mandate

We recommend the formalizing a mandate for the MSTVT to include:

- coordinate S&T activity within government ministries
- discover and analyse national problems and opportunities
- maintain an information base on Zambian S&T Policy and all related public policies and organizations
- develop policy for all the uses of S&T as mentioned in Chapter 2
- promote and carry policy and annual budgets to Cabinet
- distribute routine operations funding to the appropriate public sector S&T agencies
- enforce S&T regulations as required
- assist the S&T Committees of Parliament and Cabinet
- develop and support intergovernmental and international S&T policy issues.

[7] Revised Structure, Ministry of Science and Technology, Lusaka, May 1993.

Recommendations for Structure

We have several recommendations for structuring the MSTVT. First, the proposed hierarchy is too steep. A broader, flatter, more collegial structure is better. Thus, we recommend only two levels, one for the director, another for all the remaining posts.

Second, we recommend that the name of the staff positions be changed from "Science Officer" to "Science and Technology Policy Officer". This is a crucial distinction. The MSTVT is not there to promote pure research and isolated science. Nor are the staff doing science. Their function is to do S&T policy.

Third, we recommend that hiring of people for these positions not be based on their scientific credentials. The task of the staff is not to do science. The staff must be literate in science and technology and they may have a background in training or practice as scientists or engineers (or physicians, pharmacists or any other technical profession) but their function is to manage and develop policy for S&T to achieve development goals.

Fourth, we recommend that there be no organizational split between science and application. Each of the staff members should specialize in one or more sectoral areas instead so that all sectors are covered, following a common goal to promote industrial pull of S&T for commercial purposes.

Fifth, we recommend that the number of staff positions be limited initially to three people, a director and two officers, in order to ensure adequate financing is available for institutional development in key areas outside government. The initial task of the MSTVT will likely be focussed on implementing this action program. When this has been completed, the issue of number of professional staff may be revisited.

Training

In the event that Zambians can not be recruited who already have substantial professional training and experience in S&T policy, we recommend a training program This training program should acquaint the three professional staff with best practice in the field of S&T Policy, or to brush up their skills if they already have a general introduction to it. This will involve training periods of approximately one month each for five years for each person, to go to a similar ministry in a country with relevant practice, or to a university short training session in any appropriate country.

Facilities

We have recommended a small group of professionals. In order that these people be able to cover all their responsibilities, it is essential that they be

supported to the maximum by good facilities. Having this group a showcase for advanced electronic support infrastructure will be appropriate. Therefore, each of the professionals should have an advanced computer (PC 486 50 MHz or comparable Macintosh) and laser printer with full suite of management software (word processing, spreadsheet, presentation and drawing). Furthermore, they should be connected by e-mail to Zambian and international colleagues and quickly become fully capable of using these tools. The office should have photocopy and fax capability. A small library fund is included here to help the group gather, maintain and disseminate information relating to S&T Policy.

Funding

Item	Description	Govt. Zambia Funding Requirement	Potential Donor Funding
Staff Salary+Benefits	director	10000	
	S&T policy officer 1	5000	
	S&T policy officer 2	5000	
Standard Overheads		20000	
Staff Training	travel	30000	15000
	per diems	30000	15000
	materials	4500	2250
	communication	3000	1500
Facilities	3 computers	9000	4500
	3 printers	6000	3000
	software	5000	2500
	training	3000	1500
	library	2000	1000
	supplies	1000	500
	maintenance	1000	500
	photocopy	2000	1000
	fax	1500	750
	e-mail	1000	500
Fixed Purchase Costs		20000	20000
1st Year Annual Cost		119000	39500
Total 5-Year Inflated Annual Cost (@20%)		885598	293959
TOTAL 5-YEAR COST		$905,598	$313,959

Sustainability

The MSTVT will be responsible for all maintenance of the equipment and supplies after the project period of five years after the projected donor portion is phased out. Small cost recovery will be generated by having staff responsible for paying a portion of training costs themselves, say, to a level of 20% of local costs.

4.2 Design Funding Mechanism for Special Initiatives

Need

Reports in the past have signalled the need to increase the level of funding for the national S&T effort. Unfortunately, many past requests for increased funding have not put forth adequate plans for employing the increased funding in the national interest, or have made requests far in excess of the absorptive capacity of the S&T system, or far in excess of the capability of the nation to pay. This has led to most of these requests being ignored. The need for realistic increases has unfortunately been lost in the confusion.

What is needed is a comprehensive funding mechanism that promotes industrial development, generates a reasonable amount of money, delivers financing to the right projects and does not require a cumbersome new bureaucracy to operate. Furthermore, the mechanism must separate funding for routine operations from funding for R&D and special policy studies and initiatives. Following is a recommendation for a new funding mechanism for these R&D and special initiatives, called the Innovation Fund. Note that the Innovation Fund is above and beyond the routine operations funding for current and proposed S&T institutions which will continue to come from general tax revenues, distributed by the Minister of the MSTVT.

The amount of funding for the new Innovation Fund is determined by summing the costs presented for the projects recommended in this report. The additional cost for routine operations to be funded from general tax revenues can also be calculated from summing the routine operations aspects of the new projects. This should be an accurate and reasonable way of designing a budget request. The implications to the Innovation Fund of revenue intake generated independently by the S&T system can be assessed later on, after a few year's experience has come in.

Components of a Complete Funding System

There are three major components to a comprehensive funding system. First, there is the continued operations funding to the labs at the current level and

funding of operations for the new organizations described in this report. Increases to staff salaries, equipment, training and infrastructure funding can come later if the organizations show increased ability to achieve public policy goals.

Second, legislation should allow and encourage the existing labs and new organizations to generate and retain their own revenues from operating more on market principles and delivering more commercially-oriented services to their clients. Funding directly given to a S&T organization from any other non-commercial, international source should also be allowed.

Third, an Innovation Fund should be created which will be used to conduct special projects specifically aimed at linking the productive sector and the S&T system so that industrial output is increased as rapidly as possible.

Description

The details of regulating the routine operations and changing legislation for the R&D labs so they can generate and retain revenues need to be worked out by the MSTVT. At this point, we will concentrate on the new Innovation Fund.

The Innovation Fund should be set at an amount determined by specific project need as described in this report, not by a general percentage allocation from GDP. The Innovation Fund should be taken as a new levy on firms that produce goods and services within the productive sector. It is to be their fund, designed to be returned to them as high-value S&T services which will increase their profitability. These firms must participate in the management and disbursement of this fund, and their commercial concerns must predominate. Management of the Innovation Fund is to be contracted to the new S&T Council, described in the next project.

The Innovation Fund is to be allocated annually by the S&T Council within the general 5 year plan into the following categories which will be under the final control of other organizations. The subfunds, the organization responsible for them and the amounts are summarized in the following table. Note that in this summary, as in all project cost tables, we assume an annual inflation rate of 20% and increase the annual allocation to the fund accordingly.

SubFund Name	Controlling Organization	First Year Allocation (,000 $US)	Total Inflated Cost @ 20% per annum (,000 $US)
S&T Action Fund	S&T Promotion Council	1,000	7,442

Business Development Fund	Technology Business Service Centre	200	1,488
Design Fund	Product & Process Eng. Centres	350	2,605
Research and Innovation Fund	public R&D institutes	2,000	14,883
	Total 5 Year Amount (uninflated)	$17,750	
	Total 5 Year Inflated Fund Cost		$26,418

Sustainability

A substantial - but limited, highly targetted and realistic - increase in funding is required to achieve the policy goals set out by the MSTVT in its policy framework document. A 5 year time span is set in all instances to give the action program a chance to generate results. If funding can be set for this 5 year period, interim and final reviews will determine how well the action program is functioning. This will allow good decisions to be made on future funding needs.

4.3 Establish S&T Promotion Council

Need

The government sector, the productive sector and the S&T sector are too isolated from each other. They need to be brought into closer contact to discover, analyse and resolve national problems and opportunities relating to the development of the productive sector through S&T. There is currently no organizational mechanism to do this at a national level.

Objective

The objective of this project is to create a Science and Technology Promotion Council. This council will link government, industry (broadly defined as the productive sector) and the university/research labs. It will discover, analyse and resolve national problems and opportunities relating to the development of the productive sector through S&T in a timely fashion. It will control and allocate the Innovation Fund on an annual basis within the overall 5 year plan established by this program of action.

Description

The council will undertake projects involving thorough analysis on S&T policy issues, process work with the stakeholders and publication and diffusion of brief reports. Furthermore, the council will have its own S&T Action Fund to engage S&T work by other appropriate parties that will resolve the industrial issue.

A new body is required for this function and it should be incorporated by Act of Parliament as a Statutory Body funded by government but independent of government management, except through seats on the Board of Directors. The Board will be drawn from the universities, government-sponsored S&T organizations, the MSTVT and private industry. The function of this Board will be to ensure optimum project selection and execution, as well as the proper management of the council's internal affairs. The Board will allocate the Innovation Fund into the subsidiary funds for S&T Action, Business Development, Design and Research. This allocation will follow the guidance of a 5 year plan and only be modified in exceptional circumstances such as lapsing of funds, delays in set up of the subsidiary fund or increased needs due to unusually good performance.The interests of the productive sector will predominate in this Board.

The council will have the power to receive funding from any source and will actively solicit funds from private and public sources, national and international, to augment the Innovation Fund received through the MSTVT.

The council will have a permanent staff to maintain a core expertise in S&T policy, execute projects and manage day-to-day operations. The staff will be assisted in projects by outside experts drawn in as required. This council should develop the library collection of information on S&T Policy and Management as the national focal point. The staff will have the power to suggest projects for the Board's attention and approval, as well as to improve projects the Board suggests, based on their professional expertise. The relations between Board and Staff must be seen as collegial, even though the Board will have ultimate power over major investment decisons.

The council staff will consist of:

- director
- senior administrator
- communications specialist
- two S&T Policy & Management research officers
- support personnel.

Location

The council can be located either in the Lusaka area or in the Kitwe/Ndola area which is the industrial centre.

Funding

The council will be funded primarily by the government's Innovation Fund. However, the council should actively solicit support for its operations and

Innovation Fund from all possible sources. Funding as shown in the following table, highlighting both the Government of Zambia requirements and a potential donor portion.

Item	Details	Govt. of Zambia Funding Required	Potential Donor Funding
Office	rent	24000	
	car (1 time purchase)	20000	10000
Staff Salaries & Benefits	director	17000	
	administrator	14000	
	communications officer	15000	
	research officer 1	15000	
	research officer 2	15000	
	bookkeeper	6000	
	support staff	8000	
	Board honoraria	10000	
Staff Training		25000	12500
Infrastructure	computers, complete	25000	12500
	fax	1000	500
	photocopy	1000	500
	furniture	4000	
Operating Expenses	library	5000	2500
	communication	10000	
	supplies	3000	
	travel	10000	
	Board	4000	
	maintenance	6000	
S&T Action Fund	4 projects per year	1000000	
1 Time Purchases		$51,000	$23,500
1st Year Annual Subtotal		$1,187,000	$15,000
Inflated 5 Year Annual Subtotal (@20%)		$8,833,654	$111,630
5-YEAR TOTALS		$8,884,654	$135,130

Sustainability

This kind of structure will always require funding from its members (principally the Government of Zambia) because it generates no direct revenue.

4.4 Link Government R&D Institutes to their Clients

Need

As described in detail by previous sections, the existing government R&D institutes need to have more emphasis on market-oriented relations with customers, strengthen its relations with clients and help its clients develop commercial products.

Objectives

- Enact legislation to make each institute as autonomous as possible, keeping in mind the exclusive public sector functions such as standards and testing.
- Give each lab the ability to generate and retain revenue from its work.
- Have each institute continue to submit its annual report to government through its present minister so that current lines of reporting are maintained (except as stipulated by the overall policy framework document).
- Input public concerns to the institute's R&D program through the seat of the Ministry's Permanent Secretary on the institute's Board of Directors, but do not give the Ministry a controlling vote.
- Because they do not presently seem to have sufficient experience with client-driven research, have each institute contract out for marketing and extension services to the new Technology Business Centre described in this report.
- Create a new Research and Innovation Fund that will allow the major government institutes to link their R&D work more closely to clients in the productive sector.
- Undertake a business plan for each of the R&D institutes to start them on this new client-driven, market-oriented path.

Description

Most of the previous objectives are directly attained by straightforward legislative means. Here we will focus on the Research and Innovation Fund, which is a new concept. This fund will be under the control of each institute when it becomes more autonomous and can generate and retain revenue. It is to be used by the institute to assist industrial clients who propose R&D or engineering design projects, to carry out the work. At the discretion of the institute management, it will pay for:

- the institute staff to devote time to the project
- cost of infrastructure, specialized equipment and supplies used by the project
- partial subsidy of the client's own costs.

The institute management will determine how important is each research contract from each client and how much the client can afford to pay. Subsidies accorded to the client requesting the R&D project should be cumulative up to, say, 75% of total cost. This means that the institute can add its own subsidy, if it chooses, to the proposed R&D tax credits (as described in the section on Supporting Legislative Requirements) and any other public R&D funding source, such as that used by the S&T Promotion Council.

Funds not spent on client-driven R&D will be returned to the parent Innovation Fund and not used on other internal projects. This forces the institutes to make strong efforts to find clients. For every project funded, a portion (say, 25%) can be taken from the Research and Innovation Fund and used to build up the institute's skills, infrastructure or equipment in the technical field immediately involved with the client-driven work. This provides an added incentive to develop strong capability in areas pulled by industrial demand. Therefore, routine block allocations must be made in advance to staff training and library out of the Research and Innovation Fund. The objective of such training and information build-up will always be to enhance expertise in the technical areas immediately or soon to be required to handle projects with industrial clients.

Location

Each of the government institutes should be involved with this project. Different mandates and characteristics of each institute will naturally require modifications of the general principles laid out here to optimize the project goals.

Funding

The following table shows an estimated cost for all the government institutes, including the NCSR. More work is required to make separate estimates for each of the institutes finally chosen for this project, but within this approximate funding envelope.

Item	Govt. Zambia Funding Requirement	Potential Donor Funding
Staff Training (annual)		50000
Library (annual)		15000

Res. & Innov. Fund (initial annual)	2000000	
1st Year Annual Cost	2000000	65000
Total 5-Year Inflated Annual Cost	14884000	483730
TOTAL 5-YEAR COST	$14,884,000	$483,730

Sustainability

The fund is a cost to government, but as it is clearly demonstrated over the five year period that there are direct, measurable benefits coming from the resulting industrial development, it should be justifiable.

4.5 Create Technology Business Service Centre

Need

There are many commercial opportunities that could be realized in the short and medium term if businesses were aware how the S&T resources in Zambian universities and government labs could be applied to their needs, and if these S&R resources could be made easily available to practical problems of industrial production.

There are many opportunities for labs and universities to sell S&T that are not being realized because the researchers and designers are not aware of specific industrial needs that could translate into contracts. The S&T they could sell is in the form of services, infrastructure and prototypes sitting on the shelf from past R&D projects.

There are many technically-skilled people leaving university or technical schools who are looking for employment, but are having difficulty getting a job that uses their skills. In addition, there are significant numbers of people who have been let go from companies and people in technical positions who are dissatisfied with their salaries or job limitations. Many of these people could start their own businesses using their technical skills if they only had the right role models, business skills and access to capital. As well, there are many other people with business skills looking for good businesses to start up, but do not have access to the necessary technical and production skills.

Objective

To create a private, not-for-profit corporation that will:

- provide facilities and services for entrepreneurs to help them set up their own businesses based on the exploitation of a technology or technical skill
- undertake marketing and extension services for government S&T labs on a pilot level and make the links with industry clients to sell the labs' research expertise, specialized infrastructure and prototypes sitting on the shelf
- promote the general development of links among researchers, bankers, regulators and businessmen on the issue of new technology-based business development.

Description

The centre is to be run by a Board of Directors drawn from banks, private industry, the public R&D institutes, universities and government. The Board acts in the standard manner to ensure the centre is run well, but also has another crucial function in making contacts at a business level. The centre is run by a Director who must be a businessman with an excellent network of business contacts because his primary activity is brokerage and promotion. In addition, he must be a coach, capable of training fledgling entrepreneurs and a practised investor, able to spot good business ideas that are likely worthy of further development. The Director will need to be backed up by an Administrator who will assist in all areas mentioned above but focus on the day-to-day operations of the centre.

The centre will provide:

- partially subsidized space for fledgling entrepreneurs to set up operations
- office infrastructure for business operations
- a meeting place for the entrepreneurs to give and receive mutual support
- the full range of services required to assist business development (eg, coaching from experts in the field, technical advisors, training in specialized topics, contacts with investors).

To provide the full range of advisory services necessary, the centre will contract to experts in and outside Zambia as required. These services will be made available at subsidized rates to the centre's clients.

The centre will need to promote its own facilities to stimulate potential entrepreneurs to set up business there. It will also sponsor events for the business community that relate to technology-based business operations (eg open houses, workshops on international marketing, product design, patents, R&D funding, venture financing etc.).

The centre will have a small Business Development Fund which it uses to assist especially promising and needy entrepreneurs. The fund can be used in many different applications to subsidize the cost of a critical input to the new firm's development at any stage while it is a centre client. The fund will be approved yearly by the S&T Council Board, according to the 5 year plan. Lapsed funds will return to the overall Innovation Fund.

A major thrust of the centre's work will be to conduct marketing and extension work for several of the government labs (including the NCSR). The centre is a purely business-oriented organization which will be much more effective than the labs in bringing technology to the general business community. Reorienting the labs from the science-push perspective to an industry-pull perspective will take time; to get lab technology off the shelf and into production in the short term will require an organization like the centre to do this. There must be an obligatory arrangement worked out with government to contract out specific types of marketing services for specific technologies and specific labs. These marketing services will:

- sell technology off the shelf to industry
- develop industry-led R&D and technology development projects using skills and infrastructure of the labs
- bring in short-term contracts from industry to improve product design and process improvement.

To carry out this marketing/extension work, three professional staff will be required, each with a different specialization. The specializations required will only become clearer after a preliminary scan of technology-led opportunities has been done, but it seems likely they will be in the area of mechanical, chemical and agricultural processing technology, with a possibility for software\information technology if it can be linked to a large local market need (eg geophysics\geology for mining).

Note that the centre is designed to stimulate technology-driven business, not to build up its own in-house staff at the expense of private sector consulting firms. Wherever possible, the service functions should be done by the private sector, under contract to the centre. This concept extends to the obligatory marketing work that will be carried out on behalf of several of the government labs. If private sector firms can market lab technology, they should be given contracts to do so. Similarly, if professionals can be contracted from the private sector to handle the major services expected to be required, they should be hired on contract instead of hiring the three professional staff suggested in this description.

The centre should also develop, maintain and diffuse a small library collection relating to its area of operations.

Funding

The following table lays out an initial summary of costs and revenue potential.

Item	Details	Govt. of Zambia Funding Required	Potential Donor Funding
Office	rent	24000	
	3 cars (1 time purchase)	60000	30000
Staff Salaries & Benefits	director	17000	
	administrator	15000	
	marketing officer 1	15000	
	technical officer 1	15000	
	technical officer 2	15000	
	support staff	8000	
	Board honoraria	5000	
Staff Training		25000	12500
Infrastructure	computers, complete	25000	12500
(1 time purchase)	fax	1000	500
	photocopy	1000	500
	furniture	4000	
Operating Expenses	events	10000	5000
	communication	10000	
	supplies	3000	
	travel	20000	
	Board	4000	
	maintenance	18000	
	specialized contractors	50000	
Business Development Fund	annual allocation	200000	
Revenue Generation	services to clients	300,000	
(target 5-year total)	profits on new projects	250,000	
1 Time Purchases		$91,000	$43,500
1st Year Annual Subtotal		$454,000	$17,500
Inflated 5 Year Annual Subtotal (@20%)		$3,378,668	$130,235
5-Year Total Costs		$3,469,668	$173,735
5-YEAR NET EXPENSES (costs - revenue)		$2,919,668	

Under the general heading of "Government of Zambia Funding Required" there are two sources that should be mentioned apart from the direct financial allocation made through the MSTVT. The first is from development banks. It is crucial to get Zambian development banks to pay for part of this centre. They have great difficulty in generating a good "deal flow". Few projects coming to them are good combinations of indigenous entrepreneurs, local technology sources and good management. The centre, having the mandate to work in this area, is providing an essential service to the development banks of developing a good deal flow, and should be paid for its work for the banks. Such involvement by local development banks is already well proven in other countries, such as India.

There will be a significant revenue generation. Part of the revenue generated will come from the government labs which contract out the marketing and extension services. This service should be put on a full cost recovery basis. It will, of course, require modification of the way the labs are funded and can make money. For this feasibility-level budget, we estimate an uninflated average of $US 60,000 per year from sale of such services. Second, new R&D projects will inevitably be brought to the labs through the marketing and extension work, projects that were not previoiusly planned. It is envisaged that this profit should be shared equally between the lab and the centre. For the spreadsheet above, we estimate an uninflated average of $US 50,000 per year in such profits.

Location

The best location for this centre is usually on the campus of a university where it attracts professors out of their labs and classrooms and attracts businessmen out of their factories so they can come together. This concept assumes the university is a strong source of S&T expertise as well as a bubbling pot of new ideas and restless, ambitious, agressive students. If this is not the case, then the incubator centre should go near the biggest concentration of public R&D labs, for the same reasons. However, once again, we need a climate of inquiry, agressive exploration, risk-taking, where the rewards can be high. The site must have excellent communications and transport. If these conditions cannot be met near the labs, then the incubator centre should be located in the modern industrial district.

Sustainability

Structures like this perform a public function and are not likely to generate more than a minor part of their revenue from operations. We estimate a maximum degree of revenue generation of 30% after 5 years. A higher level might be possible, but this might force the centre into actions that were

oriented only for the very short term and ignore projects with a bigger, but longer-term potential.

4.6 Create Product and Process Engineering Centres

Need

Zambia has the capacity to make preliminary engineering prototypes of most simple products in the mechanical engineering field relating to appropriate technology and simple food processing. However, there are areas where this capacity is needed but is weak, such as control systems, electronics, software, chemicals, biotechnology and metals-materials. An inventor or entrepreneur with an idea for a product in these latter areas will find himself blocked at a very early stage because there is no expert group he can turn to for product design.

A similar situation exists for process engineering. Making a product prototype by itself is not sufficient for creating a successfully manufactured product. The industrial process by which the product is to be manufactured must also be worked out to a prototype level. Very little of this process engineering capacity exists in Zambia.

Objective

The objective of this project is (after determining general priority areas for technology-driven industrial development) to build the necessary product and process engineering capacity that will support sectoral industrial development.

Description

This centre sells engineering design services to industrial clients in a particular sector. The centre must develop a proactive program to publicize its services and visit the premises of its most promising clients from time to time.

Further study is needed to determine the sectors where product and process engineering capacity needs to be strengthened as a first priority for the next five years. Here we will set out a general envelope for three generic areas, involving building expansion, infrastructure, equipment, supplies, training and staff as shown in the next section, on Funding. The primary emphasis is on supplying product and process engineering design, but these centres should also supply, through contracts to private consultants, if necessary,

other closely related services of industrial engineering, industrial design and quality management.

The centres' setup and routine operations will be funded from general government revenues. Like the other organizations recommended for creation in this report, they will have a special fund for discretionary investments in what it deems especially worthy and needy projects. This Design Fund will be approved annually by the Board of the S&T Council, following this 5 year plan. Monies lapsed by the Design Fund will return to the overall Innovation Fund.

Note that, although we use the word centre, this does not automatically imply there is a single location and an emphasis on fixed infrastructure and equipment. Many "centres" can function better as "networks" dispersed among several sites and organizations, using equipment and infrastructure from a variety of sources as required. In this way, a broader delivery points for service can be obtained and a broader input of services and experts can be maintained for clients, all at reduced cost.

We have emphasized the concept of product and process engineering, starting from existing structures like the Technology Development and Advisory Unit which specializes in mechanical and agro-industrial products, requiring heavy investment in machinery. There are areas like electronics and software which may take entirely different shapes and the engineering support concept may need to be modified in ways we cannot predict at this initial stage. The central concept which will remain the same, though, is the provision of a set of technology-intensive services and equipment that is essential to make the firms in a particular sector develop new products. The services and equipment that the state should sponsor are those that individual companies and consulting firms are not able to afford at the current stage of national economic development.

Funding

Strengthening or creating new centres in process and product engineering involves the biggest cost item in the entire Policy Action Program proposed to MSTVT. The large cost is due to the need to equip the groups with the appropriate infrastructure. As one moves from R&D to engineering design to pilot testing to full scale production, costs generally go up by an order of magnitude at each step. Considering that we initially recommend three centres to be strengthened or created, it makes for a substantial investment. The costs involved and the need for multiple centres needs much more consideration before simply accepting these preliminary estimates.

Item	Govt. of Zambia Funding Required	Potential Donor Funding
Lab Space	50000	
Staff Salaries & Benefits	60000	
Staff Training	25000	12500
Infrastruct. & Equipment	1000000	500000
Library	2000	1000
Operating Expenses	500000	250000
Design Fund	350000	
Revenue Generation (target 5-year total)	667,620	
1 Time Purchases	$1,000,000	$500,000
1st Year Annual Subtotal	$987,000	$262,500
Inflated 5 Year Annual Subtotal (@20%)	$7,345,254	$1,953,525
5-Year Total Costs	$8,345,254	$2,453,525
5-YEAR NET EXPENSES (costs - revenue)	$7,510,729	
TOTAL COSTS FOR 3 CENTRES LIKE THIS	$22,532,186	$7,360,575

Location

One of the possible sites for a metals-materials centre is the Technology Development Advisory Unit (TDAU) at the University of Zambia. This group has the mandate to produce prototypes of products and processes on its own and for industry. It currently focusses in the mechanical engineering area. We mention it because the TDAU has a track record and an interest in broadening its services as well as becoming more commercially-oriented. However, it would have to become completely autonomous from the university to become the centre in this proposal and acquire the management skills it currently does not have. It would be possible to split off the process engineering functions from the incubator centre and have the incubator centre simply contract out this work to the TDAU. In any case, it is not in the industrial centre of the country which is in the Copperbelt, around Kitwe and Ndola. Further work will be required to choose the optimal setting for this organization.

Sustainability

For the budget above, we estimate that on a five year average, centres like this should generate at least 10% of their budget requirements by sale of services. This is conservative. If the centres are providing real value to industry, we should see the figure climb up to, say, 30-50% by the end of the period.

4.7 Create Technology Venture Capital Company

Need

Funding for small, new, technology-oriented business ventures is extremely hard to obtain. Technical entrepreneurship will not flourish until venture capital is available. There is a great deal of capital potentially available in pension and insurance funds, but the managers need to be made aware of the potential for investment in new technology enterprises.

Objective

The objectives of this project are to mount a pilot Technology Venture Capital Company to:

- invest in new technology-oriented businesses (produced primarily by the incubtor)
- demonstrate to the other potential funding sources in Zambia that venture lending can pay off
- train several managers in venture capital lending and managing.

Description

This fund is constituted from several different sources within and outside Zambia. It will be managed by a private company, work in close concert with the incubator (but not be limited to incubator client investments) and invest only in new enterprises based on the exploitation of innovative technology. It is based on a 5 year plan. Interim reviews by the groups financing the fund will determine if the fund is to wrap up operations after the 5 year period or continue in some other form.

It is essential to note that supplying venture capital by itself is not suffient; an equally valuable input is the managerial experience from the venture capital group. These managers do not get into detailed operations of the company in which they invest, but they do act as advisors and keep close watch on key decisions. Their experience is an extremely valuable input into the company management team. An experienced venture capitalist will be hired to initiate operations and continue to oversee the project for its duration. Provision will be made to train Zambians in all operations.

Location

The Green Venture Capital Fund, being promoted by Enda Esa, a consortium of institutions in southern Africa, has expressed interest in taking this proposal. This group has already started to promote a venture capital fund for another area but has not yet made much headway. The key Enda Esa member is a major commercial bank in Lusaka.

Funding

In the table below, it is seen that several sources are available for funding this project, including the Government of Zambia, donors, private Zambian groups and private foreign groups. The Government of Zambia will very likely be required to put down the initial seed funding to show its seriousness, before any others will come to the table with money. However, to the maximum extent possible, the funding should be private, not public.

Item	Details	Govt. Zambia Funding Required	Potential Donor Funding	Potential Private Zambian	Potential Private International
General Overheads		90000	17000		
Staff Salaries	Zambian director	15000			
	venture officer 1	15000			
	venture officer 2	15000			
Staff Training		20000	20000		
Additional Expenses	part-time expat director	200000	200000		
(5-year totals)	special events	50000	25000		
	specialized advisors	100000	50000		
Total Tech. Vencap Fund	investment in firms	4000000	1500000	250000	250000
Revenue Generation (target 5-year total)	return on investments	1,000,000			
1st Year Annual Subtotal		$155,000	$37,000		
Inflated 5 Year Annual Subtotal (@20%)		$1,153,510	$275,354		
5-Year Total Costs		**$4,350,000**	**$1,775,000**	**$250,000**	**$250,000**
5-YEAR NET EXPENSES (costs - revenue)		**$3,350,000**			

Sustainability

This is a pilot project which will be evaluated several times during its operation. The final evaluation will tell if it is worth extending. The degree to which the fund chooses to be development-oriented will determine the amount of income generated, assuming that business conditions are favourable. In other words, the fund could pick only the star performers and sell the investment rapidly, thereby making money. Or it could invest in important ventures with lower initial returns, thereby recovering only a portion of its investment. Public venture capital funds often do not make money because they are an instrument of public policy designed to foster a development goal. Private venture capital funds must make a great deal of money.

The sustainability of this project depends also upon the general business climate. Five years (for the first investments only) is a short time to plan on harvesting an investment. There may be serious impediments in the way of this project, such as restrictions on the stock exchange that limit its sustainability. It should be the role of the MSTVT to ensure the general fiscal and regulatory environment is adapted to ensure the greatest possibility of succes of this initiative. This is why we are promoting this as a development project, to see how a venture capital industry can function in the Zambian environment, and to demonstrate that large public funds can be oriented to this purpose. After the final evaluation, it will be clear how best to proceed with a subsequent stage - if any - of this project.

4.8 Gather and Disseminate Technical and Business Information

Need

Information on technologies, financing, markets, suppliers, regulations, standards, designs and processes is crucial to people involved in production of goods and services. Such information must be gathered in a much more comprehensive manner than is currently the case and it must be disseminated more effectively.

Objective

The objective of this project is to create a service that will manage the gathering and dissemination of key technical and business information to researchers and businesspeople.

Description

Each of the institutions described in this document has its own specialized information gathering, storage and dissemination capability. Once the institutions recommended are put in place, there will be good information gathered on S&T Policy, venture financing, methods of product and process design and diverse information relating to entrepreneurial business creation and management. People near the institutions gathering such information and people who are aware of the availability of this information will be able to access it without much difficulty. However, many people will neither be aware of the information nor be able to access it conveniently. Moreover, there will be only limited availability of information on these topics from international sources. Therefore, we propose to create a service that will:

- link with publically-available international data sources
- provide integrated access to each of the local data sources
- provide access points in each of the 8 provinces outside the institution location
- publicize the existance of this information and how to access it.

We call this a service to distinguish it from the other institutions being recommended in this document. While some specialized equipment and skills are required, the function is quite standard; this is largely the job of a modern technical library. Wherever possible, the service should use electronic means of networking existing data sources and providing hard copy to users.

We cannot stress too much the need for the Director of this service to be an independent, agressive networker and seeker of information. He or she must be technically-trained and should have training in library science as well, if possible. This person is not just a cataloguer of information, but must be strong in promotion of the service, understanding clients' unique needs which they themselves may be poor at articulating and be imaginative and persistant in ferreting out the required material. Infrastructure is far less important than getting the right kind of person to run the service.

Location

The preference is to contract this service out to a private, university or statutory organization that already has suitable library capability, or a good base that can easily be augmented. This library will be charged with the implementation of the coordination, standard setting and building and maintaining network access to the diverse data sources within Zambia and internationally. Most likely, the Small Industry Development Organization (SIDO) can be tasked with providing the locations and local personnel for accessing the data in each of the provinces. SIDO already has this as part of its

mandate; the infrastructure and training to be provided by this project will have the added benefit of improving SIDO's capabilities.

Funding

Training the Director of the service is extremely important. The best way to do this is to bring in an expert in this business from the private or public sector somewhere else in the world and have the Director work alongside this expert for two months.

Item	Details	Govt. of Zambia Funding Required	Potential Donor Funding
Office	rent	12000	
	car (1 time purchase)	20000	20000
Staff Salaries & Benefits	director	15000	
	support staff	4000	
Staff Training	periodic upgrading	5000	2500
	foreign expert	25000	12500
Infrastructure	computers, complete	25000	12500
	fax	1000	500
	photocopy	1000	500
	furniture	4000	
Operating Expenses	communication	10000	
	supplies	3000	
	travel	5000	
	maintenance	4000	
Revenue Generation	fees from large users	2000	
	directory sales	5000	
1 Time Purchases		$76,000	$33,500
1st Year Annual Subtotal		$46,000	$2,500
Inflated 5 Year Annual Subtotal (@20%)		$342,332	$18,605
5-YEAR TOTALS		$418,332	$52,105

Sustainability

Initial access to this service by individuals should be free of charge. However, fees should be charged to individuals for repeated use on a topic area. Institutional users other than the groups supplying data should be charged a corporate fee for access. It is important for the service to begin to define standard or customized information products to sell. Directories of national capabilities in science, technology and industry in specific sectors can be a

valuable and marketable product. In this way, some revenue generation will be possible. As this is a public service, government will need to assume financial support of the large part of its operation.

4.8 Create University Courses in S&T Policy & Management

Need

First, university students in management do not learn about entrepreneurship, the setting up of new, dynamic businesses by one person. Nor do they learn anything about the nature and power of science and technology to enhance the competitiveness of business.

Second, science students are focussed on research and engineering students on design. They do not learn about the opportunities and ways of setting up their own businesses based on exploiting their ideas or skills. For science students, this is especially important because they face difficulties getting employment upon graduation. These students learn nothing about how to manage technology within large enterprises. Perhaps this contributes to the relatively low prestige which engineering has in business. Management students are the ones that tend to rise to the top, not engineers. Engineering is conceived by the University of Zambia in very limited, classical terms and the students are sent out as technical specialists with extremely limited general skills for business.

Third, policy and public administration students do not learn about how and why to manage S&T for the public good, nor how S&T function and develop.

Objectives

The objectives of this project are to:

- develop three courses for university students in Zambia to make them more aware of the dynamics and power of S&T to contribute to development in the productive sector
- train university lecturers in the subject matter so they can deliver the courses at a suitable standard.

Description

There will be three courses, for:

- science and engineering students on technical entrepreneurship and management of technology
- business management students on the dynamics and power of S&T for business profitability
- political science and public administration students on the dynamics and power of S&T for national development.

The courses will be developed by a consultant (or consultants) working with the lecturers chosen to deliver them, based on the best available material.

Training will be available to three lecturers, consisting of one study period of one month per year for five years in an appropriate centre abroad.

Location

Either at the University of Zambia or the Copperbelt University.

Funding

Note that for the following, the cost item "consultant costs" can be substantially reduced if suitable courses can be found ready-made where the needs for adaptation are minor or limited. The consultant costs are made up of fees for 1 month per course, 4 weeks of per diems in Zambia, 2 plane trips to Zambia and course materials.

Item	Description	Govt. of Zambia Funding Requirements	Potential Donor Funding
Consultant Costs	consultant fees	40000	20000
(totals)	per diem	5000	2500
	transportation	12000	6000
	development expenses	10000	5000
Lecturers' Costs	local expenses	4500	
(5-year totals)	communication	5000	
Training	travel	60000	30000
(5-year totals)	communication	15000	7500
	per diem	30000	15000
	materials, books, articles	10000	5000
Facilities	computers	5000	2500
TOTAL 5-YEAR COST		$196,500	$93,500

Sustainability

Once the courses have been developed and the lecturers trained, no further expenditures will be required. It is hoped that the lecturers will work together and with other individuals involved with S&T Policy and Management in Zambia to take the initiative to go to the next step and create a Centre for S&T Policy and Management within the university.

4.9 Enhance Public Awareness of Technology Business

Need

In order for S&T to make their impact on the economy, a much higher profile needs to be given to them in several segments of Zambian society. Furthermore, Zambians need to be made more aware of how important S&T are to direct economic development, not just as an isolated prototype design or scientific concept.

Objective

The objective of this project is to deliver a series of highly targetted promotions over a two year period on the importance of S&T to economic development in the productive sector. There are three targets:

- JETS (an NGO, whose name means Junior Engineers, Technicians and Scientists), for the secondary school population
- Engineering Institute of Zambia, for the community of professional scientists and engineers
- Centre for Energy, Environment and Engineering (an NGO), for the print, radio and television media.

Description

For the JETS project, we propose funding for five years in three areas. First, to assist operations that promote student work which explores the link or chain between (or the chain of activities involving) the prototype, meeting a market need, manufacturing and sales. This may require larger teams and more interdisciplinary work. An effort in this project should be made to involve more girls.

Second, to promote the winning projects in an exhibition that travels across Zambia and reaches a much larger and broader public audience.

Third, to support prizes for the winning entries. These prizes will be awarded as part of the current prize system. It was considered that the prizes could be

scholarships, but this does not seem feasible when considering that teams of students prepare the entries and that the central purpose of the support here is for awareness.

For the Engineering Institute of Zambia project, we wish to promote professional awareness about the possibilities and desirability of using S&T within the productive sector to enhance efficiency of processes, innovate new products and set up new technology-based ventures. The primary mechanism will be the creation of three new prizes to be given at the annual prize-giving ceremony of the Engineering Institute of Zambia. The prizes will be for:

- best technological innovation
- best technology-based company
- best joint industry-lab (or industry-university) R&D project.

This ceremony should be expanded to invite other professional technical and scientific societies, and other technical professionals who do not have formal societies yet.

The media project will be run by the Centre for Energy, Environment and Industry (CEEE), a non-profit, private corporation. The media project has three separate components. The first is for the Centre to sponsor the production of discussions about S&T, highlighting its contribution to national development by focussing on the linkage aspects to the productive sector in the Zambian context. Such works do not need to be limited to actual Zambian cases, but in every case need the relevance to Zambia pointed out. We propose the Centre let contracts to ensure the production of:

- a bimonthly article for the print media
- a radio show to run weekly for a period of 6 weeks, four times a year
- two television shows per year.

Second, the Centre will run its own independent forum on national issues of S&T and development of the productive sector. Two of these will be run per year. The forum will be a one-day affair held in a public setting. The analysis or output of these forums can be used as material for the media products.

Third will be a program oriented towards professionals (journalists, producers) in the media. There will be an award given to the best production or article dealing with S&T policy. This award will be given at the annual ceremonies for other media awards. There will also be training or awareness-building assistance offered to media professionals to raise their skills in this area. The Centre will bring in 2 speakers per year to address media groups on the topic and will provide a 2 week training visit for a selected professional to go abroad every year.

Funding

Item	Description	More Detail	Govt. Zambia Funding Requirement	Potential Donor Funding
1. JETS	support for links		50000	25000
	travelling exhibit		50000	25000
	prizes		5000	2500
2. Eng. Inst.	3 new prizes		3000	1500
3. CEEE	commissioned material	TV	5000	2500
		radio	5000	2500
		print	2080	1040
	events	media prize	1000	500
		forums	10000	5000
	training/awareness	invited speakers	15000	7500
		training abroad	8000	4000
	CEEE management fee		20000	10000
Subtotal 1st Year Cost			174080	87040
Inflated 5-year total cost (@20%)			1,295,503	647,752
TOTAL 5-YEAR COST			$1,295,503	$647,752

Sustainability

This project is of fixed duration and donor support will end after the five year period. There should be a detailed evaluation of the impact of each program to determine its effectiveness. If the evaluations are positive, there should be little difficulty in attracting public support from national and international sources to supplement the partial private funding that will be generated, in order to continue in some fashion.

4.10 Investigate Supporting Policies & Legislation

Each of the investment project proposals operates within a legislative and policy framework. Some aspects of this framework need to be modified to ensure the full success of the investment projects. Key policy and legislation that can be seen at this early stage to need attention, but which have not been mentioned in the preceeding project descriptions, are summarized here. Ensuring appropriate policy and legislation for effectively managing S&T in the national interest will be an ongoing concern; for this reason, we have not attempted to go into great detail but only listed the highlights for the MSTVT to work on once it has been staffed.

Immigration Policy

As mentioned earlier in the report, technology transfer occurs best "on the hoof". Restrictive residency, work permit and immigration laws are exceptionally counterproductive to technology transfer. Liberalizing such restrictions will make a costless and significant improvement to the whole technology and industrialization effort.

Overall R&D Subsidy

The MSTVT needs to decide on an overall R&D public subsidy level to private firms before the institutions recommended in this report can be fully implemented. We suggest initially that public R&D subsidies should be able to be cumulated from different sources up to a maximum of 75%.

Lab Operations

Each lab needs to set initial targets for prices for its services, after looking at kinds of services to various markets, current and potential. This should be part of an overall new business plan made by each lab under the new S&T policy regime.

It might be worthwhile to investigate the possibility of allowing individual lab staff to bring in projects and get part of the consulting fee paid directly to them as a reward.

Government Procurement

MSTVT should select and promote areas where government can purchase technology-intensive goods and services from Zambian start-up firms to provide first markets and thereby encourage the founding and growth of these firms.

Innovation Fund

Defining which industrial sectors that will be taxed for this fund remains to be done.

We have suggested an initial target for R&D funding as 0.5% of GDP. This figure can be set more accurately by studying: 1) absorptive capacity of the S&T infrastructure, 2) sensible increase over the current state and 3) actual need as determined from this action program document.

Select Key Sectors for Process and Product Support

A study needs to be made to select the top three sectors needing support from the Product and Process Engineering Centre

Tax Subsidies for R&D and Innovation

We recommend that businesses receive tax breaks for spending money on R&D. Generating such subsides is a crucial and effective means of promoting industrial innovation by public policy. The following issues need to be investigated to flesh out the concept:

- level of subsidy
- delivery/application methods of subsidy
- definition of eligibility.

Tariffs

How best to structure tariffs on imported whole goods, raw materials and components in order to stimulate local manufacture based on local S&T resources?

Foreign Investment

How to encourage large multinational and small foreign investors to involve Zambian S&T inputs when they conduct market research, input adaptation and process design. Several cases were observed where this work was going on but did not involve Zambians in any substantial way - eg the lab work, field work and analysis were all done by the foreigners. Involving Zambians at this stage, through legislative requirements or tax incentives will greatly stimulate the development of local consulting firms, strengthen public S&T sources and improve the designs.

Technology Venture Capital

In order to improve the design of the venture capital fund, there is a need to investigate:

- banking laws to allow formal unsecured risk investments
- stock market
- repatriation of foreign venture capital
- suitable interest rate structure and stability to make such investments competitive
- interest of private businesspeople investing (eg talk to owner of the real estate on the roundabout)
- how to unblock public pension and insurance funds.

Consulting Industry

There has been a great deal of emphasis in this report on the need for the state to build new institutions to support the technologically-assisted growth of business. It should be stressed that wherever possible, the state should view these publically-initiated organizations as substitutes for private-sector groups only in cases where the private sector cannot justify such investment itself, or will not for cultural reasons. Government should never be making

investments in areas where the private sector can and is willing to provide services. There should be ongoing policy and regulation review that continually strives to increase the strength and breadth of activity of the private sector in providing S&T Policy and Management services and S&T services. Such services are usually provided by consultants and it is essential that Zambia promote the development of a broad, efficient and skilled consulting industry.

5. FINANCING THE OVERALL PACKAGE

This document is a plan of action that the MSTVT can begin to carry out to begin operations in the new Department of Science and Technology. The maximum total cost to the Government of Zambia of implementing this action plan is $US 56 million, as shown in the following table. The funding requirements have been presented in such a way that the MSTVT can prepare a Cabinet Memorandum to approve the action program and ensure that money will be made available as required.

The funding envelope summarized in this chapter describes the total maximum requirements. As we have stressed throughout this report, we recommend a start-up approach whereby the first step is always to hire dynamic and committed project directors and let them begin action with minimal budgets. This ensures better project design and minimizes initial government expenditures. Therefore, this chapter presents a maximum total program cost which will come into play only after the projects have gone through a period of start-up. Chapter 6 presents the separate start-up budget.

Project	Maximum GOZ Funding Requirement	Potential Donor(or Other) Portion	Minimum GOZ Funding Requirement
MSTVT	905,598	313,959	591,639
Government Labs	14,884,000	483,730	14,400,270
Policy Action Council	8,833,654	111,630	8,722,024
Business Service Centre	3,378,668	17,500	3,361,168
Product & Process	22,532,186	7,360,575	15,171,611
Venture Capital Fund	3,350,000	2,275,000	1,075,000
University Courses	196,500	93,500	103,000
Public Awareness	1,295,503	647,752	647,752
Information Service	418,332	52,105	366,227
Subtotals	**$55,794,441**	**$11,355,751**	**$44,438,690**
Average Inflated Annual Cost (@20%)	**$11,158,888**	**$2,271,150**	**$8,887,738**
Indicative First Year Cost	**$7,497,640**	**$1,525,982**	**$5,971,658**

Suggestions have been made in this action document as to portions of the projects that can be presented to donors for funding. The potential donor

portion of this action plan is $US 11 million. If donor funding can be attained, the initial cost to the Government of Zambia of funding the new S&T policy can be significantly reduced, to $US 44 million. Further work is required on all the projects to identify the types of donor financing possible, loan at preferential rates, grant and assistance in kind

Please note that these costs assume an inflation rate of 20% over the 5 year period. In preparing these budgets, we aimed at an initial ceiling of $US 10 million per year in new expenditures on S&T. We have come in at substantially less than this $US 10 million ceiling. The average maximum inflated annual cost is $US 11 million, which translates to a real maximum first year cost of $US 7.5 million. Of course, this cost would be higher in the first year if all the recommended projects started at the same time, given that substantial capital expenditures are required up front, but then the next years costs would be that much lower. If donor funding is attained as estimated here, the minimum expense in the first year to the Government of Zambia would be much lower still, $US 6 million.

6. IMPLEMENTATION

The program of action is an ambitious, but feasible proposal. There are two basic strategies for implementation. One strategy is for the Government of Zambia to approve the entire funding envelope for year 1. In this case, the immediate next step would be for the Government to undertake or contract out design studies of each of the projects. The projects have only been described in this report to a introductory, feasibility level and need more work to define them fully. This would keep the MSTVT fully occupied for at least half a year, or somewhat less, if external consultants (with donor financing) are used. Each of the individual projects can likely be adequately designed with the intellectual resources already present in Zambia. However, it may be useful to draw upon technical assistance from development agencies to get outside checks on the final project designs as well as to obtain additional skilled personnel to put on the design teams and limit MSTVT manpower constraints.

The difficulty of this full scale approach is that Government financial and personnel resources are limited for an all-out, immediate implementation. The strength of each of the project institutions lies not in their physical infrastructure but in the people involved. Many of the functions involve coordination and promotion. The resources required to initiate, demonstrate and promote such activities are minimal. The key resource for every project involving institution building is a dynamic, committed, capable individual. Infrastructure investments without the right people too often turn out to be very unsuccessful. Therefore, we recommend a staged investment whereby government approves the overall program of action (including a 5 year budget) and works toward implementing it in a series of smaller steps. The budget for the implementation phase is thereby much smaller as it is only a 1 year budget paying for a few people with skeleton support.

The first step in every stage is to locate and hire a competent director. This person should be given the absolute minimum resources for a period (say, up to a year) to:

- prove his abilities
- demonstrate the importance of the project
- promote the project's full establishment
- design the business plan
- secure the full-scale funding
- start up expanded operations.

There are five main stages of implementation, as follows.

Stage 1 - Staff up the DST

The very first step is to hire staff for the new Department of Science and Technology. Very little of the other project development can be done until there are people in place who will do the work. The Director should be put in place and then work can commence. Professional and support staff will follow, in time.

Stage 2 - Create S&T Promotion Council

Once a Director is in place at the DST, his (or her) first priority should be to get formal approval of the S&T Promotion Council. Once a Director is hired for this Council, the MSTVT Director and the Council Director can work together to initiate the next stages as rapidly as possible.

Stage 3 - Create Funding and Institutions

Appropriate funding mechanisms and amounts required for the overall program of action. This should be the immediate task of the S&T Promotion Council and the MSTVT. If full funding cannot be obtained, the remainder of the action program will have to be readjusted. Development of some of the legislation and policies mentioned in Section 4.10 may have to be done at this time to ensure this stage works out. Non-critical legislative and policy changes should be left to Stage 4.

Once funding mechanisms and amounts are secure, the next stage is to create the remaining new institutions. The S&T Promotion Council and the MSTVT should work together to set up the Technology Business Service Centre, the first of several Product and Process Engineering Centres and the Information Service. Note that work on these projects can proceed in parallel as they are largely independent of each other. However, before setting up the first Product and Process Engineering Centre, it will be necessary to study which sector is the most appropriate for such a centre. Again, legislative and policy extensions may be required, but if not, leave such work to Stage 4. Directors for each of the these three groups should be hired and given minimal start-up budgets.

Stage 4 - Work on Longer Range Projects

After the main institution building work has been completed, the attention of the MSTVT and possibly the S&T Promotion Council as well can then shift to the projects which have their impacts in the longer term. The first longer range project to tackle is the Technology Venture Capital Fund. This project is actually important enough to be in the previous stage of work, but is not included there because it may be significantly harder and longer to implement than the other projects. This is because the concept is newer and because it may take some corollary legislative action such as setting up the

Stock Exchange. We recommend that Government budget enough funding to hire an Acting Director who will define, promote and initiate the venture fund. If the venture fund becomes set up as an entirely private company, this Acting Director may not stay on as the permanent president of the fund corporation. Funding allocated to support for this person during the implementation phase is set at twice the rate for the other positions because the Acting Director will likely have to travel to financing centres outside Zambia.

At this point, the MSTVT should work on shepherding the necessary legislative changes through Cabinet that deal with making the government R&D labs more autonomous and responsive to market forces and customers. The other two projects, University Courses in S&T Policy and Management and Enhancing Public Awareness of Technology Business will be relatively easy to implement and should be set up now, by the MSTVT. Finally, all remaining legislative action can be done now. Legislative monitoring and improvement, of course, will become an ongoing task for the MSTVT as the operating experience comes in with the new institutions and ways to improve the national innovation system continue to become apparent.

Stage 5 - Set up Other Product and Process Engineering Centres

The recommendation is for several of these centres to be created, in key industrial areas. They should not be set up all at once, but sequentially, to minimize loads on public resources and to utilize prior experience. Therefore, the last stage is to continue to expand these investments as resources become available. Each centre should be set up in the same kind of way as the first one, that is, by initially hiring a dynamic and committed director to define the concept, prove its worth, develop a business plan and promote funding. No implementation budget entry is presented for these subsequent centres because they will not likely be set up during the first year.

With this implementation plan in mind, we can present an estimate of costs for the first year of investment which will then fit into the overall funding envelope described in the previous chapter. The total cost for the year of implementation before full scale operations funding kicks in, is estimated at US $184,000.

Project	Items	Implementation Minimum Cost
MSTVT	salary cost	10,000
	support	10,000
S&T Promotion Council	salary cost	17,000

	support	17,000
Business Service Centre	salary cost	17,000
	support	17,000
Product & Process	salary cost	15,000
	support	15,000
Venture Capital Fund	salary cost	17,000
	support	34,000
Information Service	salary cost	15,000
	support	15,000
Subtotals		**$184,000**

7. THE WAY AHEAD

The program of action suggested here as the first investments to be made under the new comprehensive S&T policy can bring great benefits to Zambia. In order to fully succeed, however, these investments need to be considered as a package. A business centre generating new technology-based firms must have venture capital available; a lab's Research and Innovation Fund must be complemented by a suitable R&D tax credit system for its industrial clients.

To achieve the benefits, the coordination role of the MSTVT must be effective in ensuring all government policy pulls in the same direction for harnessing S&T. Trade policy, manufacturing policy, resource policy, fiscal policy, tax policy, education policy, environmental policy, health policy are all to be involved with S&T policy.

Finally, government must stay the course. Though we have selected investments in S&T structures that will pay off in the short and medium terms, the benefits will still be relatively diffuse, difficult to measure, unpredictable and slow to come - relative to feeding hungry people or filling potholes in a road.

The action program, although ambitious, is within Zambia's capabilities. It is a fundamental component to national development.