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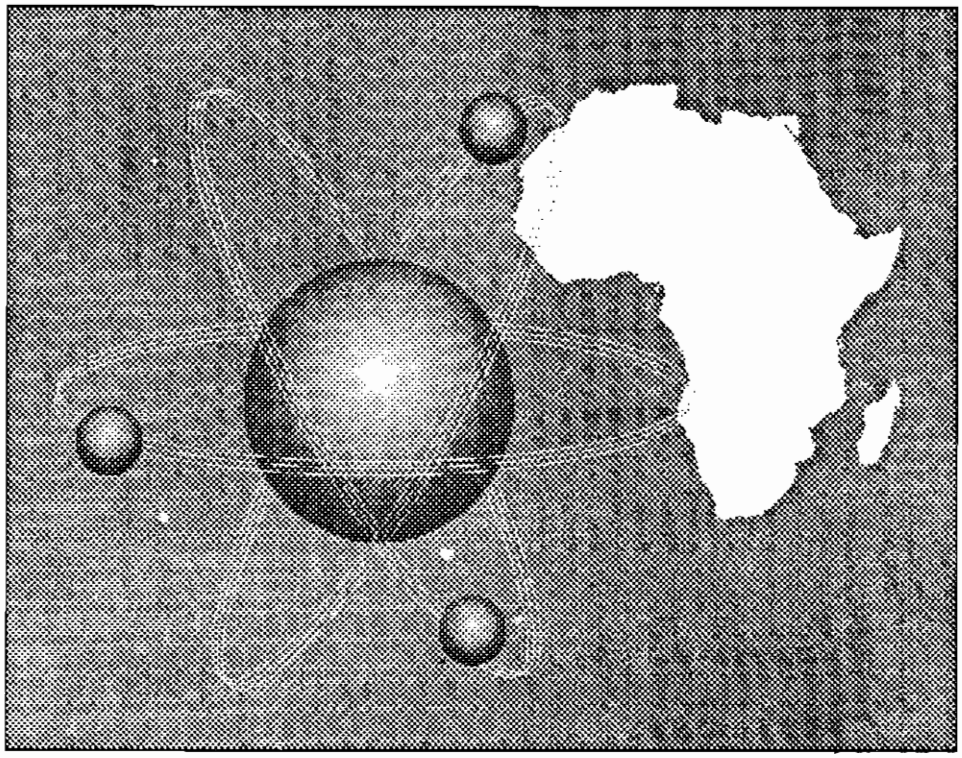
United Nations
Economic Commission for Africa

Science and Technology Management in Africa



Natural Resources Division
Science and Technology Section

September 1992

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FOREWORD

This document puts together various papers related to endogenous capacity building in Science and Technology in Africa. Endogenous capacity is defined as the capacity to manage technological change to achieve national objectives, and incorporates policies, infrastructures and manpower.

The management of technological change has many aspects and the papers presented here cover a wide range of issues: incorporating science and technology policies into national plan, managing technology transfer policies, the cultural dimension of science and technology development and application, the role of the private sector, the financing of technological innovation, methodologies for planning science and technologies policies, the management of research and development, the impact of technological advancement on the African economies and national experiences in the management of technological change.

The papers have been presented to the ECA/IDB training seminar on management of science and technology in Africa, held in Conakry, Guinea, from 26 of February to 1st of March, 1992.

The Economic Commission for Africa wishes to express its gratitude to the Islamic Development Bank for its support in co-financing the seminar and to all the resource persons and the participants.

INTRODUCTION

The first paper, presented by Mr. Ove Bugge, Director of the Asian and Pacific Centre for Transfer of Technology, India, elaborates on the incorporation of technology transfer strategy in the national development plan of countries. It deals with the issues of appropriate technology, technology decision-making, technology culture, technology acquisition and social impact of technology transfer. It then highlights the respective role of the government, transnational corporations and small and medium businesses. The paper also suggests a policital framework, national institutions for technology transfer and practical mechanisms for technology transfer.

The second paper, presented by Mr. Ousmane Souare, Director, Division of Scientific and Technological Cooperation, Conakry, deals with Guinea's experience in science and technology management. It traces back the evolution of the science and technology system in Guinea. Seven stages of development are identified from 1958 to 1992. It describes three levels in the planning process: (1) decision-making level, (2) coordination level, and (3) implementation level. The paper also analyses the programming, bubgeting and financing of science and technology in Guinea.

The third paper, presented by Dr. Muhammad Ahmad of the Islamic Development Bank, is focused on the role of private indigenous counsultancy firms in the transfer of technology. It emphasizes the role of technology transfer in development, the main source of technology and the constraints encountered in technology acquisition. It describes the role of consultants and the advantages of indigenous counsultants. The paper suggests measures to enhance the capabilities of indigenous consulting firms, such as joint ventures between local and foreign enterprises.

The fourth paper, presented by Dr. Selim Jafar Karatash of the Islamic Development Bank, underlines the role of the private sector in economic development and management of science and technology. The paper is divided into three main parts. The first one deals with the necessity of political stability, property rights, the rule of law and the reliability of the judicial system. The second one deals with the economic climate, such as macro-economic and micro-economic adjustments, monetary stability, stable prices, rates of exchange, incentives to smalll enterprises, investment rules and corporate taxes. The third one deals with the management of science and technology at the private enterprise level.

The fifth paper, presented by Prof. Soodursun Jugessur, Chief of the Science and Technology Section of UNECA, is about the popularization of science and technology in Africa. It deals with the changing African cultural scene, the demystification of science and technology and various approaches to popularization of science and technology. The paper advocates means to enhance the science and technology culture in Africa at the primary, secondary and university levels. It also deals with the use of local languages, encouragement to girls to take science, rural and urban youth clubs, radio and T.V. programmes, exhibitions, competitions and prizes, food habits, political patronage, etc.

The following paper presented by Dr. Jacques Louis Hamel, Science and Technology Officer, UNECA, deals with the strategic management of technology transfer. It reviews the role that technology transfer plays in socio-economic development and describes the characteristics of the new context of technology transfer. The paper proposes more open and sustainable technoloy transfer policies and a reduction of non-monetary constraints to technology transfer. It suggests focusing transfer policies on achieving strategic outcomes and put forward proposals for less bureaucratic control of technology transfer regulations.

The next paper, presented by Mr. Allassane Camara, Director of Scientific and Technological Research, Conakry, deals with principles and methods of planning in science and technology. It describes characteristics and guidelines of national science and technology plans and their application to Guinea.

The following papers deal with the management of science and technology in Benin and in Mauritania. They describe the administrative and management structures in these countries, the financing of science and technology activities, the major fields of research and the results obtained.

It is to be noted that in most of the cases brought out in the Africa region, science and technology have stressed on research, its organization and training of manpower. There is need to reorient this concept, and stress on (a) commercialization of research results, (b) application of available science and technologya as a start, and then undertaking research where necessary, (c) innovation in preference to research, (d) technology policies in preference to science policies, (e) popularization of a science and technology culture, and (f) close collaboration between public and private sectors in funding science and technology projects. These issues were brought out by the seminar and appropriate recommendations made.

UNITED NATIONS
ECONOMIC COMMISSION FOR AFRICA

in collaboration with the
Islamic Development Bank

Science and Technology Management in Africa

International Training Seminar

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INCORPORATING TRANSFER OF TECHNOLOGY STRATEGY AS A COMPONENT IN THE NATIONAL DEVELOPMENT PLAN OF COUNTRIES

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INTRODUCTION

As the title of this presentation indicates, transfer of technology is a *vital component* of any country's national development plans. Not only that, it is a component of a larger component, namely the industrial development plan of a country. This again is a component of the political development strategy of a country especially when it comes to decisions regarding the nature of industrialization - a capitalistic system or a social-democratic system.

The industrial policy again must be looked into through two very vital avenues: (i) the policy or strategy for large industries and companies and (ii) the policy for development of small and medium-sized (SMIs) industries.

The national strategy (policy) for large industries and SMIs may be different in a developing country. For example, a country can elect to have a social-democratic system for large industries where the government has shares in or owns the companies in question, while SMIs are owned by individuals where this system is encouraged. It must be underlined, however, that the industry of a social-democratic country should not be centrally controlled by bureaucrats in some departments, unless these bureaucrats are generally appointed as Board Members or are on the management of the industry.

If government-owned industry is controlled by a nameless bureaucracy, then it turns out to be a centrally planned economy, a system which has evidently failed at the experimental stage itself in many countries.

So, it is essential that once an industry is established, it should be permitted to do its very best within a certain framework, i.e. local rules and regulations which should be clear and transparent. In a modern society this should also include relevant environmental legislation. Further, the required emphasis on middle management, vocational and polytechnic training is often overlooked.

Consequently, I will divide this paper into two main parts - the first part incorporating technology transfer strategy vis-a-vis to large industry and the second part devoted to SMIs.

INCORPORATING TRANSFER OF TECHNOLOGY STRATEGY FOR LARGE INDUSTRIES

The establishment of large industries as part of the growth strategy of a developing country can be either fruitful or disastrous.

Unfortunately, quite often these large establishments have not been to the optimum benefit of a country - in fact, they may become "pink elephants". This applies especially to the so called prestige industry projects which consume a substantial portion of a country's financial and human resources.

Under the umbrella of technology transfer, an industry may be established which in fact is a mere service agency or assembly plant. The establishment of a large automobile or TV assembly plant (screw driver technology) may create jobs, maybe even some profit, but that is not the essence of technology transfer.

Transfer of technology is a process whereby a country *learns* and acquires the necessary *competence to develop and manufacture* a product (know-how). If, for example, the technology transfer is in the area of food processing, where certain products are processed and the plant comes with a development base where the local establishment may further study, refine and improve the processes, then the transfer of technology is real and the local industry will have the capacity to develop further.

Please note, I have very deliberately omitted the phrase "research and development (R&D)". There is a great difference between research and development. While research is tempting, it is costly and the rate of pay back is long. A pragmatic view is that while developing countries should encourage indigenous development strongly, only research programmes in selected priority sectors/areas really relating to specific needs of the country should be pursued. (This would apply, in my opinion only to basic needs such as food, clothing, shelter, health, etc. to medical and agricultural research). Funds available for promotion of indigenous technology should be channelled towards development i.e improving the existing product/process rather than reinventing the wheel.

For example, a developing country presented some time ago, proudly developed at its university an indigenous solar cell. The cell was around 10 x 10 cm2 and was in all ways a complete item. However, when talking to specialists about this research, it was learnt that the technology was already obsolete in the international market. Although this was a prestige matter for the researcher, the valuable time and money could have been better used to develop improved systems which could compete in the international market. The same time and money could have been spent to develop a casing to protect the cells from adverse weather conditions, to find ways of using the cell for lighting on the country-scale, or for other purposes. But of course, technology development is engineering and therefore, not so prestigious among academia.

Thus, when contemplating the technology transfer component as part of the industrial strategy or the procurement of a plant as a factory, the future internal development possibilities should be carefully taken into consideration. Let the rich countries do the basic research and the developing countries reap the fruit. Actually, this philosophy has been used to the best advantage by Japan, who even today have a very low BNP percentage for basic research, while their investment on development percentagewise is very large. Many of the successful products in Japan's international trade have been initially invented outside Japan, e.g. the transistor, the microchip, the fax machine, the CD, the photocopy, TV, etc. But look how Japan has managed to develop these foreign inventions into profitable products by larger long-term development investments. Actually, as part of international negotiations, the other countries are seeking to force Japan to invest more in global basic research programmes.

So the selection of large industries should be part of a developing country's strategic development as well as the mechanisms for the transfer of technology. It is most vital that the technologies identified for transfer are appropriate and include opportunities for further development.

APPROPRIATE TECHNOLOGY

In my view, it is not always that the very latest or sophisticated technology is the most appropriate for developing countries.

This applies especially to technologies geared for rural areas, where the rate of literacy is low and where the possibility of servicing of complex equipment is non-existent. For example, electronic systems of yesterday, with discreet transistors and components, and/or electronic cards for different input/output or even old-fashioned relay-logic may be still relevant for specific applications. I have personally seen sad results when a developing country insisted on the latest packaged electronic system for a certain control system. When this broke down due to water spillage, it was not possible to repair on-site and

the plant was down for a long period waiting for foreign currency allotment and expatriate service personnel. An adjacent unit controlled by conventional electronic systems was dried out and easily repaired by domestic service personnel. It is important to remember, even if the salesmen says so - nothing is fail safe!

So, how does a country proceed with technological development?

Since their emancipation from colonial bondage, developing countries have tried to achieve development with the public sector playing a predominant role initially. In the implementation of technology development programmes, it appears that the cadres of bureaucracy tended to equate business management with central administration and control, and this is often quoted as a reason for the failure of such programmes.

The private sector often played a minor role at the initial stages of development. On the other side, the training and outlook of private entrepreneurs have not been conducive to modern management techniques. The impact of modern science-based techniques and analytical tools of scientific management has not been fully understood. The same may often be said about the potential available in a vital entrepreneurial and consultative atmosphere.

Technology decision-making

Decisions on the choice of technologies are based on the:

- *Positive and negative impacts of a technology programme
- *Relative time perspective
- *Opportunity cost of technological alternatives
- *Prioritizing present and future benefits of technology, and
- *Compromise to accommodate two or more objectives of development.

Decisions may be made in certainty when the state-of-the-art of a technology is available to the decision-makers. When decisions must be made under risk, based on estimates and probabilities, modern tools and analytical procedures should be used.

The steps in technology decision-making involve:

- *Identification of problems for which technological solutions are sought
- *Generation of alternative solution
- *Analysis and evaluation of alternatives, and
- *Selection of the best alternative.

Technology Culture

Technology decision-making in developing countries is becoming more complex. It calls for specific management training and the creation of a *technology culture* - the atmosphere of technology knowledge assimilation and usage that nurtures the spirit of inquiry.

Technology Problem Perspective

There are limits to the strictly technological perspective in addressing a technology development problem. Risk analysis, a new analytical tool, considers organization and personal perspective in addition to the purely technological perspective.

The modes of inquiry under these perspectives involve collegial negotiation, consensual brainstorming, intuition, individual experience and learning.

Social Impact

Appropriate technology has been interpreted as intermediate, labour-intensive, traditional or rural technology. In developing countries, concerns for appropriate technology means adapting and developing techniques suitable to the surroundings. In developed countries, appropriate technology means technologies to correct the excesses and imbalance of an extremely materialistic industrial culture.

The total surroundings of a technology may be divided into seven components which must be considered in choosing appropriate technologies:

- Population
- Resource
- Economic
- Technological

* Environmental
* Socio-cultural, and
* Politico-legal structures.

There has been slow diffusion of appropriate technology in the developing countries because most appropriate technology seemingly represented a technological dead-end, without the embodiments of dynamism, modernity and upward social mobility. Appropriateness of a technology is not an intrinsic quality, but is derived from its surroundings, objectives and functions. It is a value judgement. Governments should actively encourage such dynamism, incorporating relevant incentives.

Technological development in developing countries is bugged with problems caused by disintegrated planning. There may be no integration of a Technological Plan into the National Plan. Technological considerations come after economic and social concerns. Most development plans do not recognize technology as an important strategic variable.

Technology Acquisition

New technology is either developed or imported. Technology importation is generally called technology transfer. Technology transfer has become more complex as gaps between transferor and transferee widen and technological orientations change.

Linkages are the ways and means of technology transfer. Between developed and developing countries, technology transfer linkages may be direct or indirect. Examples include:

* ***Direct Linkages:***

Operation of transnational corporations

-Licensing arrangements

-Hiring experts and contractors

-Training of technical staff abroad

* ***Indirect Linkages:***

-Purchase of equipment and components

-Exchange of information at international meetings

-Flow of books, journals and other publications

-Exhibitions and trade fairs.

The cost of technology transfer varies, and is determined by the recipient's built-in capacity to bargain, which in turn is determined by the source of funding and the recipients previous experience in technology transfer.

The actual acquisition, as looked at from the point of view of developing countries is very often demand oriented. One has a problem which needs a solution. However, one should also actively encourage supply oriented technology transfer. This is possible when a promoter or an entrepreneur becomes aware of technologies actively being utilized in developed countries. By acquiring such (supply driven) technologies, countries will establish new markets and industries and may even leap frog some development. One such technology could be to utilize hydrogen as a fuel for domestic purposes, hydrogen produced by solar power or surplus electrical hydropower produced at low-level periods, more energy efficient electrical appliances, energy conservation methods such as waste recycling, etc. The receiving country can certainly function afford to function without these technologies, but these technologies put into use could accelerate development and generate employment. Such development calls for active business promotion.

Another concrete example which could be very interesting to look at, would be to seek to have an investment by a foreign company to produce fluorescent lamp bulbs and/or electronic ballasts for conventional fluorescent tubes. This is a typical "leapfrogging" venture, bypassing the conventional industry. It is profit making and highly energy saving as well. A fluorescent lamp or tube uses only around a quarter of the energy a normal incandescent lamp uses for production of the same light.

TNCs and Technology Transfer

The role of TNCs in technology transfer has been usually criticized for these corporations' grossly unfair contracts, colonial approach to world division of labour, consequent deceptive industrialism, preserving superiority through complementing, perpetuating technological subordination and exerting undue influence.

On the other hand, TNCs also encounter problems in technology transfer in developing countries such as basic commercial problems, skill transfer problems

and political pressures.

Problems and criticisms notwithstanding, licensing contracts continue to be signed between TNCs and developing countries. And I think this contradicts some of the general opinion regarding the TNCs. Also later research indicates that much TNC business is a real benefit to the development of a country - a fine example is Singapore. This country opened up its borders to TNCs in the early 70s by implementing a very liberal industrial policy. Singapore has no natural resources whatsoever and is still a thriving community. The only reason can be a correct attitude to foreign collaboration with as little control as possible. However, one very vital detail is always present when TNCs establish themselves in Singapore. There must be local citizens on the local company board. The people selected are always highly qualified and give positive and valuable input and also assume responsibility for complying to local rules and regulations. In my opinion, if a country in a certain area does not have really qualified personnel to represent the country on the board or in the management of incoming TNCs, then it is even worthwhile to engage independent outside consultants to hold these positions.

THE ROLE OF THE GOVERNMENT

Technology Transfer and Developing Countries

Success in technology development depends on the mutuality of interest between supplier and recipient and on understanding the three major sub-systems in technology transfer: technology assessment; technology adoption, adaptation and development; and technology diffusion.

The existing technology transfer process in developing countries tends to be unsatisfactory mainly due to bureaucratic negotiation of technology importation and a lack of concern for assessment, adaptation and absorption of technology into the economy.

Technology transfer may occur at three levels:

*Transfer of hardware and service (no real technology transfer);

*Transfer of skills for operation and maintenance of production system (static transfer);

*Transfer of technological capacity including design and development knowledge and competence.

In conclusion, looking at technology transfer for large corporations, the last of these principles of technology transfer is a vital basis and prerogative for sustainable development.

There is, however, one vital part of this scenario which is yet to be discussed. That is the possible supporting action from governments and seats of power i.e. "politics".

This is a sensitive area, so I shall refrain from proposing any political system, either capitalistic or social-democratic. But by previous definitions, it should be clear that both these systems have common ground to prepare for technology transfer.

The basic elaborations may be:

-Governments may define fields of interest but should refrain from investing their own resources when possible. If a government does take part in a venture to exhibit support they should restrict to an optimum minority part, say 30-40% share.

-Avoid pink elephants and prestige projects.

-By careful planning, define priority areas and encourage technology transfer and investment in these areas, possibly by means of various forms of incentives.

-Selectivity and specialization. By means of foreign financing and/or human resources, seek to build up competence in sectors natural to the country. Invite foreign investment also in hi-tech natural resources development and let the foreign companies have a leading role.

-Encourage and allow massive private sector participation. Why invest government funds when private industry is willing? This should even apply to fields in which developing countries have been quite reluctant to allow private participation, such as transportation, communication and the power sector. This will encourage growth and genuine technology transfer, since the size and momentum of these sectors will automatically promote domestic development activities, and a base of growth of domestic SMI service industry.

TECHNOLOGY TRANSFER AND SMIs

We have now elaborated on the possibilities for large industries in the light of technology transfer. How-

ever, it is a fact that for all countries, be they developing or developed, the majority of jobs are in the small scale (SMI) or tiny (micro) industrial field. It is also a fact that with regard to developed countries, a lot of technological innovation is taking place in SMIs and that there are vast opportunities for technology transfer between SMIs in developed and developing countries.

Unfortunately, many developing countries have not recognized the opportunities within technological development by strengthening the (private) SMI sector. Countries possessing a flourishing SMI sector are also prospering economically.

There are a lot of products which having a definite local market could, by relative small investments be locally manufactured to meet the local demand. Such products are :

Electrical Products

* Metal sheets for switchboards
* KWH metres
* Radio receivers
* Electric fans
* Electric lamps and tubes
* Small motors
* Distribution transformers
* Electronic ballasts

Mechanical Products

* Small boilers
* Solar water heaters
*Small engines and pumps
* Small hydro turbines
* Water metres
* Pressure cookers
* Agricultural machinery

Chemical Products

* Fertilizers
* Soaps, shampoos
* Biogas systems
* Rice husk cement plants

There are other similar opportunities in the garment industry and food processing.

In all, the development of a vital SMI sector is even more vital for a developing country than to develop a large-scale manufacturing industry.

In order to develop this field, it is essential to encourage private initiative and to prepare the infrastructure for SMIs.

This preparation again consists of two main parts, the political framework and establishment of a physical infrastructure.

Political Framework

It is essential that SMIs are encouraged to blossom. The government must not see them as a necessary evil, and/or as a source of tax revenue. The formal infrastructure, especially tax laws should reflect this.

Further, physical infrastructure may be established like

-Technology Parks

-Free Trade Zones

-Telecommunication Power and Transport Facilities

-Promotion of TCDC (Technical Cooperation Among Developing Countries)

-Establishment and support of a National Centre for Technology Transfer (NCTT)

National Centre for Transfer of Technology

A National Centre for Transfer of Technology (NCTT) should be established in all countries to assist in the promotion of technology transfer to/from SMIs. Such technology transfer may be TCDC or even to/from the developed countries.

As a minimum, such a Centre should assist with:

- Active Technology Information (database information systems, etc.)

- Technology Forecasting Competence at the National Level

- Active Technology Syndication

- Human Resource Development

The overall approach is to promote ihdustrial competitiveness at all levels be removing unnecessary regulations/restrictions. All efforts should be concentrated on improving the quality of the products and manufacturing them at a reasonable price. As far as possible the policy measures should aim at promoting healthy competition among small and medium enterprises instead of over protecting and thereby nurturing industrial sickness in many sectors. Hence, there is a definite need to assist SMIs in acquisition, adoption and upgrading of their technologies through specific national, regional and global technology promotion transfer and utilization programmes.

TECHNOLOGY TRANSFER MECHANISMS - A PRACTICAL APPROACH

Ultimately, the hope for any country is that technology transfer will take place automatically, as a part of general development. This applies to both developed and developing countries.

However, it is clearly understood that technology transfer on a large scale to developing countries is time consuming, has a lower technology level and is less in capacity than to a developed country of a comparable size. However, being part of the international community, seeking to encourage technology transfer, there is one point which I wish to underline: *Technology Transfer* is not magic. It is common sense.

We may organize seminars and workshops on policy planning and strategy but it is the man in the field and the industries which shall utilize and exploit the information available. It is quite essential that an active information service and direct promotion is encouraged by the National Centres for Technology Transfer.

It is essential that private enterprise is allowed to become active on the scene. Funds available should be channelled to business visits to other countries and to the large international fairs. Minor technology transfer seminars explaining grassroots problems like financing, local rules and regulations, accompanied by catalogue and model/poster expositions on available technologies are very fruitful modes of getting information on available technologies. There should be systematic information circulated nationally and internationally with information about technology demands. Preferably, a regional or national publication like APCTT's "Tech Monitor" should be made available, at a nominal cost.

Training courses and human resources development programmes should actively seek to reach the end users. These courses may include but are not limited to:

- businessmen and entrepreneurs

- consultants

- trainers for trainers for middle management, technicians and personnel on the vocational level.

Although all these three groups are undernourished when it comes to HRD, the plight of the last category, middle management and other middle level personnel is mostly overlooked. This certainly is a very wrong policy. By improving the skills of middle management, the quality of products will be raised. This will result in more profit for the industry and the countries will benefit if the status of middle management is raised as this group is highly respected and most vital in a developed country.

One very active source of help in many instances are the large international banks who in the past have done a great deal for intercountry technology transfer. The businesses and the banks play on the same team here.

Further, the role of consultants cannot be over emphasized. Consultants with business experience and market knowledge should be actively encouraged to take part in the technology transfer process readily on a remuneration basis through honorarium or fees.

Finally, wherever possible governments should seek to provide venture capital funding or loans, earmarked for genuine technology transfer. Alternatively, some sort of national guarantee institution may be established providing the entrepreneur with the necessary guarantee to facilitate easy attainment so it is possible to obtain (cheap) bank loans for a venture.

GUINEA'S EXPERIENCE IN SCIENCE AND TECHNOLOGY MANAGEMENT

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This Seminar in Science and Technological Management being held here grants us with the welcome opportunity to share all information and experience acquired in this field by the O.D.P.S.T., Guinea's Agency for Science and Technology Master-Planning after more than three decades of its existence.

There is no doubt, nowadays, that Science and Technology (S&T) are synonymous of progress in their very core, even as they make efficient weapons and privileged instruments in the struggle for the Socio-Economic and cultural development of nations. Meanwhile, there is a gap, as narrow as it may be, that separates the potential from the real. So the unquestionable role of S&T in the overall progress of mankind cannot be demonstrated fortuitously as by a magic wand.

Applying S & T to development is a long process, the complexity of which should not be underestimated. For technical progress to be really and efficiently integrated to productive enterprises, factories or plants, farms, schools, and hospitals, the National Scientific and Technical System should be accorded serious institutional, organizational, material, and financial undertakings, likely to convert the immense potentials of S&T into concrete realities, for and within development.

In this paper, we firstly describe the evolution of Guinea's system of S & T as well as their place in the government structure. We shall later address the organization and the operation of the system as well as the unavoidable issue of the resources of the system, with special emphasis laid on the role of international cooperation in the system's evolution before posing the main problems that hinder its smooth operation and which consequently limit its real impact, on national development. A conclusion with recommendations asserted thereby, will conclude our paper.

It would be agreed that such a task is not an easy one. This paper might therefore bear some shortcomings. However, were it to raise even a little of the real problems that confront Guinea's scientific system, so that debate could be raised in order to take advantage of the time-long experience and high expertise of the personalities attending this meeting, then our paper would have met the primary goal it was given by our party.

HISTORY AND EVOLUTION OF THE SCIENCE AND TECHNOLOGY SYSTEM IN GUINEA

Throughout the colonial period era, research carried out in the colonies (British, French and Belgium) were handled in Africa by subsidiaries of institutions based in the overseas metropolis. In the case of the former French West Africa, this role was assigned to the (CENTRIFAN) French Institute for Black Africa Research Center which has an outpost in Guinea. Before the advent of independence, the following research institutions were present in Guinea:

-The Quinquina research Station at Seredon at Macenta;

-The Colonial Fruits and Crops at Foulaya, Kindia;

-The Guinea Pasteur Institute at Kindia;

-The Bordo Rice Farming Center at Kankan;

-The Koba Rice Farming Center at Boffa;

These, institutions that provided a launching ground for foreign researchers made the nuclear of Guinea's National Research system.

We shall attempt a brief presentation of the various stages that ear-marked the long evolution of the S&T system during the 33 years of existence of the Republic of Guinea.

FIRST STAGE: 1958 -1969

This stage was characterized by two essential facts. The creation of the Institute National de Recherche et de Documentation de Guinea-I.M.R.D.G. - (Guinea's National Research and Documentation Institute) by the 10th November 1958, Decree No, 74-PRG in replacement of CENTRIFAN in Guinea. Through such political will, the Guinea Government thus made a landmark at a decisive stage in the history of the country, by being among the first Independent States in Africa to establish its own (Organe Directeur de la Politique Scientifique et Technique et Technologique Nationale -ODPST-).

The upgrading of the IMDRG into a state Secretarial for Scientific Research in 1969, with the main assignment of co-coordinating and controlling all Scientific and Technological activities at national level.

This stage also established in Guinea, the then political powers' acknowledgement of the importance that Science and Technology should play in the socio-cultural development of the country.

SECOND STAGE: 1969-1972

This rather short three-year period was decisive stage in the evolution of Scientific Research in Guinea. Indeed, it was in February ,1971 that the first National Scientific Conference was held at Foulaya-Kindia. And this conference had the merit of having adopted a precise programme of scientific activities for each research institute, so doing in accordance with National development objectives. This conference also highlighted the fact that Guinea could not be a "laboratory for experimenting wherein the people of Guinea would be mere onlookers".

THIRD STAGE: 1972-1973

This is the stage at which took place the upgrading of the State Secretariat for Scientific Research into a full-pledged Ministry in charge of Scientific Research. In this critical analysis of the scientific research sector in January 1972, the Head of State outlined:

-The orientation line guiding research activities;

-The priority tasks in terms of research; and in the same analysis he laid emphasis on the necessity to adopt structures to the nature of the activities, he also demanded that all sectors be mobilized and all people able to contribute to research activities;

-Scientific and Technological activities be restructured in order to provide them with Organizational bases that fit Guinean realities;

-means be raised to allow implementation of major programmes that conform to identified priority tasks and deriving from a rapid and harmonious development programme.

It must be stressed that this political statement was not often suited with concrete actions.

FOURTH STAGE: 1974-1981

This stage was remarkable by the abolition of the Ministry for Scientific Research and a come-back to an Agency for Science and Technology Master Planning in its initial forum i.e. the(IMRDG) Guinea's National Institute for Research and documentation headed by a Director General. This naturally arose from the fact that the

Ministry for Scientific Research did not meet all the anticipated expectations.

Drawing lessons from this state of affairs, the then Cultural Commission of the Central Committee of the Party held an extraordinary sessions on 22 October 1975 and then examined the practical means for implementation of the National scientific policy by defining its structure that was based on three bodies:

-The decision-making body which was the central Committee acting through its cultural commission;

-The coordinating and Control body: arraigned to the INRDG;

-The executing body: made up of all scientific and technical institutions of the country.

We shall come back to these different bodies in detail.

This stage was also marked by a rigorous application of the principles of the 2nd August 1968 Cultural socialist Cultural Revolution to the Research and Education sectors. This led to a policy of mass-education and mass-research. Elitist education was thus dropped in favour of mass-research. There was then talk of placing "research at the crossroad of the people", Guinea's lot as such, without naming it, was even well described by Charles H. DAVIS: In one of the African countries visited by a scientific policy team in the 70's, the occupations of "griot", workers, craftsmen, or healers were regarded by Government as being part of functions of the scientific personnel. This State/Country demonstrated much interest, while it evidently adopted an official anti-elite approach towards scientific organization preferring more sophisticated management methodologies 1. Such words deserve no comment.

Despite all that has been said above, this stage was marked by the overture of Guinea's S&T system to the outside world. It was during this period indeed that Guinea, through INDRG, took an active part in the preparations of the UN Conference on Science and Technology for Development that was held at Vienna in August 1979. It was exactly at this occasion that the first International Symposium of a S&T character was held with the participation of representatives of ECA and of some neighbouring countries. This long process led to the drafting of the national paper that Guinea presented at the Vienna meeting.

This stage saw at last the beginning of the preparation of the project for Assistance to INDRG and its submission to the UN for financing; the importance and the role of this project in the Management of Guinea's S & T system will be emphasized all along this undertaking.

FIFTH STAGE: 1982-1984

At this stage, a change of name occurred as IMDRG was renamed ICCRDG (INSTITUTE CENTRAL DE COORDINATION DE LA RECHERCHE ET DE LA DOCUMENTATION DE GUINÉE) - Guinea's Central Institute for Research and Documentation Coordination by the 22nd March 1982 Decree No. 124; this arose from the confusion that had began to occur as regards the genuine attributions as to organization, administration and management of research conferred to the INDRG, and with respect to the concept of Institute which implied the idea of a place where research activities are carried out foremost.

It was also at this stage that the GUI-80-701 "Assistance to IMRDG" project financed by the UN Special Fund for S & T for development was launched and implemented with technical assistance from UNESCO.

The overall objective aimed at by this project was to assure the systematic and coordinated Development of Guinea's Scientific and Technological Activities at the service of the economic and social development of the country.

SIXTH STAGE: 1984-1985

This stage is that of the advent of the 2nd Republic, that saw the creation of the state secretariat for culture and scientific research in December 1984. This stage was also the time when the first National Conference was held under the 2nd Republic.

At this conference, various and important themes were addressed such as:

-determining science and technology priorities in accordance with goals of the national development plan;

-the funding and budgeting of S & T;

-the status of researchers

-valuing scientific and technical information;

-training and refresher courses for cadres.

SEVENTH STAGE: 1986-1992

The creation of the state secretariat for High Education and Scientific Research in December 1985 was the landmark of this stage. This stage was essentially characterized by the demonstrated will of the new authorities to intimately link Scientific Research and High Education. This link was quite clear in the structural organization of the Department of High Education and Scientific Research. This structure will be abolished (as, it must be stated, too heavy a little operational), on the 17th of January 1988 by Decree No.24 that appointed the cabinet a state secretary for Scientific Research. And in September in the same year, Decree No. 213 set out the attributions and the organization of the state secretariat for Scientific Research. But one year later, on 30 June 1989, the new Government structure enacted by the Decree No.125 ended once more the existence of the state Secretary for Scientific research bequeathing all prerogatives previously incumbent on this department to a new Directorate deprived of authority and means, the DMRST- National Directorate for Scientific Research.

This decision was to revive immediately the perennial issue of supervisory authority of the STIs together with that of its corollary, the issue of coordinating their activities at the national level. This is how we came to witness the dismantlement of the national S&T system and the distribution of research institutes to the different sectoral departments of Education, Agriculture; Transports and Works. Information and Culture; Industry, Trade and Artisanat; Natural Resources and Environment and of Fisheries (ref. the 21 December 1989 Decree No. 231). this dispersion made ODPSTs task very difficult, especially for the DMRST in carrying out their fundamental assignments of impulsing, coordinating and evaluating all S & T activities to be undertaken at national level, and of such scale. With regards to this concern, Article 9 of the above mentioned Decree provided that: " In order that this mission of coordination and follow-up be discharged correctly, the Minister in charge of Scientific Research shall file in due process of adoption a bill to enact the creation, organization and operation of the higher Council for Scientific Research". This Council which was established by the 26 July, 1990 Decree no. 146 has not yet held its inaugural session. The dossier thereto relevant is under process and will advanced, and it is quite probable that the Higher Council for Scientific Research convenes in the forthcoming months.

On the 6th of February 1992, the last change to occur in this long evolution process of Guineas S&T came about with the re-establishment of a Ministry of Higher Education and Scientific Research and the appointment of a new Minister to head this department.

We shall attempt to draw some lessons from this long evolution of S&T in Guinea in the closing of this chapter. To do so, we will compare two quite typical stages of the system: the first one that spread from 1986 to 1992 under the new regime.

The first evidence or finding is that the two stages have had practically the same duration in terms of time: 8 years and 7 years. The second finding in evidence is that the first stage discussed was characterized by a great stability. Moreover, the ODPST was put under the supervisory authority of the then Ministry of Education and Culture headed by a high personality who enjoyed great prestige at both the political and administrative levels. All this positively influenced the national S&T system which made a great leap during this period.

The second period is quite at odds with the former: 7 Decrees in 7 years affecting at once both the structure and the complements; 7 Ministers and state Secretaries headed in the same time and one after another the Department in charge of Scientific Research. This resulted into unstable structures of research projects and programmes design and implementation as well as into a great transience of administrative and scientific personnel. The system thus came to see, some of its people having acquired a long experience and a good training in the organization and management of R & D. This affected the system negatively to such extent that it no longer went on correctly, but it also lost most of its former achievements.

Their different findings seem to confirm the opinion of some writers who, while discussing regrettable dysfunctioning to which remedy must be sought, purport that the solution would probably and paradoxically lay in supervisory authority politically stronger and more competent faced with more autonomous institutions geared with a genuine scientific management.

ORGANIZATIONAL AND INSTITUTIONAL BACKGROUND

The organization of research in Guinea obeys a

structure of two fold vertical and horizontal level.

At vertical level there is the administrative organization that controls from top to bottom and from bottom to top the hierarchy relationship between political decision makers and the scientific players. At this level, S & T institutions that are usually either a creation, or direct dependents of the Scientific Research Department, are under double supervision: Administrative and Scientific.

The horizontal level gives the Research depart a right of say with regards, in all national Technological and Scientific Activities. At this level, the organic link between the Department in charge of Scientific Research and sectoral research institutions under supervision of other departments is purely scientific: this is the scientific supervisory authority.

The reasons for establishing a horizontal decision making body are many: we will cite some of them:

-The first reason is found in the obvious inability of Ministries with Vertical structures responsible for a well defined sector of the economy such as Agriculture, Health, or Industry, to efficiently and systematically attend to implementation of development science and technology overall life of the country. One of the major shortcomings of the purely sectoral system is found also in the absence of a single administration with responsibility for inter-sectoral issues or for the development of new fields not falling under sectorial ministered departments.

-A second reason for establishing a horizontal decision-making body is found in the extreme vulnerability of R & D and S & T services budgets in all sectorial ministerial departments. The STA's which are of vital importance for the future of the country at long term, however, often see their budgets amputated or even diverted totally to other ends.

-A third reason justifying the establishment of decision-making bodies with horizontal structures is the consequent administrative and financial autonomy that would be given to higher learning and research institutions of Guinea, those being the main part of the national research potentiality. the establishment of a Government body such as the Ministry of Higher Education and Scientific Research, specifically in charge of SPT fitted with a system for the budgeting and the financing of STA's zoomed on "assignments" or "Jobs" and adding support to a long term development policy would allow mobilizing the many intellectual resources found in universities and STI's with the view of solving the major national issue.

These few considerations lead us to state that government structures would gain more efficiency the functions, attributions and powers that constitute them defined clearly and unequivocally in the different operating organic laws. Duplications and red tapes would thus be avoided in the process of orientation, elaboration and implementation of the national Scientific and Technological policy.

Let us now come back to the three operational levels where the different decision, co-ordination and implementation functions are exercised with regards to National Scientific and Technological Activities.

-Level 1 or Decision - Making Level: This is the level where decisions are made by the political authority upon which it is incumbent to choose between major options and to determine thereby the main orientations that characterize the nation's overall policy in the field of Science and that of technology.

In actual practice, the inter-ministerial body in charge of planning, budgeting and overall evaluation of achieved scientific results is found at this level, for instance, the Higher Council for Scientific research. The CSRS is a government consultative body bound to assist the ODPST, inter alia, in accomplishing one of the latter's most difficult missions, i.e. coordinating STA's at national level.

-Level 2 or Coordination Level: Detailed directives for implementation of the national Scientific and Technological policy are elaborated at this level.

Sectoral programme and budgets the contents of which reflect the objective of the national scientific and technological policy and which make provisions of resources to achieve them within a given time-frame are prepared at this level.

National Councils for Science and Technology are also found at this level: these are consultative bodies, the executive powers may have recourse to obtain opinions of qualified scientists and engineers, either on personal basis, or as representatives from S & T institutions. It is notably the case for Boards of directors that have been established and are already operative in universities and scientific institutions of the country.

-One of the fundamental assignments of such councils is to ensure a bi-univocal correspondence between the socio-economic development objectives and the Scientific and Technological ones, all of which objectives will then be assigned to R & D institutions and to S

& T agencies for their attainment.

-Level 3 or implementation Level: This is the actual effective operating level of institutions, laboratories, R & D units and scientific and technical agencies.

Since her accession to national sovereignty on the 2nd of October 1958, guinea has endeavoured to establish numerous scientific and technical institutions with aid from bilateral and international cooperation.

The first census of the Scientific and Technological Potential carried out in 1982 under the GHI/80/TO1 Project with UNESCO's assistance helped identify 74 STI's throughout the country.

According to UNESCO typology, i.e. R & D institutions, S & T Training Institutions (EFST); Scientific and Technical Agencies (SST) and Scientific and Technical documentation and Information (IDST), guinea then already had institution in each of the 4 categories. With the advent of the 2nd Republic, subsequent to the closing down of several Agricultural, Industrial and Production enterprises which had their own analysis and quality control laboratories, this number was of course considerably reduced.

Pari-University institutions of S & T character have been established in Guinea since a few years. Those referred to as Pari-University institutions are, as we mean, those institutions that are established in the immediate vicinity of Universities without being organically linked to them. Usually, they are the brainchildren of Faculty researchers with a passion for some fields of Research.

As an example of Pari-university institutions, we may cite:

-The (CREDA) animal Husbandry and Research Center initiated by a University Biology Lecturer;

-The (LACONA) Laboratory of Natural Components initiated by a University Chemistry lecturer;

-The (PERTEGUI) Project for Studies and Research on Endogenous Technologies in guinea run by a University Chemistry technology lecturer.

as regards to statute, these 3 institutions are agencies under direct supervision of the DNRST.

We deem interesting to emphasize this idea of pari-university institutions, for two reasons:

The rather large number of STI's found in Guinea makes it possible for the national S&T system to encompass a broad spectrum of fields and disciplines, i.e.

-Social Science and Humanities;

-Pure Science and Nature Science;

-Agronomy and Animal Health Science;

-Bio-Medical and Pharmacy Science;

-Technical and Engineering Sciences including energy.

To these classical fields, special disciplines and some so-called advanced technologies such as:

-Oceanography

-Environment

-New and Renewable Energy and Construction Materials;

-Bioscience and Biotechnology;

-Teledetection

-EDP and Computer Sciences

To all those institutions, are added new learned organizations being formal in Guinea more and more thanks to the freedom of association granted as their right to Guineans among others ARESFOD; ANIG; SOGGO; the Guinea Mathematician Circle; AFGRED; Water and Environment for all Households (EEF), and AGHIPER.

The latest to-date is the very young and dynamic Association des Femmes Chercheurs de Guinée (Guineas association of Women Researchers) established in July 1991. Assuredly, all these associations and organizations will make great contribution to impulsing and propulsing Guineas S & T onto new orbits.

Moreover, it must be said that serious support and service are given to individual researchers since a few years. Indeed, they receive technical assistance from the DNRST in the formulation and design of their research projects. They also receive support in fund-raising for financing both locally and externally.

PROGRAMMING, BUDGETING AND FINANCING OF SCIENCE AND TECHNOLOGY IN GUINEA

As pointed out earlier above, UNESCO's role has been paramount in piloting of Guineas S & T System; through its publications on S & T policy on one hand, and on the other hand in the implementation of the GHi-80-TO1 Project.

Thus it came that a UNESCO Consulting Expert sojourned in Guinea in September 1984 with the assignment of helping Guinean scientists acquire a methodology for determining S & T priorities in accordance with the socio-economic objectives of the National development plan. Likewise another expert sojourned twice in Guinea within the context of programming and budgeting national STAs.

Those different consulting assignments enabled the foreign experts and the national cadres to draw up procedures and formulated recommendations.

With regards to the important issue of programming and budgeting, the following 3-stage procedure was recommended for the drafting of an explicit S & T budget.

STAGE 1: Each S & T institution would identify projects based on national priorities defined in prior by the decision-making body. These projects are formulated and presented in budget-programme format in reference to a model-sheet or a pattern that are usually supplied to the institution by the ODPST. Projects so elaborated are later presented to the supervisory department of the institution concerned.

STAGE 2: Within each department, projects presented by institutions are analyzed and filed according to an order of priority and submitted to the Ministry Ensuring supervisory authority of the ODPST.

STAGE 3: On the basis of projects presented, the Ministry in charge of Scientific and Technical Research then proceeds with preparation of the preliminary draft budget for S & T. This preliminary draft is later submitted to the Minister of Finance for preparation of the budget of the state for S & T.

This procedure which has not yet been applied unfortunately, would have had however the benefit of creating explicit budget lines for S & T which could have been easily grouped into a "Research-Imprest".

This procedure would have had the merit of making the Ministry in charge of Science and Technique and the ODPST participate in the decision-making and budget-drafting process for S & T, thereby enabling them to play their coordination and evaluation role more easily and more efficiently. Lastly, this procedure would have helped appreciate more easily the effort the state makes for S & T.

This method of programming which had the advantage of being relatively simple bore however some shortfalls:

-The lack of a stage for evaluating research programmes and projects a priori;

-The lack of relays in prefectures and/or region likely to follow up the preparation upstream and evaluate research programmes and projects downstream.

From this point of view, commissions or council could be established at prefecture or region level for S & T, the members of which would be chosen among the staff of the scientific and technological agencies in the area concerned.

These commissions or councils would be in charge of:

-Assessing and approving the content of budget-programmes of STIs of their geographic constituency;

-following-up the implementation of research programme that would have obtained financing;

-Proceeding to a first evaluation of results achieved;

-helping in decision-making as to interrupting or continuing whichever research project.

It must be emphasized that the procedure currently used in Agronomy Research partly obeys to the S & T budget drafting criteria laid out herein above. The shortcomings in procedure pointed out above, seem to be taken into account, notably by the setting up of decentralized structures (Regional Orientation Councils) in each Natural Region. These Councils are made up of Researchers, popularizers, peasants organisations, development projects and agricultural NGOs operating in the same Natural Region.

Research projects and operations presented by Agronomy Research Centres are discussed and ap-

proved by these Councils. They are centralized through IRAG and submitted by way of hierarchy to the Minister of Planning and Cooperation for their insertion, upon examination, in the public investment budget.

A research imprest with two components is so drawn up:

-Internal financing which is borne by the MDB;

-External financing which is done through international aid.

Disbursement of expenditures is done by means of a bank account in the name of IRAG wherein funds are remitted by quarterly instalments.

This procedure that fostered a genuine promotion of agronomy research which is gaining more and more importance in Guinea could be efficiently extended to all fields of research.

To date, there is a single international source of funding S & T in Guinea: the National Development Budget. Yet, as seen earlier above, this budget does not show clearly the STAs financed so that the amount of budget credits allocated to S & T by the state is not easily valued. Besides, the cumbersomeness and the slow pace in the expenditures disbursement process make another obstacle that is difficult to circumvent. Lastly, the overall volume of credit allocated is insufficient in proportion to the requirements of STIs. It is quite above the 1% of GDP recommended to developing countries by the several conferences held to the purpose (ref. Vienna 1979 and Lagos 1980 conferences).

To counter this state of affairs, a number of suggestions and recommendations were formulated under the GUi-80-TO1 Project, namely the establishment of an imprest for research and the setting up of a Fund for Scientific and Technical Development. In concert with national cadres of the ICCRDG, the National EDP and Management and UNESCOs Consulting Experts, this project also helped create a programme for computerization of the National Budget which highlighted explicit budget lines for S & T. quite unfortunately, these recommendations never saw a start of implementation. This leads us quite naturally to question ourselves as to the realism and the righteousness of the methodologies envisaged for our country by UNESCO. In this respect, the finding of Charles DAVIS seems eloquent: 'Doubtlessly, this is due partly to the inability of most of the African states to use the most sophisticated UNESCO methodologies available for scientific policy. Yet, research programming and budgeting are the most sophisticated as scientific policy methodology.

THE ROLE OF PRIVATE INDIGENOUS CONSULTANCY FIRMS IN THE TRANSFER OF TECHNOLOGY

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I. INTRODUCTION

The selection of the theme "The Management of Science and Technology and Its Application to Development" by UNECA for the current seminar underlines the fundamental relationship between science and technology and the socio-economic development of a country. Advancements in recent decades of this century and emergence of newly industrialized countries have clearly demonstrated the pivotal role of science and technology in the socio-economic development of various countries. It is the practical translation of the available scientific and technical know-how which provides a quantum boost to the economic development, Proper transfer of science and technology with a view to systematically develop science and technology capability, therefore, has become of paramount importance, particularly for the developing countries.

As a vehicle of development, transfer of technology has been perceived as one of the principal objectives by IDB - an international development financing institution. IDB fulfils these objectives through clearly enumerated policies related to its operations. It is in this context that IDB is extremely pleased to be associated with the organization of this Seminar by the Economic Commission for Africa.

The theme of this paper is "The Role of Private Indigenous Consultancy Firms in the Transfer of Technology". The paper attempts to identify ways and means through which the private consultancy firms can effectively contribute towards transfer of technology for the economic development of a country. If nurtured systematically, the private consultancy firms could make a significant contribution in effecting transfer of the needed and appropriate technology.

II. NEED FOR TRANSFER OF TECHNOLOGY

The subject of transfer of technology, particularly to developing countries, is vast and complex. While the transfer of technology is normally seen as a panacea for all economic ills of developing countries, in reality, the choice as well as transfer of the chosen technology to a developing country presents a host of complex problems and invariably, the cherished goal mostly remains highly elusive.

Mostly, the countries tend to purchasing whatever was perceived to be the advanced technology or was promoted by a successful vendor as the most suitable technology for the projects concerned. Such actions, we know, did not work in most of the cases and it has become clear that without due commitment to the science and technology and the necessary infrastructure support, satisfactory results cannot be achieved. It is universally agreed that purchasing large quantities of equipment and productive capacity has not resulted in the required transfer of technology in the absence of the basic infrastructure and other supporting ingredients including the trained manpower, related skills and managerial capability.

With the passage of time, the ever-increasing gap, particularly in science and technology between the North and South is creating an alarming imbalance. Like

other developing countries, very rightly the countries in Africa are also seeking ways of developing their industrial and agricultural base leading to a sustainable growth in their economies at least commensurate with the level of growth of their population. Inevitably, the road to industrialization entails heavy reliance on various technologies. The end of an appropriate technology and the desire of its effective transfer, therefore, becomes the most important and critical element in the process of the socio-economic development of a country.

Taking cognizance of the fact that science and technology is a critical factor in the socio-economic development process, it becomes absolutely necessary to undertake coherent efforts to build science and technology capacity in developing countries. At the same time, there is a need to strengthen international cooperation in scientific and technological field. This important subject, therefore, needs critical and objective attention in order to take measures which will eventually assist in developing national capacity to select appropriate technology, the ability to absorb the chosen technology and later adapt the technology to domestic needs. Such national conducive environment would pave the way for the transfer and absorption of imported technology.

III. CONSTRAINTS IN TECHNOLOGY TRANSFER

Most of the constraints in the technology transfer are attributable to the overall lack of the factors supporting such a transfer. Invariably, the large projects in developing countries were meant to provide reliable and cheap source of raw material to industries in the developed world and in this context very little serious attempt had been made to train the indigenous population. The host country was used mostly to provide unskilled and semi-skilled manpower. The skilled and managerial positions were held by the expatriate staff which exerted indirect control over any development of indigenous technical capacity. Consequently, the level of technology transfer remained almost rudimentary.

Similarly, the overseas aid programmes also did not provide a systematic and coherent development package where a suitably tailored parallel educational and training opportunities were provided to manage the industrial growth. The aid agencies primarily continued to stress speedy implementation of projects with little concern for the systematic transfer of technology to the indigenous environment or its subsequent growth and development.

In addition to this, another constraint in development of indigenous capability has been the negligible research and development capabilities at the individual plant level. Partly, this has also been due to the non-availability of trained scientists and engineers. An international survey showed that in Africa only 0.40% of the number of scientists and engineers were engaged in developmental research. Unfortunately, most of this research work is of theoretical nature and is practical divorced from the actual applied fields which are of practical interest to the local industries. Further, on an average the African countries allocated around 0.3% of their GDP to R&D compared to 2.2% in France, 2.6% in USA and 5% in Japan.

Another factor mentioned as a constraint by various researchers has been the lack of appropriate incentives to the transnational enterprises which have been the primary source of industrial technology. Besides these constraints, the lack of domestic market and the uneconomic size of market, both in the country and in the region have also tended to act as constraints.

The concerted efforts of UN and its technical agencies, like UNIDO, UNCTAD, UNFSTD and other regional organizations like the African Regional Centre for Technology (ARCT) on the other hand, are making efforts in facilitating a smooth transfer of technology and these efforts have begun to bear fruit even though only on a modest scale.

The principal difficulty in the process of technology transfer, as mentioned earlier, has been the inability of the most entrepreneurs as well as public sector organizations in most developing countries to develop an indigenous capacity to choose, absorb, and later adapt the technology acquired from the industrialized countries.

IV. SOURCES OF TECHNOLOGY

While there could be various routes for acquiring the needed technology, the majority of technology transfer to the developing countries takes place through the following channels, among others:

(i) Private transnational enterprises from industrialized countries;

(ii) Public sector transnational enterprises from industrialized countries;

(iii) Technical project-oriented centres in developing countries;

(iv) Consultants both indigenous and foreign.

With regard to the first source, a report prepared for the United Nations Centre for Science and Technology for Development/Geneva argues that industrial enterprises in the private sector have been the prime generators of technology. Many of the larger industrial enterprises are international in nature and typically they support large and productive research and development functions which they relate most effectively to different aspects of their business operations. The transfer of technology to developing countries by transnational enterprises, however, can by non means, be easily accomplished.

The sue of transnationals as a major source of technology has given rise to many problems. Confusion over basic values and social priorities has often led to the purchase of technologies that, in many cases, have proved detrimental to genuine development. It has been reported that the development fostered by transnationals, especially those involved in consumer goods has not always been responsive to the social needs, particularly those of the poor. In their operation, transnationals invariably have tended to repeat the patterns of western societies through a type of technology very often inappropriate to the needs of the countries. This theme has been a subject of discussion in a number of international conferences.

Despite these shortcomings, the transnational corporations are closely involved in many of the areas dealing with minerals, commodities, chemicals food and energy. Many of them have played a significant role in bringing technology and capital to developing countries. While the oil, food and chemical companies have been operating globally since the early years of this century, in the postwar years, the scale and sophistication of their operations have greatly increased, and they have become much more visible.

The developing countries have also substantially benefitted from the transfer of know-how through joint projects with public sector transnational enterprises from the industrialized countries. State owned transnational enterprises have been active in their specialized fields and normally have been involved in the transfer of technology on a bilateral government to government basis. On occasions, the public sector transnational enterprises have also forged project relations with public sector companies.

Depending on the source country, the level of sophistication of the technology from such transnationals may be greatly varied.

Technical project-oriented centres have also significantly contributed to uplifting the scientific and technological capabilities of many developing countries. Periodically, sector-oriented projects, most of the time involving UN agencies, international development financing institutions or bilateral government assistance, have been developed specifically keeping in mind the host country's needs, input availability and the level of indigenous skill. The contribution of these projects is over a broad spectrum covering an entire industrial sector where such specialized project centres become a source of basic skills, which is crucial for the sector concerned.

The role of consultants in the process of transfer of technology in developing countries so far has been rather modest. Very little attention has been paid to fully developing its potential. Unfortunately, unlike the transnational enterprises, the consultancy firms invariably do not have the financial resources, political influence and the enormous power comparable to transnational enterprises. Since the Second World War a number of consultancy firms have been working in the developing countries for the UN, international developing financing institutions, donor governments and other international and regional institutions. These assignments have enhanced the confidence of the developing countries in the consultancy profession to a very large degree.

It has been enumerated on various occasions that the principal difficulty in the process of transfer of technology is the inability of most enterprises, both in public and private sectors in developing countries, to develop sufficient capacity to choose an appropriate technology, absorb its critical components and later suitably adapt the acquired technology to their indigenous needs. It is in this context that the consultants appear to be a aptly suited to play the role of an effective coordinator in the process of transfer of technology.

V. ROLE OF CONSULTANTS

Normally, through consultancy the relevant scientific, technical and commercial knowledge is converted into a set of designs and instructions for the construction of specific projects ideally with least cost, optimum productivity and consistent with exogenous domestic constraints. An objective analysis of the situation shows that the shortcomings outlined in the previous section could, to a great extent, be overcome by developing and promoting indigenous consultants in cooperation with the consulting firms from industrialized countries.

Typically, a technology package consists of technical, managerial and financial elements. The consultants involved in the process of technology transfer normally undertake the assignment with a multi-disciplinary team of engineers depending on the project e.g. civil, mechanical, electrical, chemical, etc., economists, financial analysts and management experts. Modern industrial development, which implies the introduction of new technologies and the execution of complex investments, has brought about the appearance of intellectual and professional entities specializing in these tasks.

At the pre-feasibility or feasibility stage, there tends to be a fairly heavy reliance on second-hand information, i.e. on knowledge derived from experience of previous projects of a similar kind. The skills deployed are not diverse and the man-hours of work involved are not great. Where the project is complex and several technologies or combinations of technologies are possible, there may follow a detailed report which examines in more depth the preferred plan and equipment and related cost estimates with greater accuracy. If the project promoter decides to proceed, he will then commission the detailed engineering of the project which calls upon a much wider range of design skills and which requires extensive drawing office facilities. At this stage, access to process technology, knowledge of which is only needed in rough outline at the feasibility stage, becomes essential. In so far as this technology is the proprietary asset of another partly, licensing arrangements may be necessary. At the end of the detailed engineering phase the consultant concerned has broken the project down into discrete pieces of equipment, each with design drawings or, in the case of standard machines, with technical specifications, and into designs and drawings for civil works and for mechanical erection. The project, at this stage, becomes ready to go out to tender and the consultant will generally examine the bids and recommend appropriate suppliers and contractors. The consultancy service will then assume responsibility for the quality of construction and erection work and will inspect all supplies and supervise work on the site. It is often called upon to arrange start-up and commissioning before finally relinquishing responsibility.

During the course of his assignment the consultant may also undertake or arrange the training of counterpart assigned to him by the clients, especially in processing industries where know-how is acquired under license. The consultants could assist the client during the negotiation phase of the acquisition of technology and subsequently in depackaging it so that the client may meaningfully embark on the path of "learning by doing". Consultancy, therefore, can play a key role in the diffusion of technology, as it makes a meaningful contribution to evolving appropriate technical and economic solutions compatible with the prevailing situation.

Most African countries have been endeavouring to embark upon the process of industrialization with hardly any experience of modern technology and thus are heavily dependent and reliant on the professional judgement and recommendations of their consultants. Developing countries, during the early industrialization period, lack the ability and experience in project planning, design and management. Consequently, they tend to depend upon consultants for design specifications, procurement of equipment, supervision of construction phase, and commission. Very often consultants are called upon to make the choice of process, raw material, type of equipment and machinery and its specifications without explicit guidance from the client. Their intervention, therefore, is crucial.

VI. ADVANTAGES OF INDIGENOUS CONSULTANT

The establishment of indigenous consultancy capabilities is one of the cardinal factors towards the effective transfer of technology. It enhances the bargaining and negotiating capabilities and forms linkages with other activities more directly involved with technology transfer. It has been shown that the consultancy work promotes continuous cooperation where several technologies or sub-technologies become merged in the process of ordered transmission to produce new productive combinations. Eventually, with the progress of time and further experience, the process may lead to technological self-reliance.

One of the obstacles towards the development of indigenous consultancy capabilities has been the belief in the technical supremacy of foreign experts. At times, there is a deep-rooted traditional attitude in many developing countries that foreign skills are always better. Moreover, the utilization of foreign experts, in preference to indigenous engineers is often insisted upon by multilateral and bilateral development agencies. Because expatriates are paid by these agencies in foreign exchange, governments of developing countries are keen to accept them, rather than invest their scarce resources in providing opportunities to domestic engineers. Highlighting the same theme, Dr. Ousmane Kane of ARCT states that the estimated value of the consultancy market of the African continent is over US$ 400 million per year. such a market has been dominated for a long time by non-African agencies. African consultants have a small share of that market.

Supporting the need of local consultancy firms, it has been stated that engineers from industrially advanced countries generally lack knowledge about deficiencies in manufacturing environments in developing countries, and which equipment would be best suited to local labour skills, managerial capabilities and available materials. Foreign experts may be necessary for many complicated industrial and power projects but for a large number of projects associated with the transfer of technology, compatible with local cultural environment, the indigenous consultants could play productive role.

In order to face the uphill task, it is imperative to develop a degree of technological self-reliance among African countries. This would mean the utilization of a combination of imported and indigenous scientific and technological resources, in which the proportion of the indigenous components would steadily increase both in quantity, and more importantly, in the number of strategic national projects that are based upon this indigenous technology. The local consulting engineering companies could be a key link in developing this technological self-reliance and in reducing technological dependence of the African countries.

Other advantages of local consultancy establishment include, new skills, attitudes, improved administrative and management talents and capabilities are bound to emerge and develop during the project preparation and execution phase. Local consultancy activities may achieve a high social utility in terms of their impact on the transfer of technology and its effect on the proceeds of economic development. The local consultants enhance the absorptive capacity and contribute to effective diffusion of technology by imparting the knowledge and know-how acquired, to the planners, manufacturers of equipment and training the local personnel in the utilization of depackaged and acquired technology. Their efforts also make a meaningful contribution to the industrial development.

The local consultant enhances the owner's ability to choose between good and bad proposals, those which are compatible with existing arrangements and adapted to local conditions and will bring a real improvement to overall productivity on the one hand, and on the other hand, those which will prove troublesome and which will hamper productivity. With support from a good local planning and design service an enterprise has greater flexibility in choosing between sources of know-how and is able to ensure a greater local participation in project design and construction. In other words, it may be able to break apart the turnkey relationship with its disadvantages and achieve the economies of source diversification.

With the availability of competent consulting organizations, a country can have increased skill and bargaining power in the purchase of and negotiations for foreign technology, because the technology packages can be analyzed in a meaningful manner with the help of consultants. The consulting organization can also ensure that maximum local participation in goods and services is built into the packages and that terms of the contract are favourable to the local party, especially in the areas of guarantees, penalties, etc.. This would also result in more competitive prices.

Further, the experience of many developing countries have shown that buying turnkey plants is easier than running them. In the absence of local competence to run, maintain, and service the plants obtained on a turnkey basis, countries find themselves at the mercy of foreign companies that supply the packages in the first place. At times, the foreign companies no longer manufacture the components or spares because they have progressed technologically to newer and more complex plants. A Consulting Engineering Design Organization involved in imparting technologies, can ensure that adequate local competence exists before plants are purchased. It should also be able to encourage the development of local industries to produce spare parts and replace machines. With its detailed knowledge of the workings of the plant, it may also suggest innovations using locally available components and equipment.

These has been a great deal of interest in the sixties to develop local consultancy services so that they could play their rightful role in contributing to the process of transfer of technology to developing countries. UNIDO has conducted a number of surveys and assisted a number of developing countries in establishing local consultancy capabilities. It has shown that industrial consultancy is a key element of industrialization programme since it contributes directly to evolving appropriate technical and economic solution in harmony with national socio-economic objectives, securing approved terms in technology acquisition and achieving technical and managerial self-reliance through a more effective use of national resources.

Primarily as a result of this awareness, in June 1989, the International Consortium of Consultants for Africa (ICCA) was established to further the technological reliance of African countries by providing an opportunity for African consulting firms to take more initiative and participate more actively in the formulation and implementation of projects.

Despite the so-called bona fide efforts by the

international community and often publicized intentions of the developing countries, only a handful of consultancy firms from the developing countries have been able to make any meaningful impact on the domestic scene, or earn a reputation overseas. Invariably, all the major successful consultancy companies from the developing countries come from comparatively advanced ones, e.g. Brazil, Korea, Mexico, Lebanon and India.

The principal constraints in the development of local consultancy capabilities has been attributable to the conservative attitude of certain international and regional developing financing institutions, which adhere to risk-avoiding and efficiency-seeking attitudes. Despite their desire to engage consulting firms from LDC, reluctance to take risk results in opting for established consulting firms with a reliable record of performance. Understandably, the majority of these consulting firms are from the industrialized countries. Further, the tendency in many developing countries has been for a marked preference for consultants from industrialized countries, due to their international reputation. Moreover, absence of government's specific policies to encourage the use of local consultants with adequate expertise and abilities has also contributed to the problem.

Although the national and international organizations agree that the establishment of indigenous consultancy services is vital for transfer of technology, very few serious measures seem to have been taken to ensure smooth transfer of technology between the developed and developing countries. Since most of the developing countries will be depending on foreign consultants of a certain extent for a considerably long period of time, it is about time the developing countries faced the issue and took suitable measures.

The Islamic Development Bank, as an international developing financing institution, has been making systematic and concerted efforts to promote indigenous consultancy firms. It has, in fact, promoted the formation of a Federation of Consultants from Islamic Countries (FCIC). As a result, this Federation was established in May 1986 with its Headquarters in Istanbul/Turkey. IDB has also developed a roster of indigenous consultants and the data has been used to develop a database for easy retrieval by country; field of specialization and services. This database is used to encourage utilization of indigenous consultants for IDB financed projects.

Like other developing countries, the African counties themselves have to put their house in order, take up the challenge and seriously consider practical measures which will enhance the technical capabilities of the indigenous consulting firms. The establishment of ICCA appears to be a step in the right direction. The establishment of an association of African consultancy firms with the help of African Development Bank is a positive measure to promote African consultancy profession and in the coming years is expected to enormously contribute in this important area.

VII. MEASURES TO ENHANCE THE CAPABILITIES OF INDIGENOUS CONSULTING FIRMS

All measures to support and assist consultancy firms should as far as possible, be of indirect nature, without sacrificing two cardinal criteria of merit and integrity. Such measures may include incentives and financial assistance to local industries and contractors. wherever local consultants are engaged; development of local codes and specifications for materials and equipment because local consultants, naturally, thrive better in an environment where technical standards are laid down locally in the light of local conditions; and include a training component to development projects and assign counterparts to the foreign experts engaged on assignments. These are some of the practical and useful mechanisms of transfer of technology which are not given the importance and attention they justly deserve.

VIII. JOINT VENTURES BETWEEN LOCAL AND FOREIGN CONSULTANTS

The advantages of establishing local consultancy capabilities for the process of transfer of technology have been argued at length in the previous section. However, it should be borne in mind that there may be certain sophisticated technologies that could not be transferred or depackaged with the help of local consultants. The abilities and limitation of local consultants should always be borne in mind. It is in the interest of the healthy development of local consultancy capabilities not to give them the whole assignment, if it happened to be complicated or for which the local consultants might lack relevant experience. It might be in their interest to work side by side with competent foreign consultants as a process of "learning by doing".

The method could be to employ foreign consulting and engineering firms as a complement rather than as a substitute to local consulting and engineering firms, seeking mechanisms of cooperation between both in order to favour the maximum utilization of local resources

and make full use of foreign consulting firms as a vehicle for technology transfer and the training of national consulting personnel.

In this context it is deemed desirable to reiterate that in certain circumstances, transfer of technology by foreign consultants could be more effectively carried out by forming joint ventures with a professional local consultancy organization. The transfer of technology cannot be achieved where the local partner is only a front-man or an agent. All parties including the client concerned should realize that such a relationship is not conducive to transfer of technology.

The concept of joint venture also benefits foreign consulting firms in many ways. Invariably, the local consulting engineers with similar academic background and practical experience cost less compared to the expatriate consultants. The local consultants with insight and understanding of local conditions could provide useful information to enable the foreign consultants acquire an edge over other competitors for the same job.

Government should encourage international interchange between consultants including international travel by their consulting engineers, both private as well as public sector, not only for business promotion, but also to enable representatives to participate in seminars. The collaboration of consulting engineers through join venture can create an environment which is ideal for technology transfer.

The efficiency and productivity of consultancy profession, in addition to academic qualifications, depend on relevant experience of the sector, the environment under consideration and the multidisciplinary and organizational support of the headquarters. Therefore, it is highly desirable to develop local consultancy organizations by encouraging the technical association with well-developed and experienced foreign consultancy firms in the initial stages.

IX. A POSSIBLE MECHANISM

The burden of responsibility on the shoulders of consultants from developing countries is heavy and the task of transferring technology from developed to developing countries is formidable. Keeping in view the possible role the domestic consulting firms could play in the economic development of a country, in general and in transfer and adaptation of technology in particular, the Governments in Africa countries may consider appropriate measures conducive for the effective and speedy development of local consultancy capabilities for achieving this formidable task.

Such measures may involve identification of the key sectors for the economic development of the country keeping in view the endowed natural resources followed by a systematic effort to promote indigenous consulting firms initially as a joint venture with reputable and experienced foreign consulting houses for the purpose of the key projects in the national development plan. This may be followed with conscious involvement of the domestic consultancy companies from the earlier stages of the key projects ensuring that a significant portion of the project work as far as practical is undertaken domestically. Continuous association of the domestic consultancy companies and project personnel during all the stages of project development, implementation and commissioning need to be maintained as counterparts enabling them to fully comprehend and absorb the technological contents of the project. In case of a small domestic economy with limited prospects, as regional perspective for the development of such consultancy companies may be kept in mind. With such an approach, it is envisaged that over a period of time, the capability of domestic consultancy companies would improve and the local contribution for the realization of such projects will continue to increase.

Such indigenous consultancy companies should endeavour to become multidisciplinary as rapidly as possible with a view to providing a comprehensive support to a national project. Such companies naturally should seek the best qualified personnel and may engage experts of nationalities other than where the company is located.

X. CONCLUSIONS AND RECOMMENDATIONS

The role of African consultancy firms in the transfer of technology remains, to a large extent, an untapped potentiality. Consultancy, as a profession, is new to a majority of developing countries. In most cases this experience does not go beyond the late forties. Besides being new, it is not well understood. The erosion of ethics and dwindling standards of integrity in many developing countries add to the difficulty of understanding the concept and the value of the consultancy profession.

The elements of ethics, integrity, specialized expertise and absolute loyalty to the client make the consultants from African countries an ideal group for

participating in the process of technology transfer and industrial development. While most of the issues discussed in this paper are well known, there is no dearth of material regarding the importance of the consultants and the vital role they can play, a practical mechanism for involving consultants in the national projects in African countries has been lacking.

The vital role of private indigenous consultancy firms in the process of transfer of technology can never be over-emphasized. Faith, vision and courage of a high order will be needed to meet the challenge of transfer of technology in the coming years. Success will depend upon the initiative, vigour and administrative competence which the institutions and the agencies of the governments of African countries are able to develop and apply to the task of industrial development of achieving the ultimate objective of transfer of technology. Ultimately, success will depend much more on the extent the government and relevant agencies in African countries manage to formulate a practical and workable formula and come to have an awareness of the importance of the active role of indigenous consultancy firms in the process of economic developments of the counties concerned. Sections VII, VIII, & IX of this paper have highlighted a few possible practical approaches. It is strongly recommended that these approaches are tried wherever possible by a concerted and coordinated effort by consultancy firms themselves, African Governments, international organizations and above all project funding institutions and agencies, besides the relevant institutions and multinationals from developed countries

THE ROLE OF PRIVATE SECTOR IN ECONOMIC DEVELOPMENT AND MANAGEMENT OF SCIENCE AND TECHNOLOGY

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I. INTRODUCTION

In economic, scientific and technological development, the stability of institutions, including political institutions, property rights, the rule of law and the reliability of judicial systems do play a very important role. This point has not been emphasized vigorously in the literature, or in politics. The aim of this paper, first of all, is to clarify the issues related to the stability of institutions, property rights, rule of law and the reliability of judicial system in economic development. Secondly, the activities of consultants and contractors in private sector will be summarized. Thirdly, the role of private sector in the development of an effective competitive economic system will be emphasized with specific references to the management of science and technology.

II. STABILITY OF INSTITUTIONS

Stability of institutions, including political institutions, is the basic condition for any country to produce, survive, compete and develop basic human, physical and institutional infrastructures conducive for sustained economic growth and technological progress over the long run. Economic growth will not be viable in any country where institutions are not developed and where impediments exist for the development of stable institutions. It is stated that few private investors are interested in investing or lending under such conditions where the countries lack the requisite credit worthiness and basic human, physical, and institutional infrastructures.2

The development of stable institutions and the environment conducive for developing such institutions is an integral ingredient of the wealth of a country. A country may lack certain physical resources, but if it has stable institutions, stable government, the system of rule of law, and the existence of strong property rights, sooner or later it will attract foreign capital, entrepreneurs, consultants, creditors and investors to undertake profitable

projects according to the rule of market-directed system.

1. Political Stability

Political stability, and expectation of such stability, play an important role in the decision of individuals to undertake contracting and consultancy services and investments. the wealth maximizing person will find a way of managing the transfer of certain scientific information and technology to produce and sell goods and services. Countries that experience political instability are not suitable for economic progress. If government ownership becomes a channel of distribution of resources to the people (in most cases to those who are closer to the government), inefficiency and mismanagement will become the rule.

The collapse of communistic system has created conditions conducive to defend privatization of government ownership.3 The developing countries have wasted their scarce resources for government enterprises. The best thing for them now is to concentrate their energies on establishing necessary institutions and developing political stability needed for economic development and technological progress.

2. Property Rights

Property rights, like rights of access to markets, rights to exchange goods and services, and rights to use and transfer of resources are influential in every aspect of economic life. Decisions like who will produce what, in what manner, and what proportion, and for whose consumption, all depend on property rights. The decision of saving or dissaving the portion of current income for the future is also determined by the property rights. To answer the questions like "according to whose preferences and by whose authority, and who will suffer the losses of bad decisions, and who will benefit from the results of good decisions?" is to indulge in property rights.

a. Private property rights

Private property rights have been defined as the rights of owners to choose the use of their goods and resources (including labour and time) as they see fit4. In private property rights, incentives, rewards, and penalties, are orders and signals for the wealth maximizing person to look for the best. He has to produce and bear the consequences of his actions. He has to suffer for the bad decisions. He has to reap the benefit of good decisions. When he decides to invest in certain projects, he has to invest in information in order to identify "right" kind of project and bring in right kind of capital good-not just any kind of capital good. Private property rights can be strengthened with the development of certainty of property rights. The certainty of property rights depends on the existence of the following:

- legal institutions
- rule of law
- reliability of the judicial process
- security and peace
- stability of the government.

As a matter of fact, the firm existence of private property rights is an important part of wealth of a country. If the people are less fearful of theft of the wealth they accumulate, they will have incentives and positive encouragement to invest more. The more secure they feel about their wealth, the more investment they will undertake to increase their riches in different field of activities in which they perceive opportunities for profit.

The weakness of private property rights and their poor enforcement is one of the main obstacles to rapid economic growth and development in many poor countries. These countries will stay poor and vulnerable as long as their unwillingness or inability to strengthen the private property rights. When private property rights exist, the demand of the consumers and productive capacities of the entrepreneurs will regulate the market. Consumers will compte with the consumers and the producers will compete with the producers to produce at the lowest possible cost. In this manner through market competition, the scarce resources of the society are efficiently utilized.5

Here we witness the market discrimination. An entrepreneur will not discriminate against its employees because of race, religion or personality. The discrimination based on prejudice in private sector will cost dearly to the entrepreneurs. As wealth maximizing persons struggling to stay in competition, they cannot afford the luxury of prejudice, misconceptions, discrimination and nepotism.

As stated earlier, the existence of strong property rights is one of the sources of greater wealth of society

which the individuals will:

-increase saving through lower current consumption;

-develop capacity for the management of science and technology;

-generate production through investment in land, machine and material inputs;

-increase productivity by efficient use of human and non-human resources in exploiting profitable investment option;

-provide opportunities for the development of mental talents of the society for constructive business activities;

-develop conditions to utilize the knowledge of laws of nature by processing natural resources to beneficial ends.

Ownership of property, with certainty of private rights, is an integral part of freedom in which freedom of speech, freedom of resource and job mobility, freedom to search for the truth, freedom of initiativeness, individual dignity and freedom of alternatives would exist and flourish.

In private property, the prices and profits are the basis for economic activity. The resources are mobilized because of expectations of higher prices and profits. Prices and profits have been employed as incentives and rewards to solve the economic questions. The government would protect and enforce private property rights. The governments can supplement private property investments through incentives and tax-relief. Governments can increase investment in education, health, and physical infrastructure, etc.. In order words, government can provide conditions conducive for private investment where the individual can develop science and technology for economic ends.

b. Public sector

In public sector, on the other hand, the uses of resources are divided among various people in government agencies with orders and penalties. The economic questions are solved through political power and exchange of non-privately held rights. Then, political and bureaucratic exchange, political and bureaucratic decision-making and political and bureaucratic competition shape the society and regulate the behaviour of people accordingly. The resources are used and privileges are given according to the preferences of people in authority. No one suffers in authority to the losses of bad greed,"which"is responsible for wasteful use of resources"6 in government agencies and agencies owned by governments.

International finance institutions have been trying to channel private capital from industrialized countries" to some of developing countries because of "a show of confidence from foreigners will be a great incentive for domestic investors to invest in the stock market in their own countries."7 However, International finance institutions cannot convince local investors about the economic and political stability of their own countries. Thus, the countries themselves have to establish political and economics stability necessary to increase the confidence of native and foreign investors to invest. When required stability is necessary to increase the confidence of native and foreign investors to invest. When required stability is established, the capital flight will reverse itself and foreign and domestic investors will look for profitable options.8

3. Rule of Law and Reliability of Judicial System

The establishment of law and order is a prerequisite for the development of private property rights. By law and order, it is not meant the suppression of any voice by brutal force. By law and order, it is meant the use of the ultimate judgement. With the lack of law and order, it means the rule of arbitrary decisions as a basis for ultimate judgement. Without the rule of law, no legal institutions and laws protecting private property rights can develop. With the rule of arbitrary decisions and the bureaucrats, the potentialities, the resources, and the mental talents of the society will not be utilized for the benefit of all, including the benefits of the decision-makers in the long run. Without the certainty of property rights and the reliability of the judicial process, no investor will dare to undertake the financing of a viable and profitable project.

If the laws weaken the property rights, less investment and less flow resources will be channelled to the country. No doubt, capital outflow will take place. If the expectation of weak property rights persists, then less current saving and more current consumption out of current income and wealth will take place in the private

sector. In many less and least developed countries, including communist countries, the political leadership should develop legal institutions as permanent wealth of a country. The development of these institutions and stability take long time to mature and bear fruit.

4. Legal Reforms to Improve the Environment for Private Sector Development

The establishment of clear rules of law and contract that supports private property and competitive markets within predictable laws and regulations and with competent institutional structures in the legal, administrative and judicial framework is a must for a civilized society to realize its potentialities in all aspects of life, including economic development and management of science and technology. For domestic or foreign investor in the third world, the existing legal and bureaucratic system, from time to time, can become a nightmare. He may deal with ill-considered laws, over-regulations, poor administration, delays, red tape, uncertainty and a deficient court system. He may face an unresponsive legal system detrimental to the needs of the community, including the business community; he may encounter minor commercial disputes which may remain unresolved for years through an inefficient court system and judiciary that may follow protracted procedures resulting in unreasonable delays and may be unable to enforce judgements and contracts. All these problems and hurdles do increase the cost of decisions of the investors, domestic and foreign investors alike, in developing countries.

In order to reduce the cost of decisions of the investors in the third world, undertaking of certain legal and institutional steps, which is summarized below cannot be delayed:9

-a comprehensive well-defined sound body of laws and regulations dealing with business;

-a legal system responsive to the needs of the society, including business community;

-the efficient application of laws and regulations with the development of an institutional body through safeguards;

-reduction and elimination of bureaucratic delays, red tape, and irregularities;

-clarification and simplification of customs, taxation, licensing and other regulatory requirements;

-the training and motivating of civil service in charge of administration and over-looking private investors;

-the development of legal, administrative and judicial structures necessary for the implementation of contracts and enforcements of decisions with respect to property rights;

-elimination of barriers to competition;

-the development of a simple accounting system without the excesses of regulatory bodies;

-the simplification of laws and regulations with respect to labour, developing flexible labour laws;

-clear cut laws and regulations in establishing and liquidating firms;

-proper incentive system and proper regulation of investment and banking activities, including incentives to the management of science and technology in private sector;

-proper taxation that does not discourage consultancy and investment activities;

-the development of laws and regulations with respect to land tenure.10

5. Education, Science and Technology

The role of education and investment in human capital for the economic development and management of science and technology and transfer of technology can not be denied. The more a country invests in educating its citizens, the more incentives it provides to the private sector for direct foreign investment. The foreign investors will look at the markets where labour force will be able to handle highly complex and capital intensive technologies for their undertakings.

The relative existence of semi-skilled and skilled workforce can be an inducement for favourable transfer of technology. The technological capacity of a country among other things, is much related to the skills of the local labour force and their level of education; higher the inflow of capital, and the higher the chance will be for successful transfer of technology. With a relatively higher level of education of the labour force, the entrepreneur will invest less in training and know-how to handle the transfer and management of new technology. And this is

a great incentive for him to choose a country with relatively well-trained labour force.

Education and investment in human resources also reduce the cost of transfer and management of technology. If a country invests a substantial portion of its budget in education, human capital and integrated science programmes, then it is able to provide a better infrastructure necessary for the development and management of science and technology and sustained economic growth. Moreover, contents of education programme are important too. As an example, South Korea has invested in education and human capital. The contribution and share of education in Korean economic development can not be denied. South Korea, unlike North Korea, has devised an education programme heavy with mathematics, integrated science sources and English. The achievement of South Corea in education can be compared with other countries as is seen in Table 1.

Table 1
Percentage of Age Group Enroled in Education

	Primary (Total)		Secondary (Total)	
	1965	1987	1965	1987
Cameroon	94	109.	5	26
Indonesia	72	118	12	46
Egypt	75	90	26	69
Malaysia	90	102	28	59
Senegal	40	60	7	15
Turkey	101	117	16	46
South Korea	101	101	35	88
United Kingdom	92	106	66	83

Over-age students have been enroled in primary education.
Source: World Bank, World Development Report, 1990

South Korea has been able to achieve in enroling 88 percent of the relevant age group in secondary education. Such an investment in human resources will provide conditions for the management of advanced technological development and progress in high technology. Adding to such achievement in education, South Korea has planned to spend 38 billion U.S. dollars on integrated high technology infrastructure. Indeed, this will further accelerate the rate of economic growth and development.

Furthermore, public and private universities in South Korea have been oriented to train graduates in economically practical feasible research areas in which the country has comparative advantage or aims to achieve it.

Some countries, on the other hand, have not achieved the kind of development that we have witnessed with the case of South Korea. It seems that bureaucratic set up in certain countries are too rigid to restructure seriously the priorities of the countries in favour of greater investment in education, science and technology. The direct and indirect military expenditures of some countries are not less than 40 percent of their national budgets. What some countries have done for the sake of "transfer of technology" is to invest in assembly lines to assemble the imported parts of military equipments and weapons. In economic and technical terms, it is a very costly and inefficient way of "transfer of technology" and industrialization. Direct military production, by itself, is a very inefficient way of utilizing scare resources. The recent reduction of military-oriented investment activities in the United States is one of the means of injecting dynamism and efficiency in industrial sector. The current thought in the United States is that if they want to protect their current economic position from falling further, they have to invest in civilian sectors and high technology, subject to the rigors of international competition. They think the less military-oriented industries they have, the more they will become competitive vis-a-vis Japan and West Germany.11

III. ECONOMIC CLIMATE

The soundness of economic policies have overall impact on the establishment of private enterprise, capital accumulation and inflow of foreign investment. The decisions of local and foreign investors to hire consultants to undertake feasibility studies of certain projects are much dependent on the viabilities of certain economic policies. Under given economic policies, some projects may be feasible. However, if a policy change occurs, many projects can become unfeasible. Under an inflationary circumstances, the feasibility of some projects may be profitable; the same projects may become unprofitable if the rate of inflation started to decrease. for these reasons, the macro-economic adjustments and micro-economic adjustments to have certain impact on

the development of private sector and the management of science and technology within a sector.12

1. Macro-economic Adjustments

The over-all fiscal and monetary policies of a government, without doubt, has positive or negative impact on the economy and private sector, dependent on what kind of policies have been followed.

a. Monetary stability

A stable monetary policy with fiscal restraints can be one of the policies conducive for the development of private enterprise and transfer of technology. Entrepreneurs would decide to invest on the assumption of stable monetary and fiscal policies. Other things being equal, countries with stable monetary and fiscal policies have been able to provide the expectation of certainty the businessmen are looking for increasing their investment activities.

b. Stable Price Level

A suitable monetary and fiscal policy, other things being equal, will create the conditions for stable price level. Inflationary environment is not conducive for investment activities. Inflationary tendencies and unstable prices for materials, goods and services, intermediate goods and equipments may create uncertainties about the future and proper evaluation of projects which may hinder the realization of new investment projects.

Inflationary trends and unstable prices (as result of unstable monetary and fiscal policies) may force the authorities to impose price controls in order to "stop" the trend. The problem becomes worse. Such an environment is the worst enemy of private sector.

The entrepreneur, private or foreign, has to be subjected to the rules of competition in an environment where price level is stable and expectation of stable price level is firmly established. The entrepreneur would favour stable prices for raw materials, intermediate goods and equipments needed for his projects. With sound economic policies and stable price level, a favourable investment climate can be created and decisions in project evaluation would be based on the stability of price level. The best policy is to let the price of a good to reflect its scarcity. The imposed price controls destroy the scarcity concept. It distorts production and market mechanism. A project evaluation based on distorted prices may channel the scarce resources to the wrong direction. The failure of communism is due to the control mechanism imposed on prices of goods and services. In certain countries we see the continuation of march of people from the countryside to the crowded cities. One of the reasons is that for years the prices of farm products were controlled by the authorities. As a result, the controlled price signal gave the wrong direction. Under controlled prices to invest in agriculture and increase the transfer of appropriate technology to the countryside become very costly and uneconomical to the peasants. With given prices, they made their decisions to leave the farms to the birds.

If prices were not controlled, without doubt, more investment, more talents and more technology transfer to the agricultural sector could have been channelled. As a result, the development of management of science and technology in increasing food production could have been realized.

c. Exchange rate mechanism

In most of the developing countries, foreign exchange rate controls have been imposed. Recently, this rigid restriction in some counties has been lessened in favour of a more realistic exchange rate. The controlled exchange rate, like the controlled prices, distorts production and consumption and channels the scarce resources to different areas. It provides incentives to the wrong type of projects. Mostly, under this kind of controlled mechanism, import-oriented non-competitive projects become profitable at least in the short run. The resources of the country may not be utilized according to the signal of a controlled exchange rate. Sometimes, the production of agricultural and food products become uneconomical because the importation of food products under a controlled exchange rate, relatively is very profitable. The relative decline of agricultural activities in many developing countries, is mostly due to two factors: namely, the internal price control and exchange rate control.13

The adaptation of a realistic foreign exchange rate based on market forces will give the right signals to the private sector to engage in investment activities wherever it deems profitable, be it agriculture, industry or service sector.

d. Export performance and value added in manufacturing

The achievement of a country in handling science and technology in economic activities can be seen clearly in value added in manufacturing activities and

export performance. In 1970, the value added in manufacturing in Korea was 97.4 percent of Turkey and 189 percent of Indonesia. In 1988, the value added in Korea was about 323 percent of Turkey. For instance, in 1970 the value added in manufacturing of Korea was 13 times of Senegal; in 1988 it was 58 times of Senegal.

Again, in machinery and transport equipment, the value added of Turkey was much higher in 1965 than of Korea. In 1970, the value added for the same sector in Turkey was around 73 percent of Korea; in 1989, it dropped to 44 percent. This decline mostly is attributable, among other things, to the unstable monetary, price and exchange rate policies and the deficits of state economic enterprises in Turkey. During 1970-1989 period, the increase in value added in machinery and transport equipment for Korea and Turkey were 190 percent and 75 percent, respectively.

The higher value added in manufacturing can be seen in higher rate of export performance.

The total exports of Korea in 1967 was less than that of Turkey. In that year, the value of exports of Korea was around 61 percent of Turkey; 57% of Egypt; 48% of Indonesia; and 26 percent of Malaysia, respectively. The exports of Senegal was around 74 percent of Korea. However, after a span of twenty-two years, Korea had dramatically increased the value added portion of machinery and transport equipment in manufacturing from 11 percent in 1967 to 32 percent in 1988. The structural change has been reflected in export performance. In 1989, the exports of Korea was 5.3 times of exports of Turkey; 24 times of Egypt; 29 times of Indonesia; 2.5 times of Malaysia; and 103 times of Senegal respectively. Between 1965-80, and 1980-89, Korea's export performance rate was 27.2 percent and 13.8 percent per annum, respectively.

Economic development and management of science and technology is not a magic word. It is the result of right policies for the right time and environment. When the policies are conducive on macro and micro level, the native and foreign entrepreneurs take the risk of bringing new technology and capital to the country in order to make profit. In the process, science and technology is integrated into production function in order to produce more at the lowest cost.

The countries that attract more private capital are the ones that have followed stable monetary and economic policies. For instance, in 1989, around US$ 2,525 million was disbursed by non-guaranteed private sector in Thailand. For Turkey it was just US$ 432 million. However, Turkey followed an expansionary monetary and inflationary policies that relatively discouraged the inflow of private capital which decreased its competitiveness vis-a-vis Thailand.

2. Micro-Economic Adjustments

a. Incentives to small enterprises

Most of the developing countries have almost neglected to provide incentives to small industrial establishments. The credits and financial incentives, mostly, have been given relatively to large scale enterprises, especially state owned-enterprises and privately owned monopolies. These enterprises have been producing their products for internal markets at higher prices. They have captive markets and they have no incentives to be competitive and sell their products abroad. As a matter of fact, they cannot sell abroad because of higher production costs and low quality of their products.

However, recently the privatization process and rethinking of the previously failed import-substitution strategy have provided an opportunity to re-orient sectoral developments through small-scale industries and small-size enterprises.

One of the main reasons for the failure of previous strategies is due to the lack of development of management of science and technology. Management of science and technology through small industries and small enterprises can result certain degrees of success. In a small industry and small enterprise, problems can be identified and solutions can be offered more quickly. The entrepreneurs in developing countries can handle the management of their small enterprises. They can learn to adapt new technologies and scientific methods faster than in big enterprises. They would be less dependent on outside consultants. As a matter of fact, they could be more imaginative and innovative in identifying new products and adapting new technologies at cheaper costs. The learning process and learning how to manage a new process would be faster and economical.

b. Revisions in Commercial codes

Revisions in commercial codes favouring business enterprises, first of all, will help in reducing red tapes and bureaucratic traps in front of the businessman. It will also help in streamlining of regulations in establishing

Table 2

STRUCTURE OF MANUFACTURING

	Value added in manufact. (Billions of $)		Distribution of manufacturing value added (percent, current prices)									
			Food		Textile		Machinery & Transp. equipment		Chemicals		Others	
	1970	1989	1970	1989	1970	1989	1970	1989	1970	1989	1970	1989
Low Income economies	46,1	227,4										
China & India	38,4	185,1										
Other Low Income Countries	7,1	39,1										
Lower Mid. Income Countries	35,6	202,7										
Upper Mid. Income Countries	32,5											
Sub-Sahara Africa	0,6	18,1										
Indonesia	1,0	10,6		23		11		10		10		47
Senegal	0,14	0,94	51	48	19	15	2	6	6	7	22	24
Egypt	4,4		17	29	35	20	9	9	12	17	27	25
Turkey	1,9	16,8	26	18	15	16	8	14	7	11	45	41
Malaysia	0,5		26	18	3	6	8	23	9	3	54	39
Korea	1,9	54,2	26	11	17	15	11	32	11	9	36	33

Source: World Bank, World Development Report, 1991

private firms and business enterprises.14

c. Reform of investment rules

Reform of investment and export rules and incentives with respect to private enterprises will be an important step in generating a new interest in enterprising spirit. It will encourage inflow of new capital and entrepreneurship. with new capital and new projects, naturally the transfer of new techniques and management will take place. The new management will augment all the resources for the production of the final products and services.15

d. Reduction in corporate taxes

An investment strategy to increase private enterprise activities has to pays attention to taxes in general and corporate taxes in particular. The rule says higher the corporate taxes, the lower will be the investment activities. Any country that tries to increase investment has to decrease corporate taxes. A lower corporate tax structure will attract foreign investment.

Table 3

Export Performance

Country	Value ofexports (millions of US$) current prices		Average annual growth rates of exports (%)		Average annula growth of gross domestic product (%)	
	1967	1989	1965-80	1980-89	1965-80	1980-89
Senegal	237.8	600	2.6	2.5	2.1	3.1
Egypt	566	2,565	0.1	9.2	7.3	5.4
Indonesia	665	21,733	9.6	2.4	7.0	5.3
Malaysia	1.216	25,053	4.6	9.8	7.4	4.9
Turkey	522	11,626	5.5	11.4	6.8	5.1
Korea	320	62,283	27.2	13.8	9.9	9.7

Source: World Bank, World Development Report 1991 and Previous World Bank Publications

3. Development of Local Consultancy and Contracting Firms

The developing countries have been constrained, especially in certain areas by the lack of skilled and experienced consultants in designing certain appropriate projects or assessing the feasibility of a proposed project. An incentive system to develop local consultancy firms through learning process with foreign consultants, would be economical and efficient without sacrificing safety and technical adequacy of a project. The local consultants, through on the job training, would be able to handle all aspects of a project, from its pre-feasibility stage to that of implementation. The development of management of science and technology depends on the development of two critical sectors, besides other important variables; that is, the development of local consultancy and contracting firms.16

However, the development of local consultancy and contracting firms in management of science and technology in the application of know-how in projects can be realized through following steps:

a. Training in engineering activities

In consultancy, especially, in construction and related activities, such as dams, irrigation schemes, buildings, power and electrical networks, most of the works are related to different branch of engineering. The consultancy and contracting capability can be acquired with only a thorough knowledge in a field of specialization. It also requires experience and on-the-job training that gives the engineer the capability and capacity to provide judgement on different technical issues which are clearly related to safety and efficiency. Through this method, the learning of how to apply science and technology in actual projects with practical experience becomes cost efficient and economical.17

b. Management training of consultants

The consultants in most of the developing countries have been specialized in certain areas of interest. Few of them have been trained as over-all consultants to manage and deal with multitude of parties involved in the project such as engineers, architects, economists, contractors, sub-contractors, equipment and materials suppliers, manufacturers, labour, labour organizations, regulatory bodies, financing entities, and governmental organizations. The consultants have to be given incentives to be trained in project management with a firm to handle project planning, to coordinate design services, procurement, construction management, commissioning and tasks such as feasibility studies and financing arrangements. All these skills can be acquired through training and on-the-job learning process. Experience with project management teams is one of the ways of increas-

Table 4

Private Non-guaranteed External Capital

	The Flow of Private External Capital Disbursements (millions of dollars)		Long Term Private Debt (millions of dollars)	
Country	1970	1989	1970	1989
Senegal	1	8	31	33
Egypt	0	142	0	1,081
Indonesia	195	1,329	461	4,626
Malaysia	12	675	50	1,377
Turkey	1	432	42	795
Korea	32	1,798	175	5,961
Thailand	169	2,525	402	4,658

Source: World Bank, World Development Report, 1991

ing the capability, skills and capacity of consultants of developing countries. Some of them would become contractors in future.

c. Sub-consultancy and sub-contracting

When the privatization process continues, it will be very attractive for the local consultants and contractors with government encouragement to get sub-consultancy and contracting assignments from big firms to deal with specific issues. such assignments would increase their capabilities and capacities gradually in order to be able to undertake independent assignments and establish their own consultancy and contracting firms later. Further, sóme engineers with the government can be encouraged to give up their jobs for some sub-consultancy activities through offering their skills as consulting engineers in certain firms. After working for a time with an established firm, they could feel confident to establish their own consultancy and contracting firms.18

d. Joint undertakings between foreign consultant and contracting firms and domestic firms

It is no secret that sometimes domestic consultant and contracting firms may not have desired experience, exposure and information to be eligible for a government contracting agency. For such local domestic firms in order go gain skills, experience, information and contracts, it may be the best way to establish a joint venture firm with foreign firm. As a result, local firms can get regular assignments tailored to their size and experience. For example, a joint venture consulting or contracting firm with foreign firm would be able to get a steady stream of work from the government and would be able to attract high calibre and better qualified staff.19 Further, experi-

enced local consultants and contractors can enter into contracting activities with other companies. Thus, the transfer of "know-how", the knowledge of management and transfer of technology can take place properly and productively.20

IV. PRIVATE ENTERPRISE IN SCIENCE AND TECHNOLOGY MANAGEMENT

Private enterprise managing science and technology (S&T) related activities can flourish in the proper environment based on positive incentive system. Private sector will not invest in any activity unless there is an opportunity to earn more. If S&T will help run its activities more profitably, then it is ready to invest in it. The same thing is true for the development of a new product. No doubt, the development of a new product or the adaptation of an existing product or machinery, requires the application of science and technology in that new environment. Private enterprise may be reluctant to go into risky products and technologies as in the case of Korea.

The Korean Government, established three integrated science and technology institutes, Korea Institute of Technology (KIT), Korea Institute of Science and Technology (KIST) and the Korea Advanced Institute of Science (KAIS) in order to provide technological manpower needed in private sector for effective management of science and technology with respect to new product development in industry. These institutes established organic links with private enterprises, helping them to choose certain products with certain science and technology contents in specific sectors, where they thought they had comparative advantages in international markets. At the beginning, no private enterprise contributed financially to the Korean institutes. This trend changed as the Korean outward-oriented enterprises competed in international markets with their products. They have realized the value of science and technology in the product development cycle. Nowadays, they finance the development of prototype productions in Korean science and technology centres. They pay for it and perceive net gains. Science and technology management in product cycle with research and development in new technologies have become a major area in which the private enterprise has been involved totally.

Further, the rapid development of industry in Korea forced the authorities to establish the Korea Advanced Institute of Science and Technology (KAIST). This industrial research institute provides facilities to graduate students to participate in practical oriented research work to solve the applied technical and managerial problems related to goods, services and products. KAIST also aims to train high calibers manpower in managerial positions urgently needed in private sector to manage the application of science to advanced technology in industry.

It is true that Korean authorities financed the development of certain prototype products in the beginning and still continue to finance the science and technology oriented products in different centres. However, if Korea did not follow a stable monetary exchange rate policy with export oriented trade system, the Korean miracle would not have occurred.

With the accumulation of funds and prospects of profits, private enterprises in Korea are able to invest in research and development of certain identified foreign products and technologies for transferring and adaptation for local small and medium enterprises with the aim of exporting the final products.

Korean firms always find help of Korean research institutes and the Ministry of Science and Technology. Any country or any region which tries to put its will-power and resources into development through private sector with generous incentives from the research centres in applied technology and product development aiming to compete in international markets, will not fail. For example, the Koreans invest in human resource development and applied technology through private sector and did not fail; Taiwanese invested in human resources and applied technology for the world markets and did not fail; Thailand has started to invest in human resources and technological development through private sector and has not failed. If Turkey, Egypt, Senegal, Guinea and regions in Africa aim to invest in human resource development and applied technology for production for international markets with their rational economic policies through private sector, they will not fail in their economic undertakings. They will meet nothing but success.

First of all what we can learn from the experiences of countries like Korea, Taiwan, and Thailand is that we have to establish rational policies with respect to our goods and products and sectors in which we think we have comparative advantages through the studies of some science and technology centres in the region; secondly, we have to undertake a thorough study of human resource bases and inputs which the private sector can utilize in its investment activities; thirdly, we have to identify the channels through which local private enterprises can improve management capability to deal effectively with science and technology in product adap-

tation for competitive markets; fourthly, we can reorient existing vocational training away from classroom based system to private workshop training; and lastly, we have to find a mechanism in establishing organic links between the universities, research centres and private sector in order to provide the needed manpower and management for the requirements of the economy, especially the private sector.

V. CONCLUSIONS

Ensuring reliable and consistent private property rights, stable institutions and stable monetary and economic policies are the prerequisites for accelerating the transfer of technology and economic development of a country. To accomplish this task, it is essential to provide incentives to build an indigenous technical capacity to assimilate new technology and its adaptation to the country's economic needs and conditions. The establishment of stable monetary, realistic exchange rate, and price policies, with clearly defined private property rights and rule of law and a generous incentive system, are the necessary conditions for providing a proper competitive environment for economic development in general, and for the development of science and technology through private enterprise in particular. This process requires the accomplishment of the following tasks:

(1) investment in primary, secondary and vocational education to develop education and training level of the population;

(2) development of strong export-oriented policies for scientific and technological developments in the production process through increased public interest in science and technology;

(3) establishment of viable institutions, with links with private enterprises for applied Research and Development, by attracting capable engineers and scientists;

(4) increasing the numbers of technicians, engineers and scientific manpower in different fields;

(5) identification and screening of the transferable technology before its assimilation;

(6) investment in appropriate research equipment and technical information;

(7) generation of adequate capability for assessing the economic implications of R&D before commercializing the results of the efforts;

(8) development of conditions for the effective participation of the private industrial sector in the formulation of science and technology policy and its implementation; and

(9) provision of positive incentives for the development of consultancy and contracting activities in the country.

Taiwan, Korea and Thailand have followed stable monetary, price and realistic exchange rate policies. They have provided generous incentives to private enterprise to involve in every socio-economic field in a competitive environment. They established applied research institutes to help private enterprises, especially of small and medium sizes, in identifying economically and technologically viable transferable technologies and products to be produced internally for international markets. Private enterprise has excelled in every economic sector, including high technology; they have established vocational training centres, engineering institutes, universities, and technology adaptation and development centres with incentives and encouragement from their governments; they have employed and trained a relatively educated labour force. Especially, Taiwan and Korea have invested heavily in human resource development. With favourable economic policies, laws and regulations and well-trained labour force, these countries have become attractive places for foreign entrepreneurs to invest. These countries have not wasted their resources to finance the deficits of bureaucratically managed loss making state economic enterprises like in some other countries. This is one of the reasons why Thailand has become a power-base for foreign investors. In short, private sector in these countries has been able to manage in choosing, adapting, digesting, and producing any technology or product which is saleable in international market. For instance, Taiwan based Acer personal computers have become more attractive to buyers than IBM personal computers.

In short, given positive incentives to private enterprises in a stable political and economic environment, the development and management of science and technology will gain momentum in producing goods and services which are demanded and are competitive in the international market. The problem of slow development can be solved gradually by providing stable institutions, including political institutions, stable macro and micro

economic policies which will provide necessary conditions for economic opportunities and activities for private enterprises and private consultants and contractors with incentives to compete in the international market. This is the crux of economic development and the management of science and technology for developing countries, including those in Africa.

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POPULARIZATION OF SCIENCE AND TECHNOLOGY IN AFRICA

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Contents

Introduction

The popularization of science and technology in Africa with the development of S&T culture is a prerequisite to the enhanced development and application of science and technology in the region. Africa is grappling with problems of underdevelopment, itself resulting from an under-utilization of science and technology. Modern science and technology have shifted the comparative advantage of the earlier strong resource base, and African commodities are no more fetching the foreign currency necessary for local development. On the other hand a poor appreciation of science and technology coupled with traditional African culture are often stumbling blocks in the assimilation and enhanced application of science and technology, essential tools for socio-economic development.

It is recognized that efforts to industrialize African States have met with dismal failure because little or no attempt was made to develop a scientific and technological culture and consider the cultural prerequisites of such development imposed from outside. The advent of colonization did not contribute to the building of an endogenous scientific and technological culture, as development was externally oriented. Even after independence, most African countries continued to rely on old masters for their technological development. Though, of late, science and technology have been accepted as a priority, the popularization of basic science and technology has not been receiving the weight necessary and the critical economic situation in most African countries has not made matters any easier. Unless people at the grassroots level have the minimum knowledge to enable them to appreciate the development and role of science and technology in the present day world, the country as a whole cannot take advantage of these very developments and apply them to their environment.

The superiority of western technology in terms of meeting basic needs and a higher standard of living, forces developing nations to depend on such technology, often with scarce attention to the development, upgrading, and exploitation of indigenous science and technology. The indiscriminate adoption of foreign technologies, without due consideration of local culture and tradition has led to multiple problems in the development process. It is to be noted that the technologies developed in the West are meant to meet the westerners' own needs, and are seen to be appropriate to their socio-cultural norms. When transferred to developing countries, these socio-cultural

norms are often absent in the new set up, and hence always a major problem. What should developing nations then do to prepare themselves for facing the inevitable advent of such technologies necessary for their own development? What are the cultural prerequisites for the development and application of modern science and technology? Is there any room for a closed-wall policy in this world of inter-dependence? These are the questions that will be attempted in this paper, while highlighting the different approaches to the integration of modern science and technology into traditional African culture, through popularization of Science and Technology.

The Changing African Cultural Scene

Traditional African culture englobes not only the fine arts but all human activities based on folk traditions, beliefs, and rituals that affect the daily lives of the people. Whether it is eating, working or sleeping, whether it is agricultural practice or medicinal cure, whether it is dress, dance, drama, music or sculpture, all these are part of African culture based on age-old wisdom. This culture has necessarily been influenced by tribal movements through war and conquests and through exigencies of natural calamities like drought and desertification. Since culture is never static, there is no reason why the advent of modern science and technology will not bring new changes necessary for the survival of the race. Any society that will try to close itself from outside influences will necessarily be marginalized and disappear in the course of time. Adaptation to new environmental impacts is a necessary condition for survival and growth. Hence it is necessary to find ways and means by which the African society can capitalize on the advent of modern science and technology and use it to improve its quality of life. The pitfalls of the industrial society can be avoided in this process, by a judicious science and technology policy that takes care of the environmental hazards created by indiscriminate adoption of technologies. At the same time, inherent African values can be preserved to some extent so that one is not completely uprooted and mentally colonized by a 'superior' exogenous culture. Klaus Gottstein 1/ remarks that we should not encourage the disappearance of old cultures when such disappearance can be avoided, as they contribute to the richness of the human heritage. The impact of modern science and technology with their means of communication, however, is such that it is very difficult to preserve old cultures without any transformation. And we should not be unduly dogmatic about the need to preserve fully all the aspects of culture, for change is a necessary condition of life.

Approaches to popularization of science and technology

How can this change be therefore brought about so that African culture can, with minimal conflict, absorb modern science and technology to its advantage, and create an indigenous scientific and technological culture? Most of the methods enumerated below are of the domain of popularization of science and technology in the African scene, and this involves a process of education at all levels. The different segments of the society - children, women and men, both in the rural and urban areas, have to be educated by all the possible means available to the community.

Present systems of education have favoured the growth of an elitist class bred in urban areas, a class that tends to decry traditional practices and a rural way of living, and that tends to emulate the westerner in all his ways of thinking and living. Such a class controls the governmental machinery and directs the national resources to feather its own nest, much to the detriment of the vast majority of rural dwellers. Science and technology are exploited by this class only to widen the gap between the urban and the rural. Modern science and technology do not reach the vast rural masses who form the majority of the nation. Hence development, if at all, is minimal. It is then essential to change this trend by bringing the benefits of modern science and technology to the entire mass of people in the country, by a process of redistribution of wealth and by the provision of adequate facilities for education in the rural areas where traditional culture tends to inhibit any change and growth.

The demystification of science and technology

Basic principles of science and technology are found in many of the traditional practices in the daily lives of people. These principles are however covered with a veil of mystery and black-magic, and few African scientists have attempted to explain their daily practices from a scientific standpoint. On the other hand, they have tried to implant western science in the schools from a western approach. Without linking it to the surrounding phenomena, or to the activities in their daily life. This has only perpetuated the mystification of science and therefore the associated technology. The situation has worsened with the advent of new and high technologies. The starting point for demystification of science and technology should be the teaching at primary and secondary levels of traditional science and technology so that the children can grasp the fundamental principles much faster. Then they can apply the same principles while adopting foreign

technologies to meet their socio-cultural needs. It is worth seeing in detail the methods to be adopted at different levels of the educational process.

Primary and secondary school level

Most schools in Africa have introduced science teaching both at primary and secondary levels. At the primary level science is introduced as environmental nature studies, while at secondary level, the classical version of science subjects are introduced. In a few exceptional cases integrated science curricula have been introduced. The teaching of the sciences, however, has not been able to inculcate the basic principles properly, as a practical, hands-on experimental approach, has been lacking due to a dearth of laboratory equipment. The fact that the surrounding environment provides adequate illustrative tools for transforming abstract scientific concepts into concrete realizations, has not been exploited. Nor has indigenous science and technology been brought out and highlighted to make the students understand the ideas in a concrete way. This depends very much on the initiative and drive of the teachers who are often not adequately trained. I once visited a secondary school where students were being taught, in a descriptive way, the physics and the biology of the eye. When I asked them whether they had actually dissected an eye, the answer was no. Yet every student could afford to get a bull's or a goat's eye from the town butcher. Nobody had taught of bringing one and use it, through dissection, to illustrate the abstract physical and biological concepts. Dozens of other examples can be cited to show that the teaching of basic science can be immensely improved by making use of surrounding illustrations available in the traditional life of the people. In the field of physics, the laws can be illustrated by taking examples of flying birds and running beasts, of cooking pots and evaporating pans, of ex-carts and bicycles, of hoes and cow-bars, etc. In the field of chemistry, instances can be cited of food fermentation, of alkaline soap and acid fruits, of home-made plasters, etc. In the field of biology, examples are many. Ideas of plant growth and fertilizer usage, of the structure of plant tissues and animal parts, of birds and insects can easily be illustrated to allow the children to grasp the concepts. These concepts should then be translated into actual practice in the homes. For example, a child can instruct his mother why it is important to boil river water before giving it to his baby broth or sister. Elements of hygiene are to be practised both in the school and at home. A budding scientific culture can be imparted to the grown-ups through the children in the schools.

Use of local language

Whenever necessary, there should be free usage of local dialects and languages. Very often the teacher tries to inculcate new ideas using a foreign language, thinking that using local dialect is humiliating. At times he is himself from another locality, and does not know the local language. The use of an appropriate medium of instruction plays a very important part in imparting the proper education to the children.

Encouraging girls to take science

The development of a scientific culture starts in the schools and at the secondary level, African girls should be encouraged to take science subjects. Most often boys prefer science while girls take to the arts subjects. These girls who become mothers and householders later on, need to have adequate science education, in order to enable them to apply scientific concepts in their daily lives. Hence right at the secondary school level, more and more girls should be encouraged to take science subjects, and to give up their prejudices against science education. Why shouldn't African girls become scientists and engineers in larger numbers? Taking science subjects should not be seen only as a means to a vocation, but as a means to develop a scientific and technological culture necessary for a wider development and application of science and technology.

University education and research on traditional science and technology

Once a proper foundation has been laid at the secondary school level with appropriate teaching of science and technology using environmental tools and suitable laboratory equipment, university science education can improve immensely. University graduates in science and engineering will have grasped the basic principles and will be able to apply them in their daily life. The chemists, the physicists, the biologists engineers and agriculturists, should have acquired the basic know-how to find gainful employment not necessarily in government service. The private sector can employ them, and the growth of the private sector will depend on the graduates themselves taking self-employment and starting small and medium-scale enterprises and industries. This should be the primary objective of university education in a developing country.

For those who go for post-graduate work and research, they should be encouraged to do research on

traditional science and technology with a view to demystify existing traditional practices. By so doing, they will upgrade traditional science and technology, and give a sense of self-confidence to their people. Ethno-medicine, ethno-psychiatry, ethno-botany and ethno-zoology, should be given high priority in university curricula and research, and the results of research should be disseminated among the masses so that they realize that science and technology are not completely foreign to Africa.

For years now African universities have done research on traditional pharmacopoeia. Multiple research papers and books have been published. But the common man has not gained an iota from this research. How can we then develop a scientific culture? Is it not time the results of the research be exploited through small and medium-scale industries that can bring the benefits to the common man? The problem is that in spite of university education, the eyes of our academics are still glued towards western science and medicine. And to make it worse, our policy-makers prefer to get free or cheap medicine dumped in developing countries by international organizations working for strong multinationals, without realizing that such free or cheap medicines (often outdated) will only stifle the local entrepreneurial spirit to manufacture local medicines.

To avoid such a situation, African universities should be primarily developmental universities, where the teaching and research should be aimed at meeting local developmental needs. We should not train chemists, doctors and engineers for the developed countries of the West. Even if it means 'lowering' standards as compared to western standards, we should give appropriate education to our university graduates who can utilize their knowledge fruitfully in contributing to local development, and in finding solutions to local problems. We have so far measured academic standards by the number of publications a researcher has made in foreign journals. Such publications have hardly contributed to alleviating local problems. It would be better to recognize our scientists and technologists who publish even in the local newspapers or magazines, but whose publications have a direct bearing on alleviating local problems. And those scientists and technologists who succeed in getting their results commercialized through local enterprises need to be awarded the highest distinctions in a developing country. This alone will give self-confidence to our scientific and technological community, and help to integrate science and technology in our culture.

The university should be a centre not only of learning, but also of collaboration between the local enterprises and the scientific community. Industrial parks within university campuses will encourage applied studies. These industrial parks will bring together researchers, technologists, entrepreneurs, and financiers who can take any innovation and bring it on the production line. Modern science and technology will then be integrated into the local fabric of the society.

Rural and urban youth science clubs

In most African countries where youth clubs are found in the rural areas, they are mainly sports and entertainment clubs. There are hardly any science clubs. Such science clubs are very important for they can enable the youth to practise the science they learn in schools, after their school hours and in weekends. Radio-amateur practice, video-games, scientific farming, home-science, tool-making, animal-training, and a host of other activities can be practised in such rural and urban youth science clubs. Organized competition will also motivate them to improvise, innovate, and develop their talents. The school teachers living in the vicinity should sponsor such clubs, and with the support of the community, popularize such clubs throughout the country. Science and technology will then not be contained within the four walls of the classroom. Conscious efforts must be made by the responsible members of the community to encourage such clubs that can develop a scientific culture amongst the masses.

Radio and T.V. programmes

Radio and television are powerful tools to educate the masses, and to create the society we desire. If science and technology are to be integrated in our traditional culture, they should be given adequate time in our broadcasts. In Africa the radio has reached the far-away villages, and this is where successful programmes can be very effective in inculcating a scientific culture. The usual traditional radio programme consists of local or foreign music, or political propaganda. Very rarely do we have a science programme in the local dialect. Since the radio broadcast reaches the young and the old alike, the men and the women, basic science and technology education can be imparted in the local languages so that even the illiterate can assimilate elements of science and technology. Such programmes should be given emphasis on local endogenous science and technology, on the upgrading of their traditional practices using modern science and technology, and on occasional foreign programmes garbed in local language so that the people are made aware of developments outside. This needs

heavy financial investment by the governments to enable the production of such programmes. It is so easy to fill the broadcast time with cheap readily available tapes from the western media, but these will not help in creating a local scientific and technological culture. Local producers and mass-media technicians and specialists need to be trained. The number of scientific programme producers has to be increased, broadcast stations and networks have to be multiplied to cover the length and breadth of the country. And where possible, private radio transmitting stations have to be multiplied to cover the length and breadth of the country. And where possible, private radio transmitting stations have to be encouraged. As long as the radio as a medium of instruction, stays in the hands of a minority elitist group, there can be no hope for creating a scientific and technological culture amongst the people. The same applies for television broadcast though the latter has its place mainly in the rich urban areas. These days video recorders and players are being increasingly used, and governments should not restrict the purchase of such gadgets through heavy taxation, as they can contribute immensely to popularize science education in the rural and urban areas.

For those who have access to T.V. programmes, the introduction of science programmes in local languages, depicting current developmental issues like health, sanitation, agriculture, farming, animal husbandry, building and construction, use of chemical and biological fertilizers, hybrids, post-harvest storage, food processing, bicycle and tool repairs, chicken and pig rearing, etc., can be very effective in creating an understanding of science and technology applied to the environment. Here again the increase in T.V. networks and T.V. channels requires extra resource allocation. Such resources are available only if the policy makers are keen on spreading the network through the country. Unfortunately, this is not always the case for the deep interiors of African countries still have little access to the available means of communication. And when the villagers come to the towns and cities, it is a cultural shock they have to bear. A high placed official in a city in Central Africa once related how his uncle from the village visited his house in the city. He was sitting in the drawing room when the T.V. was turned on. The announcer was talking in a foreign language and looking at the uncle. The latter could not understand from where the intruder hand entered the box, and why he was facing him and talking to him in a language he did not understand. He felt perturbed and embarrassed, and was ready to leave the house when my friend intervened, and explained to him what the televisions was! This happened in the 1980's! Naturally, such a shock could have been avoided if the local radio programmes had prepared the uncle to what he could face in cities.

Exhibitions, competitions and prizes

Roving exhibitions which enable the organizers to move printed materials, charts, equipment, gadgets, and specimens, with the possibility of demonstrations and talks, are very effective in educating the people. Appropriate technologies can be popularized and transferred through such exhibitions in different parts of a country. Local competitions can be organized to bring out the budding talents. Innovations from schools, colleges, local craftsmen and technicians, engineers and manufacturers, can be exhibited, and the best ones rewarded through prizes. Such exhibitions and competitions need to be organized regularly, and become part of the culture of the people. Local folks learn a lot by seeing and often handling things that can affect their lives positively or negatively. The local market place is a suitable place for such events, and is likely to attract many people from the surroundings. It should be the responsibility of village leaders and chiefs, district commissioners and representatives to organize such exhibitions and competitions with the support of the scientists and technologists in the country. Once again, as long as science and technology stay within the walls of schools, colleges, and universities, their impact on the masses will be marginal, and no scientific and technological culture can be inculcated in a traditional society.

When it comes to raising funds for the organizations of such events and the provision of prizes, it is always possible to find some wealthy businessmen or agriculturists who are eager to see their name published and their contribution recognized. What is essential is a group of dedicated individuals who have to run around to carry the message and influence the potential donors. If such persons get the patronage of the local authorities, politicians and chiefs, the task becomes easier. Science and technology activities should find a place in the lives of all categories of people concerned with the socio-economic and cultural development of the country.

Community centres and village councils

In any organized society, community centres and village councils are the meeting grounds of development workers. Such centres and councils need to be created where they do not exist, and be strengthened where they do exist but are inactive. Through such centres and councils, science and technology can be propagated by organizing talks, exhibitions, competi-

tions, implementing micro-projects using science and technology for the welfare of the people, and thus by developing an appreciation of what science and technology can do to improve the quality of life of the inhabitants. Since such centres are mostly run by the influential people of the locality, their own interest in science and technology will be roused by such events and activities, and integrating a scientific and technological culture amidst the masses will become easier. Local politicians even at the village level, have to show evidence of innovative approaches, and science and technology offer them this opportunity. Gossip and back-biting as undesirable aspects of local politics will yield to constructive activities that can have greater impact on the people who elect them. Community development projects can benefit immensely from the introduction of modern science and technology, and traditional practices can either be upgraded or replaced by more efficient technologies.

Songs, folklore and plays

Traditional songs, folklore and plays have been instrumental in carrying particular messages to the people, and in fostering any culture. A scientific and technological culture can also be fostered through such vehicles. Those who watch western television serials for children, are surprised at the number of examples of modern science and technology introduced in the programmes. Concepts of space travel, for example, are inculcated at a very early stage of child's education. Why should it then not be possible for us to introduce basic concepts of science and technology through our songs, folklore and plays? The usual theme of an African song is love or marriage. The usual theme of a folklore is the local social problem depicted in picturesque way. Even the local dramas and plays stress socio-political issues. These cultural vehicles are very powerful in educating a people, and can be utilized to introduce scientific and technological knowledge to the people. In India, family planning techniques have been introduced to the masses through songs, folklore and dramas. Is it not possible to introduce techniques of biogas digesters or solar driers, or agricultural production through similar songs, folklore and dramas? The community development workers can capitalize on such vehicles to take their new ideas to the people. Educated people in a particular locality can also encourage the local singers and drama producers to introduce concepts of science and technology in their programmes. For the appeal is not only to the emotions but also to the intelligence of the people. Instead of the usual table and chair, or the flower pot on the stage, laboratory experimental equipment, or biological specimens, or micro computers could form the decor. And the theme could be the village budding scientists finding a cure for dyspepsia or meningitis. Instead of the lamentations of love loss in a local song, one could have the eulogy of scientist who has made a better bread, or produced a better seed. The folklore could relate the story of the village school boy who went to the university and invented the machine that could do the work of hundred hands. Thus songs, folklore and plays can contribute to the development of a scientific and technological culture in the people. There is no dearth of new ideas and approaches.

Dress and behaviour

The scientists and technologists who have been educated in urban areas tend to adopt western life styles and outlook, and automatically alienate themselves from the vast rural masses who still follow traditional customs. When such people try to educate the others around them, specially in the rural areas, there is either an aura of distant admiration for them, or mistrust for exogenous elements. Their dress and behaviour have to be in tune with those of the local folk so that they can find a place in the hearts of the people. Creating a sense of mutual trust is essential, and the dress, the behaviour, the language and the expression, all contribute to the effectiveness of imparting a particular education to the local folks. For a farmer to adopt a particular technique in his field, the extension worker must come down to his level and dip his hands in the soil, and speak the dialect of the man. The colonizers of yore transferred very little scientific knowledge to the people, for they could never integrate into their culture. We have to stoop in order to conquer. And the conquest here is the imparting of a scientific and technological culture to people who have for millennia followed a traditional culture which has kept them at subsistence levels.

Food habits

Western education has also contributed to changing our food habits. African staple foods are rapidly being displaced by western style foods. In many countries, local production of staple foods has given way to imported cereals, often dumped as food aid. Rice used to be the major food in many parts of Senegal. Now French bread has found its way to the remotest village, and the people are dependent on imported wheat. Though local food had its own value, since science and technology were not used to upgrade their quality, and since vested commercial interests have had the upper hand, the food habits of the people have changed. The things people eat, and the

way they eat them form part of their culture. If we want to impart a scientific culture to these people, it is necessary to bring out the plus points in their food habits, upgrade the technologies where necessary, and make them feel proud of their heritage. In Ethiopia, biotechnology has been practised for millennia in the making of the 'ingera', a local pancake. While the fermentation process is still the same, new cooking stoves and electrical injera making hot plates have been developed, thus upgrading the traditional practices, and not supplementing them by introducing new food habits. When people are taught the scientific basis behind their traditional practice, they develop a sense of self-confidence, and it is then easy to make them assimilate new scientific ideas and technological processes. Throughout Africa, the food habits of the people offer an open field of research whereby one can integrate a scientific and technological culture into the traditional culture. The same reasoning applies for traditional medical practices as well.

Political patronage

For a scientific and technological culture to develop and flourish, political patronage is essential. African leaders have recognized the importance of science and technology as an essential tool for development, by adopting the Lagos Plan of Action 2/, but have, in most cases, paid lip service to the development and application of the same science and technology. The resource allocation for this intersectoral field has been far from the targets expected 3/. Scientific and technological institutions have been created, but have not received the necessary tools to enable them to function properly. National priorities have been very different from what one would have expected in order to meet basic needs. In those countries where science and technology have been integrated into the local culture of the people, the heads of state and government have personally taken up the stewardship of science and technology programmes. This is the case in the newly industrializing countries of the East. Unless science and technology receive the patronage of politicians and policy-makers, their development and application will always trail behind, and any approach for integrating modern science and technology into traditional African culture will be futile. Consequently, development in all its aspects will not be possible, and Africa will remain for centuries, the least developed continent on the globe, even stretching its arms with the begging bowl.

Conclusion

While enthusiastically trying to popularize science and technology into traditional African culture, one has to guard against the negative consequences of a rapid integration. The most obvious is the disruption of families, communities, and the break in the affective bond that has kept the traditional society together for ages. There is need to find an acceptable blend so that the positive elements of African culture can be preserved, while scientific and technological progress are still possible. Some sacrifice is inevitable. But we should not allow ourselves to be led to acculturation which can only destroy our personality and lead to mental imbalance and dependency, while creating slums, overpopulation, deforestation, and hunger. We should guard against the environmental pollution problems which the West is facing, because of overexploitation of natural resources and excessive industrialization. We should guard against the excessive materialism 4/ that has crept in wealthy societies, and where the human spirit lives but for the ego, where fellow-felling is measured in terms of dollars, and where the old and the sick crave for a heart-to-heart greeting from the passer-by. There are values that Africa has to preserve at any cost, and still be able to cope with improving the quality of life of its people through a rational application of science and technology integrated into the traditional culture. Unless conscious and deliberate steps are taken to integrate modern science and technology into traditional African culture, there will be no progress on the African panorama.

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STRATEGIC MANAGEMENT OF INTERNATIONAL TECHNOLOGY TRANSFER: MANAGING THE TECHNOLOGICAL WINDOW

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Contents

1. INTRODUCTION

Confronted with a new set of economic and financial constraints and an emerging new global system of technology transfer, African countries are in the process of readjusting their technology transfer policies. This paper offers some elements of discussion for this readjustment.

The first part outlines the role and the structure of the system of technology transfer, the main actors, the relationships between them and the policies that are put into place to regulate technology transfer from technologically advanced countries to developing countries with particular reference to Africa. The second part deals with the new context of technology transfer and its consequences for African countries.

In the third part, a more discriminating transfer policy is advocated, which is more open to industrial and agricultural technologies and more closed to consumer technologies. In the fourth part we examine the necessity and the ways to reduce non-monetary constraints to technology transfer. The fifth part focuses technology transfer policies for achieving strategic outcomes while the control of less restrictive industrial, mining and agricultural transfer policies is dealt with in the sixth part.

2. THE GLOBAL SYSTEM OF TECHNOLOGY TRANSFER

In order to be able to design meaningful technology transfer policies developing countries must have a clear perception of the functioning of the global system of technology transfer. In this respect it might be useful to share a common understanding of what is being transferred in a process of technology transfer, who are the main actors of the transfer system, what kind of relationships the actors have between themselves, what are the regulation mechanisms, how the system is evolving, etc. In this section an attempt is made to characterize, in an

oversimplified and inevitably mutilating way, its components, structure and dynamic.

2.1 Strategic Role of Technology Transfer

Technology transfer has played not only an important but a predominant role in the prosperity of nations throughout history. The most productive and innovative economy in the world today, the USA, is at the same time the largest importer of technology embodied in products through the mechanism of trade, the largest acquirer of industrial and manufacturing technology embodied in plants through the mechanism of foreign direct investments, and by far the largest brain drainer.

Japan is also very successful in technology transfer through copying, imitating, replicating, and improving on the transferred technology. This has been particularly so after world war II but also from the first contacts with the Europeans in the 17th century where the Japanese have been very good in copying foreign technology, including the portuguese cross-bow that helped Japan to dominate militarily the subregion for centuries.

The Europeans have also greatly benefitted from technology transfer. From China, for instance, they brought back cannon powder and compass technologies that helped them to dominate the seas and the world for four centuries.

Looking back at history and the world of today, technology transfer may be singled out as the most important contributing factor explaining the success of nations.

2.2 The Object of Technology Transfer

Technology transfer usually means that a particular technology, tangible or intangible, protected or unprotected, packaged or unpackaged, is identified, negotiated, acquired and transported from one place (a country, sector, research center ...) and adapted, absorbed, assimilated, internalized, installed and applied to another place. In the process of transfer many things can be "transported" from one place to the other: technical information, knowledge, trained personnel, management techniques, consumption patterns, values, forms of production organization, industrial culture, rights (trade marks, patents, franchise, designs, ...), financial capital, facilities, machineries, equipment, spares, guarantees, etc. The counterpart flows may include lump sums, fees, royalties, dividends, profits, interests, scholarships, subscriptions, and since transfer is a two-way learning process, it may also include knowledge, information, experience.

In Africa a lot of equipment and products with a high technological content, such as airplanes, cars, trucks, buses, radios, telephones, tv sets, cameras, watches, construction machineries, medical equipments, computers, military hardware, etc., have been and continue to be transferred. But industrial and agricultural technology transfer is occurring at a much slower pace. It is this type of technology transfer that must now get the priority.

The objectives of technology transfer pursued by the acquiring and supplying parties do not usually coincide. The acquiring party frequently seek modern technologies and modern management techniques to sustain export and earn foreign currencies while the supplying party may seek market penetration and a flow of real profits in hard currencies. So it is not uncommon to see a transfer process evolves along various phases that include romance, enthusiasm, hope, misunderstanding, disenchantment, nitty-gritty business.

2.3 Main Technological Actors

The main actors of the system include the governments of the most industrialized countries and the technological corporate leaders within these countries (the top 500 multinationals as regard to their investment in R & D and their technological assets). Most new or advanced technologies are developed within technologically advanced countries and technological development is, globally, equally funded by the governments and the private corporations (about 1.5% of GNP each). The other actors of the system are the governments, the public or private enterprises and the consumers.

2.4 Technological Relations

Between technologically advanced countries and developing African countries technological relations are very:

unequal, hierarchical, asymmetrical, conflicting and divisive

The antagonistic character of these relations is exemplified by the divergence of opinions and interests on trade issues (particularly those related to investment measures and intellectual property) in the current Uruguay Round of negotiation. Technological complementarities are important for both technologically advanced countries and developing Africa. The former

group needs larger markets for its technological products in order to grow and the latter group needs the technology for its development and to be competitive, to be able to export and earn hard currencies. Technological competition is very disadvantageous for developing African countries that are faced with a much weaker base and much fewer resources to leapfrog and catch up in order to be able to compete on an equal footing with the most advanced countries.

Within technologically advanced countries, the technological relations are:

-complementary (alliances, cooperation, partnerships, associations, mergers, common negotiating positions, ...)

-competitive (innovation, differentiation, conflicts, rivalry, antagonism, lawsuits, hostile takeovers, ...)

Examples of technological complementarities between competitors are found every day -the latest striking one being the agreement between archrivals IBM and Apple to develop common standards and joint products that will shape the computer industry in the years to come. Examples of bitter antagonism are also frequent, particularly between former partners, between innovators and imitators and between competitors for large procurement contracts.

Within developing countries of Africa technological complementarities are ratherweak and only partially exploited. Technological competition and antagonism are also weak but growing, particularly in their attempt to attract and acquire foreign technologies on the best possible terms. Technological complementarities between developing Africa and other developing countries are not fully exploited. Developing Africa also has fruitful cooperation relations with the international organizations dealing with technology transfer (ECA, FAO, UNIDO, UNESCO, WIPO, UNCTAD, ILO, ...), NGOs and bilateral development agencies.

2.5 Technological Transfer Regulation

The technological transfer system is essentially regulated by three mechanisms:

A. government policies;

B. business practices.

C. consumer behaviours

These policies, practices and behaviours differ substantially according to the positions of the countries in the transfer system, that is whether the countries are mainly transferrer or transferee.

2.5.1 Transfer Regulation by the Transferrer

The most technologically advanced countries develop and market most new technologies and they undoubtedly exert tremendous influence on the evolution of the transfer system in order to get the most benefits from their investments in R & D and their advantageous positions.

Governments and multinational corporations of technologically advanced countries are presently pursuing mainly six types of policies to regulate the transfer of technologies between them and developing countries:

(a)Strong support for the production of new technologies by the governments and heavy investments by the large corporations. These policies keep technologically advanced countries permanently in a position of transferrer.

(b)More protective intellectual property rights (IPR) policies to keep the property of the technologies firmly within controls. The present effort of technologically advanced countries, particularly the USA, which is losing $40 billion each year according to The International Trade Commission through pilfering by foreign companies, to move intellectual property rights issues from national frameworks to a multilateral framework (GATT), to uniformize IPR, to establish common minimum standards, to set up enforcement and dispute settlement mechanisms, may have extensive consequences on the transfer of technologies to developing countries21.

(c)More liberal trade policies to expand markets for the corporate technological leaders and sustain their growth. These policies have important impacts on the transfer of technologies since they imply that developing countries will open their domestic markets to technologies embodied in products.

(d)More restrictive transfer policies of strategic technologies for security, economic stability and prosperity reasons. These policies will particularly affect developing countries with some military ambitions or that

support "terrorist" activities and the NICs, particularly in the semiconductor industry where they have become strong competitors on the international scene.

(e)freezing technical cooperation effort with developing countries to their present level. This trend has already started and is motivated partly by budgets constraints of many industrialized countries, particularly the USA, Canada and Italy.

(f)Restrictive business practices from the technological corporate leaders which erect entry barriers to possible new entrants: scale barriers, financial barriers, market barriers, information barriers, technology barriers (such as the shortening of the new product life cycle), etc.. These practices are receiving some government policy support (such as the relaxation of antimonopoly laws making it much harder for new entrants to compete). These policies are not directed against developing countries but designed to check possible new competitors, wherever they come from.

2.5.2 Transfer Regulation by the Transferee

Developing countries of Africa are regulating the transfer of technologies by practising essentially five types of policies:

(a) General technological capacity building through education, training, research, sending of students in foreign universities, etc., in order to be able to keep up with technological innovation and be able to assimilate foreign technologies.

(b) Institutional and policy making capabilities building, including selection, assessment and negotiation capabilities, intellectual property protection, standards formulation, information system, etc.

(c) The relaxing of foreign investments laws and codes, the establishment of foreign technologies control bodies and registries.

(d) Structural economic reforms, including monetary, to facilitate trade and the integration of national economies into the global economic system.

(e) Increased cooperation with the industrialized countries, NGOs and regional and international organizations.

3. THE NEW CONTEXT OF TECHNOLOGY TRANSFER

In the '80s, the flows of foreign direct investment (FDI), licensing and trade have diminished in many developing countries, particularly in Africa where they have dwindled considerably. Bad transfer experiences, political instability, difficult economic climates and high indebtedness, have contributed to the diminishing inflows of technologies, although some countries like Egypt, Mauritius and Botswana, have managed to keep a good level of foreign capital and technologies acquisition. Recently Nigeria, Ghana, Zimbabwe, Zambia and others have become more successful in attracting foreign capital and technologies.

The flow of technologies has also been curtailed for reasons proper to the strategies adopted by the technological corporate leaders and the international economic context. The USA, for instance, -the largest producer of new technologies- has become the world largest debtor and the most favoured country for foreign businesses while the NICs have been preferred to developing countries for investments, licensing and trade, particularly for intermediate and high technology, such as electronics, semiconductors and computers technologies. China and India, with their huge internal integrated markets, are also attracting more foreign technology than the fragmented and unstable African continent.

In the '90s, the policies of technologically advanced countries outlined above, the greater attraction of some East European countries and the continued success of some NICs will make it more difficult for African countries to reverse the declining trend of foreign technologies transfer. However, the greater capacity of the African countries to acquire and assimilate commercial and non-commercial technologies, the improvement of the economic and political environments, and their greater opening to the outside world are positive factors that should not be minimized.

Perhaps the greatest constraint and natural barrier to technology transfer is the widening technology gap itself between technologically advanced countries and African developing countries. Many high technologies have or will become simply impossible to transfer because of the inadequacy or inappropriateness of the

environments to receive them.

Proprietary and strategic technologies will probably become more a "chasse-gardé" of the technologically advanced countries and the evolution of the global technology transfer system could become even more asymmetric. This evolution should perpetuate and even strengthen the inequalities and the extreme dependence of African developing countries towards technologically advanced countries.

African developing countries will still have access to a growing pool of non-proprietary technologies, free or only at a fraction of the actual cost of development. Over two million scientific and technical papers are published every year and this scientific knowledge and technical know-how, financed mostly by technologically advanced countries, is readily available for consultation and assimilation although only a small percentage may be relevant to developing countries' problems. The sheer size of this new knowledge and know-how raises additional difficulties to developing countries that must look harder to find and treat useful information. More technical information and know-how will also be available through international development organizations and NGOs. As regard to new technologies embodied in products they should be available at a reduced cost if developing countries open their markets while mature technologies could be more accessible. Although most developing countries of Africa are condemned to lag far behind they can benefit tremendously from the strengthened technological world innovation system.

Some criticism is presently addressed to the USA as the chief advocate of the policies referred to above. Some of these criticisms may be misplaced. The policies are not directed against developing countries. They mainly stem from very important structural imbalances in the USA economy that if not corrected will jeopardize the world economy in the long term, making every body worse off, and from an erosion of its technological leadership in many industrial sectors due to technological imitation or replication of USA innovations. The USA has been the leader in promoting Europe and Japan after the second world war, in supporting all the NICs and in helping developing countries, particularly in the '80s, by borrowing money and buying 70% of all their exports.

Although the situation is disadvantageous, African developing countries can still benefit tremendously from the technological innovations originating from the most advanced countries. Excessive pessimism, negativism and defeatism do not seem to be justified.

4. A MORE OPEN AND SUSTAINABLE TECHNOLOGY TRANSFER POLICY

The contribution of African countries to the world technology pool is less than 2%. In this context, African countries have no choice but to develop close interrelations with the main producers of new technologies. This appears as a necessity since some of these technologies are needed to foster productivity, quality, competitivity and growth and since developing and testing new technologies is a costly process often beyond the means of developing Africa. In most cases it is more advantageous to acquire a well proven technology if it already exists than to develop it.

The main thrust of most S & T policies in Africa has been to build research and institutional capacities without sufficient regard to achieving specific strategic outcomes. Building a research capacity per se without direction and focus and without links with the industrial sector and the external sector and without the necessary accompanying conditions for success produces little results. These policies have contributed among other things to internal brain-drain, i.e. research orientations aiming at producing results in a paper form published for the international community, and eventually to external brain-drain (reverse transfer of technology).

Even if more resources would have been spent on research in Africa in the last thirty years the results would have been pretty much the same. Experiences outside Africa suggest that even with sufficient resources, research can have little impact on the standard of living and quality of life of the population if the wrong objectives are pursued, if technology transfer is viewed as secondary and if the accompanying conditions are not met. The former Soviet Union, China and India, for instance, have built impressive S & T apparatus and capacities with ratio of S & T expenditures relative to GDP or to IGDP comparable or superior to those of the most advanced countries. But these greater S & T efforts have produced little socio-economic results so far: China and India are still among the poorest countries in the world while the former Soviet Union is unable to satisfy the basic needs of its people. In these three countries future prospects look better since their economic policies are being changed towards a greater opening to and a greater participation in the world economy.

It must be noted that the huge internal markets enjoyed by large developing countries are definite but not sufficient advantages to socio-economic development and that these advantages are not present in the frag-

mented African market. Isolationism is not conducive to development.

The much quoted success of some Asian countries, particularly the four Dragons, should provide some insights into strategic S & T management. These countries have practised market-oriented, outward-looking strategies and have built S & T strategic competitive global advantages based on intensive technology transfer, assimilation and emulation coupled with sound long-term sustainable overall economic policies and hard work.

Sustainability is a very important characteristic of any good technology transfer policy. Many policies put forward by African countries since independence could not be sustained. In the '60s, for instance, high wages policies in the public sector relative to the level of economic prosperity, have contributed to the import of consumer goods rather than the import of industrial technologies. Policies to maintain higher commodity prices than what the market was dictating have had adverse effects by stimulating higher production, pushing down prices, displacing location of production, and in many instances, through the agency of technology, triggering substitution. This contributed to the collapse of prices and of production. Policies to artificially maintain higher prices of currencies also have had adverse effects in favouring imports of consumer goods, discouraging exports, inviting black marketeering and, as a result, increased the difficulties in the balance of payments that constrained the import of needed technologies. Policies to keep down prices on the domestic front, particularly in the agricultural sector, led to under-production, under-investment, including in technology, food scarcities and increased external dependence. Research-push S & T policies, disconnected from the productive and the external sectors led to a further erosion of appreciable resources while the failure of many technology transfer projects, partly due to overestimated indigenous capacities, undue political interference in the economic decision process and a distorted system of resources allocation compounded the crisis to make it worse.

At the beginning of the '90s, the high indebtedness of most African countries constitutes an important constraint to technology transfer. So African countries must continue to press for a substantial reduction or cancellation of their debts. This financial constraint means that in many cases borrowing money to acquire foreign technologies is no longer an option, and alternative methods of transfer must be sought.

A greater utilization of non-proprietary, non-commercial technologies can be achieved by a better use of non-classified published technical data, books and expired patents, by professional visits of experts, engineers, scientists, businesspeople and managers, by attendance of international seminars and symposia, by participation in fairs and exhibitions, by technological intelligence work, by sending professionals abroad to further their training, etc.. These methods should be accentuated.

5. REDUCING NON-MONETARY CONSTRAINTS TO TECHNOLOGICAL TRANSFER

Fortunately, a lot of progress has been made by African countries in capacity building and in economic reforms. More can be done to remove other constraints that impede technological transfer and assimilation.

5.1 Cultural constraints

There are intangible aspects rooted in religious beliefs, norms, ideologies, attitudes, life styles, values, which exert negative or positive influences on technological changes22. In general technological advancement is both destructive or disruptive, and constructive. It destroys ways of life that are incompatible with advanced industrial cultures and myths that are inconsistent with scientific rationalism. It commands stable, open and efficient social organizations. Therefore a development strategy cannot be achieved only with the management of physical, material or monetary assets. It must also include a good deal of social and cultural engineering. The most important assets are the human resources and development policies, including S & T policies, must aim at enhancing these resources and fostering the potential of creativity and entrepreneurship that are necessary to launch a process of technological accumulation and economic growth. In this respect high rates of demographic growth are not conducive to technological accumulation.

5.2 Political constraints

As noted above African countries are making a lot of progress to make their economic system more compatible with those of the technologically advanced countries. But S & T policies may fail if other political constraints are not reduced or removed. In this respect Africans themselves are realizing that political reforms are imperative if their countries are to make significant

progress. A sound and stable political system is supportive of S & T policies. The African Leadership Forum, for instance, a think-tank group of high ranking African leaders, has come up with a very penetrating diagnosis of the African crisis and has advocated bold and broad policy measures to set Africa on a solid development path. The Forum, among other things, arrived at the conclusion that socio-economic progress cannot be accelerated without sweeping political changes including full democracy, respect for human rights, freedom of the press, of speech, of association, independence of the judiciary system, security, a market economy, continental economic integration and cooperation23. These are necessary accompanying measures that could make science and technology play its full role in development.

5.3 Legal constraints

Because of ideologies, past policies or bad experiences, many African countries have legally ruled out possible sources of financing and possible channels and mechanisms of transfer. Although there has been improvement in the attitudes and the national laws governing technology transfer, African countries in general are still on the defensive and inhibited towards foreign acquisition of technology. They should move on the offensive to take advantage of the tremendous opportunities that the world technology pool has to offer.

Many countries, for instance, do not facilitate foreign direct investment although it may be the only way to get the technology either for reasons proper to the vendor's strategy or reasons proper to the receiving country (no resources for instance). Some countries allow joint-ventures but only to the extent that foreign participation be in minority24. Since these countries have little money to fund their shares and little borrowing power, the result is that there are very few joint-ventures and that these joint-ventures are limited to some sectors and to small projects.

Some countries have put arbitrary across-the-board maximum percentage to be paid under the form of fees or royalties. This may help, in some cases, the negotiating position of the acquiring party, but it may also prevent the acquiring party from getting a badly needed technology that is worth paying the price for. In some instances it may also help the selling party to charge fees or royalties well below the arbitrary maximum but still above what it is worth. Clearly a case by case analysis seems to be more appropriate for it is not the cost of the technology that matters. It is its capacity to generate some future streams of economic gains, including foreign currencies. A low cost technology may sometimes generate economic losses while a high cost technology may generate profits. Fixing rigid legal arbitrary limits on costs makes no economic sense. In the same way fixing legal arbitrary limits on the repatriation of dividends may be more costly in some instances than beneficial.

Similarly, across-the-board legal rules for selecting the right vendor in a technology acquisition process, for instance the obligation to select the lowest bidder, may not lead to the best choice for many other considerations must be taken into account, including the experience of the bidder in developing countries and the guarantees that he can give.

Some countries may go too far in legally forbidding some restrictive measures in technology transfer agreements, such as restrictions on the use of the technology, the markets to be exploited by the technology, the supply of inputs, the prices of the products, etc. Fixing performance criteria or arbitrary rules for unpackaging the technology does not change the reality of the acquiring country. On that point it is worth underlying that countries that decry turn-key projects because of bad experiences should logically experience higher difficulties in managing more complex unpackaged forms of technology transfer. Local content should be made as high as possible and progressively increased as the country acquires more capacity but fancifully overstretching a single component may be very dangerous to the viability of the whole project.

Some countries also rule out by law some reconditioned, second-hand industrial technologies for fear of dumping by the technologically advanced countries. Again this can only constrain the flow of appropriate technologies for a well-proven reconditioned technology may not be as good as a brand new capital intensive technology that cannot be afforded but may be a lot better than no technology at all. The successful textile and garment industry in Mauritius for instance, rely heavily on this type of technology.

Some countries go as far as controlling the inflow of such obviously useful, ready-to-use, off-the-shelf, inoffensive technologies as micro-computers. The buyers must apply for a permit, justify its use and go through long delays. If a part needs to be replaced or an add-on or an up-grade needs to be acquired, the buyer must prove that these products are really needed and go again through an unnecessary, counterproductive, irritating and discouraging procedure. Such measures inhibit entrepreneurial initiative and technological dynamism.

Flexible guidelines and negotiation seem to be more appropriate than rigid legal instruments to regulate the flow of technology transfer. The bottom line is that both parties must find their profit.

In addition many administrative controls, not designed as restrictive, protective or limitative measures, impede and hinder the import of essential technologies. In many African countries customs clearance entails going through a long bureaucratic process. In a country of Central Africa, for instance, a study has reported that as many as forty steps were required to clear goods, including foreign exchange regulations. In some countries getting a passport and an exit visa is also very difficult and can only be obtained, in some countries, through bribing. These regulations and practices restrict technology transfer and constrain technological change.

6. FOCUSING TRANSFER POLICIES ON ACHIEVING STRATEGIC OUTCOMES

As noted above, African countries have made substantial progress in endogenous capacity building (education, training, research, institution, legal framework, etc.). The new global context of technology transfer may however warrant a revision in some of the policies that need to be better articulated to the productive and the external sectors. This is particularly so in the francophone countries where S & T are viewed as an outgrowth or an extension of education and where S & T issues are mostly dealt with by the ministry of higher education. In these countries policy revision may include ministerial reorganization.

Technology policies should not simply be focused on the building of a general endogenous research and institutional capacity coupled with restrictive measures towards external inflows of technology. It should be focused on building global competitive advantages in order to gain foreign hard currencies that are needed to import the technology required to increase productivity and quality that will sustain exports25. The external sector is the weakest sector in most African countries and technology transfer policies should aim at strengthening this sector.

The choice of technology needed to build strategic competitive advantages should be based on what can be and should be developed locally and what can be imported given the specific context of the country. Here the issue of 'appropriate product' is a precondition for the choice of appropriate technology. Consumption patterns similar to those of developed countries should be discouraged.

Comparative advantages are more and more human made and less and less given by nature. This has important policy implications. It means that a country cannot rely any more on its physical endowment of natural resources and its cheap labour for its development. It means also that the competitive advantages must be built not only at the micro-level but also at the macro-level. In other words, the product must be competitive and also the monetary system, the banking system, the judiciary system, the transport system, etc.

Competitive advantages cannot be achieved with scattered and remote research efforts without ever reaching any significant masses of competence in a specific sector or sub-sector. Science and technology is not something to be mastered as such and as much as possible. It is, in any case, an impossible task to keep abreast of each and every S & T development. It is rather something to draw specific benefits from and in that sense the allocation of S & T resources must obey the laws of sound financial investments made in a very complex and dynamic international environment. Decisions should be made on those projects with the greatest expectations of economic return. In some African countries S & T policies as actually practised are a far cry from this point of view and this is one of the causes for the improductivity of S & T resources.

7. THE CONTROL OF TECHNOLOGY TRANSFER

The irony of over-restrictive technology transfer policies is that even if African countries would relax restrictions overnight, foreign investors would probably not rush like vultures into Africa as some policy-makers seem to think. Tangible incentives may be needed to make the environment competitive with other countries in the world.

Relaxing restrictions and offering incentives do not mean that foreign technologies would be imported indiscriminately. On the contrary, technology inflows and endogenous technology development must be guided by careful analysis of the actual capacities and resources available and of the missing capacities that have to be supplemented from outside26. A greater opening to and participation in the world technology pool does not mean a greater dependency towards the outside world. On the contrary, the closed economies particularly the small ones, have put themselves in situations of extreme

dependence while the more open, interdependent economies are more secure and more able to influence policies and events to their advantages. Less restrictive technology transfer policies do not mean either being passive and letting outside forces define national development. It means being very active and fully in control with a clear sense of direction.

Less restrictive technology transfer policies is not an easy course to follow. It is probably a more arduous one to practice but is one in line with the fundamental international dynamics of technological innovation. Science and technology know no frontier and whether we like it or not, an innovation in one part of the world affects directly or indirectly the well-being of people everywhere. The competitivity of African commodities, for instance, is affected by development occurring within technologically advanced countries.

So nobody is immune to technological progress and over-protective transfer policies only lead to technological stagnation and its associated problems. A country can switch away from import of consumer goods that can be produced locally even at a sub-standard quality and slightly higher production cost and it can be more restrictive toward luxury goods but it can be very dangerous to be over-restrictive with the import of needed industrial, mining and agricultural technologies. Opening and closure under various forms should be set accordingly. In practice, more liberal productive technology transfer policies and more protective consumer goods import policies are not mutually exclusive but complementary.

Less restrictive technology transfer policies do not imply that the individual economic agents would make the decision alone for the government has an active role to play in the decision making process. Foreign acquisition of technologies must be analyzed in their techno-economic context, taking into account all negative and positive externalities, including the balance-of-payment, employment generation, income distribution and the environment.

8. SUMMARY AND CONCLUSION

The new global system of technology transfer and the new international context that are emerging will have profound impacts on North-South flows of technology in the years to come. Proprietary and strategic technologies will be more protected and more restricted. Technology embodied in products will be more accessible as trade gets freer. Non-proprietary technologies will be more abundant but probably less relevant to developing countries as the technology gap gets wider. Severe economic and financial problems experienced by many African countries will continue to curb commercial technology acquisition while political instability and cultural blockages will also contribute to constrain technology inflow to a low level. Technology transfer will increasingly be supported by advances in telecommunication and information technologies. In this context many African countries might want to revise some elements of their technology transfer policies in order to be able to fully benefit from the new avenues of opportunities that are opening up and minimize the threats that weigh upon them.

In addition to being subjected to the pressures of the rapidly changing external environment, particularly in the field of science and technology, African countries are subjected to tremendous internal demographic, political and economic stresses. Under these forces Africa is changing quickly and one must discard the often projected image of stagnation and immobilism. Africa is also a very diverse continent and general analyses and policy guidelines do not do justice to the great varieties of situations encountered in each country. Nonetheless African countries have many things in common and they share many development problems. Hence the importance of fostering cooperation and integration.

Africa is not all gloom and doom. It is a horn of abundance with a considerable development potential. The historical advantage enjoyed by the late-comers can be better exploited provided technology policies are better interfaced with the productive sectors and the external sector.

History clearly shows that inward-looking, over-restrictive technology transfer policies, disconnected from the world economy and also from the basic needs of the population do not lead to true socio-economic development. Technological progress is a global, intensely complementary and competitive phenomenon that evolves in a dense web of interactions of diverse inputs and for which there is no effective immunization. Technological innovation has its own logic that blows away those that are not willing or not able to capture its benefits.

Technological choices are limited by scarce internal financial resources and by a credibility gap from external investors. For many countries the menu of options has narrowed down significantly during the '80s. Hence the importance of keeping all available options unrestricted with unnecessary and cumbersome regulations inherited from past situations and development policies and a foregone international context. More

restrictions should however be put on consumer goods that do not satisfy the most important needs of the population or that can be produced locally.

The challenges of the '90s can best be met by focusing technology policies on the external sector - the most critical sector - and building global competitive advantages that will bring hard currencies necessary to acquire the technologies needed to start a process of technological accumulation and reverse the present gradual impoverishment. Investment climates must be made more competitive and the acquisition of technology should be regulated more by negotiation, on a case by case basis, taking into account all factors of analysis, including the impact on income distribution, employment generation, balance-of-payment and the environment. Hence the need to create a strong governmental unit to monitor and guide technology transfer.

Deliberate or de facto isolationist technology policies cannot reverse the diminishing flow of technology into Africa in an increasingly interdependent, productive and competitive technology-driven world economy. These policies can lead to a dangerous delinking from the scientific and technological locomotives that will continue to shape the international pattern of growth for a long time to come and also hamper cooperation with other developing countries that have appropriate know-how, technology and markets to share. Hence the crucial importance of managing the 'technological window' with openness in order to capture the immense opportunities that the world has to offer and prevent the technology gap from growing larger and larger. It can be done with the right policies. Policies matter.

9. RECOMMENDATIONS

A national conference on technology transfer policy should be organized in each country to look into the following and take appropriate measures:

1- First, in view of the new African context characterized, among other, by diminished flows of commercial loans and technology and difficult economic climates, and in view of the emergence of a new global system of technology transfer and new competitors on the international scene, there is a need for a **revision or an adaptation of some elements of technology transfer policies** in many African countries.

2- Second, there is a need to design a policy instrument, to be approved by the highest governmental authorities, taking the form of a **clear policy statement on technology transfer**, specifying the objectives pursued, the guiding principles, the role of various public institutions, the role of market mechanisms, the role of foreign investments, promotional activities, priority sectors, etc.

3- Third, there is a need to design competitive **laws**, - including protection of property rights and foreign investments - and competitive **regulations and guidelines** to guide the transfer of environmentally sound, culturally compatible, socially beneficial, economically profitable and sustainable technologies. This can be implemented with the support of joint advisory services by ECA and UNCTAD.

4- Fourth, there is a need to **reduce cultural and political constraints** to technology transfer and development, and to promote values of openness, self reliance, initiative, entrepreneurship, freedom, stability.

5- Fifth, there is a need to continue **structural economic reforms** so that African economies can better exploit technological complementarities among themselves, participate more in the global economy and benefit more from the world technology pool.

6- Sixth, there is a need to create a strong **Governmental Unit** to manage and monitor a more discriminating technology transfer policy in the direction of the national objectives and advise the government on issues of technology transfer.

7- Seventh, at **subregional level** there is a need to evolve a **concerted and harmonized technology transfer policy** to make optimal use of resources and enhance a common stand when negotiating foreign acquisition of technology.

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PRINCIPLES AND METHODS OF PLANNING IN SCIENCE AND TECHNOLOGY

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TABLE OF CONTENTS

INTRODUCTION

The objectives of the present paper is to make the synthesis and adaptation of some works on the current issue and to show the importance of Science and Technology Planning.

To do so, after having drawn from the conceptual and methodological treasure of the well-informed authors on the issue, I mainly tried to state in some twenty pages what required whole books to have the great cultural wisdom of these authors shares.

Shortcomings? Indeed, the paper has, this is due largely to my difficulty of choice intaking and adaptative arrangement of relevant and voluptuous notes of the above-mentioned wisdom. In brief, the bibliographical references speak for themselves.

Presented in two major sections A and B, the paper tries in Section A, to reply to the question: what is the Science and Technology Plan? Its characteristics and outlines. This leads me to speak descriptively of the objectives, the human, material and financial resources of the Plan to end with the typology of the STAs and properly speaking outlines and objectives of the planning. It should be noted in passing that each type of STA may be the subject of a full programming and consequently, the global S-T plan will devolve upon all the programmes designed and drawn up at the level of each type of activities considered.

In turn, the second major section B tries to reply to the question which Planning Methodology is necessary? This leads to tackling the objectives and bases of S-T planning before a theoretical application in Guinea. From the reply to the question, it emerges that the social function of Planning is to replace all forms of anarchy, a conscious and organised action and that the economic objectives command the orientation and choice of priority S-T objectives. On the other hand, the preparation of the S-T plan requires that the prior technical conditions, such as the S-T statistical data collection, the inventory of STP and S-T situation studies, be met.

Furthermore, S-T Planning in Guinea would be based on reciprocal commitments between State-Prefectures and State-Enterprises that is on the contractual planning.

The implementation of these commitments would be effected in five stages in which the Supreme Council for Scientific Research (SCSR) would play the interface role between the principal actors.

Finally, annexes on the major S-T indicators and on corresponding statistics models complete this paper.

1.1 What is the Science - Technology Plan?

The S-T plan is the systematic and coherent statement of the short, medium and long term objectives

and the human, material and financial resources to be used to attain them.

A.1 Characteristics of the S-T Plan

1. The objectives: They must be stated precisely and concisely. In addition, they must meet the national development needs or the specific needs of one or several branches of the socio-economic and cultural activities of the country. Consequently, the objectives must be attainable, assessable and controllable.

2. The Human Resources: It is all the actors intervening explicitly in the implementation of the S-T plan.

Among the explicit actors, one can note the scientists and engineers, technicians and support staff who act directly in the attainment of the objectives of the S-T plan.

The S-T personnel usually groups the local and foreign staff working in national or foreign S-T institutions. It is, therefore, to know the composition, structure and level of qualification and the time for action for each category of S-T staff working on the objectives of the Plan.

The implicit actors of the S-T plan forming the fabric of the socio-economic and organisational relations within which the plan is implemented and which is, therefore, a critical factor which planning must not underestimate. This fabric comprises particularly the staff of the production units, state organisations and social programmes which are the possible users of the results of the Plan and the levels at which resources are allotted, develop the sensitization and correct the shortcomings of the market.

3. The Material Resources: This expression covers both the natural and anthropogenous products available or possible, internal or external and the local scientific and technological infrastructure. The equipment and information support and the scientific and technological documentation are also included in this expression. The qualitative and quantitative inventories of these products, equipment and supports, constitute an indispensable tool for planning.

4. The Financial Resources: The monetary expression of human and material resources makes it possible to know the volume and structure of the investments of the S-T Plan. The latter are usually composed of the state subventions, bilateral and international aids and through the loans granted by the financial firms. The mobilisation of financial resources under the S-T plan must be initiated from the first outline of the latter to avoid all hindrances at the time of its implementation.

A.2 Outlines of the Global S-T Plan

The global S-T planning encompasses the main levels of the following S-T activities:

-level of scientific and technological research;

-level of scientific and technological education and training generally of tertiary level;

-level of scientific and technological services.

1. Level of Scientific and Technological Research: The following principal scientific and technological activities correspond to this level and the major characteristics are: the presence of an element of creativity or innovation; the use of scientific methods, and the production of new knowledge.

1.1 Experimental Research and Development (R-D) Activities in Exact and Natural Sciences, Engineering and Technology, Biomedical and Pharmaceutical Science, Agricultural and Veterinary Science: In general the experimental Research and Development activities in the above-mentioned fields tend to determine the links and essence of natural elements and phenomena, establish the laws governing them and facilitate the utilisation for practical purposes the laws, forces and bodies existing in nature as well as produce new materials, products and mechanisms or establish new systems, procedures and services and improve substantially those already produced or established.

1.2 R-D Activities in Social Science and Humanities: These activities aim at increasing or improving knowledge about man, culture and society including the application of this knowledge to the solution to social and human problems.

2. Level of Scientific and Technological Education and Training Generally of Tertiary level: These are the activities mentioned below which correspond, in general, to levels 5, 6 and 7 of the Model International classification of Education (CITE).

2.1 Specialised Education and Training of Non-University Advanced level: It is the very type of education and training required to acquire the qualifications demanded for high level technicians working in R-D, the scientific and technological services (STS) and the

different sectors of the national economy using modern technology.

2.2 Higher Education and Training lead to a University Degree: It is considered that this type of education gives access to a career in all the scientific and technological fields. The graduates at this level are called: «Scientists and Engineers» (SE).

2.3 Post-University Training and Further Training: This type of education concerns the scientists and engineers who are given special courses in R-D Centres attached to a Science academy or to various ministries dealing with specific branches of the economy. This training based on special programmes lead to the award of «Ph.D type» degree. The preparation of a thesis consists in effect of personal research work on the basis of a specific R-D project.

3. Level of Scientific and Technological Services (STS): S-T planning at this level concerns the activities linked to R-D and contributing to the production, dissemination and application of scientific and technological knowledge. The STS activities distinguish themselves from those of R-D by the fact that they do not have the character of innovation. The STS comprise:

3.1 The S-T services provided by the libraries, archives, information and documentation Centres, the popularisation services, the scientific Congress Centres, the data banks and processing centres;

3.2 The S-T services of museums of Science and/or technology, botanical gardens and zoos as well as other S-T collections (anthropological, archaeological, geological, etc..)

3.3 The systematic translation and edition of S-T books and periodicals except school and University manuals;

3.4 The topographical, geological and hydrological surveys;

The meteorological and seismological observations, the inventories of soils, plants, fish and savage fauna; the regular tests of soils, air, water; the systematic control and monitoring of the level of radioactivity.

3.5 Prospection and related activities with the aim of localising and the termination of oil and mineral resources.

3.6 Data collection on human, social, economic and cultural phenomena generally so as to collect current statistics as, for example, the population censuses, the production, distribution and consumption statistics, the market studies, the social, cultural statistics, etc....

3.7 The tests, standardisation, metrology and quality control, current and regular work of analysis, control and test of materials, products mechanisms and procedures according to tested methods as well as the establishment and maintenance of standards and legal units of measure.

3.8 The current and regular work aimed at advising the customers, other services of an organisation or the independent users in order to help them apply scientific, technological and management knowledge.

3.9 The activities related to the patents and licences

To these different types of STS activity should be added:

-the activities of preparation and evaluation of national development programmes and plans or strengthening of scientific and technological capacities as well as activities relating to the social and human sensitization and mobilisation in favour of the adaptation and implementation of these programmes and plans;

-the organisation activities of establishing reception structures of national programmes and plans.

B. WHICH PLANNING METHODOLOGY IS NECESSARY?

In general, in economics, distinction should be made between two planning methods: guided and indicative. The first is based on the public and social ownership of the major means of production and is applied imperatively to all economic agents of the nation. While the second one, that is indicative planning, is based on the market economy in which case the plan is the reconciliation ground between the public and private interest. Its achievement is accompanied by incentives linked to market mechanisms such as tax exemption, preferential tariffs, price credit and public spending policies.

Thus while trying to place itself in the perspective of «indicative» S-T planning, the paper will try to define the social objectives of this planning method, its technical

means such as S-T data collection and S-T inventories and its preparation process. It should be noted that the notion of «methodology» will apply to the clear statement of these objectives, means and process which only the concern about clarity makes it compulsory to deal with them as separate points.

In this approach, particular attention is given to the sense of relation between economic and S-T planning to understand where and when the latter begins.

Finally, it would certainly not be presumptuous to note that as S-T planning is a new branch of the economy the paper has not tried to deal with the properly so called techniques of this planning. It is a complex field in gestation whose blossoming and development will not be one of the least feathers of glory of Science and Technology.

B.1 Objectives and Bases

S-T planning aims at attaining, among others, the following objectives:

-encourage the effective and harmonious development of national S-T activities through the gradual strengthening and widening of the scientific and technological capacities of the country;

-coordinate and assess the implementation of strategic, operational and budgetary programmes related to these activities;

-meet the expectations and needs of national economic agents and rural and urban communities in Science and Technology.

The following consequences issue from these proposals:

(a)The S-T plan has a constraining character: the work of planning does not end with the preparation of the plan just as the latter is not limited to the adaptation of the document. This work continues until the objectives set for the S-T activity have been attained. The differences that occur between the S-T objectives and the achievements are corrected through adjusting measures inspired by the circumstances. This points out that the drawing up of the S-T plan extends until its complete execution.

(b)The social function of the S-T planning of replacing all forms of anarchy, a conscious and organised action. This is only possible in a context where the S-T plan represents the interests of large strata of the population and where the scientists and the technicians participate actively in its preparation and implementation;

(c)The S-T plan is an instrument of orientation, coordination and strengthening of national scientific and technological capacities in the service of development.

1. Economic and Scientific Plan

Considering the fact that Science and Technology integrate or are called upon to integrate into all the sectors of economic, social and cultural activity, from then the need for measure to be able to guide the real weight or potential of this integration in understood. The principle is that the objectives of economic development command the orientations and choice of priority objectives in Science and Technology.

As the short term economic development plan aims at laying the foundation of national development or strengthening the existing one, the S-T plan will not intervene in this case for the simple reason that materials, products and services to be used are known and exist at present either abroad or in the Centres and laboratories of the country itself.

On the other hand, the long term economic development plan should aim at the production of goods and services which do not yet exist in the country, for some of them, which must be totally improved, adapted, designed or created. In this case, the S-T planning could intervene after a first outline of the long term economic plan or at least, after reflection on such a plan.

This reflection will give an indication of the major areas of the national effort in investment, production and export in the next 15 or 20 or more years. The fields of Science and Technology will identify them from the technological priorities, the direction of basic and applied research and those of higher S-T education and training can then be determined.

This means that the S-T programmes on which the R-D efforts of a country will focus should correspond to the types of specific production of the stage which follows immediately the one in which the country is so that this stage can be effectively prepared and it can carry it out in an adequately autonomous manner that is by reconvening for a fraction limited to the foreign industrial initiative. It is in the preparation of this new stage that the S-T plan will intervene.

2. Prior Conditions for the Preparation of the S-T Plan

2.1 Collection of Statistical Data on Science and Technology

The statistics on Science and Technology developed very recently. However, the need for Science statistics has become increasingly obvious and now we are, in general, aware of their two stage, national and international, usefulness.

The need for Science statistical data has become obvious when administrators, planners and those responsible for the scientific policy realised that, in the absence of adequate statistical data, they will not be able to deliberately, take decisions required by the implementation of S-T programmes or evaluate the results of their execution. The allotment of resources demands that complete, exact and reliable data be communicated to those responsible for important decision-making in these fields.

The integration of the scientific and technological development into the economic and social development plans makes indispensable also the quantification of the objectives of the different sectors of the national economy from coherent definitions and classification. To illustrate the foregoing, the major Science and Technology indicators and models of corresponding statistical tables are attached as annex.

2.2 Statistics of Science and Inventory of the National Scientific and Technological Potential (STP)

When the principal characters of the statistics of Science are considered, it is necessary to point out their close links with the broadest and most comprehensive inventories of the STP. These inventories which constitute the concrete data base on which depends the preparation of the S-T Plan, constitute in a collection a periodic updating and processing of a broad spectrum of data on all the resources a country has for its scientific and technological activities. These data may be of administrative, functional, operational, structural or statistical nature; they may be numerical or not and they relate to all the scientific units of the country. These inventories provide an effective means of obtaining, by simple calculation, most of the statistical data at present necessary in the field of Science. Due to the cost and time demanded by the STP inventories, statistical surveys must be carried out annually if the minimum of indispensable quantitative information is to be obtained for the S-T policy and planning.

2.3 Study of the S-T situation

The inventory provides a description and an evaluation of the STP in the recent, past and at present. The cyclical study aims at describing and evaluating this potential but this time in its subsequent development.

If it is well taken, the inventory of the STP reflects real situations, the cyclical study, on the other hand, announces possible or probable situations: by definition, it does not lead, therefore, to any certainty.

The cyclical study is based on the hypothesis of the sense and aptitude of change, the simplest and most current one is the hypothesis of the protraction of trends observed in the past which gives rise to forecast by projection. Other hypotheses are based on theoretical or economic models which are designed to give an account of the internal dynamics of the S-T system.

The results of the cyclical study can in no way be considered as S-T objectives. They constitute, as the inventory of the STP, an element of information for those who must take decisions for the simple reason that S-T cyclical study serves to identify the aspects of the development which can and must be accepted, arrested or accelerated.

The S-T cyclical study may be detached from the general economic and social forecast. That is why there must always be a constant dialogue between the organs of economic and S-T planning such that the global objectives which the nation sets itself take into account the action of all the qualitative and quantitative factors of the development process.

B.2 S-T Planning Process: Theoretical Application to Guinea:

PRINCIPLES: In conformity with the liberal orientation of the Guinean economy, the S-T plan would be of contractual type that is reciprocal commitments aimed at attaining the S-T objectives in the various fields of the STAs (**cf. para. A II relating to the outlines of the global S-T plan**).

The contracts of the plan between the State and Prefectures would be the meeting place for national priorities in Science and Technology and the Prefectoral development priorities accepted in the plans of the pre-

fectures. It will be, under the circumstances, actions by which the prefectures participate in the implementation of the national priority S-T programmes and actions of purely prefectoral interest contributing to the attainment of objectives compatible with those of the national S-T programmes.

As for the contracts of plan between the State and the enterprises, they will be meant for:

-ensuring coherence between the strategies of the enterprises and the technological orientations defined by the State in its industry, energy, transport and communications policy;

-associating the public, semi-public and private sectors with the attainment of the S-T objectives of general interest within the framework of the autonomy of the enterprises;

-making it possible to mobilise the staff of these enterprises for the S-T objectives thus fixed.

2. Role and Place of Institutions

The organisation system to be gradually established from one S-T plan to another aims at reconciling between them two exigencies:

-the exigency of coherence and technical rigour which requires obviously the active participation of planners, teachers-researchers and technicians in the work of national STP assessment, evaluation of existing technical and economic, social and financial constraints and particularly the determination of the most appropriate S-T development pattern to attain, at the least cost, the general S-T objectives.

-the exigency to associate with the preparation of the S-T plan, if not all the S-T organs and services of the country, at least the most representative ones among them, so that the choice of S-T objectives and means to be used to attain them meet the approval and agreement of those who will be called upon to implement the plan and without whom there can be no success.

Thus, it will be accepted that the ODPST, on the basis of national medium and long term economic development programmes and plans, prepare the scientific policy orientations envisageable at the dual horizontal and vertical levels to be submitted to the CSCR for approval and design the mechanism of the plan to be executed: schedule and system of technical commissions.

The Ministries responsible for the different technical sectors ensure the control of all the work relating to the preparation of sectoral reports within the framework of Scientific policy orientations approved by the CSRS and laid down by the government.

The CSRS, as S-T consultation Organisation, would be the venue for the meeting of representatives of trade union and professional Organisation, directors of national S-T institution, heads of industrial, bank and commercial establishments and enterprises, representatives of socio-economic groupings and cooperative movements,representatives of NGOs. The essential thing is to make all the socio-professional categories participate in the preparation of the S-T plan by helping them to be aware of the problems that pose in their respective branches and encouraging them, if necessary, to suggest indispensable reforms.

3. The Procedures

First stage: On the basis of national scientific policy orientations, the S-T institutions will prepare their draft programmes and will submit them, if necessary, to their respective prefectoral development councils for amendments.

Second stage: Each Ministerial Department will centralise the draft programmes of the S-T institutions under its responsibility. After improving these drafts, they will be transmitted to the Ministry in Charge of Scientific Research.

Third stage: The Department of Scientific Research prepares the instruments for submission of programmes thus processed and accepted by the CSRS which evaluates the results of previous and new programmes.

Fourth stage: After the evaluation and adoption of programmes, the CSRS will submit them to the Government to obtain the funds through the Ministry of Planning and Finance.

Fifth stage: The programmes financed will be followed and evaluated by the ODPST, being understood that each S-T institution will be responsible for the man-

agement and execution of the programmes falling within its competence.

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ANNEXES:

1. Principal Statistical Indicators of Higher Education in Guinea.

2. List of Principal Indicators of Science and Technology.

3. UNESCO Standardised S-T Statistical Tables.

4. Manpower of SITA in Guinea employed in S-T activities per juridical-administrative Sector of S-T institutions.

ANNEX I

Principal Statistical Indicators of Higher Education in Guinea

Source: Statistical Directory 1987-1988, Office of Director of Statistics and Planning of Education.

1. Indicators Relating to Students

-Development of student population: Year, Specialisation and Sex;

-Student Population: Age, Level, Option;

-Repeaters Population: Level, Option, Sex;

-Foreign student Population: Country of origin, Level, Sex and Option;

-Repeaters Population: Level, Sex, Option;

-Admission Rate to State examinations: Option and Sex.

2. Indicators relating to the teachers

-Strength of teaching staff: Grade and Specialisation;

-Strength of Extra-mural teaching staff: Grade and Age;

-Strength of Extra-mural teaching staff: Grade and Specialisation;

-Strength of expatriate staff: Grade and Specialisation;

-Strength of Intra-mural and Expatriate teaching staff: Weekly;

-Strength of Intra-mural teaching staff: Grade and Specialisation;

-Strength of Extra-mural teaching Staff: Grade and Age;

-Strength of Extra-mural teaching staff: Grade and Specialisation;

-Strength of Expatriate staff: Grade and Specialisation;

-Strength of Intra-mural and Expatriate teaching staff: Weekly.

3. Other Indicators

-Strength of administrative staff in charge and not in charge of courses: Grade;

-Strength of technical and maintenance staff: Grade.

ANNEX II

List of Principal Indicators of Science and Technology

Source: Statistical Guide on Science and Technology ST84/WS/19 - UNESCO.

1. S-T Staff

-Number of SIT: Sex, Nationality and Profession;

-Number of SI: Field of qualification;

-S-T staff: Executing Sector;

-S and I in PT and TP: Field of qualification, Executing Sector, Field of Activity;

-SIT: Category and Nationality;

-SIT: Sex and Age.

2. Intra-Mural Expenses of STAs

-Total expenses of R-D and STS: Executing Sector;

-Total and Recurrent Expenses of R-D and STS: Executing Sector;

-Detailed Recurrent Capital Expenditure: Executing Sector;

-Recurrent Expenditure, R-D and STS Type: Executing Sector;

-Total Expenses of R-D and STS: Financing Source and Executing Sector.

ANNEX III

UNESCO Standardised S-T Statistical Tables

Source: STS/W/851 pages 5 and 7.

Explanation of Concepts Used

This explanation focuses here on concepts which have not been dealt with in this paper and relating to executing sectors of STAs and the time of work devoted to them.

1. Executing Sector: The notion of executing sector was introduced in the statistics of Science to indicate the sectors of the economy in which the S-T activities are carried out, particularly so as to establish a relation between the statistical data on the S-T activities and the data on general economic development and national accounts.

The Executing Sectors represent large categories of institution which have a certain homogeneity as regards the functions they carry out and the services they render and which are defined by their principal function, namely:

(a) The scientific and technological activities carried out for the production of goods and services for sale: it is the production sector. These S-T activities may be integrated into the production or not integrated into the production. In the first case the S-T activities serve only one production line while in the second they serve two or several production lines;

(b) The S-T activities meant mainly to provide a tertiary education and ensure the general progress of knowledge associated with it: it is the sector of Higher Education;

(c) The S-T activities aiming at meeting the general needs of the Community and the collective needs of the members of the Community, except higher education: it is the General Service Sector.

2. Time of work devoted to the S-T activities

For the presentation of the data on the S-T staff, the determining factor is the time devoted to the S-T activity considered. In order to measure that time, it is proposed to use three different concepts: Full Time (FT), Part Time (PT) and Full Time Equivalent (FTE).

The S-T staff member working Full Time (FT) is defined as the staff member who devotes all or almost all his working time to a given S-T activity.

The S-T staff member working Part Time (PT) is defined as the one who devotes only part of his time to a given S-T activity.

EXPERIENCE OF BURKINA FASO IN SCIENCE AND TECHNOLOGY MANAGEMENT

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BURKINA FASO.

The fields of Science and Technology are, by excellence, those about which awareness grew most belatedly after the political independence of my country in 1960.

The «Symposium On Science and Technology Policy in Upper Volta» held in February 1978 was an opportunity for an in-depth diagnosis of the potentialities of the system of Scientific and technological research.

The recommendations of that symposium led to the establishment of a Ministry of Higher Education and Scientific Research comprising the National Scientific and Technological Research Centre (C.N.R.S.T), created with the merger of the Voltaic Scientific Research Centre (C.V.R.S.) (formerly under the responsibility of the Ministry of National Education) and of Agronomic Research (Ministry of Rural Development - M.D.R).

That organisation was the beginning of the coordination of research activities at that time scattered among many structures.

Today, Scientific and Technological Research is considered as a tool in the service of development.

Consequently, the application of Science for economic and social purposes depends necessarily on the use of the research results, the management of human, material and financial resources; everything that requires an effective national research institution. On that score, the National Scientific and Technological Research Centre was established in 1978 and turned into a public administrative establishment in 1985; it was given the following missions:

-to contribute to implement the National Scientific Policy;

-to ensure the Research/Development Liaison;

-to prepare and implement Scientific and Technological Research programmes;

-to participate in the Scientific training of Officers.

The activities of the Centre covering several key fields concerning the socio-economic life of Burkina Faso, are carried out through multidisciplinary teams based at the Headquarters, the regional research Centres or in the branches.

The Inter-ministerial nature of its Governing Board and its Scientific Council enables the Ministries, using the results of Scientific and Technological research, to orientate their programmes on the basis of the objectives assigned to their sector in the national development process.

The Ministries sitting on the Governing Board and the Scientific Council contribute to establish national priority research programmes to be entrusted to the institutes of the C.N.R.S.T. for implementation, in return, they wait for results likely to help them carry out their production tasks.

As regards the C.N.R.S.T, the carrying out of the scientific and technological research activities mobilises 650 persons including 120 researchers. This scientific potential is distributed among the following operational structures:

-Burkinabe Institute of Energy (I.B.E.) which initiates and coordinates the research activities linked to the energy problems;

-Institute of Agricultural Survey and Research (IN.E.R.A), its mission, among others, is to define and implement research programmes on plant, animal productions, the production systems; ensure a technical support to agricultural development and contribute to the use of research results;

-Institute of Tropical Biological and Ecological Research (I.R.B.E.T), which is in charge of research work

in the fields of forestry, biology, ecology and support to teaching as regards teaching materials;

-Institute of Research on Natural Substances (I.R.S.N) which is mandated to carry out activities in the field of medicinal and toxic plants in the whole country and on all products used in traditional therapy;

-Institute of Research in Social Sciences (I.P.S.S.H) which has the main mission of ensuring the coordination of research in Social Sciences so as to contribute to a greater effectiveness of development actions;

-Biochemistry and Food Technology Laboratory (L.B.T.A), recently established, is in charge of:

*promoting the integration of the objectives of Food and Nutrition Technology into development projects;

*improving, developing the process of industrial and traditional processing and conservation;

*developing the activities of the Department of Food products quality control, specific surveys and research work, technical support and training.

The Coordination of the activities of the Institutes and the Laboratory is ensured by the General Directorate (Director General and Secretary General) then four Technical Directorates:

-Directorate of Scientific and Technological Information (D.I.S.T); its mission is to locate, collect, select and process the relevant scientific data in various fields. It publishes the research results.

-Scientific Directorate (D.S) is in charge of planning the scientific and technological activities of the Centre, prepare the recruitment and training of researchers in relation with the Administrative and Financial Department and ensure the conduct of the Scientific life of the Centre.

-Directorate of Scientific Cooperation (D.C.S); it is in charge of:

*the follow-up and maintenance of Conventions and Protocols of Agreement signed with external and national partners;

*the research for Conventions or partners capable of contributing to improve the quality of Scientific and technological research work;

*the follow-up and management of research authorization;

*relations with the public at large.

-The Directorate of Administrative and Financial Matters (D.A.A.F) is in charge of the administrative, financial, material and human management of the Centre.

This is the organisation established for the management of Science and Technology in my country. However, it will not be superfluous to point out the existence of the University of Ouagadougou which has its own organisation within the framework of the missions entrusted to it.

The two structures, the C.N.R.S.T and the University, are complementary and work for the promotion of Science and Technology.

In principle, the BANWTIU should ensure the Coordination of the activities of the Scientific institutions. For the moment, it is not fully operational.

I cannot help commending the convening of this seminar which comes at the appropriate time because, in order for Science and Technology to play fully their role, there is need for men capable of making dynamic the research structures, mobilising the necessary human, material and financial resources.

PANORAMA OF THE MANAGEMENT OF SCIENCE AND TECHNOLOGY IN BENIN

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In the telex announcing the convening of this training Seminar on Management of Science and Technology in Conakry, it was requested that each participant present a paper on the experience of his country in the Management of Science and Technology. For us it is a question of giving a panorama of what has been done in Benin in the field of the Management of Science and Technology and, if necessary, draw the lesson. We shall base ourselves on the principle that no experience is ever absolutely negative if the conscious actors draw important lessons. It is certainly the case of Benin today, yesterday Dahomey, the Latin area of French speaking Africa.

I BEACONS OF THE PAST

Without going into semantics, it can be said that if Dahomey has been rightly called the «Latin Area» it is particularly not because of the number of graduates produced by that country to serve the Colonial cause; until the years of independence of African countries, especially those of West Africa, this country has been a source of producers of Science and Technology for the sub-region.

But if Science and Technology were to be produced without research, it should be stressed that the word «Research» applied to that period of history is treated as Scientific research in the sense of the European culture.

The Science and Technology policy aimed at essentially economic objectives and accessorily at humanities and literature as shown by the following development:

Field of Literature:

In the literary field there were famous writers but there was no real organisation to take responsibility of their works.

Fields of Agriculture, Animal Husbandry, Water and Forestry:

In the field of Agriculture, Animal Husbandry, Water and Forestry, the technical services established during the 1939-1945 war made it possible to carry out, in the experimental farms, tests in the form of the introduction and study of the behaviour of new varieties and breeds for crossing. The work concentrated mainly on Palm oil trees, industrial plants (such as cotton and groundnut) and food plants.

With the end of the war in 1945, the colonial policy of France was to establish or strengthen, in the metropolis specialised organisations oriented towards action in the French territories. On this score, we can mention:

-The Overseas Scientific and Technological Research Department (ORSTOM) which in Dahomey was particularly known for its «Pedology» Division;

-The Tropical Agronomic Research Institute (IRAT), specialised in studies on food crops, fertilisation and crop rotation and whose station in Dahomey dates as far back as 1904;

-The Oils and Oil seeds Research Institute (IRHO);

With the independence in 1960, other Institutes were established, particularly:

-The Cotton and Tropical Textile Research Institute (IRCT);

-The French Institute of Fruits and Citrus fruits (IFAC);

-The Livestock and Veterinary Medicine Institute

of Tropical Countries (IEMVPT);

-The Technical Tropical Forest Centre (CTFT).

Until the time of independence, the Organisations carried out programmes prepared and financed by France.

With the independence (1960), the need to institutionalise the relations led to the signing of the Convention between the French Government and the Dahomean Government.

That Convention distinguished two types of research programmes:

-the programmes of general interest financed by France;

-the programmes of local interest submitted for consideration of the local Scientific Research Committee of Dahomey; they were financed, after agreement, equally by two Governments.

For a better performance, it was established at the same time:

(a) National Agronomic Research Committee requested, among others, to define the general orientation of State Agronomic Research, take cognizance of the results obtained in the field of Non-State Agronomic Research, consider the measures likely to ensure the popularisation of results, etc... The work of the Committee was prepared by Six Commissions;

(b) The Agricultural Education and Agronomic Research in charge, among others, of:

*determining the Agronomic Research programmes to be proposed to the National Committee;

*publishing and disseminating the results;

*managing the National Agronomic Research Institutions;

*determining the outside the station multilocal trial programmes and control their implementation, etc..

Among the experimental stations and Centres, one can mention:

Pobe, Seme, Sekou, Niaouli, Ina, the farms of Kpinnow and Okpara. Scientific results of world scale were achieved in those structures; thus in the field of Palm-oil tree, the Pobe station was one of the four world stations which contributed to the development of the presently known high-yielding varieties.

In the other fields

As a logical follow-up of the colonial and neo-colonial policy, the other fields of Science did not benefit from a particular structuring. The University had to be established in 1970 for Scientific and Technological Research to witness a development towards the sectors other than Agriculture, Livestock, Water and Forestry on the basis of the Applied Research Institute of Dahomey established in 1959 from the remains of the Dahomean branches of the French Institute of Black Africa (IFAN). Publications of the magazine «Etudes Dahoméennes» of that Institute covered a large field of Science and Technology Botany-Geology-Religion-Arts-Culture-Linguistics, etc...

II. SCIENCE AND TECHNOLOGY OF INDEPENDENCE

From the very first days of its independence (1960) the «Latin Area» endeavoured to preserve that comparative advantage. It was thus that the Applied Research Institute of Dahomey (IRAD), established in 1959 and run by the National Officers, took over the Dahomean branch of IFAN.

In the field of Agriculture, Livestock, Water and Forestry, the 1960 Convention between the French and Dahomean Governments continued in conformity with the provisions of its Article 9 which stipulates:

« this Convention is concluded for a period of five years, renewable by tacit agreement... ».

Consequently, the first ten years of independence passed as a period of transition. Indeed, at the end of this first decade, two important events marked the end of the transition:

-the establishment of the University of Dahomey in August 1970;

-the National Seminar on Rural Development in April 1971.

From these two events, the management of Science and Technology assumed a different character

with the establishment of the Departments of the University and the Research Units peculiar to Dahomey. Some Ministerial Departments have, henceforth specific research structures.

In 1975, the National Council for Education and Research (CNER) was established charged, among others, to propose to the Minister of National Education the policy and orientation of education, training and Scientific research.

That Council never became a reality in spite of the different recasting of the responsible Ministry that marked the period from 1975 and 1986 through:

-the Ministry of National Education, Culture, Youth and Sports (1973-1975);

-the Ministry of Technical and Higher Education (1975-1981);

-the Ministry of Higher Education and Scientific Research (1981-1985);

-the Ministry of Middle and Higher Education (1985-1990).

In 1976, the establishment of a Directorate of Scientific and Technological Research in the Ministry of Technical and Higher Education gave hope to make that sector of activity dynamic.

As a matter of fact, the Directorate of Scientific and Technological Research is in charge, among others, of organising, stimulating, promoting, coordinating and monitoring all the Scientific and Technological research activities at the National level. The Decree relating to the Directorate of Scientific and Technological Research specifies that the Research Organisations are grouped within the following Departments:

-Department of University Research;
-Department of Agronomic Research;
-Department of Research in Pharmacopoeia and Traditional Medicine;
-Department of Specialised Research in the Ministries.

In conformity with the provisions of this text, it appeared clearly that all the National Research activities were under the responsibility of the Ministry of Technical and Higher Education which later on became in charge of Scientific Research.

But it should be noted that ten years after its establishment, the DRST could never play its role; the transfer of the Directorate of Agronomic Research to the Ministry of Rural Development contributed to weaken further that Directorate.

III. MANAGEMENT OF SCIENCE AND TECHNOLOGY TODAY

Since 1986 two Decrees were adopted successively for:

-the National Scientific and Technological Research Council (CNRST);

-the Beninese Scientific and Technological Research Centre (CBRST);

These two organisations are today under the responsibility of the Ministry of National Education.

The CNRST:

The National Scientific and Technological Research Council groups:

-the representatives of all the Ministries having research structures under their responsibility;

-the heads of National Research Organisation.

It deliberates on all the questions relating to the development of research work. It meets in an ordinary session once a year.

The CBRST:

The Decree establishing the Beninese Scientific and Technological Research Centre (CBRST) specifies that the latter is a state institution having a legal status and financial autonomy.

This Centre is the permanent Secretariat of the National Scientific and Technological Research Council and on that score it is in charge, among others, of the coordination, follow-up and evaluation of the activities of all the research units.

It is responsible for the National Scientific and Technological Potential and the coordinated establishment of the programmes of Research Organisations.

A National Scientific Council (CSN) assists the

Beninese Scientific and Technological Research Centre in the preparation of the Draft National Research Policy and the preparation of the meetings of the National Scientific and Technological Research Council.

The National Scientific Council is composed of:

-the Director of the Beninese Scientific and Technological Research Centre (Chairman);

-the Director of Agronomic Research (Vice Chairman);

-the Director of Research, Follow-up and Programming of the Beninese Scientific and Technological Research Centre (Secretary);

-the Permanent Secretary of the Scientific Council of the National University of Benin;

-the National Scientific personalities chosen in their personal capacity because of their confirmed competence in the different sectors of Science (modern medicine, traditional medicine, pharmacy, linguistics, oral traditions, agronomy, civil engineering, energy, history, environmental Science, soil and marine Science, legal Science, exact Science, sociology, economics, arts and culture, industry, education, technology).

To carry out its mission, the Beninese Scientific and Technological Research Centre has three technical directorates, namely:

-the Directorate of Administrative and Financial Matters;

-the Directorate of Research, Follow-up and Programming;

-the Directorate of Documentation, Dissemination of Scientific Information and Training.

MANAGEMENT OF STRUCTURES

Scientific Research in Benin today is very decentralised not to say scattered or diversified.

In fact, a certain number of Ministerial Departments has, directly under its responsibility, specific research structures. This situation which meets the need for specialisation, presents some drawbacks particularly as regards the pluridisciplinary nature of implemented programmes, the possible duplication of the latter and sometimes the isolation of some researchers.

To make up partly these inadequacies, the National Scientific and Technological Research Council decided in November 1991 to divide the research structures into networks in the following fields:

-Science of life and Traditional Medicine;

-Soil, Water, Air and Atmosphere Science;

-Exact Science, Industry, Technology and Agronomy;

-Research Units in Linguistics, etc...

The objective aimed at by the CNRST by adopting the Organisation of Structures into networks in these major fields is to encourage a better mutual knowledge of Scientists working in the neighbouring fields through regular scientific events.

As it can, therefore, be noted, it is through a sound structural Organisation of Research that the CBRST can play effectively its role of Coordinator and assessor of programmes.

Management of Scientific Programmes and Information

For lack of a consistent Coordination, the evaluation of the programme management cannot be correctly apprehended. Today, it can be said that the present situation is marked by scattered indeed fragmented research projects. The sectoral programmes, when they existed, were not always geared towards meeting the local needs but rather guided by the concerns of foreign donors, which increased dependence in the area of research and highlighted the insufficiency of pluridisciplinary work which a genuine Research-Development demanded. Today there are about a hundred units or laboratories carrying out resources activities.

In the field of Scientific information, more than fifty documentation Centres are scattered over the whole national territory. Some documentation Centres are less known and not too frequented. The Inventory of the Scientific and Technological Potential of 1985 points out

that the number of works per Scientist is small: about 110 books and 11 periodicals per Scientist and Researcher.

The corollary of the lack of consultation between Specialised Research institutions is the inexistence of circulation of Scientific information and the inexistence of a collective concept of the establishment of data banks.

Management of the Scientific Community

The driving element of every scientific Community is composed essentially of researchers. It was only in 1981 that the first text on the special status of the Scientific and Technological Research Personnel was adopted. This legal and administrative document, updated in 1985, takes into account the staff of all categories but does not define clearly the profile of the Researcher. In other words, this status does not valorize the Researcher and hides his scientific promotion. Even in the National University of Benin where the Teaching-Research Staff have a specific status, promotion on the basis of Scientific work remains diffused.

Furthermore, it should be pointed out that the Inventory of the STP in 1985 identified that Benin had a very high index of official control of Scientists and engineers: about 25 of the latter devote more than half of their time to administrative work.

Financing of Science and Technology

No special provision for financing of Science and Technology is applied to date. As a corollary to what is said above in the field of programmes, more than 60% of funds allotted to Science and Technology in Benin are of foreign origin; the expenses borne by the state related essentially to the salary of the officers involved. This strong index of the external source of funds for Science is very detrimental to the very development of the country.

The lack of the real coordination encourages this dependence and the dispersal increases the prejudice; the individual actions of structures, indeed, men are not always likely to be credible.

Even at the University, the public funds allotted for Science and Technology are negligible.

The Inventory of the Scientific and Technological Potential of 1985 points out that only 0.09% of the total expenses of this institution is on Scientific and Technological activities.

The text of the National Policy on Research adopted in 1989 and updated by the National Scientific and Technological Research Council in 1991 provides for the establishment of a Support Fund for Research whose resources represent 1% of the GDP. That Fund will be maintained by state subventions, research contracts, state and parastatal enterprises, external funding.

This principle has to be made enforceable with the adoption of a law.

Conclusion

The experience of Benin in Management of Science and Technology since the colonial era todate identifies the following essential elements:

-A strong index of externally oriented nature since the colonial era.

Only the forum has changed, yesterday the decision-making Centres for research programmes were based in the Metropolis, today it is through the financing of programmes essentially ensured by the donors.

-the Scientific and technological activities engage very little attention of the political authorities. This poses the essential problem of development.

-Benin has in the sub-region considerable Science and Technology potential which must be better organised to enhance its credibility and enable it better participate in the growth and better contribute to the world potential of Science and Technology.

NOTE ON THE MAURITANIAN SCIENTIFIC RESEARCH INSTITUTE

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Mauritanian Scientific Research Institute

The present note aims at enlightening the reader about the role which this institution can play, the resources it has, the difficulties it faces in the accomplishment of its mission and the results obtained.

The Mauritanian Scientific Research Institute was established by Decree No. 74243 of 31 December 1974. This Decree requests it to stimulate and develop research work in the field of humanities in general, ensure the conservation and development of the National Cultural heritage.

This mission is of exceptional scope but the lack of adequate material means led the Institute to limit itself, for the expenses related to this activity were fully borne by France whose researchers were also on the spot.

In a second phase, the section of manuscripts was encouraged thanks to external financing.

I. Role of the Institution

The Mauritanian Scientific Research Institute seems to be an instrument of national sovereignty. Indeed, research work in the field of humanities is complicated, thus demanding an important control in-so-far as the results may have a dangerous socio-political scope

and, considering the fact that, the recording of the history of a nation is the most difficult thing to do.

Besides, at the National level, the Institute should be in a position to:

-establish a National Archaeological Map;

-locate all the excavatable sites;

-restore all the manuscripts threatened by destruction;

-organise manuscripts libraries over the whole extent of the national territory;

-prepare a Mauritanian manuscript directory;

-study the non-disseminated valuable manuscripts;

-write the history of the country with the support of oral traditions and written archives;

-carry out studies on social changes;

-carry out sociological studies.

This list is limited to three (3) major areas:

The history of our country is to be rewritten or at least revised for most of the available documents were prepared by foreign historians.

The manuscripts of our country are a treasure and it is a true miracle that in a country where the social and material conditions (nomadism) are those which we know, such fragile documents have survived the various depredations.

In the field of oral traditions, it is necessary that an action be carried out to save these sources whose safeguard should constitute a priority for our country whose civilisation is to a large extent called «Oral Civilisation».

There are, therefore, many things to be done in this important field.

II. Administrative Structure

The Mauritanian Scientific Research Institute, placed under the responsibility of the Ministry of Culture

and Islamic Guidance, is administered by a deliberating organ and an executive organ.

1. Deliberating Organ

The deliberating Organ called the Board of Directors, is appointed by Decree at the proposal of the Ministry having the technical responsibility for a duration of three years. In general, the Board of Directors manages the Institute. It has, namely, power to:

-draw up the Rules of Procedure of the Institute;

-lay down the modalities for the remuneration of the staff in accordance with the regulations;

-deliberate on the financial management of the past financial year and adopt the budget for the next financial year prepared by the Director;

-give its opinion on all the problems concerning the general orientation of research and the Scientific activities organised by the Sections of the Institute.

2. Executive Organ

It is chaired by the Director, appointed by Decree at the proposal of the Ministry having the technical responsibility and requested to implement the decisions of the Board of Directors to which it reports about its management. The Director is assisted by a Deputy Director appointed by Decree at the proposal of the Ministry having the technical responsibility.

In addition to the Director and the Deputy Director, the administration comprises the administrative and accounting services and the scientific sections.

3. The Scientific Council

Appointed by a Ministerial order and at the proposal of the Director, the Scientific Council is in charge of the Scientific Orientation, the preparation of research programmes. Besides, it gives its viewpoints on the recruitment of researchers, the vocational training and advanced training in knowledge.

III. The Resources

1. Financial Resources

The budget of the Mauritanian Scientific Research Institute amounts at present to 19,756,000 Ouguiyas which stresses the contradiction between the objectives and the means...

It goes without saying that the suspension of the French subvention (amounting to 20,000,000 Ouguiyas) in 1981 had a detrimental effect on the Institution.

More especially as the State budget did not take into account this loss for the Institute.

The discrepency between the budget and the increasing expenses posed serious difficulties for the Institute for the functioning, research work and maintenance represented only 25% of the budget while the staff costs represented almost 50%.

It should be noted that staff costs in a normal budget should not exceed 25 to 30% of the global mass.

This situation of imbalance leads to a situation of under-employment indeed of unemployment which in the end leads to the frustration of the most occupied employees who feel injured by those who are paid «to do nothing».

It also slows down the research activity of the Institution. Concerned about the financial reorganisation of the Institute, the Director is establishing a reception and animation Centre at the National Museum so as to obtain the specific incomes from the activity of the Institute.

2. Human Resources

The Institute is characterised by the absence of senior Mauritanian cadres resulting from several factors:

-the French cadres were capable of carrying out the archaeological work and the training of national substitute cadres was not encouraged;

-at the level of manuscripts, the selection is made in relation to the appurtenance of families to know in order to facilitate the contacts with the manuscript holders.

3. Material Resources

The Institute has, at present, in its car fleet:

-one Toyota (four wheel drive) in good running order, the only vehicle ensuring at present the research missions;

-a light Toyota Vehicle (diesel), broken down, whose spareparts cannot be found on the local market;

-one Land Rover out of use since 1990;

-One Unimog out of use since 1990;

-One truck out of use since 1988;

-One Range Rover out of use since 1983.

We recall that this car fleet was quite full in the initial years of its functioning.

Furthermore, the Institute has a more or less important equipment in the field of its activity: computer, reproduction machines, photocopying machines, typewriters, cameras, microfilming equipment, cassette recorder, film, slide projectors, sound recording equipment.

IV. Results obtained

Without taking stock of 16 years of existence, we can say that the results achieved by the MSRI are overall positive. We shall try to recapitulate them by type of activity.

1. Historical and Archaeological Studies Section

In this field, the MSRI has made several excavations, the sites of Tegdaoust and Koumbi Saleh have become internationally reknown and made it possible to give clarification on the history of the Mali and Ghana Empires and consequently, on the history of the sub-region.

The site of Azougi, whose excavations have not been completed, seems to be the capital of the Almoravides. Some dating already made enabled to confirm that this town was, in any case, contemporary of the Almoravides.

At the level of discoveries: two Dinar coins of the Almoravides and the unidentified seal with Arabic writing were noted.

At the level of collection: more than 100,000 archaeological objects making our reserve one of the richest of the continent.

In prehistory, prospection work were carried out in the regions where a concentration of mesolithic sites was identified.

They focussed mainly on the North and the Dhar from Tichitt to Oualata.

Attempts of reconstructing a neolithic village were made at the Akreijit site in Tagant.

At the level of publications, the Tegdaoust Books 1, 2, 3, 4 have come out and also a book on Tichitt.

Several students were trained in techniques of Archaeology.

2. Arabic Manuscript Section

Its mission is to compile, maintain, restore and publish the manuscripts.

The Manuscript Library of the Institute today has about 6000 manuscripts, 3000 others in the form of microfilms thanks to the assistance of the Germans and the Libyans and more than 400 collections of Arabic and popular poetry. As regards the restoration, it is still done abroad thanks to the cooperation with some friendly countries.

Within the framework of a Protocol of Agreement of Cultural and Scientific Cooperation with Spain, 250 manuscripts have already been restored, 500 others are being restored.....

With regard to publication, the Institute still calls upon the Cooperation of International Organisations.

A catalogue on manuscripts is being prepared thanks to the German Assistance.

3. Social, Oral Traditions and Linguistics Studies Section

Research work in this field led to the recording of some 400 cassettes on history, culture and oral traditions of Mauritania.

We should point out the collection of Seddoum Ould Ndiartou (famous poet and founder of Mauritanian traditional music) and the volumes 1, 2, 3 of the Hassaniyya - French Dictionary within the framework of the cooperation with France.

In the field of Sociology, we can note the publication of the first part of a thesis under the theme: «Tribal

structure and the precolonial Mauritanian State».

Furthermore, it should be pointed out that a project on Oral and written traditions is at present financed by France.

This project aims particularly at the collection, tapping and exploitation of these oral and written sources.

Several activities are scheduled:

-the recording of stories, proverbs and sayings;

-collection of Arabic and popular poetry;

-photocopy of manuscripts available at the Institute;

-photocopy of Mauritanian Arabic manuscripts available at the National Library of Paris.

4. Islamic Studies Section

This Section works in cooperation with the Commission in charge of Moctar Mamidoun works.

Parts 1 and 2 have already come out. This section also deals with Research on the resistance heroes and the major Mauritanian Ulemas.

This year, information collection from the elders on the historical personality of Sidi Ould Moulaye Zein has been carried out and also a census of the Ulemas in Aoujeft.

This information will be used and published soon.

5. National Museum

The transfer of our cultural heritage of the French Institute of Black Africa led to the establishment of the National Museum inaugurated on 28 November 1972.

The mission of this Unit is the conservation and development of a set of elements of cultural value (collection of artistic, historical, scientific and technical objectives.

The National Museum has developed so much that it has reached the point of continuous exhibition.

Inside the Museum, one can distinguish two types of exhibition:

-prehistorical exhibition: it comprises the results of scientific missions to the North, South and Centre of the country;

These exhibitions show that the Mauritanian Society participated actively in the development process of mankind.

Among the monuments in the National Museum, some were made locally, others were imported from North Africa or Black Africa.

-Ethnographic Exhibition: these are household, agricultural, pastoral tools thus characterising the traditional Mauritanian Society. Pamphlets are being prepared for the use of the Museum.

6. Campaign for Safeguarding Ancient Cities

Following the appeal made by Moctar Amadou MBow in February 1981 and thanks to the support of UNESCO, the Institute could restore the Mosque of Tichitt from 1985 to 1987 and removed sand from that of Oualata in 1988.

For this year, the UNESCO experts have identified a project for the establishment of an agricultural Centre in Chinguitti.

These experts will arrive by the end of 1991 for the follow-up of that project.

As for the Spanish Government, it had accepted the responsibility to build a Library-Museum complex and a Centre for Women's promotion at Oualata inaugurated in March 1991.

Spain also agreed to finance a village water project in Oualata.

This project aims at meeting the needs of the people in drinking water and encourage agricultural activities in that town.

It should be noted that several missions were carried out during this year in the North, South and Centre of the country. The results of these missions will be published in the review «EL WASIT» 4 being prepared.

It appears useful to recall that all research policy to be implemented depends on the financial resources

available.

Even if it is necessary for short and long term programmes to be implemented, there should then be an assurance that resources required for implementation were available.

These programmes will take into account the results obtained and national priorities for research in humanities.

Scientific Research started in Mauritania only in 1974 with the establishment of the Mauritanian Scientific Research Institute (IMRS) which was directed towards the fields of history, archaeology and sociology.

Substantial results were obtained until 1981, date on which the French subvention was suspended.

Then, other research institutes were established, particularly:

-the Mauritanian Geological Research Department (OMRG, 1975);

-the National Livestock and Veterinary Research Centre (CNERV,....);

-the National Agronomic Research and Agricultural Development Centre (CNRADA);

-the National Oceanographic and Fisheries Research Centre (CNROP);

-the National Hygiene Centre (CNH);

-the Higher Scientific Institute (ISS, 1986);

One of the major problems faced by research work is inherent in the diversity of the responsible structures under which the various research institutions are placed, hence the obvious incoherence in their administrative management and their follow-up. Similarly, in the functions of most of the ministries in charge, research work is only an incidental activity of secondary importance. Besides, the administrative unwieldiness of these structures in charge is detrimental to research work which demands more flexibility and spirit of initiatrve.

Research work in Mauritania did not also have the means commensurate with its ambitions: limited financial, material, logistics and human resources.

The seminar on the evaluation of Scientific Research organised in 1989 by ISS led to the establishment of a National Scientific Research Commission requested to take stock and ponder over an adequate structure capable of managing, coordinating and promoting Scientific Research in Mauritania.

By the time the decision-makers consider the results of the work of the said Commission, the research institutions try somehow to carry out their delicate but noble mission with the sole subvention of the State.

Report
of

The International Training Seminar on Management of Science and Technology Conakry, Guinée, from 26 to 29 February 1992

The International Training Seminar on Management of Science and Technology, organized jointly by the United Nations Economic Commission for Africa (ECA), the Islamic Development Bank (IDB), and the National Directorate for Scientific and Technological Research (NDSTR) of Guinée, was held in the Palais des Nations in Conakry, from 26 to 29 February 1992.

Around thirty participants from the following countries attended the seminar: Benin, Burkina Faso, Guinée, Mali, Mauritania, and Niger.

The following regional and international institutions were also represented by well-known personalities: ECA, ARCT, IDB, and the Centre for Technology Transfer of Asia-Pacific region. The list of participants is in annex I.

The official opening ceremony was presided by the Minister for Pre-University Education and Professional training, Mme Haja Aïcha Bah. She was accompanied by Mme Nantenen Camara, Minister of Commerce, Transport and Tourism, and by many high officials of the Ministry of Higher Education and Scientific Research. At this inaugural session, speeches were made by Professor Kabine Kanté, Director of National Scientific and Technological Research of Guinée, Mr. S. Jugessur, ECA representative, and Mr. Mohamed Ahmed of the IDB, before the opening speech made by Mrs. Hadja Aicha Bah. The Minister welcomed the international participants in the name of the Guinea Government and the national scientific community, and said that she was happy that the seminar was taking place in Guinée. She stressed the fact that the seminar was taking place when they were being forced to review their entire system of management of S&T in order to adapt them to the stupendous developments in the industrialised North, and to integrate them to their own national environment for their better utilization for the people. She highlighted the fact that the seminar was offering the African representatives an ideal opportunity for exchange of views that can be mutually enriching to one and all.

During the half-day the proposed programme of the seminar was examined, amended and adopted, and the Bureau was elected.

On the question of election of the Bureau, the following countries were elected by acclamation for the posts as shown:

President:	Guinée
Vice President:	Burkina Faso
Rapporteurs:	Mauritania, Niger and Guinée

Every participant then introduced himself personally to the others. After this the representative of ECA, after congratulating the level of Guinean participation, expressed the desire to see amongst them representatives of the private sector, banks, chamber of commerce, agriculture and industry. The organisers said they were willing to meet this request.

Proceedings

The actual proceedings of the Seminar

started on Thursday 27 February 1992 by the presentation of a series of communications as foreseen in the programme.

The first theme dealing with the popularisation of science and technology was presented by Mr. Jugessur of the ECA. In his exposé, the speaker deplored the poor situation concerning S&T in Africa, and an absence of a S&T culture, which have led to little development in the region. He raised the issue of how to introduce the achievements of modern S&T in traditional African culture. He also brought out the existing dichotomy between the African elite researchers and the masses whereby the former devote their energy to high level scientific publications without caring for the real problems that affect the latter. He stressed the need to demystify S&T and elaborated on measures to do this, namely by popularising S&T through the media (Radio and TV), folk songs, dances, all expressed in national languages readily understood by the masses.

The discussions that followed brought out the clarity and brilliance of the exposé, and also the fact that time was not enough to do justice to the different issues raised by the speaker.

Some participants, like those of Benin and Burkina Faso, brought out the difficulties and factors limiting the popularization of S&T using national languages and television, as suggested by the speaker.

The representative of ARCT also remarked that the use of national language could be difficult in those countries having many dialects.

The second theme was presented by Mr. K. Lakshminarayan, representing the director of the Asia - Pacific Centre for Technology Transfer. He spoke on a strategy for technology transfer as a component of a national development plan.

He started by noting the complexity linked with managing S&T both in industrialised and in developing countries, before highlighting the need to develop S&T activities which can improve both productivity and the quality of life of the people. He then gave a historical background of the Asian Centre which is operational since 1977, and the experiences of which deserve to be shared in the context of inter-regional cooperation.

All this will be possible through the necessary information that can facilitate the contacts. He ended his exposé by hoping that a greater cooperation between the centre and Africa could develop through promotion of small and medium enterprises. He also suggested that a centre similar to that in Asia be set up in Africa.

Following the speaker, a Guinean participant wondered how the newly industrialised countries of Asia and South America which were, earlier, in the same conditions as the African countries, had succeeded in overcoming the cultural barriers and got their population interested in S&T activities. He also questioned if the Asia Pacific Centre was playing the same role as the ARCT in Africa.

The representative of Benin noting the high speed with which countries in Asia and Pacific region were developing, asked how they are protecting industrial property rights.

The ARCT representative congratulated the speaker for the quality of his exposé, and said that there is a misunderstanding on the part of those Africans who believe that the quantum jump of Asiam countries dates back only to the last few years. He pointed out that this dates back to 1901 when Japan had conquered Russia and that during the Second World War, Japan was already able to produce its own airplanes. Both the ARCT representative and the President of the seminar suggested that certain publications

of the Centre be translated in French for the benefit of the seminar participants.

The third exposé concerning the management of international transfer of technology was presented by Dr. Jacques Louis Hamel of the ECA.

The speaker started by bringing out the strategic role played by technology in development, and highlighted the dominating role of the United States of America in the international transfer of technology. He remarked that though Africa is the least successful, things had started to change. Africa has to play a new economic role having to face an international context which is difficult to master. Hence the need for it to review its political and economic orientations in order to establish large and more competitive African markets.

The debates that followed showed the importance and relevance to the problem of technology transfer. The ARCT representative said that technology transfer is itself an issue. Exporters of technology are always in a position of strength vis-a-vis the importers. The Burkina Faso representative wanted to know about the links that exist between ECA and OAPI. Africa must not only be on the receiving end, but must also offer something to the outside world.

Before closing the discussions, on this theme, the President remarked that everything revolves around models of development; one had to come out of classical western models, and have more faith in local national cadres.

The fourth and last communication of the day was on the role of the private sector in the development and management of S&T. The speaker, Dr. Selim Jafar Karatash of the IDB underlined his exposé by referring to an Arab sage Ibn Khaldoun, who had very early, in his treatise: 'Introduction to history,' stressed the importance of private property in development.

He highlighted the role of private entrepreneurs in the management of S&T as well as in the economic growth. He also stressed on the need for rights to property, right of the state, judicial institutions and political stability. He drew the attention of the participants to the importance of human resources, for Asian countries had succeeded by investing on human resources, and African countries had to do the same for ensuring success.

During the discussions, questions were raised whether one could leave everything to the private sector. What would happen to the energy sector which is generally subsidised by government?

The session president then proposed a solution whereby both the public and private sectors should work hand in hand.

On Friday, 28 of February 1992, three topics were discussed.

The first one was related to capacity building in science and technology management and was presented by Prof. J. Olufeagba, Executive Director of the African Regional Center for Technology. The orator first elaborated on the classical definition of science used by UNESCO before recalling the various meetings and conferences, including the Lagos Plan of Action, which dealt with a better integration of science and technology. The orator underlined the fact that one has to pay the price to develop science and technology because it is not a free commodity. He also advocated a greater use of the available knowledge in the field of local agriculture and agro-industry that generates jobs.

The second topic dealt with scientific research

and experimental development and was presented by Dr. Osakwe, coordinator of UNDP projects at ARCT. The orator mentioned that he was very happy to be back in Conakry where he taught at the former 'Institut Polytechnique' twenty years ago. He then stressed the necessity to integrate the research and development system at the regional level even though each country was free to elaborate its own research and development capacity independently. Projects related to food self-sufficiency should receive the top priority. ARCT is working on adapted technologies in food transformation and preservation for rural Africa, taking into account food habits. The orator then drew the attention of the participants to the fact that African scientists are not well supported by their governments because they do not sufficiently link their projects to the basic needs of the population. He continued by stressing the necessity of the participation of the rural farmers in order to improve the economic situation in Africa.

The discussions on these topics highlighted the important support that ARCT is providing to member States. The chairman congratulated the two resource persons of ARCT.

The third and last topic of the day, presented by Dr. Muhammad Ahmad of the Islamic Development Bank, revolved around the role of local private consultancy firms in technology transfer. The presentation underlined mechanisms to create national capacities in the choice of appropriate technologies. A greater attention should be paid to the creation of private local consultancy firms to better absorb technologies. He referred to page 15 of his paper where he has detailed a practical mechanism playing the role of interface between the development and transfer of technology.

The discussions that followed welcomed the proposals put forward by the orator.

A representative from ECA asked how most engineering consultancy services go to foreign firms. The representative of Burkina Faso wished that the priority be given to local consultants who know better the field. The chairman, after having observed that the use of consultants is necessary, suggested that a subregional consultancy service be created for West Africa. He then invited the participants to study carefully the paper so that African countries can benefit from it.

The third and last day of the seminar started on Saturday, February 29, with two communications by Guinea.

The first orator, Mr. Alhassane Camara, presented a paper on "Principles and methods of planning in science and technology". Starting from the social function of planning, he derived priority objectives in science and technology to be integrated in the national development plan. He drew the attention of the participants on certain prerequisites to planning, namely economic studies and the collection of data. The orator concluded his presentation by elaborating on the theoretical stages that one has to pass through to integrate the science and technology plan into the national development plan.

The second orator, Mr. Ousmane Souare, presented Guinea experience in the management of science and technology. He started by tracing the historical evolution of the science and technology system in Guinea from the colonial period up to now, stressing the main stages that have marked the system. He underlined the fact that the institution charged with the responsibility of elaborating science and technology policies, has been created in the first days after independence. He then put a particular emphasis on the programming/budgeting and on the funding of science and technology activities. He also elaborated on the problem of human, material, financial and informational resources and the role of international cooperation in filling gaps in

the national science and technology system. He identified the main problems that limit the real impact of science and technology on national development and he formulated a few recommendations to improve the situation.

Following the presentations, many participants congratulated the two authors and noted the similarity of the organizational and managerial problems in the other countries of the subregion.

One resource person from ECA drew the attention of the participants to the fact that many more technicians and assistants in science and technology must be trained than scientists and engineers. He gave the example of Mauritius which, owing to this policy, has been able to raise the level of income per inhabitant from 500 to 2500 USD.

The representative of the Asian and Pacific Center for the Transfer of Technology noted that science and technology will stagnate if they are not directly applied to the socio-economic and cultural development of their countries.

The delegates of Niger and Burkina Faso showed their surprise in learning that the status of their colleague teachers of Guinea are not linked to CAMES as it is the case with their colleagues of other countries of the subregion.

Other participants raised questions about the performance of the local researchers and their ability to convince the decision makers and the economic operators to use their expertise.

Finally, the representative of Benin wished that the seminar came out with concrete mechanisms to help decision makers to take more science and technology into account in national development plans.

After the coffee break, the representatives of Niger, Mauritania, Benin, Burkina Faso and Mali, presented the experience of their countries in the organization and management of science and technology.

The general observations showed that all science and technology systems of the subregion suffered from the same problems: inappropriate organizational settings, difficulties in the coordination of the science and technology activities, poor resources mobilization, particularly financial. The participants recognized, however, the potential of highly qualified human resources that need to be better organized and motivated.

The fruitful discussions that took place following the presentations highlighted the absence of direct links between the research and development institutions of the subregion. One representative from the IDB underlined the fact that all countries represented to the seminar have invested more resources in research than in technology. This hinders the application of science and technology for development.

One representative from ECA brought to the attention of the participants that African countries rely too much on funding by the government. Other sources of funding of research must be exploited.

Conclusions and recommendations

After four days of presentations and fruitful discussions on the management of science and technology, the participants in the international training seminar formulated the following recommendations:

1- In order to accelerate socio-economic development, it is necessary to elaborate a science and technology policy with the active participation of the private sector, banks and engineering consultancy firms. To achieve this, countries must organize national conferences on science and technology policies with the

participation of the stakeholders.

2- Science and technology must have a visible impact on socio-economic development. This can be achieved by direct application of available science and technology. Such an approach could muster more support from the public authorities.

3- Governments should support the popularization of science and technology as a prerequisite to their application to development.

4- Political will expressed by decision makers to promote science and technology should be matched by appropriate actions.

5- The allocation of means and authority to the science and technology policy institutions for the discharging of their main missions.

6- The adaptation of the missions and structures of the institutions of higher education and of research to the needs of the local markets.

7- The support to the expansion of local engineering consultancy firms and their involvement in the design and realization of projects, so as to create an environment more favourable to the development of small and medium enterprises.

8- The teaching of scientific and technical courses in the universities should be improved through the use of more adequate laboratory equipment.

9- The support in setting up science clubs through which the young will be able to propagate a true scientific culture.

10- Member states should create mechanisms to promote endogenous capacities in the field of consultancy.

11- The IDB is invited to consider projects aiming at the production of school science equipment in selected countries in order to satisfy subregional needs in this field.

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