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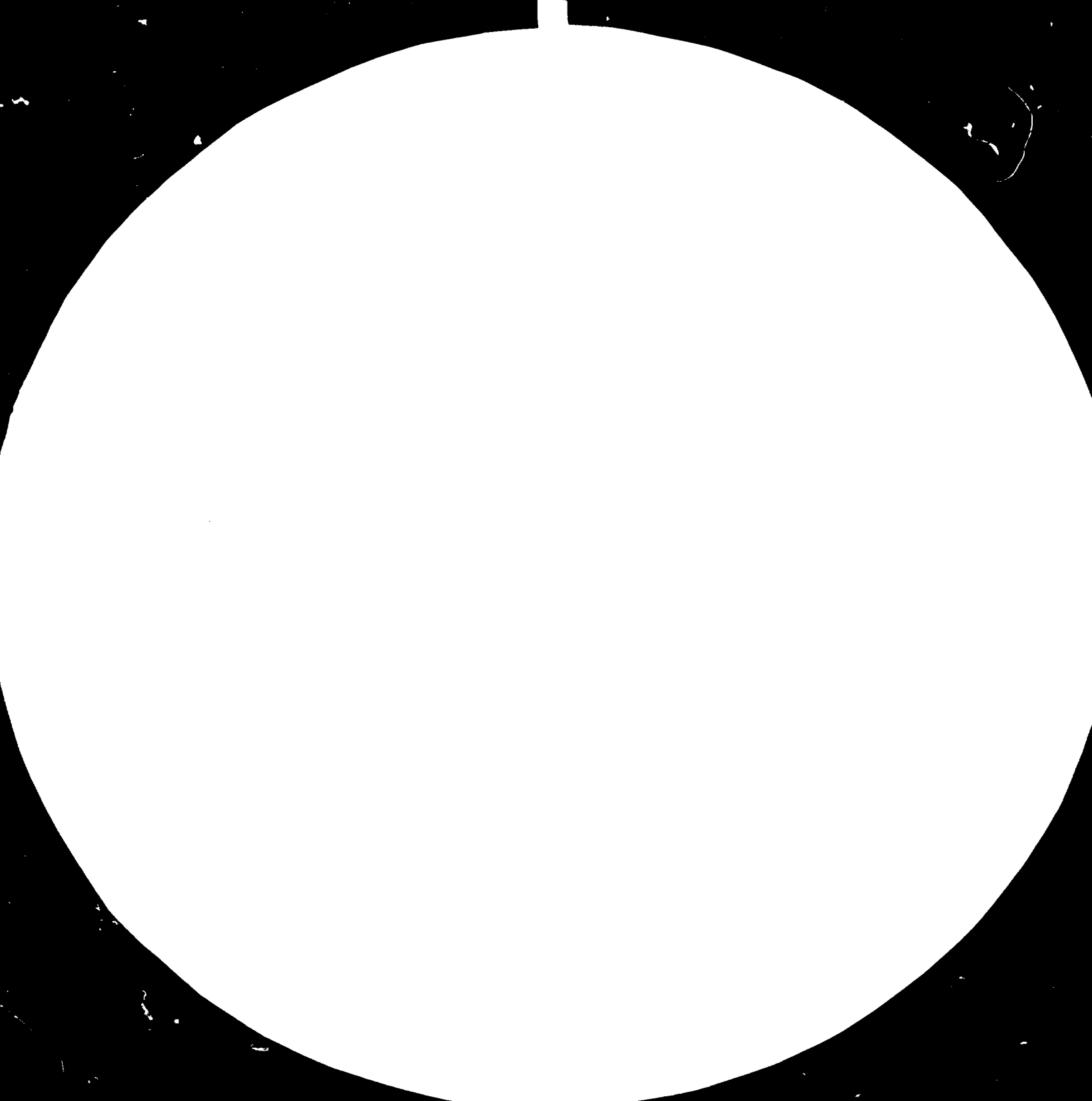

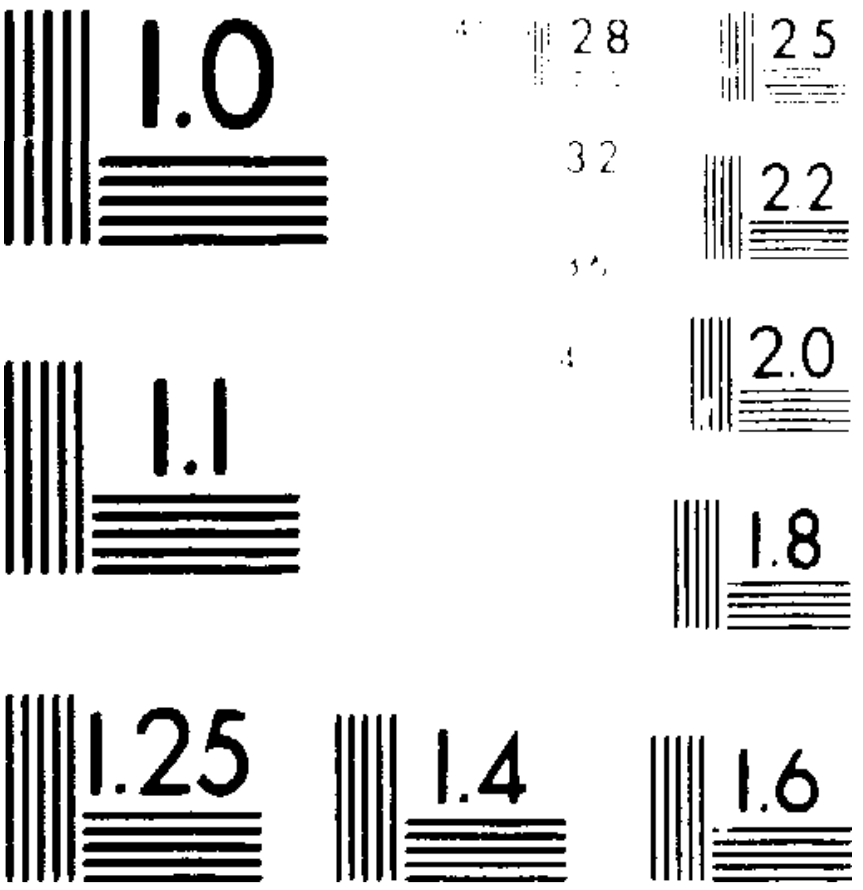

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1984

Contract no: CLT/83-317

UNIDO VIENNA — Dr. H. S. RAO NEW DELHI

Sudan.

TECHNOLGY TRANSFER:
-NCR, KHARTOUM, SUDAN.

from: V. Benzroch

LETTER OF TRANSMITTAL

Vide Contract No.CLT/83-317, the undersigned was required to perform the following services :

(1) Description and analysis of the methods and Institutional Mechanisms adopted in selected developed and developing countries for commercialisation of Technologies developed in the public domain, in particular in the Government Research Institutions.

(2) Study several specific technologies proposed for commercialisation by the National Council for Research of Sudan, and the present facilities available in Sudan for their commercialisation.

(3) Propose in the light of the above and the objectives of the Government, general policies and Institutional Mechanisms to promote the commercialisation of technologies developed by Research Institutions in Sudan.

In terms of the same, the undersigned left for Sudan on the 21st Jan.84 and returned to New Delhi on 12th February 1984, staying in Sudan for just over 3 weeks. The work plan had been sent to UNIDO, VIENNA from KHARTOUM through the Program Officer, UNDP,KHARTOUM.

A report has been prepared covering the terms of reference, and the same is herewith submitted.

H. Shivpathi Rao

(H.S.RAO) 18/3/84.

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INTRODUCTION

For any developing Country to become economically self-reliant, it is essential to establish a sound technological base. This is possible through rapid development of industries and the building up of a strong indigenous R&D infrastructure to sustain them. For effective coupling of these two sectors, however, the via media of technology transfer operations become equally important.

The creativeness of men is judged by the way they are able to translate their thought processes into realities, that of industries by the way they can implement R&D results, through the purposeful process of technology transfer into commodities that go to enrich the human society. How effectively this transformation of an idea or technology into a practical reality could be achieved depends largely on the sense of commitment, dedication and ingenuity of the people involved in the whole process. Besides, when we consider the relevance of Technology vis-a-vis Society, we have to take all the concerned segments -- academicians, R&D organisations, industry, consumers, etc -- into account as a whole. Obviously, in the arena of technology transfer, one has to take a 'systems approach' -- which has far reaching implications for appropriate utilization of both material and manpower resources.

PART - I

The Dynamics of Technology Transformation through Indigenous R & D in the Public Domain - the scenario and back-drop in some Developing Countries.

A study of the scenario in many developing countries, as it exists today including India, South Korea, Iraq, Mexico, Pakistan, Sri Lanka and Phillipines leads to a common denominator perception which is brought out by the following observations and questions:

Given all the favourable factors for the creation of technology, its diffusion, adaptation and absorption, the record has been rather dismal. This is evident from the fact that while much has been produced in the R&D Laboratories over the years, very little has been found application in industry - whether public or private sector. At the same time, there has been a continuing import of technology and often in a repetitive fashion and a failure to commercialise indigenous technology. One is tempted to ask :

- Why has the inter-action between the seeker of technology namely the entrepreneur on the one hand, and the creator of technology, namely R&D facilities on the other hand, not been adequate.

- Why continued preference for imported technologies when counterpart indigenous technologies exist?

- Is the glamour of imported product/technology on the part of the entrepreneur/investor adversely affecting the R&D innovation chain from maturing into a competitive option.

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- Why and what gaps in the innovation chain leading to incomplete packages which entrepreneurs are legitimately finding it difficult to accept?

- Have the incentives for completing the innovation chain in the publicly funded domain been adequate to provide the required motivation to R&D scientists as a co-ordinated task force to complete pre-identified goals.

- Have the incentives for innovation in the form of tax concessions been adequate to motivate entrepreneurs.

- Why no horizontal transfer of technology or diffusion has taken place?

- Who should undertake the horizontal transfer of technology?

R&D Laboratories especially in the public domain -

Consultants, especially in the public domain -

Operating plants, especially in the public domain -

- Has protective policy and sheltered market in which the industry has operated inhibited the entrepreneurial innovative spirit to venture into commercialisation of technologies generated in the publicly financed R&D Institutions?

- Have the research and development programmes and projects undertaken in the R&D Institutions adequate orientation to the market needs.

- Are there adequate insitutional links between the market and the R&D Institutions through which market feed-back could become available to the R&D Institutions?

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- Has the management structure of operating enterprises adequate sensitivity and capability to ensure absorption of technology at R&D levels of operation and develop it internally to a manufacturing scale.

- Are our Scientists engaged in the National Laboratories, Institutes of Technology, Universities and other publicly funded R&D Centres, and elsewhere, attracted by fundamental research which may be publication oriented, rather than dealing with real life problems which may be pedestrian in nature, but vital and of immediate concern nonetheless.

- Would the publicly funded R&D Institutions be more successful in interfacing with Entrepreneurs, if they tilted towards small and medium scale industry to provide them with technology inputs on a custom made basis.

- Have the project formulations and appraisals in publicly funded R&D centres been sufficiently meaningful and relevant, especially in relation to current consciousness of the energy budget, impact of the project on the ecological systems and a detailed analysis of balancing the economies of scale against the social costs of consequential unemployment that this usually results in.

- The question of reluctance on the part of the entrepreneur at the micro-level and the Economic Planners at the macro-level to take the risk of first-time use implicit in the use of locally generated technology.

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- The problem of finding Venture Capital for first time use.

Analysing this last point of risk, if one were to disaggregate the amorphous concept of risk into the various components of a manufacturing project such as civil engineering, utilities and services etc, in a project, one may well find that the notion of risk associated with the use of local technology for the first time is grossly exaggerated. There are several examples in the experience of developing countries to support this. It is however common knowledge that the technologies as developed in the R&D Institutions are rarely at a stage where they can be transplanted into commercial operation. At best, the technologies as well as the products developed are at the first stage to fulfill certain performance requirements. These have to go through a further stage where production technology, materials of construction, reliability, economics of production, and various other factors have to be taken into account before a viable project and/or its associated manufacturing technology emerges and this is where a close co-operation between the consulting organizations and the R&D Institutions is a compelling necessity. An engineered package of "technology" buttressed by suitable guarant es would, to a large extent, help facilitate acceptance of newly created technologies by even Venture-shy entrepreneurs. Another question associated with the concept of risk is as to who is to bear the consequences of the risk involved in the first-time use. The obvious answer would be not the entrepreneur but the Government, which in some form or the other has to bear all or a portion of the cost, so as to help transform the indigenous technological effort into productive application. Many Developing Countries hasten to make large investments for setting up technological facilities in the Country, but seem to begrudge the ingredient of seed money for risk which would go a long way to increase the use of indigenously developed technologies.

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If this were to be in the nature of a revolving fund, it would not burden the Country with any large additional investment.

Depending upon their perception, resources, availability of Scientific & Technological leadership, different developing countries have created within their S&T domain, technology generating Centres, transfer modes, fiscal entities and artefacts and attempted coupling mechanisms, often incomplete, but neverthless with some success stories.

INDIA : Speaking of the Indian experience over the last thirty years, it has been observed that conveying knowledge, skills and experience is not easy. The Indian scenario consists of a large number of publicly funded R&D Institutions under various Agencies like the Council of Scientific & Industrial Research (CSIR), the Indian Council of Agricultural Research (ICAR), the Indian Council of Medical Research (ICMR), the Space Research Organization (ISRO), the Bhabha Atomic Research Centre (BARC) etc. The oldest of these is the CSIR which between its numerous R&D Centres and Co-operative Research Associations is staffed by about 10,000 technical personnel with a large infrastructural, science and engineering base. Besides the CSIR and the other Agencies which in terms of the scale of investment and human resources deployed, constitute a very large R&D resource base, the public domain also includes large funding for R&D programmes in the Universities and Higher Technological Institutions, some of which are in the nature of inter-disciplinary, inter-institutional All-India co-ordinated programs.

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Besides the R&D Centres, the other structures which play an important role in technology development are the Consultancy Engineering firms. Some of these in the public domain like the (EIL) Engineers India Ltd, MECON EPDIL, CMPIDO, NIDC are large organizations capable of undertaking both basic and detailed engineering in their own areas of speciality like petroleum process refining, petro-chemicals, fertilisers, ferrous and non-ferrous industries. Besides the Consultancy Engineering firms in the public domain, there are a large number of active consultancy firms in the private sector with limited capabilities in design and detailed engineering.

The laboratory work in the initial years was one based on forward thinking by the scientists who conceived of a technology gap or a process gap for a product in demand and came up with bench scale solutions. Experience has however shown that even when these were taken to the pilot plant and scale upphase, the communication gap between Industry and Laboratory was still very wide. Mechanisms had to be evolved for bridging these gaps and providing the various requirements which included feasibility reports, market survey, basic engineering, detailed engineering and assistance in erection, start-up. trouble shooting, plant maintenance etc. While the laboratories themselves could take on some of these jobs, it was found possible to provide some of the other services through consultancy firms.

However, successful transfer of technology to one unit itself does not make an adequate impact at the national level. Through trial and error as well as by the deployment of scientific and engineering skills, an entrepreneur would have succeeded in receiving and adapting the technology for successful production. However, unless his operating experience is standardised to a degree where it can be

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successfully replicated to produce re-generative technology, the technology is not available to give a multiplier effect. This is an aspect which is to be gone into, especially as industry when successful may not like to share its expertise to avoid competition.

Another important experience that has come in technology transfer is that both the cost frame and time frame of technology transfer can be substantially reduced if operating and working expertise from engineering and fabrication companies is brought to bear on technology development in the laboratories at least during the scale-up stage. The drawings and designs as evolved in the laboratory must have a relevance to the working expertise and fabrication capabilities available with the engineering firms. What this really means is that the engineering and consultancy firms have to develop "backward linkages" with the laboratory at the R&D stage itself. The backward route is based on the concept that the need and extent of the experimental work in the laboratory depends on the capability and experience of the agency involved in detailed engineering designs. A two way evaluation mechanism is also contemplated in that while consultancy and engineering firms will evaluate the R&D work and determine the additional R&D inputs that are essential, the R&D institution itself may carry out an evaluation of the detailed engineering/ design firm agency.

The desirability of operating expertise being linked to R&D efforts through "Backward Linkages" was just now mentioned. Correspondingly R&D scientists should reach out to develop "forward linkages" with the end-user and industry. The starting point of technology creation or development is a clear enunciation of the required technology and opportunities criteria. If the

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R&D effort is market oriented, the output of R&D effort is tailor made and usually very close to appropriate technology. As a consequence, the adaptation process gets simplified and reduced to some minor modifications. The hardest thing is to identify and define in precise terms the R&D work that is required. Once the problem is identified, results usually follow. Development of such "forward linkages" with the market requirement can play a positive role in creating a market demand for the technologies generated.

An important aspect in marketing technology is that all the agencies involved, whether it be the buyer or the seller or the engineering firm should be prepared to work as a team towards the common objective of successfully completing the project. Projects of this type being developmental in nature, legal positions and purely commercial stands taken by any party are not likely to be conducive to the success of the project.

The National Research Development Corporation(NRDC) created as an Agency in the public domain specifically for promoting and effecting technology transfer has through its long years of experience developed considerable expertise in the "technology of technology transfer". The NRDC has devised mechanisms for utilising consulting Engineering Firms as the "Midwives of Technology Transfer and Diffusion", and giving them a prime role in facilitating technology transfer from domestic R&D laboratories to Industry. NRDC's strategy involves strong institutional linkages with R&D Centres on the one hand and consulting Engineering firms on the other through back-to-back agreements to provide a consortium approach. ~~In acting as a consortium~~

In acting as a Consortium leader NRDC provides a complete technology package with performance guarantees and acts as a single focal point to an Entrepreneur for negotiations.

An innovation evolved by NRDC is the backward route. The backward route is based on the concept that the need and extent of the experimental work in turn depends on the capability and experience of the Agency involved in detailed engineering design. There is also a two way evaluation mechanism contemplated in that while the Consultancy firm will evaluate the R&D work and determine the additional R&D inputs that are essential, the R&D Institution itself may carry out an evaluation of the detailed engineering design firm/Agency on the following guidelines:

(1) availability of a team of mechanical, electrical instrument, civil, piping, vessels and utility engineers;
(2) availability of internationally acceptable engineering and drafting standards;
(3) experience in engineering of a number of plants of similar nature;
(4) good project management roup including project managers, estimators, planners, buyers, inspectors, site supervisors, contract administration etc.

At each stage of development of the process, working expertise, data from literature and experience of the Agency involved goes in to makethe process workable. Selection of an Agency for each of these stages is very important and goes to make or break the project.

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At each stage of development of the process, working expertise, data from literature and experience of the Agency involved goes in to make the process workable. Selection of an Agency for each of these stages is very important and goes to make or break the project.

In a technology being developed from scratch, it is not correct to "freeze" each stage before going on to the next stage. It happens almost always that one may go back to the previous state due to problems revealed in the next stage. It is therefore not entirely possible to establish normal commercial basis for transfer of technology upto the stage of selection of vendor systems(by which time the project would have reached a good portion of even the detailed engineering stage). Before reaching this particular state, documents submitted or prepared do not mean "goods" delivered. They remain technical proposals. Also, there will have to be a tremendous amount of back-and-forth communications between different agencies and groups.

All groups/agencies ought to be involved from a stage before completion of "Process" stage upto completion of "Basic Engineering" stage. However, for coordination and lead, some main agencies may be chosen.

(i) Process Development Laboratory
(ii) Process Design and Basic Engineering Group
(iii) Project Engineering Group
(iV) Group with plant operating experience from an allied industry (with similar process/problems).

It is possible that more than one or even all groups are available under one corporate entity. However under the existing state of growth of Indian Consultancy firms, it may be desirable to form consortia, and adopt the consortia

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approach to such problem solving to provide the entire range of expertise that is necessary, with one of the Consulting firms being nominated as the lead agency which will coordinate activities between the different agencies. Negotiable basis can be "Cost plus", fixed fee, lumpsum turnkey price percentage etc.

NRDC attempts to take care of all the elements of technology transfer, which is a truly professional job and requires back-up services for the following aspects:

(i) planning; (ii) selection of equipment; (iii) layout; (iv)purchase of equipment; (v) erection; (vi) selection; recruitment and training of staff; (vii) commissioning; and (viii) trouble-shooting.

The success of transfer depends on the transmitter, the receiver, the technique, the channel of transfer, and the climate. In each of these areas, gaps, if any, should be identified and bridged to ensure successful transfer.

The contents of a technology transfer agreement should include a clear presentation of patents and knowhow involved, basic designs of plant and procedures in compliance with local requirements, guidance on procurement, installation and operation of machinery, quality control, marketing, and a definite program of training of personnel at all required levels, as may be necessary.

Apart from the above, other important aspects of technology transfer are: (i) technical and commercial information or data in the form of specifications, blueprints, test results, and other documents; (ii) capability or skill which is not easily definable on paper:this may be transmitted by training of staff and with assistance of specialists; and (iii)capital goods and specialized components, which ensure the performance envisaged by the designers: this may also include catalysts.

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The success of the transfer operation also depends on proper evaluation of the process. In this context, following questions may have to be asked:

1. Is the technology proven?
2. Is it an improvement on an existing technology?
3. Is there scope for expansion and improvement?
4. Is it suitable for local conditions and appropriate for the purpose envisaged?

Ultimately, however, the success of technology transfer depends to a large extent on the resourcefulness of the entrepreneur, who must have the necessary background to understand and assimilate the technology.

Because the NRDC is dedicated to innovation, the industrial projects which it has supported have invariably been of a high risk nature. The greater the degree of innovation, the greater has been the risk of failure on both technical and commercial grounds. NRDC has provided risk finance in those cases where conventional sources of funds were either unwilling to become involved or were unable to offer a satisfactory financial package. The accepted and advertised practice in joint ventures is for NRDC to invest in equity or pay the client Company an agreed proportion (normally but not necessarily 50%) of costs incurred in connection with the project and to recover this through a percentage levy charged on subsequent sales. The concept has been one of shared risk, in that NRDC's return is directly related to the consequent volume of sales and in the event of failure the NRDC takes its share of the loss. This method of funding has no parallel in venture capital or merchant banking practice. Because returns are by way of a percentage charged on sales, the effect of inflation are self-compensating.

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Nevertheless, much more needs to be done in the provision of financial support for technological innovation, the so-called "pre-development gap", the lack of facilities for underwriting technical performance guarantees and the general lack of support for new technology based firms. In the export of technology, a corresponding gap is the underwriting of technical risk, particularly for turnkey contracts where there is a greater order of risk. Loss of opportunities can be avoided only if NRDC can step up its venture capital support through tie-ups with financial Institutions, especially for small innovative enterprises, start-up Companies and for export of technology.

Since NRDC is able to interface with Entrepreneurs and Industry better than Development Banks, it has under proposal a scheme to draw on the finances of Development Banks, and act as a conduit to provide rsk finance for Entrepreneurs for profitably combining indigenous R&D with investment capital. This should enable NRDC to augument its limited financial resource base which now comes from the limited equity capital and loan monies it raises from Government.

Entrepreneurial Development and provision of entrepreneurial motivation: This has been a relatively neglected area and it is clear that there is an immediate need to strengthen the characteristics of the technology recipient base. NRDC's analysis clearly shows that the fault does not lie with scientists or bench-workers. The weakness of the system has been in the lack of effort needed to generate the software working culture within institutions, concurrently with the development of systems to reach out to a large diversity of end-users, while providing the multiplicity of inputs that are needed to complete the innovative chain. A massive national effort needs to be mounted for entrepreneurial development and entrepreneurial motivation.

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NRDC is also attempting to provide the Law makers the basic data to decide upon provision of fiscal reliefs and the reform of law, especially patent law expertise, to enable these to be integrated into the S&T innovation chain. Specific points for consideration are:(a) the urgent need to reform patent laws and trademark practices; and (b) provision of professional satisfaction and recognition to scientists and innovators to adequately motivate them.

Guidelines followed by NRDC of India in Licensing Know-how

(1) Normally NRDC licenses both know-how and patents. Only in the case of individual inventors NRDC insists upon patents.

(2) Usually, the know-how and patents are licensed on a non-exclusive basis. In early years exclusive licensing has been done but experience has indicated that there was no special merit in such a practice.

(3) NRDC accepts a lumpsum payment at the time of signing the licence agreement and stipulating payment of a specified amount of royalty as a percentage of sales. The period of payment varies between 5 to 10 years.

The mandate of NRDC being the transfer of technology from R&D institutions to industry, and as the policy of the government is to help establishment of small scale industries, the payments taken by NRDC for giving the know-how and licensing patents are modest, in most cases less than 5%. Only in one case the royalty rate was 7%. NRDC is flexible in its approach with regard to collection of lumpsum premium and royalty. If an entrepreneur does not want to pay any royalty, NRDC will negotiate a total payment in instalments over a period of years. Even the small lumpsum specified for payment at the time of signing the agreement is collected in instalments if the entrepreneur is not capable of paying it at one time.

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Special Scheme of NRDC of India for Promoting Transfer of Technology

NRDC is currently implementing two schemes for generating confidence in the buyers of technology.

(i) Financial collaboration between NRDC and the entrepreneur

Under this scheme NRDC and the entrepreneur collaborate to establish a pilot plant or a demonstration unit or build a prototype. The total cost of the project is divided in the ratio of 50:50 between the entrepreneur and the NRDC. Such payments from NRDC are interest free. After successful completion of the project the entrepreneur is expected to pay back to NRDC their contribution but without any interest. The technology is also licensed to the entrepreneurs on preferential terms. When the technology is licensed to other parties the benefits are divided between the entrepreneur and the NRDC on mutually agreed terms. If the project is unsuccessful NRDC writes off its contribution to the project. Under the incentives provided by the Government of India for R&D, the entrepreneur also is in a position to claim the losses as a tax rebate.

(ii) Equity Participation

NRDC can participate in equity in companies specifically established for exploiting NRDC technologies. The equity can be of the extent of 25%.

Technology transfer from R&D institutions to industry involves a highly complicated operation. There are many factors--status of the technology, capability of the entrepreneur, markets, fluctuating prices, imports, availability of raw materials, etc--which influence the successful establishment of commercial production. However, by studying cases of successes and failures in technology transfer, some broad conclusions could be drawn as to the factors that go to make a technology transfer operation a success--or a failure. There is an important need for developing the process on the largest scale possible, so that the technological difficulties are minimized. And sufficient care must be taken in the selection of the

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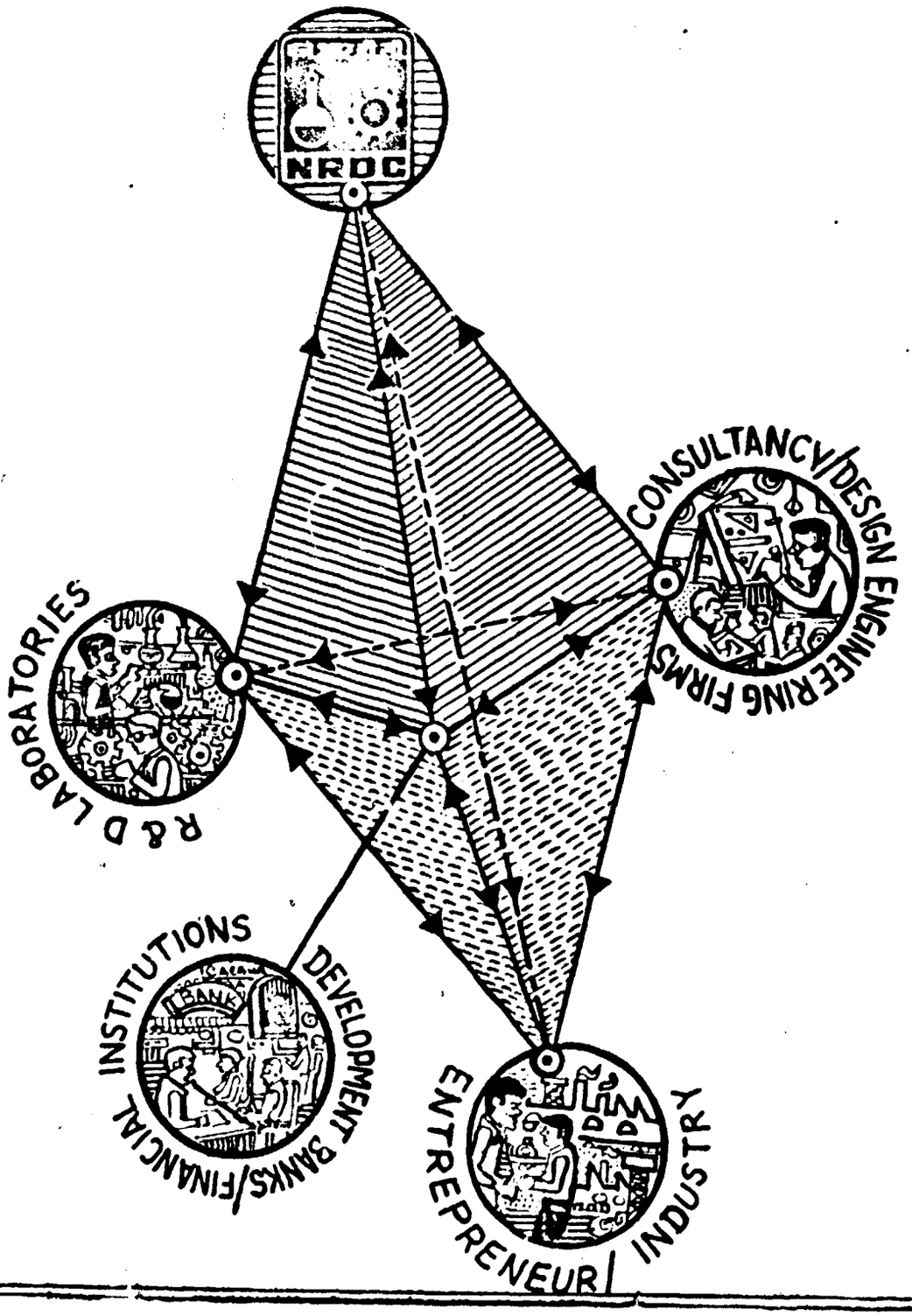
entrepreneur, keeping in view his personal capabilities and the resources that he can garner for the successful implementation of his venture. Of course, he has to be given necessary financial and technical support, wherever needed. The existence of markets cannot be over emphasized. And association of the user and a competent consulting design and engineering firm with the R&D institution, from as early a stage as possible, would go a long way in making technology transfer a success.

The NRDC as the Licensor & prime co-ordinator, the R&D Laboratories, consulting Engineering Firms, the Entrepreneur and Risk Financing Institutions working together for technology transfer is graphically illustrated in the TRIGONAL BIPYRAMID structure given below:

DYNAMICS OF TECHNOLOGY TRANSFER

THE INDIAN EXPERIENCE AND EVOLUTION

MULTIPLE INTERACTIVE SYSTEMS AND COUPLING MECHANISMS (A TRIGONAL BIPYRAMID)



Effective interfacing and dynamic interaction as illustrated can bring about the much needed technological transformation through indigenous R&D.

The NRDC has so far signed over 2000 Agreements commercialising in the process more than 400 indigenous R&D technologies. As is readily apparent, many technologies are under commercial production by more than one entrepreneur.

KOREA

Nearly 65% of the R&D spending in Korea is accounted for by the public sector research institute system (Government institutes, public institutes and universities). The dominance of the public domain research institute system in Korea finds a parallel in most Developing Countries, including India. The issue is whether the Institutes in the public domain serve Industry effectively. In Korea, the public sector research institute system does not seem to have the inclination and capability to supply industry with rapidly growing and increasingly complex industrial technologies.

In 1966, the Government established the Korea Institute of Science & Technology (KIST), a multi-disciplinary research institute, to perform industry oriented RD&E activities. During 1976-78, the Government established some 15 additional public research institutes to complement the functions of the existing institutes. These institutes many of which are spin-offs of KIST, specialise in individual target industrial sub-sectors. Unlike KIST which was under the responsibility of MOST, these institutes were placed under relevant operating Ministries with a view to promoting close link with the respective industries.

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These Institutes recruited heavily from academic fields, and consequentially found themselves particularly weak in manufacturing know-how and the development of proto-types, and could not compare with foreign licensors in supplying the detailed blueprints and other manufacturing know-how as well as in assisting industry to solve teething problems in the crucial initial production stage. As such, their work tends to be too theoretical to serve industry effectively. The weak link between industry and public research institutes is best illustrated by the volume of Industry's contracts with these Institutes.

In a major departure from the nature and activities of other public research institutes, KIET was established as an RD&E-cum-service organisation to support the electronics industry. KIET's RD&E work is done on facilities that can also be used for production purposes, and the manufacturing know-how will be readily transferable to industry.

In December 1980, in order to form an effective critical mass, and to avoid the pitfalls of spreading limited resources too thin, the Government merged closely related public research institutes, reducing the number from 19 to 13, and consolidated the administrative responsibilities under MOST.

The Government is currently formulating policy measures to promote closer co-operation between public research institutes and industry. During the fifth five year plan (1982-86), the Government (MOST) would commission the public research institutes to carry out "national projects" to develop jointly with industry, technologies in areas of critical importance to future growth, such as semi-conductor, computers, fine chemicals, automobiles, nuclear engineering and industrial systems engineering.

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Although it is too early at this stage to assess how successful "national projects" will be in promoting a closer link between public research institutes and industry, it is almost certain that other mechanisms will be called for if the link between industry and public research institutes is to be further developed. One such mechanism would be to channel a certain percentage of research institutes' annual budgets through intermediaries such as KTDC, which would then use the funds to finance a p. t of the cost of the RD&E projects from industrial compenies to be contracted out to research institutes. This arrangement is under consideration by the Government.

KTDC was established in 1981, as a private sector entity with strong private sector support to fill the Institutional gap in the Korean Capital Market. KTDC will help strengthen the link between public research institutes and industry through its financing of RD&E projects sponsored by Industry but carried out by the Institutes.

KTDC will complement the activities of existing financial institutions, as well as those of other industry support organizations, including KTAC and KOPTEC. KTAC was incorporated in 1974 as a wholly owned subsidiary of KIST, now the Korean Advanced Institute of Science & Technology(KAIST), an institute of technology-cum-RD&E institution, with the primary objective of commercialising production technologies(products and processes) developed by KAIST. To this end, it was set up to prepare detailed feasibility studies for selected projects with strong commercial potential based on the results of KAIST's RD&E efforts, and to approach interested parties to sell such projects for a commission. It will also make equity investments in such projects. During the last few years, KTAC has made about a dozen sales of know-how and half a dozen equity investments, with its total assets amounting to about US$ 1.5 million. It is currently seeking to increase its share capital.

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KTDC will put strong emphasis on sharing the risks with project sponsors and thereby will influence and reinforce industry's attitude towards further undertaking of RD&E's activities . The financial support provided by KTDC will basically serve as "seed money" which should have a multiplier effect on industry's RD&E investment necessary for the accelerated development of industrial technological capability. In addition with its firsthand knowledge of the status of technological development and needs of industry, through direct contact at the firm levels and through periodic surveys by KTDC staff and consultants, KTDC will be in a good position to assist industry to identify international technological trends and areas in which it should focus its RD&E efforts. Also through the process of appraising and particularly supervising its RD&E projects, KTDC will induce a measure of discipline, and hence increase the efficiency in industry and management of RD&E activities. Finally KTDC will promote a closer link between industry and public research institutes, by encouraging and financing projects sponsored by industry and carried out by these research institutes.

Since KTDC's financing is oriented towards the risk sharing, venture capital type, KTDC will emphasise ~~x~~ software loans without collateral, rather than hardware loans with collateral security, as financing for the latter may be available from other financial institutions. In supporting industry RD&E ventures, KTDC will put strong emphasis on sharing the risks with project sponsors and thereby will influence and reinforce industry's attitude towards further undertaking of RD&E's activities. The financial support provided by KTDC will have a catalytic and multiplier effect on industry's RD&E investment necessary for the accelerated development of industrial technological capability. In addition, with its knowledge of the technological status of industry and technological trends through surveys and studies, KTDC will be capable of assisting industry in identifying areas in which it should focus its RD&E efforts. Also through the process of

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appraising and particularly supervising its RD&E projects, KTDC will induce a measure of discipline, and hence increase the efficiency in industry's management and implementation of RD&E's activities. Finally, KTDC will promote a closer link between industry and public research institutes, by encouraging and financing projects sponsored by industry and carried out by these research institutes.

The most important lesson from other institutions in the world that are of similar nature to KTDC is that, for this kind of risk-sharing financial operation to be successful, the institution must have autonomy and a strong, independentand entrepreneurial management, and the ability to attract and retain a competent and a high-calibre professional staff. This condition has been met in the case of KTDC which has also evolved sound legal framework and operating policies and procedures that provides KTDC with the autonomy and flexibility of a private sector organization.

Another aspect that is also of critical importance to KTDC, is the financial support that it requires during its early stage of operation. Unlike most of its counterparts in the world which are government-owned and financed through government's annual budgets, the majority(60%) of KTDC's share capital is owned by the private sector. Due to the nature of the risk-sharing business, a new Company such as KTDC, is expected to experience losses of income during its initial years (5-10 years) of operations before earning profits when its risk taking ventures begin to yield returns. During this period, KTDC should be able not only to withstand these losses, but also to mobilize additional funds from various sources including the capital market to continue and expand its operations. As such the Government's firm commitment to provide KTDC with the necessary financial assistance,

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such as equity capital and loans, as well as funds to cover a portion of KTDC's losses pertaining to its conditional loans during this 5-10 year period would be crucial.

PHILIPPINES :

The TTB (Technology Transfer Board) is an inter-agency body attached to the Ministry of Industry, which requires registration of all technology transfer arrangements. It was created by a Presidential Decree.

The Technology Transfer Board is composed of representatives from the National Economic and Development Authority, Central Bank of the Philippines, National Science and Technology Authority, Technology Resource Centre, Board of Investments and Philippines Patent Office under the Chairmanship of the Ministry of Industry, which enables it to operate as a well co-ordinated and represented body.

The Board has the following functions:

a) Formulate policies, including a system of priorities which would promote an integrated approach to the developmental and regulatory roles of the government in the field of technology transfer;

b) Issue rules and regulations for the effective, efficient and economic implementation of policies and guidelines relative to technology transfer;

c) Establish a system for co-ordinating all governmental activities on technology transfer and ensure continuing and meaningful interaction among various governmental agencies, particularly with respect to the determination of the impact of technology transfer on national development;

d) Serve as a forum for the continuing interchange of ideas and information among the concerned government agencies, the private sector and the general public on policy issues, problems and alternative approaches relating to technology transfer; and

...

e) Perform such other functions as may be necessary for the accomplishment of its objectives;

f) The TTB has the specific function that all technology arrangements are required to be registered with the Board after due evaluation in the light of the technology transfer policies set by the Board, subject to such sanctions the Board and/or its member agencies may impose for the effective implementation of this requirement.

In evaluating agreements the Board is guided by such policies as:

a) Appropriateness and need for the technology/industrial property rights;

b) Reasonableness of the technology payment in relation to the value of the technology to the technology recipient and the national economy;

c) Restrictive business clauses shall not be allowed in any agreement. Among these are:

- Those which restrict the use of technology supplied after the expiry of the agreement.
- Those which require payments for patents and other industrial property rights after their expiration, termination or invalidation.

d) The agreement shall provide that the law of the Philippines shall govern the interpretation of the contract.

e) The agreement shall provide for a fixed term not exceeding five years and shall not contain an automatic renewal clause in order to ensure adequate adaptation and absorption of technology.

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National Science and Technology Authority:

The National Science Development Board (NSDB) was reorganized into the National Science and Technology Authority (NSTA) by the issuance of Executive Order No. 784 on March 17,1982.

The NSTA is mandated to formulate a national plan for science and technology. Upon approval by the President, the plan is to be implemented by all government agencies and institutions.

The objectives of NSTA are:

a) To stimulate and guide scientific, engineering, and technological efforts towards fulfilling the basic and the immediate needs of the people;

b) To survey scientific, engineering and technological resources of the country and formulate a comprehensive program for the development and maximum utilization of such resources in the solution of the country's problems;

c) To strengthen the educational system of the country so that the same will provide a steady source of competent scientific and technological manpower;

d) To furnish incentives to private and individual initiative in scientific work, as a fundamental basis for the advancement of science;

e) To promote and encourage the dissemination of the results of scientific and technological research and the general application thereof;

f) To encourage and facilitate the active participation of domestic and foreign sectors in furnishing financial, technical and other forms of assistance for scientific and technological activities;

g) To promote co-ordination in research in order to secure concentration of efforts, minimize duplication and thereby achieve maximum progress;

h) To initiate and bring about the establishment of standards, quality control measures and documentation facilities; and

i) To encourage studies in the pure and fundamental sciences.

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Sectoral councils are created under the umbrella of NISTA. These are :

- The Philippine Council for Industry and Energy Research and Development (PCIERD).
- The Philippine Council for Health Research and Development (PCHRD).
- The Philippine Council for Agriculture and Resources Research and Development (PCARRD).
- The National Research Council of the Philippines (NRCP).

PCARRD, PCHRD and PCIERD are under the administrative supervision of the Authority while NRCP remains as an attached agency for purposes of policy co-ordination.

The NRCP has retained its character as a collegiate body of scientific workers, and is responsible for basic and social science researches. The governing bodies of the three applied research councils are composed of government officials and private sector representatives appointed by the President. This composition guarantees the council's linkage with national development, and provides for wider participation of all sectors concerned.

All R&D institutions are under direct supervision of the Authority. Amongst these are :

a) The National Institute of Science and Technology (NIST)
b) The Philippine Institute of Volcanology (PHIVOLC).
c) The Forest Products Research and Development Institute (FPRDI).
d) The Food and Nutrition Research Institute (FNRI).
e) The Materials Science and Research Institute (MSRI).
f) The Philippine Atomic Energy Commission (PAEC)

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The R&D Institutes adopt a task force approach in the new organizational set up to provide for flexibility under the scheme, research personnel being grouped into task forces or research teams for specific programs and projects. Upon completion of a program or project, the researchers concerned become available to join other existing programs or projects or form new ones.

Also under the umbrella of the NSTA are three S&T support agencies. These are:

a) The Philippine Invention Development Institute (PIDI)
b) The Science Promotion Institute (SPI)
c) The National Academy of Science and Technology (NAST)

Two major developments further strengthened the technology transfer capability of the NSTA. Firstly, an Executive Order virtually institutionalised the technology transfer within the NSTA and its agencies. A technology utilization division NSTA was created to identify and promote the utilization and commercialization of R&D results. Each of the R&D institutes was likewise directed to organize their own technology transfer and utilization units.

Secondly, under the umbrella of the NSTA - KKK Action program (a machinery for the active and systematic diffusion of technologies generated by NSTA research agencies), the NSTA research institutes identified about 50 viable technologies for transfer to the rural areas and pinpointed the suitable areas where these technologies can be applied.

NSTA has linkages with the Technology Research Centre(TRC) in matters concerning commercialization of technology. Also it has linkages with 25 industry sectors of the Ministry of Trade and Industry including the small and medium - scale industry groups of the Bureau of Small and Medium Scale Industries (BSMI).

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Technology Resource Centre :

The Technology Resource Centre is a government corporation created in 1977 by a Presidential Decree. It is attached to the Ministry of Human Settlements, but operates independently under its own charter.

The TRC was organized to promote, foster and spread the use, application and commercialization of all kinds of technology which will give social and economic benefits to the people. It is also a link between the scientific community engaged in research and the end users of technology.

To carry out its tasks, the TRC offers a package of services to technology developers, small and medium - scale industries, urban and rural workers, entrepreneurs, industrial workers, households, community leaders and the general public.

These services are: technological information, technical advice and training, management, financing and marketing assistance for industries making use of the new technologies, and computer services.

The Technology Dissemination Department (TDD) spreads technology by creating popular awareness of its value and its many uses and by transmitting knowledge of the latest and most appropriate application of science and scientific methods.

Under the TDD are: Popular Technology Program (POPTECH); People Program; Technobank; Bagnog Lipunan Sites and Services Level II (BLISS II) Program and the Technology Library.

The Technology Utilization Ventures Department, composed of the Technology Utilization Support System(TUSS) and the Technology Ventures Development Program (TVDP), promotes the use of new or improved technologies which have market potentials.

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TUSS provides pre-investment services including funding assistance, management consultancy, technical advice and marketing assistance to help institutions and individuals launch developed technologies into the commercial market.

TVDP, on the other hand, assists institutions and individuals in the manufacture of technologies and innovations which have passed both technical tests and economic viability studies.

A Presidential directive authorised the TRC through the Livelihood External Assistance Program (LEAPO) to be "the implementing arm of the National Science and Technology Authority for fostering and promoting the commercialization of available and appropriate technologies" by putting all foreign-assisted TRC loan programs under one management group.

The LEAPO has three programs under it; the Export Industry Modernization Program (EIMP), the Agro-Industry Technology Transfer Program (AITTP), and the Urban Livelihood Financing Program (ULFP).

The Information Systems and Services Department(ISSD) provides computer-generated economic and technological information, the ISSD is composed of the Systems Services Program (SSP), the Computer Services Program (CSP) and the Graphics Services Program (GSP).

The SSP designs and develops programs, systems and other soft-ware that enable decision makers and managers in government and private institutions to use the computer in the various aspects of management.

The CSP operates a computer services time-sharing network which is monitored and controlled at its central site facility. This network is capable of providing both on-site and off-site data processing services through remote stations. The network offers a wide array of utilities and software packages to technical, scientific, as well as commercial applications.

Intellectual Property Rights :

In protecting industrial and intellectual property rights and in promoting scientific research and invention, the Patents office plays a constructive role.

CHINA :

China is very different in some respects from other Developing Countries and only some of these will be commented upon.

As there is no patent system in China for a long period of time, the transfer of technological achievements has always been rewardless. In the past there was lop-sided thinking that the unanimity of interest between socialist enterprises and between these enterprises and the research institutes, the transfer of technology would automatically take place without any conditions, as the transfer would be beneficial to Society as a whole. However, experience over a long period demonstrated that this was not working. Two years ago, China began to give rewards to the transfer of technological achievements on an experimental basis. This turned out to be quite beneficial, as it generated in the transferor a higher sense of responsibility and obligation. In order to promote the transfer and diffusion of achievement on a large scale, the Chinese are now putting into practice the system of transfer with rewards.

China is also conscious that their technology management level needs to be strengthened and has recognised this as a basic weakness in their development and transfer mechanism.

SRI LANKA :

The Ceylon Institute of Scientific & Industrial Research (CISIR) is the largest complex of applied research activity in the Country. While most of the projects that are being handled are carefully selected, relative to their immediate relevance to the Country's needs, technology transfer is accomplished on a relatively ad-hoc basis. Besides the CISIR, there are other Institutions in Sri Lanka which play a part in the process of technology transfer and development. The principal problem is lack of co-ordination, and in particular the isolation of the research and development organizations from both the productive system and the system for monitoring and screening imported technology. For these reasons, Sri Lanka Centre for Technology was established within the Ministry of Industry and Scientific Affairs, with appropriate linkages with other Ministries and organisations concerned. Sri Lanka did not consider it necessary to set up an entirely new apparatus, and preferred to draw upon the existing potentially available arrangements.

MEXICO :

Prominent amongst the R&D Institutions in Mexico may be mentioned IMP, Institute de Investigations & Application Eu Systems UNAM, Centre De Investigations, IPN Av Institute Polytechnique Degasses; Institute of Investigation Electricas.

INFOTEC which is run on commercial lines has been identified as a successful operating technology transfer Agency.

IRAQ :

In Iraq, yet another approach has been made. Iraq is building up a socialist economy.

Their technology centre is composed of five departments.

1. Technology Planning and Policy

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2. Technology unpacking and evaluation
3. Technology Information
4. Registration of Contracts, agreements and other technology documents
5. Co-operation Department

The Centre was set up as a separate entity and guided by a technolog board which has close links with the National Planning Board.

JAPAN :

Japan is selected as an example of a Developed Country, and a brief resume' is given of the Exploitation Activities of the Research Development Corporation of Japan.

JRDC

Research Development Corporation of Japan was established on July 1, 1961, under the Research Development Corporation Act. The purpose of this national corporation, operating under Science and Technology Agency, is to develop the outcomes of scientific research in Japan on an industrial level and to promote the effective exploitation of such development.

Many domestic research projects, however, although potentially applicable to industry, are apt to be left at a stage at which they require further development before they can be fully exploitedby industry. This tendency is partly due to hesitation at undertaking projects in fields new to industry and partly due to a lack of sufficient development capital within industry.

To meet this situation a proposal was put forward by the government as well as by interested groups in industry; it called for the establishment of a national organization devoted solely to the task of bringing promising research projects to the attention of industrial circles in order that they could be fully exploited by industry, the cost of development being borne by the government. Thus was established the Research Development Corporation of Japan which plays a liaison role between research centers and industry. ...

It selects prospective research projects and assumes full responsibility for undertaking the developmental work.

I ORGANIZATION AND CAPITAL

The organization, capitalization and others matters relating to the Corporation are set out in the articles of Research Development Corporation Act of 1961.

The capital, which is provided by the government, amounts at present to 14.8 million dollars with an expected annual increase of a few million dollars.

II FUNCTIONS

The tasks of Research Development Corporation of Japan can be outlined broadly as follows:

1. Development of new research projects of national importance whose industrial application entails difficulties (Commissioned project)
2. Effective exploitation of projects following stage 1 (Exploitation)
3. Liaison activities related to promising research projects which have industrial application (Liaison)

...

1. Commissioned Project

a) Investigation and Selection of a New Project for a Commission

There are now more than one hundred national and other public research laboratories, in addition to numerous private institutes, carrying out research in Japan. The Corporation conducts a close examination of submitted research projects undertaken by these organizations to determine whether any should be classed as "commissioned" research projects in that they may be difficult to develop but with a potential industrial application.

After further consideration of these research projects by the Development Council, some are selected by the Corporation as new development projects.

b) Selection of an Industrial Firm for a Commission

The Corporation then proceeds to tailor the selected project to its requirements and takes the measures necessary for its full development such as obtaining licences from the researcher. It will then be announced publicly that the project is available for bids by interested firms. After receiving tenders, the Corporation carefully examines the applicants' qualifications for commission on the basis of their technical competency, financial soundness and interest in carrying out the developmental work. Thus a company suitable for a commission will be selected.

...

c) Method of Granting a Commission

Between the Corporation and the selected firm negotiations will proceed in the following manner:

1. Detailed study of the developmental project
2. Determination of the financial assistance to be advanced by the Corporation and its method of payment
3. Licencing and other protective measures
4. Setting of Standards to determine the success or failure of the project
5. Determination of royalties and method of payment

When agreement is reached on all questions and the contract signed, the Corporation, by acting as co-ordinator between the research group and the selected firm, supervises the development work.

d) Evaluation of the Development

Upon completion of the developmental work, the Corporation, on the advice from the Development Council, will assess the results to determine success or failure in accordance with the standards set in the initial agreement. Evaluation is based on whether or not the project has reached a stage at which it can be considered a success in terms of its industrial application. This criterion is set out in as specific a manner as possible, both from the economic and technological points of view.

... [redacted]

e) Steps to be taken after completion

1. Success

When a development project has been judged as being successful, the firm which carried out the project begins its exploitation and repays the commissioned sum to the Corporation in annual instalments over a period not to exceed five years; it also pays the Corporation the agreed royalties. Approximately half of all royalties thus received will be in turn forwarded to the research organization which undertook the original research.

2. Failure

When the project is determined to be unsuccessful, the firm will cease work and repayment of the commissioned sum will not be required. The Corporation shall repossess the remaining related material, etc. from the firm for disposal.

2. EXPLOITATION

The technological opportunities gained by a firm as the result of a commissioned project will usually be followed up by the same firm and legitimately incorporated into its regular operations. If the firm so wishes, the right of exploitation may be retained exclusively by the firm for a given period. As such a period of monopoly control draws to an end, the Corporation will invite other parties to undertake wider exploitation, subject to a specified licence fee. Part of the fees thus obtained will be forwarded to the original research organization.

...

3. LIAISON

In addition to commissioning developmental projects, the Corporation performs the role of mediator between research organizations and industrial firms.

When a request for liaison on an engineering matter is received by the Corporation, it finds a suitable party to meet the requirements of the applicant and carries out the necessary mediation.

Especially, the Corporation conducts evaluation of patents invented in more than one hundred national research laboratories using outside evaluators. When an interested industrial firm is found, the corporation negotiates a license with the company under the patents rights on behalf of the national research laboratories. If the mediation is successful, the corporation obtains the intermediary fee.

II - A study of the specific technologies proposed for commercialisation by the National Council for Research of Sudan, and the present facilities available in Sudan for their commercialisation :

Visits in accordance with a carefully worked out schedule were made to National Council for Research, Council for Scientific & Technological Research, Council for Medical Research, Energy Research Council, Agricultural Research Council, Social & Economic Research Council, the National Documentation Centre, Faculties of Engineering & Architecture in the University of Khartoum, Buildings & Road Research Institute, Industrial Research & Consultancy Centre, Food Technology Research Centre, The Institute of Technological Colleges, the Management Development Centre, the Patent Law Office, the Ministry of Industry, the National Energy Administration Department, the Industrial Bank, the Sudanese Industries Association, the Saeed Food Factory, a number of private entrepreneurs, Private Consultants and the Engineers Club, apart from discussions with officials of UNDP/UNIDO. The officials/Experts/Entrepreneurs with whom discussions were held and briefs obtained are listed at the end of this chapter. Through the courtesy of the President, NCR, and Secretary General, NCR, ample opportunities were made available for studying the physical and experimental facilities, and for technical discussions with experts in all relevant cross-sections of the Sudanese Scientific Community, as well as inter-related Institutions.

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Between the NCR and the four specialised Councils i.e, the ARC, ESRC, STRC and MRC which cover all the main development sectors, there is complementary leadership in Science & Technology(S&T). The five National Committees and Centres (the Atomic Energy Commission, the National Computers Committee, the National Committee for Man, Environment and Development, the National Remote Sensing Centre and the National Documentation Centre) and the Centres affiliated to the Council (Institute of Tropical Diseases, the Medical and Aromatics Herbs Unit, the Institute for Oceanography; the Institute of Energy Research, the Central Instrument Repair Workshop; the Cellulose ~~Resource~~ Research Unit and the proposed National Centre for Technology, speak of the coverage. Besides these are Institutions co-operating with the NCR and giving strength to the total structure which are listed herewith (i) The Universities of Khartoum, Juba and Gezira (ii) Veterinary Research Administration (iii), the Agricultural Research Corporation (iv) Food Processing Research Centre of the Ministry of Agriculture, Food and National Resources (v) the Tanning Institute of the Ministry of Agriculture, (vi) Food and Natural Resources; (vii) the Industrial Research & Consultancy Institute of the Ministry of Industry; (viii) the Research Wing of the Meterological Dept; (ix) the Geological and Mineral Resources Dept of the Ministry of Energy and Mining and (x) the Building and Road Research Institute of the University of Khartoum.

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It is thus observed that the NCR being directly attached to the office of the President of the Republic, and operating through a number of research units, centres and institutions, some of which belong to various Ministries and Govt. Depts, controls and supports a modest, but committed S&T capability base, and has successfully built up the culture and ethos for the use of science & technology for the benefit of the Society in Sudan.

With the commitment and co-operation from the Sudanese side that was so readily forthcoming, it was easy to see the strengths, as well as the weaknesses, in the existing structures for generation and commercialisation of technologies.

Some of the technology packages which were in various stages of development, and which have a definite potential for commercialisation in the Sudanese context in relation to their utility by way of satisfying a need, providing an efficient artefact or upgrading an existing traditional practice are listed below, along with the Institutions actively engaged in the work.

I Council for Scientific & Technological Research :

(1) Building with Earth-Soil stabilisers

(2) Brick Making

- Both ~~(a) & (b)~~ for Low Cost Housing

(3) Cellulose ~~Unit~~ - Briquetting of cotton husk/stalks

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II Council for Medical Research :

(1) Assay for the activity of medicinal plants and their standardisation that could lead to more productive medicinal plant farms

(2) Upgrading and standardisation of traditional medicines

III Energy Research Council :

1. Solar Water Heater
2. Solar desalination
3. Solar Grain Drier
4. Wind pump
5. Wind Generator
6. Bio-gas unit
7. Efficient charcoal burning stove

IV Agricultural Research Council :

1. Micro-nutrient programme for trace element deficient soils

V Buildings & Roads Research Institute :

1. Brick Kiln
2. Hydrated Lime
3. Roof Panels - corrugated sheets to replace asbestos

VI Food Technology Research Centre :

1. Sorghum decortication
2. Banana Ripening
3. Canning of Fruits & Food

It is readily apparent that these technologies have a local relevance. Although most of them have drawn on only limited scientific inputs, they have resulted in skill formation and a perception of what appropriate technology development can do in problem solving on a national scale.

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Hardly any organized technology transfer mechanisms (formal or informal) exist at this point of time. In the Sudanese context, it is considered that not only has this prevented commercialisation and diffusion, but has also acted as a constraint on technology generation. The Indian experience elaborately discussed in Part I of this report has clearly shown that the backward linkages and demands that a Technology Transfer Agency makes on S&T resources in terms of proto-type development, adaptation to varying field conditions and the different tiers of operating skills available in different human settlements provides the necessary stimulus and direction to successive stages of technology development. The basic thesis which has come out of the Indian experience, and applicable in the Sudanese context, is that technology transfer and technology generation should not be looked upon as successive steps where technology transfer comes in as a discrete sequential operation after technology generation is completed. Technology Transfer and Technology generation are symbiotic and interactive, and successful technology packages cannot be developed in the absence of the stimuli and demand that they receive from transfer mechanisms. The total absence of an institutional structure for technology transfer of domestic R&D is considered a very serious gap in the S&T innovation chain in Sudan. This is all the more so, because of the weak characteristics of the recipient base when it comes to private entrepreneurs, and the large dimensions of the country with a variety of eco-systems, life-styles, consumer demand patterns etc. In the near total absence of motivations and mechanisms for successful commercialisation of indigenous technology, the urgency of setting up a Technology Transfer Agency cannot be over-stated, and the elements that should go into such a structure are discussed in Part-III.

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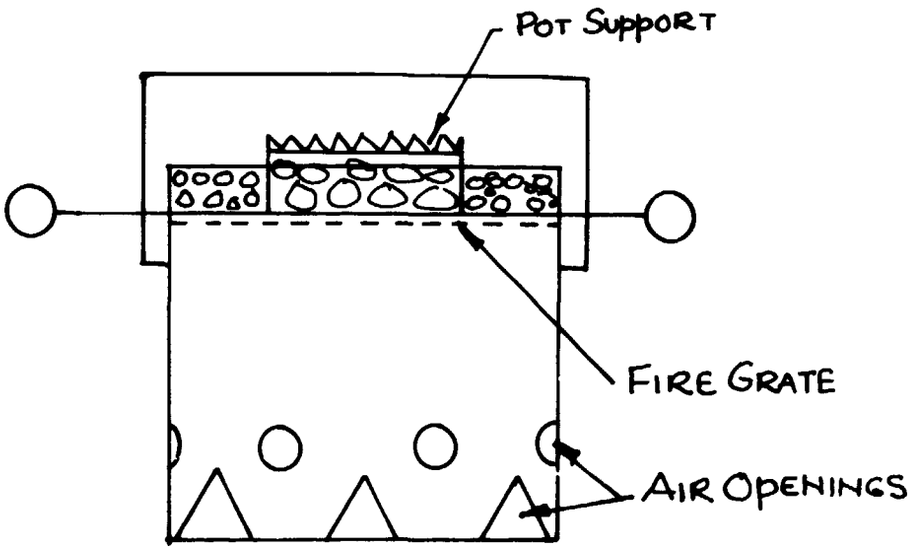
A remarkable example of technology transfer took place when one of the top Scientists from the Food Technology Research Centre in Khartoum moved to set up an Industry "The Saeed Food Factory Ltd.(Khartoum North), and in the process, as a technocrat who had himself contributed to the generation of know-how, was able to transplant and graft into the production stream, the research findings done by Sudanese Scientists in production, handling and processing of fruits and vegetables. Although machinery and equipment was obtained from abroad, Sudanese experience was utilised in the field of planning, engineering, production and maintenance of the project. The complex consists of a farm and factory with tomato paste production (820 kg/hr), fruit juices, nectars and squash line, jams and marmlade line, canned vegetables and ready meals line, sauces and ketchup production line, canning line for cans, Bottling lines for jars, packing lines for jars, bottles and cans, can making line etc. This success story is apparently a rare case of a technologist who could combine know-how with entrepreneurial capability and investment resources.

An "Improved Charcoal Stove", as an appliance needs special mention. The stove is made from two concentric cylinders of steel sheet metal. The inner cylinder (25 cm.diameter) supports the fire grate and provides support bars for the pot. The outer cylinder, which acts as a protection wall against outside air drafts, provides some thermal insulation and rests on the support bars. The support bars extend to the outside forming handles for lifting the stove.

A SKETCH OF STOVE DESIGN 'E'



Since it was found from the socio-economic surveys that charcoal is the most popular type of fuel, the project was directed to achieve the following objectives:

(a) To minimize waste in the consumption of fuel

(b) To save the traditional sources of energy whether in its raw form(wood) or processed form(charcoal)

(c) To obtain the maximum possible thermal efficiency from fuel (charcoal)

(d) To use available and durable materials for the stove

(e) To minimize the level of skills needed for fabrication

A study was conducted in the household in the suburban areas of Omdurman, Al Fateiheb in the first part and El Gezira Islang in the second part. The study included the socio-economic technique of handling the household fuel, through interviews, questionnaires, observations, the way the home manager obtained, the type of fuel available, at what cost and the mechanism of transforming it into energy.

From field experiments carried out at the two mentioned areas, it is reported that there is a popular acceptance for the new stove. The stove was taken around houses where techniques of use have been demonstrated. It is reported that the daily consumption of fuel was reduced by 60%.

Neverthless, technology transfer to a large number of small manufacturers and widespread adoption in end-use has not so far been accomplished.

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Brick-making :

First, endeavours to improve the present known methods of manufacturing red bricks, and :

Second, applied studies targetted to study the technical feasibility of modern manufacturing of clay products, in general, and red bricks in particular.

Experience revealed that the improvement of present techniques of production of red bricks in the Sudan, requires an intensive work to improve the composition of the basic materials, their mixing technique, methods of shaping and drying and best means of firing. Improvement, rather than abandonment, is presently the generally accepted target because of multiple socio-economic reasons.

In this context the National Building Research Station has investigated :

1. Effects of various additives to the basic raw material which is the Blue Nile clay deposits, and
2. Effects of drying the shaped bricks directly under the sun or in a shaded area, the bricks being open for air circulation in both cases.

The use of four additives, namely, saw dust, zibala, Garad and Graw Nuts Crust have been experimentally investigated.

The basic raw material is the Blue Nile clays. The corresponding waste or additive, was 20% by volume of the clay. The two components were mixed by hand, water being added to yield a homogenous mix to be shaped in a hand-press machine. Firing of the dried bricks was to a predetermined temperature programme

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to eliminate variations in brick qualities implemented by burning parameters e.g. firing rate, maximum temperature, soaking time at the maximum temperature and cooling rate.

Evaluation tests confirmed that the additives upon fermentation, improve the plasticity of the basic material and act as reinforcing fibres thus reducing greatly concentrated cracks. Further, and upon firing, these fibres ignite thus assisting in even firing of the brick and minimising the development of high temperature gradients within the brick unit, a phenomena which may otherwise lead to firing cracks. When these fibres burn out, they have cavities within the brick, the result being a reduction of the unit weight and an improvement of the thermal characteristics. Cavities on the top and bottom surfaces of the brick increase the bonding when bricks are built up.

Based on the studies, the following guide recommendations were made:

(a) Use of dried agro-waste additives improve the quality of fired red bricks, the availability of the additive at the field being the governing criteria for use. Though these additives affect the product in varying degrees, it is recommended to have the additive in the form of fibres, i.e thin and tall. The mixing water should be kept to the minimum necessary for shaping without leaving air pores in the produced brick unit (b) In case ordinary wooden or steel moulds are used to shape the material, close supervision must ensure thorough fill of the mould.

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It really pays to introduce a simple hand-pressing machine which at least regulates the size and results in a more compacted brick (c) If additives are used to a reasonable proportion (about 20 to 30 percent by volume) it is not necessary to dry the units under shade as long as they are open for air circulation. The ground, however, should be levelled and the bricks frequently turned to guard against warping and ensure even drying.

The NBRS is ready to visit the sites, and also investigate innovations like pressing the cotton stalks to reduce their volume and thus enable their more effective use as a burning fuel.

These innovations in brick making have been described in some detail to illustrate their possible impact on low cost housing. And yet in the existing situation in Sudan these innovations have not found their way into large scale building practice, raising a question as to what type of technology transfer mechanisms are suitable for the purpose.

The two examples on charcoal burning stoves and bricks for low cost housing have been dealt with in some detail, as these have a relevance to large sections of the Community. The Technology Transfer Systems that are going to come up as recommendations in Part III, would therefore have to go beyond just the Licensing style of working, as inputs other than technology donor-recipient relationships would have to come in as support systems.

THE EXPERIMENTAL SOLAR STILL DESIGN FOR SUDAN

By its very nature, solar desalination is suited for application in the arid hot regions of the world. Large areas of many of the Northern and Western African Countries fall in this category, i.e mainly arid.

Favourable technical features of a design which is being locally worked upon may be classified under construction features, operation features and maintenance features, as detailed below:

a. Construction features: On the whole the design was meant to be simple and easy to construct. The brick structure of the still is laid horizontally with minimum secondary jobs such as preparation of site, finishing, etc. There are no fittings for filling or discharge of brine. The ends are simplified and require the same type of skill as that for the glass covers. The distillate troughs are easy to construct and the brine basin ends are removable. Wider glass cover panes may be considered to reduce cost of silicone and on-the-job labour.

b. Operation features : Batch fill and discharge are adapted. The filling and discharge of the brine require no skill. The collection of distillate midway across the bay reduces re-evaporation loss and improves the drainage efficiency.

c. Maintenance features: The proposed ten metre bay length provides for easy cleaning from the ends. Periodic dumping (weekly) of brine from the basin as a result of the batch filling minimizes cleaning and reduces the chances of salt and algae formation.

OFFICIALS FROM ACADEMIC, RESEARCH, FINANCE & OTHER RELATED INSTITUTIONS AND PRIVATE ENTREPRENEURS INTERVIEWED

1. Prof.A.A. El Agib,
   President,
   National Council for Research

2. Dr. Saad Abbadi,
   Secretary General,
   National Council for Research

3. Dr. Abdel Karim M.M.Salih,
   Director,
   Medicinal & Aromatics Herbs Research Unit
   National Council for Research.

4. Dr. Ahmed K. Bashir,
   Medical Research Council,
   National Council for Research

5. Dr.Yahia Hassan Hamid,
   Energy Research Council,
   National Council for Research

6. President,
   Energy Research Council,
   National Council for Research

7. Dr. Cecile Mesley,
   Director,
   National Documentation Centre,
   National Council for Research

8. Mr. Abdel Rahman Ahmed EL.Agib,
   Director,
   Council for Scientific &
   Technological Research,
   National Council for Research

9. Dr. Sulieman Gabir Hamad,
   Director, C.C.T.R.U,
   National Council for Research

10. Dr.Ahmed E.Elhassan,
    Director,
    Conventional Energy Deptt.,
    National Energy Administration

11. Dean,
    Faculty of Engineering &
    Architecture,
    University of Khartoum

...

12. Dr. Farouk El Tayab El Abadi,
Acting Director of Indus.Research,
& Consultancy Institute

13. Director,
Food Technology Res.Centre,
Ministry of Agriculture

14. Dr. Hamid Ahmed El Hag,
Building & Road Res. Institute
University of Khartoum

15. Mr Widatalla E. Abdalla,
Researcher,
National Council for Research

16. Dean of Institute of Technological
Colleges(Polytechnics)

17. Dr.Ahmed Elbesha Awadalla,
Building & Road Res. Institute,
University of Khartoum

18. Dr.O.I. Yagi,
Building & Road Res. Institute,
University of Khartoum

19. Dr. Paavo Harju,
Senior Industrial Dev.Field Adviser(SIDFA)
UNIDO-UNDP,
SIDFA Office,

20. Mr Cornelia Oimann,
Junior Professional Officer,
UNDP

21. Mr.R.H. Wootton,
Assistant Res. Representative,
UNDP

22. Dr. Suwar Et Da hab A.Eisa,
Director General,
Management Development Centre

23. Prof. Abdel Rahim Saeed,
General Manager,
Saeed Food Factory

24. Dr.Eng. amin Hussein,
Senior Lecturer & Head of
Deptt. of Textile Technology,
Khartoum Polytechnic

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25. Dr. Lee G. Burchinal,
Ahfad University,
Omburman.

26. Dr. Hassan A. Mekki,
Chairman Board of Directors,
& Managing Director,
Industrial Bank of Sudan

27. Mr Ismail A/R Elgizonli,
Acting Director General,
National Energy Administration

28. Mr E.Y Elhag
Industrialist

29. Mr Abdul Gadir Suliman,
Under Secretary
Ministry of Industry, Sudan,

30. Mr Mustafa A. Osman,
Managing Director,
Factory Equipments Ltd.

31. Mr. Ahmed Ezzelarab Yousif,
Executive Director,
Sudan Industrial Association

32. Mr Osman El Amin,
Ministry of Industry,
Sudan,

33. Mr. Elha Yousif Elmakki,
General Manager,
Elmakki Trading Company Ltd.

34. Mr Kamal Abdelmoneim,
Deputy Secretary General,
Arab Economists Association,

35. Mr. Marwan K. Abdelmoniem,
Abdelmoniem Corporation,

36. Mr Abdel Rahman Mohomed,
Assistant Director,
Investment Board

37. Dr Abdel Salam Abdel Moniem,
Chairman,
Abdel Moniem Industrial &
Engineering Co.Ltd.

38. Mr Maha Hassan Osman,
Energy Research Institute,
National Council for Research

39. Dr.M.O.Sid-Ahmed,Director of Energy,
Research Institute, National Council for Research.

40. Prof.E.A.Karib,
Rector,
Darfur University
National Council for Higher Education

41. Dr. Jadie Yanni Magar,
Director,
Agricultural Research Council,
National Council for Research

42. Dr.M.H. Satti,
Institute for of Tropical Medicine Research

43. Dr. Osman Sid Ahmad Ismail,
Minister for Education, Sudan.

44. Dr. Amin Hussein,
Head, Department of Technology,
Implementation,
Renewable Energy Research Institute

45. Mr Abdel Rahman Mohamed,

45. Dr. Bashir M. Mohamedeli,
Ministry of Industry,

46. Mr Hassan Mohd. Saeed,
Agriculture Research Council.

47. Mr Sulieman Gabir,
National Council for Research

48. Mr Fathi Mohammed Ahmed,
(Chemical Engineering)
National Council for Research

49. Dr. Asim A. Daffalla,
Medical Research Council,
National Council for Research

50. Dr. Ibrahim Habiballa,
Director of Research,
Management Development Centre,

51. Prof. I. Eldiougi Mustafa,
Head,
Agricultural Research Council

52. Prof. B. Bashir,
Food Research Centre.

III. RECOMMENDATIONS to promote the commercialisation of technologies developed by Research Institutions in Sudan :

The Government of Sudan has persistently and passionately advocated the building of the Modern Science-based State. The National Council for Research has formulated guiding programmes so that the 1980s decade can be described as the era of the inception of the Science-based State. The NCR is working to utilise Science & Technology(S&T) as a means for promoting economic development, especially to support the "Back to the Country Side" programmes. Suitable Research is to be correlated with developmental plans.

However, admittedly in the existing situation the research results are not finding commercialisation and application.

Technology must suit local needs and to make an impact on the lines of ordinary citizens, must give constant thought to even small improvements which could make better and more cost-effective use of existing materials and methods of work. The development of SUDAN has to be based on its own culture and personality. Technology must also be viewed in the broadest sense covering the agricultural and service sectors along with the obvious manufacturing sector. The latter stretches over a wide spectrum ranging from village small scale and cottage industries (often based on traditional skills) to medium, heavy and sophisticated industry.

Success in implementation demands a conscious integrated approach covering technology assessment, development, acquisition, absorption, utilization and diffusion and connected aspects of financing, based on overall national interests, priorities and the attainment of the most challenging technological goals.

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A situation analysis was made in Parts I & II where the experiences of other countries were compared with the Sudanese scenario, and an appreciation of the Institutions, structures and linkages was given following visits to the participating Laboratories and associated Agencies, and a study of the specific case histories of inventions and artefacts through the various stages of development, but nowhere near commercialisation. The analysis makes it abundantly clear that a New Agency with the character of a NATIONAL CENTRE FOR TECHNOLOGY TRANSFER AND DEVELOPMENT (NCTTD) needs to be created with the specific function assigned to it to look at the Innovation chain as a totality - bridge the gaps in the Innovation chain - and charged with the single point responsibility of "PROMOTING NEW TECHNOLOGIES TO THE PRODUCTION LEVEL", as a PRIME CO-ORDINATOR.

In doing this the NEW AGENCY will have to immediately address itself to the following tasks to enable it to play the desired role.

1. <u>SPONSORED RESEARCH PROJECTS</u>

Arrange a mechanism through which Industry, Industry-User Associations, User Government Departments and Private Entrepreneurs can on terms to be mutually negotiated sponsor research programmes of immediate relevance to them. As illustrative examples could be cited dyestuffs technology and auxiliaries for the textile industry, partial deoiling of groundnuts by solvent extraction for lean pea-nuts for export purposes - chrome ore based synthetic tanning chemicals

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for upgrading semi-processed leather, calcium carbide using active charcoal for acetylene generation, salt farm chemicals , pottasium chlorate for matches etc. Such sponsored research projects stand a chance of ready commercialisation by end-users. Recycling of Waste Lubricating oils from automobiles and railroad engines, sulponation of oils for the leather tanning Industry, production of table salt, utilisation of the by-products of the vegetable oil industry such as soap sticks etc., are other examples.

A mechanism through which END-USER INVOLVEMENT IN PROBLEM SECTION could be done in an organised way would be to hold once or twice a year, a GET-TOGETHER or "MEET" of Research & Development Scientists in the R&D Institutions on the one hand and practising Entrepreneurs/Industrialists on the other, with perhaps the CHAMBER OF INDUSTRIES as a focal point. The same MEET could also be used to effectively communicate to entrepreneurs, R&D inventions awaiting to be commercialised and promote effective interfacing and interaction and initiate a continuing dialogue between R&D Scientists & Entrepreneurs.

2. PROTOTYPES :

Demonstration Units & Prototypes :

The value of these is illustrated by taking the mechanics of commercialisation of Solar Thermal Devices. Solar Water Heaters, at competitive costs with boilers using furnace oil (with flate plate collectors to capture solar radiation as developed through indigenous R&D) represent a case for commercialisation to save dependence on scarce furnace oil. A demonstration plant put up on the roof of one of the Luxury Hotels in Khartoum or else a Hospital or Textile Mill or an Academic Institution/Hostel is an essential prerequisite to prove the

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cost effectiveness and also develop the engineering fabrication capability. It should be the function of the proposed NCTTD to find funds and engineer the first demonstration plant which if successful, can be sold off, and the expertise made available for replication and commercialisation. The Brick Kilns and improved brick manufacturing systems are other examples where technology multiplication would be accelerated through Demonstration Plants.

3. CENTRAL DESIGNS ORGANISATION

The proposed NCTTD should also take on itself the task of establishing a critical much needed capability - namely a Design Engineering Unit suitably staffed to do both basic and detailed engineering. The function of this unit should be to convert inventions and process know-how generated in R&D into engineered prototypes and produce fabrication drawings ready to be taken up at the shop-floor level. The Unit can be a key linkage in offering to Entrepreneurs R&D Process know-how on a Turn-Key basis.

The Central Designs Organization could also be charged with the responsibility of designing pilot plants for laboratory level know-how and further scaling up from pilot plant to the manufacturing level. Sponsored Research Programmes are more likely to come in, if the Entrepreneurs have an assurance that what can be given to them will be R&D followed by suitable engineering.

The Organization will need to be staffed mainly by Chemical & Mechanical Engineers who can develop forward linkages with Fabricators and backward linkages with R&D Scientists. Access to a good Workshop would be essential.

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4. MOBILITY OF SCIENTISTS: SCIENTIST-ENTREPRENEUR SCHEME

Conveying knowledge and skills developed at the R&D level is not easy. In actual practice it is found that no amount of documentation is adequate. The best way to ensure that technology transfer is total and complete is to evolve systems under which R&D Scientists who have come up with commercialisable inventions can be loaned to Industry which takes up their processes for commercialisation. The services could be given on loan for a period of two to three years if necessary, but the movement will not take place unless the service benefits of the loanee employees are fully protected. The National Center for Technology Transfer & Development should counter-guarantee these service benefits to permit maximum mobility of Scientists from Research to Industry and back.

A strategy for generating a whole new class of entrepreneurs and also ensuring effective transfer of technology is to encourage the R&D scientists themselves to take up their inventions and processes, by the Scientist himself acting as an Entrepreneur. This would call for suitable amendments in the Service Rules which should provide for an R&D Scientist-Entrepreneur coming back to his parent Department in the event he fails in his entrepreneurship. The NCTTD should provide the necessary counter-guarantees to ensure retention of service benefits, and thus try to develop a whole new entrepreneurial class.

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5. VENTURE CAPITAL :

Commercialisation of indigenous technology by the First Entrepreneur involves a greater element of risk than by subsequent entrepreneurs. Psychological barriers also exist in the money market to invest in indigenous technology, as contrasted to imported technologies. Some mechanisms for Venture Capital assistance therefore need to be formulated. A suggestion is made that Commercial Banks may place at the disposal of the NATIONAL CENTRE FOR TECHNOLOGY TRANSFER & DEVELOPMENT a small proportion of their profits to be given as an interest free loan to enable the NCTTD to give seed capital to inventors. When the research invention gets commercialised, the seed capital should be returned to the Technology Transfer Agency which will re-invest it in other Research Commercialisation Ventures, and use the limited fund as a revolving resource. The investment is best made as Equity in the Venture Company and the Technology Transfer Centre can oversee the operations of the New Companies through the appointment of NOMINEE DIRECTORS.

6. LICENSING :

All inventions and processes developed in publicly funded programmes in all Institutions should be assigned to the NCTTD and shall be the property of this Centre for Licensing. The assignment can be for know-how or patents where patents are taken, and these may be duly licensed by the NCTTD to Entrepreneurs on a selective basis. A draft license agreement is placed as an Annexure. The know-how or patents may be licensed for a down-payment(premia) and also a royalty to be levied as a percentage (which could be anywhere from 1 to 5%) of the sales. The income generated from

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the premia and the royalties shall be used to further developmental work, and over a period of time is expected to generate adequate revenues for the National Centre for Technology Transfer & Development to support its activities. The NCTTD will arrange to collect the premia and royalties, and it is recommended that some part of the same(about 40%) be disbursed to the inventors to motivate them to continuously improve upon their inventions. The income from premia and royalties together with the revolving fund for equity investment(seed capital) for Venture Companies should sustain the NCTTD as an instrument of public good.

7. PATENT LAW :

It is observed that the existing Patent Legislation does not provide adequate protection to indigenous inventions, and in fact can be counter-productive to exploitation of indigenous technology, as it permits foreign patents to be in force, even when the patentee has no intent to manufacture in Sudan. This blocks generation of indigenous technology, for fear of patent infringement. Measures for compulsory licensing should therefore be liberalised, and it shall be the responsibility of the NCTTD to recommend to the Government from time to time suitable changes in the Patent Act. While safeguarding intellectual property rights, the Patent Law must be structured to be a dynamic instrument of progress for indigenous technology.

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8. The NCTTD will also be in a unique position to act as a repository of all technologies available in the public domain and also such technologies as are assigned to it by private companies and individual inventors who will be welcome to take advantage of its services. By virtue of its character as a Technology Reservoir, the NCTTD will also act as a focal point for international inflow of technology, especially from friendly developing countries. This will strengthen its capability base, and also over a period of time permit it to act as a conduit for export of technology and trading in technology with neighbouring countries. Technology and trade have a symbiotic effect, and it is likely that as the effectiveness and dimensions of the NCTTD grow over a period of time, it can act as an entry point for Sudan in overseas trade using the technology door. The NCTTD may also establish reciprocal agreements for exchange of technologies with its counter-part Agencies in friendly countries with a commonality of interest.

9. INVENTIONS :

The NCTTD may promote inventive talent amongst the lone inventors in the Country by providing financial assistance(a) for patenting of ideas and inventions in deserving cases and (b) developing technically feasible and commercially viable ideas and inventions to the extent of the estimated amount required for making a prototype of a model. The NCTTD may also consider giving Certificates of Merit to meritorious inventions, especially those coming from the student community, the lone inventor and the young scientists. These Certificates of Merit

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can be awarded at a formal function by a High Dignitary of the State, so that they gain national stature. Such honours, although non-financial, provide enough motivation within the Country to keep up the spirit of invention and also prevent brain-drain of qualified scientific talent to overseas countries.

10. FISCAL INCENTIVES, RELIEFS AND PREFERENTIAL PROMOTIONAL MEASURES FOR COMMERCIALISATION OF INDIGENOUS TECHNOLOGY

The NCTTD would be best placed to examine and recommend to the controlling authority what special reliefs should be given to entrepreneurs who risk commercialisation of indigenous technology and show demonstrated preferences for indigenous technology over imported technology. Depending upon the tax laws and licensing practices in Sudan, the reliefs could be in the nature of ready registration which affords them some advantages, delicencing and preferencial allocation of scarce materials, appropriate tax relief on profits, and tax reliefs on monies appropriated out of profits by existing Companies for investing in indigenous technology commercialisation. Such fiscal incentives and motivations should strengthen the character of the indigenous technology recipient base.

11. TECHNOLOGY DELIVERY SYSTEMS FOR CARRYING TECHNOLOGY(ESPECIALLY TECHNOLOGY FOR MINIMUM NEEDS OF SOCIETY)TO REMOTE AREAS

(a) MASS MEDIA : It shall be one of the functions of the NCTTD to maximise the use of the mass media like radio and especially television for popularisation of technologies generated to create public awareness and acceptance. The use of Vocational and Educational Institutes and Extension Centres is also recommended.

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Publications & Newsletters like 'TECHNOLOGY AWARENESS SERVICE' should be brought out regularly.

However, the most effective way of getting technology commercialised in remotes areas, for technologies which are appropriate to that area is through DEMONSTRATION-CUM-TRAINING-CUM-REPLICATION CENTRES. It shall be the function of NCTTD to set up such Centres in collaboration with suitable Counterpart Voluntary Agencies at selected remote Locations. These Centres will serve the function of not only demonstrating the technologies, but of training young artisans and craftsman in these technologies, so that the artisans can turn into entrepreneurs and the technological units will undergo multiplication to produce an avalanche type of impact.

The concept envisages that the Demonstration Centres will be on display only for a limited period of say a few weeks at a given location - at the end of which period the equipment and men will move on to a different location. Basically they will be thus nomadic in character, to enable coverage of as large an area as possible.

The media of participation in rural exhibitions shall also be encouraged by the NCTTD.

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12. APPROPRIATE TECHNOLOGY DEVELOPMENT

Research Laboratories often tend to go through long gestation period programmes for technology generation and standardisation.

A case in example is that of the work being done by the National Institute for Herbs & Medicinal Plants to promote traditional medicinal systems. While the system of identifying the different generic and botanical species, isolating the active principles, measuring their therapeutic activity, carrying out the clinical, pharmacological and toxicological tests is the correct way of doing things before developing a drug and placing it on the Market after obtaining the approvals of the Ministry of Health, the gestation period involved in systems of development are often protracted in time scales extending from 5 to 8 years.

If it is recognised that one of the thrusts of Appropriate Technology is to provide quick relief and make an immediate impact on the life styles and quality of life of the people, systems of rapidly cutting down on the gestation periods in upgrading technologies based on traditional medicine or traditional methods of construction or even food preservation must go through a dual approach. The first can be a rigorous scientific approach involving long gestation periods. Concurrently, a semi-empirical approach leaning more on perception and analysis of existing practices and usages, and blending it with the available scientific knowledge to evolve progressive incremental improvements, adaptation and acceptance is recommended.

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If this strategy is accepted, the NCTTD should be allowed to participate in an advisory capacity in the programme formulation of all appropriate technology development and upgradation of traditional skills, such that technology utilisation within a reasonable time-span is ensured.

13. ENTREPRENEURIAL DEVELOPMENT

The NCTTD shall also be charged with the responsibility of building up a whole new class of Entrepreneurs with commitment to indigenous technology and evolve suitable linkages with Educational Institutions, R&D structures and Financial Institutions to come up with a National Entrepreneurial Development Programme.

14. The NCTTD should also be represented and consulted on all decisions involving the import of technology to be able to unscramble the technology package and progressively substitute these with indigenous elements concurrently with adaptation.

15. UNDERWRITING TO ENSURE MINIMUM OFF-TAKE-MARKET DEVELOPMENT BOARD

MARKETING NEXUS : The NCTTD may consider in collaboration with other Agencies the development of a suitable Marketing Nexus, such that entrepreneurs fabricating and producing consumer artefacts utilising indigenous technology for better efficiency and value can take advantage of a Nation Wide Marketing Network to sell their merchandise. The question of under-writing a minimum off-take may also be looked into.

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16. The NCTTD will also be charged with the specific responsibility of exploring other innovative methods of promoting and commercialising technology to respond to changing opportunities and needs, such as technology nurseries, science parks, technology museums etc.

17. PRIME CONTRACTOR

The NCTTD should also be in a position to offer on a consortium basis, as a prime contractor, technologies with built-in-performance guarantees to an Entrepreneur. In this it will have to develop close linkages with FINANCIAL INSTITUTIONS AND THE DEVELOPMENT BANKS.

18. The NCTTD shall also promote innovations within Industry(in-house) as a means of generating inventions that can be readily grafted on to a production stream. The philosophy here is that innovations outside industry generated within an R&D structure run into problems of interfacing for commercialisation, whereas inventions generated within industry on an in-house basis find greater acceptability and less resistance to commercialisation.

19. STANDARDS :

The NCTTD should also be represented on the Authority for laying down standards and enforcing them, as this is an element which intimately concerns commercialisation for public good.

20. LINKAGES WITH CONSULTANCY FIRMS :

The NCTTD shall also build up close linkages and ties with consultancy firms, recognize them as a valuable resource and utilize their services for Technology Transfer.

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V. ALTERNATIVE TYPES OF STRUCTURES & ORGANIZATIONAL PATTERNS ENVISAGED FOR THE NCTTD

The proposed NCTTD arises out of the gaps in the total innovation chain necessary to convert an idea into success as outlined. A question is therefore raised as to what is the best structure which while working harmoniously with the existing S&T Structures can also bring into operational play non S&T Agencies like functional Ministries, Entrepreneurs, Consulting Firms, Financial Institutions like Development Banks etc.

At the same time the STRUCTURE should be such that it becomes accountable in terms of the expenditure incurred and services provided, and success/failure ratio.

The STRUCTURE should also be able to operate within a financial frame-work which once provided with a basic capital input, should be able to while rendering services, make profits and set off losses.

A CORPORATION governed by a Board of Directors chaired by the President, National Council for Research, and Directors drawn from the Financial Institutions, Banks, Entrepreneurial Community, Affiliated Institutes of Technology, Regional (Provincial) Representatives and Patent Experts is one concept. Such a Corporation can start with a relatively small equity capital base, but be authorised to borrow fairly large amounts for promotion and investment. The Corporation would need a very senior Chief Executive who can command the world of S&T with his expertise, has an overview of finance & industry and can effectively liaise with a variety of organizations, and functional Ministries. The Corporation can have units headed by Experts to head the Central Designs Organization, the Legal & Patent Unit, Entrepreneurial Promotion Unit, Publications & Mass Media, Demonstration Centres & Exhibitions etc. The Corporation will also need a Company Secretary.

The other style of working structure would envisage the NCTTD functioning as an affiliate unit/Agency of the NCR. The staffing pattern can be more or less the same. However it remains to be examined whether such a unit can operate within a balance-sheet and can operate Venture Capital and also take on the Legal responsibilities of Licensing which can conceptually lead to litigation.

A compromise strategy would be to start with NCTTD as a Unit under the NCR, and allow the Unit to grow into a Corporation with a National Mandate, just as soon as possible.

CONCLUSION :

Sudan has a committed Science & Technology base and an acknowledged National Policy in this regard. As with all Developing Countries, the required additional inputs come into focus with growth. The proposed NCTTD should stimulate more meaningful R&D by generating mechanisms for their commercialisation and lead to visible results of S&T effort on economic development.

SUMMARY

Although Sudan has the nucleus of a technological base and has managed to establish a good number of scientific & technological research institutions, it has not yet been able to utilize these institutions effectively, largely because of the weak contact between indigenous research and development institutions and the users of their research findings. Comparing the present Sudanese situation with the traumatic experience which other developing countries have gone through at this stage of development, and the general appreciation that academic bodies and publicly financed research organizations are not well suited either by experience or outlook to exploit inventions arising from their own researches, it is considered essential to build up an organised institutional mechanism for holding and exploiting in public interest inventions and patents assigned to it. This has been envisaged through the formation of "National Centre for Technology Transfer & Development"(NCTTD) which shall be charged with the responsibility of completing the total innovation chain. Existing gaps have been identified, especially in relation to the need for a Central Designs Organization, provision of Venture Capital, Mobility of Scientists from R&D Centres to Industry, Licensing Mechanisms, Prototypes

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and Demonstration units, provision of services as a Prime Contractor, Entrepreneurial Development and especially Technology Delivery Systems for carrying Technology to Remote Areas. The concept of Demonstration-cum-Training-cum-Replication Centres has been advocated and remedial measures have been suggested in a manner in which these would readily fit in with the process of development and accelerate the process of technological transformation.

Alternative types of structures and patterns have been proposed for the NCTTD. In the interests of quick implementation, the NCTTD could start as a Unit under the NCR, and just as soon as possible be built up into a National Corporation. The President, NCR, may also take on as an additional responsibility, the Chairmanship of the NCTTD.

ACKNOWLEDGEMENTS

1. I feel obliged to the officials of UNIDO, VIENNA, for giving me the opportunity of making this study in Sudan, which turned out to be professionally very interesting and exciting.

2. I must express my deep indebtedness to the senior officials of the National Council for Research, in particular to Prof. A.A. El Agib, President, NCR, Dr. Saad Abbadi, Secretary General, NCR and Mr. Abdel Rahman Ahmed El Agib, Director, Council for Scientific & Technological Research, NCR, for the personal warmth with which they received me, the professional co-operation which they gave me and for the many fruitful discussions. I should also make particular mention of Mr. Widatalla E. Abdalla, a bright Researcher of the NCR who guided me in my visits. My thanks are also due to the numerous Research Workers and Faculty Members for the informative and candid discussions. I am also grateful to the large number of Govt. officials and the private entrepreneurs who gave me freely of their time.

3. Thanks are also due from me to the UNDP/UNIDO officials in Khartoum for their co-operation.

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4. Finally, I should like to once again place on record the stimulating interaction I had with Prof.A.A El Agib, President, NCR, whose sharp perception, analysis and commitment and openness for considering the views and experiences of others, made my stay in Sudan a most rewarding professional experience.

ANNEXURE I

Draft Memorandum of Articles for the proposed
National Centre for Technology Transfer and Development(NCTTD)

The objects for which the Company is to be established are:

(a) To develop and exploit in the public interest, for profit or otherwise:

(i) Inventions, whether patentable or otherwise, of the National Council for Research and its affiliated bodies including technical and engineering'know-how'of processes;

(ii) Patents and inventions of different departments of the Government of Sudan and other statutory bodies including technical and engineering 'know-how' of processes;

(iii) Such other patents as may be voluntarily assigned, by general or special agreement, by Universities, research institutions, or individuals; and

(iv) Such other processes and patents, the development of which may be entrusted to the NCTTD by the Government of Sudan.

(b) To enter into reciprocal arrangements with similar Organisations in other Countries to exploit Sudanese inventions in those Countries and their inventions in Sudan;

(c) To issue exclusive and/or non-exclusive licences on such terms and conditions regarding payment of premia, royalties, share of profits and/or any other basis as are considered advisable to commercially develop inventions and ensure commercial production of the products of inventions;

(d) To secure co-operation of such state-owned or state controlled industries or any units thereof as are deemed or are likely to be interested or necessary to develop the new processes or inventions and reimburse such industries any loss that they may incur;

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(e) To enter into agreements with a private firm or firms to develop inventions by trials at their works and to reimburse them any loss that may be incurred during these trials;

(f) To instal and work pilot, prototype or semi-scale units or full commercial plants to develop a particular invention or inventions and ensure production from such invention or inventions, to sell or otherwise dispose of the products or such inventions on payment or otherwise, and generally on such terms and conditions as may be deemed fit;

(g) To transfer by sale, lease, hire, or otherwise dispose of any pilot plant, prototype plant, semi-scale plant or full commercial plant to any firm, individual, association or Institute and entrust the same with commercial production of any products of invention or inventions for which the plant or plants had been installed on such terms and conditions as may be deemed fit;

(h) To afford facilities for advising and assisting government departments, universities, research institutions and individuals in filing applications for patents and prosecuting the same before the Controller of Patents and to frame rules for the purpose and to vary them from time to time;

(i) To distribute a share of profits, premia and/or royalties from any particular invention or inventions to government departments, institutions, organisations, universities, or individuals from whom such invention or inventions were received and to frame rules for the purpose and to vary them from time to time;

(j) To reward, in special circumstances, any particular invention or inventions by gifts, rewards, ex-gratia payments or in such other manner as may be deemed fit.

(k) To exercise as a continuing activity the function of looking at the Innovation chain as a totality, identify the gaps in the innovation chain as they appear in response to the changing demands of technology transfer and transformation, and take on the responsibility of bridging these gaps.

ANNEXURE II

DRAFT LICENSE AGREEMENT

NATIONAL CENTRE FOR TECHNOLOGY TRANSFER AND DEVELOPMENT
(NCTTD)
KHARTOUM (SUDAN)

THIS LICENCE is made of this _____ day of _____ 19___ BETWEEN The National Centre for Technology Transfer & Development, a Company registered under the Companies Act(hereinafter known as the NCTTD) and having its registered office at KHARTOUM (hereinafter called 'the Corporation' which expression shall where the content so admits include its successors and assigns) of the one part and _____

_____

_____ a Company incorporated and registered under the Companies Act, and having its registered office at _____, SUDAN (hereinafter called 'the Grantee' which expression shall where the context ~~so~~ admits include its successors and permitted assigns) of the other part :

WHEREAS the _____ (hereinafter called 'the Research Centre or NCR or Agency/Institute) has developed valuable know-how for the manufacture of _____

_____(hereinafter called 'the know-how') and full rights in the know-how have been assigned to the Corporation.

AND WHEREAS, the Corporation is in possession of and is the proprietor of the know-how.

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AND WHEREAS, the Grantee is satisfied with the workability of the know-how and has requested the Corporation for a license to work the know-how;

AND WHEREAS, the Corporation agrees to grant the Grantee a non-exclusive license to work and use the know how on the terms and conditions hereinafter contained and mutually agreed upon.

NOW THIS DEED WITNESSETH as follows :-

1. For the purpose of this Agreement, the following terms used herein shall be construed so as to have the following meanings :

"KNOW-HOW" shall mean and include all information at the disposal of the Corporation or Research Institute or Centre or Agency both written or oral relating to the working/manufacture/ construction and fabrication of _____ _____.

"ARTICLES" shall mean and include (i) all products, intermediates and by-products manufactured in accordance with a part or whole of the know-how and include the modification or improvement referred to in Article 3(ii) herein.

2. In consideration of the payment of LS._____ by the Grantee to the Corporation before the execution of these presents, as and by way of premium and the payment of the royalty hereinafter specified, and the observance and performance by the Grantee of the covenants herein contained

and on its part to be observed and performed, this non-exclusive licence is hereby granted for a term of _____years from the first day of _____198___ and shall comprise the right to work and use the know-how at the Grantee's own factory/factories/works and further include the right to sell the articles.

PROVIDED THAT notwithstanding anything contained in sub-clause(i) of Clause 6 of this licence, the Grantee shall pay royalty at the rate and in the manner specified in sub-clause(i) of Clause 4 of this licence for a minimum period of _____ years commencing from the date of start of regular manufacture of the article, and this licence shall continue to remain in force for that period for that purpose even after the expiry of the period specified in Clause 2 above, provided that the said date of start of regular manufacture shall be within the period of this agreement, as set out in Clause 1 hereinabove, is in force.

EXPLANATION :

Regular manufacture shall be deemed to have commenced when the grantee undertakes manufacture and sells the article so manufactured, and/or uses the same for its own use.

3.(i) The Corporation shall forthwith disclose or cause to be disclosed to the Grantee the know-how and, further, if so required by Grantee, cause:

a) The Research Institute Centre/Laboratory/Unit to demonstrate the working of the know-how on the scale at which it is developed: and

b) The Research Institute to train the Grantee or his authorised representative/s at the premises of the said ...

Research Institute.

3(ii)A. That during the continuance of this licence, the Corporation and the Grantee shall promptly disclose to each other all improvements or modifications made by the Research Institute and the Grantee respectively on the know-how and strictly relatable thereto, and that in the instance when the improvement or modification has originated from the Grantee, the Corporation shall have the right to permit any other licensee of the Corporation to use the know-how or the improvement or modification without the payment of any money to the Grantee and that, in the instance when the improvement has originated from the Research Institute, then and in such an instance, the Grantee shall have the right to use the improvement without the payment of any additional money to the Corporation.

3(ii)B. During the continuance of this Agreement and when the said improvement made by Grantee can form or forms the subject matter of a Patent, then, such patent shall be in the joint name of the Corporation and the Grantee subject to Clause 4(iii) without payment of any money to the Grantee and that the Grantee and other licensees of the Corporation on the know-how, if any, shall have the right to use of the patent without the payment of any additional money to the Corporation.

...

4. The Grantee shall, during the continuance of the licence observe and perform the convenants and provisions following, that is to say:

i) During the period of the said term the Grantee shall pay to the Corporation for _____ years a royalty at the rate of _____ on the ex-factory sale price of the article manufactured by it, excluding Government duties and taxes. Such royalties shall become due twice a year, say on the First of April and on the First of October in every year in respect of the articles manufactured and marketed or used by the Grantee during the proceeding half-year, and shall be paid by the First day of May and First day of November of that year. In default of payment of such royalties on the due dates, the Grantee shall pay interest on the amount in default at the rate of _____ per cent per annum :

(ii) All articles manufactured by the Grantee shall be deemed to have been marketed by it within the meaning of these presents, if it uses or consumes them for its own purpose, including use in the manufacture of other articles whether by itself or by its agents or employees.

(iii) It will not be open to the Grantee to claim any exemption from or reduction in the payment of royalty accruing under this clause on the plea of having used its own know-how or having effected any improvement upon the know-how or on the plea that the articles manufactured

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under the know-how have been manufactured by using a different process and the Grantee shall be liable for the payment of the royalties for all the articles manufactured by it and covered by this agreement irrespective of any plea whether the same have been manufactured by the said know-how or otherwise, and FURTHER that All articles known as _____manufactured by the Grantee shall be deemed to have been manufactured in accordance with the know-how, hereby transferred.

(iv) That the Grantee shall keep, at its usual place of business, books of accounts relating exclusively to the royalties and containing such information and particulars as may be necessary and/or proper for enabling the amount of royalties hereby reserved to be conveniently determined and then, at all reasonable times, produce the said books and all other relevant books of accounts, vouchers,documents, receipts and connected papers, if any, to the Corporation, its attorneys or duly authorised agents, and will permit the Corporation, its attorneys or duly authorised agent(s) to inspect the same, take copies or extracts therefrom, and the Grantee shall give full information as may be necessary or proper to calculate the amount of royalties payable hereunder to be ascertained as aforesaid:

...

(v) The Grantee shall, within fifteen days of each one of the two days hereinbefore fixed for payment of the royalties deliver to the Corporation, its attorneys, or duly authorised agents, a true and complete statement, in writing of all articles manufactured and marketed by the Grantee during the preceding half-year, and of all royalties payable to the Corporation in respect thereof duly certified by the auditor of the Grantee or provisionally by the Grantee/Director to be confirmed by the Auditor within six months after submission of the provisional statement.

(vi) The Grantee shall permit the Corporation, its attorneys, its duly authorised agents and its authorised representative(s) of the Research Institute at all convenient times to enter into and upon any premises of the Grantee where any articles manufactured as aforesaid may be stored or manufactured or sold under this licence for the purpose of inspecting the same and the manner of manufacture thereof and generally to ascertain that the provisions of this licence are being complied with :

(vii) The Grantee shall employ its best endeavour to work the know-how and sell the articles on commercial scale within SUDAN and abroad.

(viii) The Grantee shall not, at any time, assign, mortgage, charge, grant sub-licences in respect of or otherwise deal with or part with the possession or control of the licence hereby granted :

...

(ix) The Grantee shall, at its own costs, affix a label or plate or inscribe in a conspicuous manner upon every article, box or packet containing the said article, the legend or inscription 'Process developed at' " and licensed by NCTTD, and similarly every advertisement publicity material/hoardings in respect of the articles shall include the same inscription in bold letters as aforesaid, at a conspicuous place in such advertisement :

(x) The Grantee shall not directly or indirectly and either by itself or by its agents use the know-how otherwise than in accordance with these presents.

(xi) The Grantee shall notify to the Corporation change in Registered Office/factory within 15 days of such change and shall so notify the change in the constitution of the Grantee within the aforesaid stipulated period.

5. The Corporation hereby covenants with the Grantee as follows :

The Corporation has granted this licence on a Non-Exclusive basis, covering the whole of SUDAN, and reserves the right to grant licences to any other parties at its discretion on terms and conditions to be solely decided by the Corporation.

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6. The Corporation may, without prejudice to its other rights and remedies on the happening of any of the following events, by notice in writing to the Grantee forthwith determine this licence namely :

Termination Clause:

(i) If the Grantee fails to start manufacture according to the know-how within a period of _____ months from the date of the licence viz _____ 198___. In the event the Grantee being unable to set up production within stipulated period, viz. _____ due to unavoidable circumstances and causes beyond the control of the Grantee, the Grantee will make a request in writing for extension of the time limit before the expiry of the date, giving detailed reasons. This request will be carefully examined and considered by the Corporation. The decision of the Corporation in this regard will be final and binding on the Grantee :

(ii) If the Grantee suspends or discontinues use of the know-how for a period exceeding three continuous months, provided such suspension or discontinuance is not due to recognised force majeure and causes beyond the control of the Grantee. In the event the Grantee suspending or discontinuing manufacture for a period exceeding three months, the Grantee shall make a request in writing for further extension of the time limit, giving adequate reasons. This request shall be considered by the Corporation and the decision of the Corporation in this regard shall be final and binding on the Grantee :

...

(iii) If any of the instalments of royalties payable under the provisions of this licencee shall be in arrears and shall remain unpaid for a period of three months after the same has or have become payable, as hereinbefore provided, whether demand therefor shall have been made by the Corporation or not;

(iv) If the Grantee shall have committed or knowingly permitted the breach of any of the covenants herein contained and on its part to be performed and observed.
PROVIDED THAT, in the case of such breach as is capable of being remedied, the Corporation may not determine this licence unless and until the Grantee has failed to have made good such breach within a specified period, say thirty days, from the date of the notice given by the Corporation to the Grantee in that behalf :

(v) If the Grantee, is wound up otherwise than for the purpose of reconstruction or if the business relating to _____ of the Grantee changes hands or have a Receiving Order or other order under an Insolvency Act made against the Grantee or if the Grantee enters into any arrangement or composition with its creditors;

In the event of the licence being terminated at the request of the Grantee or revoked by the Corporation under the powers given to it, the Grantee or their assignees shall not use the know-how and all sums of money heretofore paid by the Grantee under the terms of this licence shall be forfeited to the Corporation and the Grantee shall not be entitled to any credit or allowance in respect thereof.

...

7. No waiver by the Corporation, express or implied of any right of the Corporation or any breach by Grantee of any term, condition or obligation of this agreement shall be construed as a waiver of any subsequent right or breach as the case may be, or of any other right or breach of the same or different nature.

8. No one party hereto shall be construed as an agent or representative of the other party.

9. Grantee shall not disclose to any third party, without the prior wirtten consent in writing from the Corporation, any part or whole of the said know-how given by the Corporation within the terms of this Agreement.

10. These presents shall not be construed as a warranty by the Corporation of the novelty, utility and workability of the said invention.

11. All notices required to be served on the Grantee under the terms of this licence shall be considered to be duly served if the same shall have been delivered to, left with or posted by registered mail to the Grantee at its last known address of business. Similarly, any notice to be given to the Corporation shall be considered as duly served if the same shall have been delivered to, left, with, or posted by registered mail to the Corporation at its registered address in KHARTOUM, SUDAN.

...

12. The Corporation shall arrange payment of all fees and the performance of all acts and things required by law for keeping up the said patent in SUDAN, before the expiration of the period prescribed and shall similarly arrange all payments and cause to be done all other acts and things which may be necessary for restoring the said patent if the same shall become void, and if the Corporation shall neglect or fail to arrange the said payment of the said fees or any of them or to cause to be done any of the said acts or things, the Grantee may pay or do the same and may realise any moneys expanded by him under this provision from the said half yearly payment due from him.

13. This agreement shall be the sole repository of the terms agreed to between the parties and no amendment thereof shall take effect and be binding on the Corporation unless it is authorised by the CHIEF EXECUTIVE of the Corporation and is communicated in writing by the Secretary of the Corporation.

14. If any dispute or difference arises between the parties heretofore their representatives or assigns with respect to their rights or liabilities or in regard to any other matter under these presents, save as to any matters the decision whereof its hereinbefore expressly provided for, the same shall be referred to the sole arbitration of the President, National Research Council, SUDAN, and if he is unable or unwilling to act, to the sole arbitration of some other person appointed by him and willing to act as such arbitrator. Subject to the consent of

...

the parties, the arbitrator shall have the power to enlarge the time for making of the award. The reference to the arbitration shall be deemed to be a submission within the meaning of the Arbitration Act, or any statutory modifications or reenactment thereof and the rules made thereunder for the time being in force shall apply to such reference and this deed shall be deemed to be a submission to such arbitration. It is the condition of this Clause that all hearings of the arbitration will take place at KHARTOUM.

15. That all suits or other legal proceedings relating to or arising from the arbitration proceedings on the award made in pursuance thereof or otherwise will be subject to jurisdiction of Khartoum Courts.

IN WITNESS WHEREOF the Corporation and the Grantee have executed these presents the day and year first above written :

Signed by the Managing Director for
and on behalf of the NCTTD in the
presence of :- Managing Director

1._____

2._____

Signed by Mr _____
carrying on business under the name
and style of M/s _____
as the sole Proprietor thereof in the
presence of :- 1.Name & Signature 2.Name & Signature
Occupation Occupation
Address. Address.