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FORMULATION OF A STRATEGY AND PLAN OF ACTION FOR THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

FINAL REPORT

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CONTENTS

INTRODUCTION

This final report was prepared by Dr. Sergio Musa L. Director of INTEC-CHILE, as UNIDO High-Level Expert on Strategy for Applied Research and leader of INTEC-team under UNIDO subcontract, in collaboration with Mr. Nils Ramm Ericson, UNIDO Consultant and Project Coordinator.

This version of the report corresponds to a complete revision and takes into account, among others, the results of the discussions held on March 3rd. At the same time, main marketing considerations have also been included in order to give an integrated vision of the global strategy and action plan recommended for improvement of TISTR performance and higher impact accomplishment in industrial and service sectors.

Those who prepared this report would like to express their special thanks to TISTR Acting Governor Mr. Chalermchai Honark, to Mr. Anek Tamratanaporn for his valuable advice, opinions and information, and to all the members of TISTR staff that enthusiastically contributed to make this draft possible.

I FRAMEWORK

Country Background

Large land areas, sparse population, and traditional agriculture make up the economic basis for Thailand's rural inhabitants, who constitute approximately sixty percent of the population. On the other hand, the main urban concentration currently existing around Bangkok, has greatly increased during the last thirty years.

The strategy for industrialization, characterized over time by an emphasis on varied aspects, has been developed within a background of coexistence among state-owned enterprises, Thai private enterprises, and foreign corporations, most of them transnational.

Moreover, the exports promotion has been developed putting emphasis on light manufacturing and, recently, on more sophisticated products as part of the current plan. Agricultural activities are also experiencing the trend towards incorporating added value in natural products, and the need for modernization of this sector is being addressed.

The mining, gas and petrochemical industries are also becoming part of the process of changing the Thai economy and incorporating new relevant technology, thus stimulating the rest of the system.

Part of the current strategy is to deal with problems such as the fast and continuous changes and the necessity for every agent to adapt constantly, the need to reinforce the educational system, industrial activities that are unnecessarily capital-intensive, the creation of a basis for significant investment development focused on more sophisticated products and the existence of relatively new medium- and small-size enterprises.

In addition, particular attention must be paid to the current national development plan aimed at reducing poverty, reaching a better distribution of income, developing small- and medium-scale industries, supporting regional modernization and taking responsibility for environmental preservation.

This last aspect constitutes a special concern in relation to sustained development and a better quality of life. At the same time the growing importance of this matter in international commerce has not been left out of sight.

Thus, structural changes in the industrial sector have brought into sharp focus the relative weakness of the country's scientific and technological base. Government and private sector leaders are now

seriously concerned about this constraining factor which limits movement into more valuable areas of production.

The science and technology aspects included in government policies give special emphasis to the increase of supply of engineers, the promotion of technical skills at the craftsman level, and the development of science and technology methods at the school level.

Likewise, a technological strategy involves the intensification of cultural changes by promoting a better public awareness and appreciation of science and technology. In this sense there is to mention the convenience of supporting professional associations in order to increase their role in technological development.

At the same level, the establishment of a network for dissemination and exchange of information and the development of a science and technology indicator system for monitoring achievements are part of the approach.

An improvement in the funding system for technological development support of private sector projects, among other economic incentives, forms part of the program currently in progress.

Finally, specific measures in priority areas such as biotechnology, materials and metal technology, and electronics and computers, are in process of implementation by the Ministry of Science and Technology with the creation of three specialized centres.

The policy definitions and measures indicated above concerning the economic and technological aspects, which make up the development strategy adopted by the government, are congruent with the framework of a changing world characterized by growing challenges.

Staying competitive in the years to come and maintaining a long-term and self-sustained development impose the unavoidable need to make a significant commitment to scientific and technological investment. On this there is a wide consensus in Thailand.

Science and Technology Relationship Considerations

The relationship between science and technology is of great complexity, and it is less direct than usually assumed. The purpose of science is the continuous movement of the frontiers of a knowledge that is public, universal, and cannot be held as property. It has a specific place in culture and is linked to education and to academic advancement, for this reason it should not be separated from the universities and their work.

Scientific activity is performed within a global context. From this viewpoint, a sustained scientific activity at national level becomes indispensable, thus constituting a genuine opening for communication with the rest of the world.

Technology, by contrast, is inseparably linked to production know-how and its enhancement. Technological knowledge is associated with industrial property, and in its innovative phases it constitutes an essential factor for industrial differentiation and secrecy.

Nevertheless, it must be recognized that scientific activity demands and makes possible the training and development of human resources for excellence in the field of research. The method and mastery of basic sciences, and the deepening of knowledge in applied sciences are relevant features that form the essence of a scientist who is permanently handling knowledge on the frontiers of his own area.

This situation allows a substantial relationship of great potential between scientific activity and applied technological research as such, so that in critical stages of the latter, scientists can be incorporated in order to provide highly specialized knowledge. Moreover, there is the phenomenon of constant movement of people between different fields of activity, by which scientists become technological researchers, enriching therefore the expertise of the groups working on innovations and adaptations of industrial processes.

Primary Considerations and Initial Approach

The need to contribute to the process of modernization of the industrial plant leads to the definition of the central mission assigned to technological supporting institutes. Additionally, and in accordance with this purpose, the tasks of acquiring knowledge and capabilities and working in conjunction with companies must be continuously developed.

These ways of acting take us to new forms of technology transfer in which research must go hand in hand with a practical sense of innovation and adaptation.

Efforts to bring laboratories closer to enterprises and to fill the gap between technological research and market are intensifying in most countries. This constitutes a conditioning factor of industrial fitting out, an indispensable element in facing the challenges that the prevailing rules of international competition impose.

Technological knowledge, which doubles itself every ten years, as well as the growing complexity of the factors involved and the ingenuity that rests on the simplicity of many innovative ideas, represent the main challenges for society and consequently for technological institutions.

The form and speed of changes everywhere and the need for adaptation and insertion at the right time into those associative networks which form and regroup themselves dynamically, constitute

facts and signs for the design of new approaches for the relevant work.

The time to reflect, the ability to associate with other people's efforts, the dedication to observation, and the will to do things well in a process of continual questioning and progress are the cultural factors that ought to work in association with the technological innovation process.

The supply of services and technological products cannot now be dependant only on the internal generation of projects made by isolated groups of researchers. On the contrary, this supply should be a response to those demands that the agent involved in production identifies from his own view of his field of activity. In accordance with this, a dialogue and an interactive search for creative solutions must prosper.

Laboratories, pilot plants, equipment and instrumentation, and the readiness of the professional and technical staff of a supporting technological institute should be a resource made permanently available to companies so that it acts as a natural extension of their facilities and workshops, in such a way that the tasks to be carried out have the purpose and mode of a true joint venture.

In the same way, the growing diversity of knowledge and disciplines that characterize production and its multiple forms of subdivision and specialization oblige to focus the work on technologies whose applications are generally present or are common to various industrial sectors.

Such is the case of flexible automation, environmental technology, techniques of management, and others that have proved to be keys for the success of enterprises in developed countries, as well as in many successful developing countries. This success means not only a predominance in the markets but also growth and diversification.

The concept of necessary coordination and inter-connection of available resources at a national level must guide the strengthening of relations among those organizations that work in the supply of services on the technological frontier. In accordance with this, varied forms of association for the development of joint projects should be established.

As a product of this approach, a special strategy must be designed which should take into account the private engineering consultancies and contribute to their development, providing support and offering joint work.

It is highly convenient for technological institutions to establish work relationships with consultancies or technology-based companies, with high levels of professionalism and whose principal

material to work on consists of proposals for innovation and modernization, but lack certain physical facilities and specialists that may be present at the institutes.

For their part, this type of companies bring to the joint action their substantial capability to penetrate the market. These consultancy units can act as a bridge between technological institute capabilities and actual demands of industrial companies.

Considerations on Why State Action is Necessary

At least some consideration must be given to why State participation is necessary in technological activities.

By and large the capacity to innovate or to adapt a process or a modification of the design of a product under an applied project concept requires such a capacity which is only possible by means of permanent learning and experimentation on the line of technology or discipline proper to each case. This activity is previous to any particular productive application with a direct profitable result.

The costs involved in performing these basic works are hardly ever paid by private enterprises. The associated benefits are of a general kind for a sector. In addition there remains the fact that further projects aiming to prove the advantages of some technological modifications in a practical way, give results which still can not be used as property by any one in particular. Moreover, some uncertainty accompanies the development of this type of project.

On the other hand, the technological development of a company is a process that requires external support, due to the critical mass necessary for the company to do its own research. This is the case especially for medium and small-size business units, being more critical in developing countries.

Furthermore, enterprise development is currently affected by a high speed cycle of technology and by the fact that investment in laboratories and in rather complex teams of researchers is too high to be afforded by isolated enterprises.

Finally, the progressive implementation of new technological elements implies, both as purpose and consequence, the creation of new labour opportunities for workers, technicians, and professionals. The creation of more productive and better-paid positions becomes possible as jobs diversify and are enriched by means of innovation and modernization of productive processes. This allows an increase in value with higher content of skill and intelligence.

Likewise, other activities are necessary such as those associated

with government tasks aimed at defining, for example, policies, regulations, support programs, etc.

On this issue, general benefits beyond direct returns, inappropriateness of results, levels of uncertainty, and medium- or long-term projects and programs must be the guiding factors in matters of assigning resources to the technologically-involved public sector organizations. To this effect, it should be understood that these institutions, especially the technological institutes, are the vehicle for State action.

The State should concentrate its efforts along these lines, otherwise the financial, human, and institutional resources will not accomplish their objectives.

II THAILAND INSTITUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH

History and Mission

The Thailand Institute of Scientific and Technological Research (TISTR) is a non-profit state organization working under the Ministry of Science, Technology and Environment (MOSTE). TISTR was originally set up by the Applied Scientific Research Corporation Act of Thailand in 1963 which was repealed and replaced by the Thailand Institute of Scientific and Technological Research Act in 1979 following the establishment of MOSTE in the same year.

The mission of TISTR is basically to carry out the task of propagating the results of scientific and technological research to benefit the country in agriculture, industry and commerce. Public and explicit purposes are to expedite the policies of the Ministry of Science, Technology and Environment oriented towards the promotion of the country's scientific and technological research and development activities. These policies include measures for screening, controlling and distributing technology systematically and encouraging local inventions and high technology productions for future applications.

Likewise, part of TISTR's task is to operate as a centre of excellence responsible in general for the provision of scientific and technological services, to supply relevant information and consultation to the government and private sectors, both locally and regionally, and to work in close cooperation with the private sector engaged in various enterprises and with other research and development units in order to build up an atmosphere in which science and technology are seen as the means by which national problems may be solved.

Other specific actions for accomplishing the Institute's goals are to initiate and conduct research activities and to provide scientific and technological services to state agencies and private enterprises; to conduct scientific and technological research in order to promote the utilization of natural resources appropriate to the economic conditions; to improve productivity in accordance with Government policies by propagating the results of scientific and technological research; to train scientific and technological researchers; and to supply standards, testing, measuring and other scientific and technological services.

Specifically, TISTR is a government's state enterprise responsible for scientific and technological research and development activities. Originally the Institute was staffed with the best personnel using an adequate pay scale to attract well-qualified people. However, this policy was impossible to hold because the institute, as a state enterprise, was forced to use the same salary scale applicable to other similar institutions and to follow the

same administrative regulations.

Nevertheless, in spite of numerous difficulties, obstacles, and limitations, staffs keep fulfilling their duties to help develop science and technology within the real possiblities. Valuable achievements of great merit for the country have been carried out and TISTR executive officers are anticipating greater favourable acceptance and full support from the various authorities concerned in order to enable the institute to render greater benefits from science and technology so as to favor the development of the whole nation.

The Institute human resources are constituted by seven hundred persons approximately, including therein one hundred twenty master and doctoral degrees, two hundred bachelor degrees and two hundred sixty graduated professionals.

TISTR budget approximately amounts to ten million American dollars per year and external sales reach more or less five million per year. These sales include goverment and industry requirements in research project activities and provision of services.

Technical Function Organization

TISTR organization covers twenty technical units, departments or centres. Their fields of activities are defined according to the different disciplines or specific industrial or agriculture sectors that are serviced.

The Food Industry Department (FID) sets research and development targets for the food industry to serve the demands of the local market and export-oriented production, and to solve problems encountered by industrial entrepreneurs. FID operations include research and development facilities with laboratories and pilot plant, consultations for commercial production, transfer of technology to industrial sectors, process improvement, and analysis and testing of food products.

FID places special emphasis on post-harvest technology, production technology for small and medium-scale processed food factories, and design of processes, equipment and plant layout.

The Pharmaceuticals and Natural Products Department (PNPD) carries out research and development activities on pharmaceuticals and natural products to promote industrial production of raw materials, drugs, essential oils, cosmetics and household products from Thai medicinal plants and natural products.

Among various activities, PNPD develops technology for the production of high quality medicinal plant raw materials and improves scientific and technological bases in pharmacology/toxicology, chemistry, quality control and clinical

cooperation.

The Chemical Industry Department (CID) develops commercial products in response to the demands of local and foreign markets. Operations include the potential use of surplus and waste materials from the chemical industry to alleviate problems concerning production cost, process efficiency and pollution. Also, CID works on the improvement of existing technology appropriate to local chemical industries, as well as selection and modification of advanced technology for transfer to various industries.

CID places its main emphasis on the fat and oil industry with special attention to the potential use of oil-bearing vegetables and process improvement for the vegetable oil industry, and on the chemical industry in relation to fibers and textiles focusing on the potential use of tropical plants in chemical and paper pulp industries.

The Biotechnology Department (BID) conducts research and development on the utilization of living organisms, especially microorganisms, to develop new industrial processes and products. Moreover, BID renders analytical services in microbiological examinations and tests for various industrial products. Also BID's microbiological culture collection has been supplying cultures of yeast, mold, bacteria, and algae for technical uses in industry as well as in research and basic science education.

Some current R & D activities are pilot scale production of biofertilizer from N_2-fixing blue-green algae, utilization of phosphate-dissolving micro-organisms for agriculture, production of organic fertilizer from industrial wastes, and production of mosquito larvicide from bacteria, eicosapentaenoic acid (EPA) by microalgae and pesticides from plant extracts. Also, BID develops processes for decolorization of molasses pigments by microorganisms and microbial degradation of oil spills in Bangkok.

The Building Technology Department (BTD) acts as a center for research and development on buildings in cooperation with building construction agencies, belonging to both public and private sectors. BTD operates three laboratories, namely Building Materials Lab., Building Technology Lab. and Architectural Lab. BTD efforts cover two main activites. Firstly, R & D applicable to construction policy and planning, such as, for example, studies for flood prevention of a city, sewage disposal and waste treatment planning in a city, physical development of rural settlement, etc. Secondly, R & D concerning construction technology including materials, processes, and architectural design procedures.

Besides these two main activities in R & D, BTD also acts as a center of building material testing services for building construction and related agencies in both public and private sectors in Thailand.

The Electronic Industry Department (EID) sets up and implements R & D programs in order to find appropriate solutions for existing problems and to meet the requirements of, specially, small and medium-sized enterprises for development of new products and process control systems.

Moreover, in order to cope with the lack of R & D personnel, since the beginning of 1991 and with cooperation from the private sector, the department has started up a new program - "PROJECT ON DEVELOPMENT OF PERSONNEL TO CONDUCT SPECIFIC RESEARCH (DPS)". Through this program, experienced personnel will receive special guidance, practical training, assistance, and proper motivation so that their skill can be applied effectively to fulfill their specific R D & E requirements.

Major fields of interest include telecommunications, medical electronics and industrial monitoring and control system applications.

The Engineering Industry Department (END) is responsible for research and development of machinery products. Emphasis is placed on high quality products by improving the quality of raw materials and applying the production technology that is most suitable to the available resources and economic condition of the country, which will lead to added value of national resources and new products.

END is targeted on activities as the development of alloy products by focusing mainly on raw materials available in the country with the object of developing various metal alloys for specific needs, and the development of machine parts, machine tools, and engineering tools. Also, END carries out activities in research and development on pilot scale for further study in large-scale production.

Among other projects, the Engineering Industry Department has carried out the research and development of desalination units for removing salt and impurities of brackish and sea water by reverse osmosis in order to yield drinking water that meets the "WHO" standards. The desalination units can be developed to reach various capacities. Nominal capacities vary from 10 - 100 m^3/day.

The Metal and Materials Technology Department (MMTD) focus its activities on support to government agencies and private sectors in R, D & E on new materials and composites, research services for material characterization according to their reliability including corrosion prevention and control in various environments, and improvement of beneficial techniques and quality control for both metallic and non-metallic industrial minerals.

Specifically, MMTD is working, among other projects, in scientific techniques for improving the color of gem minerals, exploitation process for high-quality kaolin, development of capability in

engineering ceramics, development of ferrites for loudspeakers and development of transducer materials for ultrasonic cleaner.

The Agro-Technology Department (ATD) carries out multi-disciplinary research on industrial and economic crops in order to develop appropriate technology and integrate the agro-industry with the large-scale processing of agricultural products. Consultancy services and research by contract are provided for government agencies and private sectors.

Among the main projects undertaken by ATD, are the Research and Development Project for Agriculture-Ocupational Extension in Coastal Sandy Soil, the Economic Forest Research and Agro-Forestry Demonstration for North-Eastern Thailand, and Evaluation of Plant Resources of South-East Asia.

The Energy Technology Department (ETD) is responsible for conducting energy research and development that lead to rational and efficient uses of energy, and the creation of indigenous capabilities for the design and construction of commercial energy conversion systems using domestic renewable non-conventional energy as a source of raw material. The prime objective is to reduce the country's dependance on imported energy.

The Environmental and Resources Management Department (ERMD) has dynamic professional staff consisting of engineers, economists, sociologists, geographers, forestry scientists, chemists, biologists, architects, environmental scientists and regional planners. This core group, in conjunction with other research departments in the Institute, is capable of undertaking practical study and research for policy formulation, integrated planning, and feasibility evaluation in various areas such as land and water resources development, environmental quality management, environmental impact assessment and wastewater treatment.

The Ecological Research Department (ERD) is involved in conducting research on the complex interrelationship of living organisms with their natural environment in order to determine the structural aspects of the ecosystem in which all components closely interact with one another in a continuous chainlike fashion.

Scientists in ERD are principally specialized in biology, environmental biology, fisheries, agriculture, museography, etc. The scope of some research works includes studies on environmental biology with emphasis on environmental quality and pollution impacts on living organisms, and studies to determine the structure of the ecosystem to be utilized in effective planning and remedial measures for environmental problems.

ERD acts as the largest biological reference centre of the country and is used as baseline data for applied scientific research; moreover, it serves as consulting agent to governmental and private

agencies in conducting studies on environmental biology and planning, natural history museum exhibition, management of plant and domestic pests, etc.

The Thai Packaging Centre (TPC) has been established under TISTR in order to upgrade the quality of products, minimize losses, increase exports, raise national packaging standards, and serve the needs of governmental and private sectors.

The Thai Packaging Centre is conveniently furnished with modern testing equipment and adequate space in order to develop various activities such as complete packaging cycle services including material quality, style, packing method, and cost; testing of packaging materials and containers; and providing of general technical consultation and packaging technological information.

The Automotive Technology Centre (ATC) is responsible for studying, exploring, collecting, following up, and conducting research and development activities for obtaining automotive and aeronautical technology. ATC also acts as a coordinating centre for all concerned government agencies and automotive sparepart manufacturers and assemblers.

The main objectives of ATC are to act as a coordinating centre in the field of automotive and aeronautical technology, to provide interested persons with technical knowledge of component parts of automotive and aeronautical technology, and to enhance technological knowledge of automobile, aeronautics and component parts in order to promote the country's self-reliance in automotive and aeronautical technology.

The Special Programme Centre (SPC) is responsible for the operation of specially-defined projects that are not duplicated by other departmental research projects, or management of SPC-initiated integrated projects developed under combined R and D efforts among specialists from different departments and centres of TISTR. SPC also provides training services in modern technology to strengthen technological capability which would benefit national development.

The framework of SPC mainly involves programs as machinery computer control for better quality products, computer training services for users and Microcomputer for Data Exchange Service System, shiitake mushroom cultivation, technology transfer for highland agriculture, supervision of the work of the Sakaerat Environmental Research Station which serves research and educational interests in tropical forest ecology, and information and consultancy services on foundation engineering for medium-to-large scale constructions.

The Industrial Metrology and Testing Service Centre (MTC) supports industrial development and acts as the principal centre for testing industrial products and metrology and measurement systems of the country. Among MTC principal functions and activities are to

provide testing and analysis services for industrial products and to certify standards of commodities and industrial products as required by the Thai Industrial Standards Institute (TISI); to provide standards calibration services for industrial equipment, measuring apparatus and laboratory instruments; to provide consulting services for the improvement of production processes and quality control; and to provide inspection services on quality assurance systems in manufacturing industries.

The Thai National Documentation Centre (TNDC) is a well-established source of scientific and technological information aiming to contribute to the promotion of science and technology in national development. TNDC is capable of providing documentation facilities to scientists, research workers and practitioners in areas such as library service for research activities, compilation of bibliography and literature searching services, and service for research data analysis by computer.

In addition, TNDC also maintains a collection of scientific and technological information (STI) concerning Thailand for further dissemination and exchange both locally and internationally.

The Engineering Consultancy Service Centre (ECSC) has been established in order to develop and strengthen domestic consultancy services for greater technological self-reliance and to improve technoeconomic decision-making processes. The main objective of ECSC is to enlist experienced consultants from various fields in order to provide consultancy capabilities and facilities to both government agencies and private sectors.

ECSC has the capability to participate in the development of infrastructural construction projects and the establishment of intricate industrial plants which require substantive professionalism and expertise.

The Industrial Cooperation and Promotion Centre (ICPC) carries out activities concerning transfer of technology developed or improved by TISTR for large-scale production in order to accomplish the objective of industrial promotion in the country. ICPC is mainly responsible for providing interested parties with TISTR research results and operational support facilities such as training, testing, analysis, quality control, as well as the design and installation of equipment and machinery, in order to serve the private sector needs. Likewise, ICPC provides assistance for urban and rural industries using results of research and development carried out by TISTR, as well as services for marketing surveys and feasibility studies. ICPC is also responsible for making the promotion of quality Thai products by conferring official awards to producers together with an emblem representing good quality: "THAI-MADE QUALITY PRODUCT".

The Research Service Centre (RSC) is responsible for the

arrangement of research projects requested by outside agencies. The investors, entrepreneurs or government agencies who wish TISTR to carry out some research projects can use the service of TISTR by contacting the RSC.

III INSTITUTIONAL ENVIROMENT

Environmental Conditions under which an Institute Should Work

Policies encouraging industrial technological demand, adequate institutional structure, systems of stimulus to the economy in general, different instruments acting on the productive sectors, and a governmental joint vision of innovative changes and production development, are, among others, basic factors which build up the environmental framework for proper performance of the research centres.

Such conditions depend mainly on governmental decisions whose effects are generally perceived on a short-term basis. Moreover, there are other relevant conditions imposed by the general environment where technological institutes accomplish their tasks.

Other aspects also affecting the environmental framework are the degree of maturity and professionalism of industrial plant management, the professional standards that characterize the workforce present in the industrial sectors concerned, the greater or lesser openness to international competitive trade, the existence of private business working in the field of consultancy and technological innovation, and the existence of other centres devoted to technological development.

Such environmnental conditions derive less from current governmental decisions than from policies implemented by the State over many years.

Bearing in mind those factors which are currently feasible regarding short term effects, and considering the desired requisites for adequate performance of technological institutions, it is worthwhile considering and reviewing the general question of which new short-term elements should be included in a government policy that is satisfactory for these ends. The other factors have to be taken as given, at least from the point of view of the concerns of those in charge of the technological system.

Government Policies

A wide range of experiences indicate the necessity to implement an institutional structure that gives coherence to the Scientific and Technological System with special attention to budgetary analyses and long-term program assignations. Otherwise there is the risk of

an occurrence of project and program self-definition among the centres and institutes of the State. To avoid this, adequate levels of dialogue on matters involving the formulation of plans and programs have to be established. Likewise, funding requirements should be presented to the budgetary authorities in a global manner through a reliable institutional centralization level.

This concern is neither new nor confined to developing countries. In the U.S.A., for instance, the national organizations created for technological support, such as the National Institute of Standards and Technology (NIST), are constantly being changed in order to achieve a better performance.

This institutional acting level must be of a multi-sector and inter-institutional nature in order to allow the definition of policies and to guide, encourage, evaluate and coordinate the actions of the different organizations involved in the technological system. Moreover, it should be seen as the means for dialogue on matters of proposals and recommendations for the assignment of resources, both in general and according to each body in the system.

An essential point in the technological policy is the definition of a flexible system in order to make budget and human resources management more flexible. In this case, it is important to take into consideration a greater compatibility with the labour market and to allow, for instance, a reduction in the number of people so as to benefit from fewer but more highly qualified personnel. In other words, going from quantity to quality.

In most countries budgetary analysis is carried out by the financial authorities in a direct manner, and every institute must necessarily depend on the authorities' understanding of and confidence in the technical importance of their technological plans and programs. The systems for obtaining resources are unstable and dissimilar, especially when State funding is shrinking on account of stringent fiscal policies. This circumstance generally comes together with the small role seen for the Public Sector in industrial activities.

Consequently, the controlling factors that must be taken on and overcome are the administrative and budgetary restrictions. In order to establish a greater rationality in the relationship with the financial authority, it is necessary to activate and reinforce the channels of dialogue through the adequate level.

Necessary reforms of the legal system and administrative organization should be made in order to improve the capacity of management including, among other improvements, the design of an adequate system for evaluating the performance of technological institutions. The creation of a mechanism to establish effective

relationships between universities and institutes by means of State funding for joint project development must also be considered.

State institutes in many countries, although considered as the principal means of technological supply, show problems of such extent that it is impossible to think of making the system adequate without planning substantial changes in its operation, function and legal restraints.

This has led in developing countries to serious doubts about the effectiveness of institutes, considering the lack of adequate funds, poor salaries, further depression of the morale of personnel, loss of sales, and reduced salaries again. This vicious circle constantly tranforms the consequence into its own cause.

Financing provided by the state through regular budgetary transfers should ensure activities such as spread and dissemination of general and specific technical information through seminars, courses and workshops on new trends that are appearing in the international sphere and that simultaneously represent threats and opportunities for the country's competitive potential. This type of activity should constitute a way of delivering knowledge to the economic sector and providing professional and entrepreneur training.

In the same way, consideration must be given to those activities that benefit in general various production and service sectors, and those that give technical support to governmental permanent provisions, such as regulations, environmental protection policies, design of technological promotion programs, standards, etc.

Among other State responsabilities it is appropriate to consider the funds for assuring, through institutes, the exploratory activities for acquiring knowledge and experience for handling lines of technology for further applications according to client requirements. This is known as pre-competitive work.

On this issue, the inappropriateness of results, the levels of uncertainty, and the medium or long terms involved with this kind of projects and programs, must be the leading criteria in matters of resource assignation for technological institutes.

These fund transfers should contribute, in a long-term perspective, to institutional stability and improvement in performance.

Moreover, the flow of funds for institutions, whether through direct aid or through funds that are applied for and competed for, should be linked, according to each case, to the role that these institutions are to perform and to the signs exhibited by the market and the demand.

There is also a fundamental restriction regarding the level of

outlay of private companies on technological development and innovation activities. Consequently, there is a need to consolidate and design the means, incentives and mechanisms that increase technological demand and spending on the part of the producing industries at a faster rate by means of State funding. Private sector technological projects must be supported with greater o lesser levels of subsidy as applicable to each case.

The identification and financing of private technological projects for specific applications constitute one of the principal means for motivating the demand for institute capabilities, facilitating therefore the fulfillment of their goal.

Private projects that are eligible for financing should consider among other factors the scaling-up to production level of innovations, technological modernization, and other multiple forms leading to technology transfer.

Engineering Consultancy Companies

Administrative process mechanization through the use of computers, design of production processes, basic engineering, electronics applications, plant design, communications system, modern management techniques, etc., are some fields of action that characterize the engineering consultancy companies, also known as new technology-based companies. This kind of enterprises basically works with advanced aspects of technological know-how that has been relatively disseminated.

An active process of industrial investment, at a country level, as well as a progressive cultural change oriented towards modernization and innovation, create the necessary demand conditions for the appearance of this type of highly professionalized companies, whose work is strongly linked to technological transfer and its necessary adaptations.

However, given that the business tax system existing until year 1992 penalized interfirm transactions it was difficult for companies to specialize and to use subcontractors. Consequently, larger enterprises tended to be vertically integrated. According to this no appropriate conditions existed on the past neither for engineering consultancy companies nor for intermediate suppliers.

For that reason, new technology-based companies are still a rather recent phenomenon that affects the commercialization possibilities of the existing technological know-how and enhances the emergence of indigeneous technologies.

This type of companies constitutes a bridge between centres that carry out development projects and industries demanding technological application.

The presence of a significant number of engineering consultancy companies working for the productive sector represents a favorable condition for task achievement of the technological centres and institutes.

On the contrary, if these consultancy companies are not sufficiently available, a set of measures must necessarily be designed in order to encourage their development. For this purpose, universities could play an important role as incubators of new-born enterprises perhaps following the model of some North American universities, as is the case of the University of Maryland.

Moreover, the government should also design special incentive and subsidy systems in order to accomplish this goal in cooperation with universities or by means of a multipurpose technological institute as is the case of TISTR.

Offer and Targets within an Environment Context

The enterprises which form the universe of service users can be distinguished according to small, medium or large size, field of activity or speciality, and rural or urban location. Among other differences, the specific choice of which industries to serve will affect the manner and content of the services covered, contributing therefore to create to some extent the institute's own profile.

As to the different kind of services available, a broad range of fields of activity on research and development and technological services can be distinguished among the tasks that a technological institute should accomplish in order to fulfill its objectives.

On the other hand, the country currently has various centres and technological institutes apart from the universities. This set of institutions covers practically the whole range of services that usually make up a satisfactory offer.

Nevertheless, each of these services does not necessarily meet in every case the requirements of every segment of industrial specialization nor makes distinctions according to enterprise size or location, either rural or urban. An ordering matrix having as axes the industrial specialities, type of services, enterprise size and alternate location, would show some idle elements.

All the same, a useful starting point to understand the institute role would be to develop a clear comprehension of the domestic science and technological system, including public and private resources that support the system. Once having a better idea of its current structure, it is possible to clarify TISTR institutional environment considering the type of services and target industry groups focused by the other components of the system. A brief and quick description of the activity profile and objectives of the

other institutions will help to accomplish this understanding.

Other Technological Institutions. The Ministry of Industry (MOI) is in charge of activities for providing technical and management consultancy services to small- and medium-size firms through its Department of Industrial Promotion (DIP). DIP includes several regional centres and specific industry divisions that provide technical, financial and management support. It also contains some specific centres and institutes, namely:

The Thailand Management Development and Productivity Center (TMDPC), which provides management and technical training to small and medium firms. TMDPC conducts training courses and seminars in the field of modern business and management practices and provides consultancy services to local manufacturers in the fields of marketing, management, production, and quality control. It also compiles and disseminates relevant information on the corresponding businesses and industries.

Moreover, TMDPC supports the activities of various institutions such as the Thailand Management Association, the Marketing Association of Thailand, and the Government Enterprise Productivity Group. In addition, it provides assistance to a group of firms interested in forming a Technology Transfer Group seeking to facilitate purchases at a minimun cost and dissemination of technology for common use of its members.

In early 1994 the (re-named) Thailand Productivity Center was strengthened through the provision of a 5-year technical cooperation funding from the Japanese International Cooperation Agency (JICA) for the purpose of transferring Japanese technology and experience in this field

The Metalworking and Machinery Industries Development Institute (MIDI), which was recently established with assistance from the Japanese Goverment, was upgraded from a subdivision of the ISD.

MIDI provides support to small- and medium-scale metalworking and machinery industries through consultation and training courses on casting, welding, heat treatment, electroplating, machining, gear cutting, machine design, engineering drawing and automation technology.

It also supports company production activities through inspection and measurement services. Moreover, it offers consultancy services on factory planning and layout, information services, and applied R&D and trial manufacture of products, jigs, and tools.

Others institutions under the supervision of MOI are:

The Thai Industrial Standards Institute (TISI), which operates under the policy guidelines of the Industrial Standards Council to establish national standards, issue certificates, and promote the implementation of standards.

The Industrial Service Division (ISD), DIP, offers technical information, dissemination, and advisory services in such areas as industrial engineering, industrial design, packaging, furniture, woodworking, ceramics, and agro-industries.

The Textile Industry Division,DIP, conducts training courses on production techniques and offers consultancy services to solve textile manufacturers' problems and improve their productivity. It also maintains modern laboratories in order to test textile materials and products and to carry out research on textile materials, manufacturing processes, and textile machinery and equipment. Finally, it collects and disseminates relevant information concerning the textile industry.

The Northern, Northeastern and Southern Industrial Promotion Centers, DIP, which are located in Chiang Mai, Khon Kaen and Songkhla, respectively, act as DIP's representatives to promote vocational training in cottage industries and to promote and develop rural industries. They coordinate with other DIP divisions in providing services to meet local needs.

The Ministry of Science, Technology and Environment (MOSTE) supervises and supports institutions and activities devoted to technological development of enterprises by providing them with research and development and a broad range of technological services. TISTR is one of the most important institutions acting under MOSTE.

The main R&D institutes under MOSTE working on industry, besides TISTR, are three centers of the National Science and Technology Development Agency (NSTDA), namely the National Center for Genetic Engineering and Biotechnology (NCGEB), the National Metal and Material Technology Center (NMMTC), and the National Electronics and Computer Technology Center (NECTEC). As yet none of the three specialized NSTDA research centers is, however, equipped to carry out in-house RD&E activities. Initially, the three centers were expected to be the technical planning arms of the former Science and Technology Development Board (STDB) but were eventually established as separate entities within MOSTE itself.

When NSTDA was set up in 1992 under MOSTE they were incorporated within that Agency, by virtue of the Science and Technology Act promulgated in late 1991. The specific technology areas (biotechnology, material and electronics) designated for

development by NSTDA provide a clear framework for its task, not too narrow and yet not too broad to be too difficult to accomplish.

Another specialized institution, under the overall jurisdiction of MOSTE, is the Environmental Research and Training Centre (ERTC) of the Office of the National Environment Board of Thailand, established at Technopolis, Pathumthani (north of Bangkok) with assistance from Japan. The basic purpose of ERTC is to carry out research and to provide technical support in training for the implementation of environmental policy and environmental management initiatives.

Furthermore, within MOSTE itself, some centres are providing special technological services, namely:

> The Technology Transfer Center (TTC). This center was set up in 1983 as a division of MOSTE's Office of the Permanent Secretary. It promotes technology transfer from abroad and improves its effectiveness while contributing to economic and technological development. Thus far, TTC's activities have focused primarily on information dissemination and providing training as well as guidelines for acquiring technology.
>
> The Department of Science Services (DSS). The DSS provides a variety of testing, certification, and information services mainly to the industrial sector.

The Ministry of Agriculture is also responsible for a large number of specialized institutes involved in R&D, such as the Rubber Research Institute, and two institutes currently under establishment, the Palm Oil Institute and the Thai Tapioca Development Institute (with Japanese assistance).

Some public sector R&D activities take place also in state universities. The sixteen public universities employ most of the highly-educated personnel in the country. It is obvious that universities should do research not only for academic purposes but also to solve practical problems, but practical R&D is still of little magnitude, and its direction questionable. The establishment of closer links between universities and industries is of vital importance for transferring the fruits of R&D to the production capabilities of private manufacturing firms. At the same time, practical R&D researchers in universities would be able to sense the direction dictated by world market forces.

There is also the Technological Promotion Association (TPA), which is a non-profit private organization set up in 1973 with the aid of the Japan-Thai Economic Cooperation Society (JTEC) for technological enhancement of the Thai industry. It actively promotes industrial training and technological know-how through the translation of textbooks, language courses, and organization of

seminars and training courses. It has also set up an industrial instrumentation project to provide courses and to establish a calibration center, and has pioneered a quality control project to encourage the formation of Quality Control Circles.

Main private sector enterprises carrying out R&D include Shell Company of Thailand, Esso Standard Thailand Ltd., the Siam Cement Group, the Premier Group of Companies, Bangkok Bank, and Siam City Bank. Most of the private sector activity is however not so much research in the sense of technological research and development, but more in terms of oil exploration (Shell and Esso) or economic research (Bangkok Bank and Siam City Bank).

Technological R&D is carried out by the Siam Cement Group and during the past four years it has been building up within its Technology Development Institute a series of specialized R&D centers covering fields of direct interest to the Group, namely cement and construction materials (in Bangkok), paper (in Bangkok) and machinery (in Don Muang). The Premier Group of Companies has recently established research and technology development facilities of a scale beyond the Group's own needs.

Research laboratories existing in various government departments include those of the Royal Irrigation Department, the Department of Fisheries, the Department of Livestock Development, the Royal Forest Department, the Department of Agriculture, the Department of Highways, the Department of Medical Sciences, Ministry of Public Health, the Department of Mineral Resources, Ministry of Industry, etc.

Furthermore, research laboratories existing in state enterprises include those of the Electricity Generating Authority of Thailand (EGAT), the factory of the Preserved Food Organization (PFO), the Dairy Farming Promotion Organization of Thailand, the Thailand Tobacco Monopoly, the State Railway of Thailand, the Telephone Organization of Thailand (TOT), the Communication Authority of Thailand (CAT), the Metropolitan Electricity Authority, the Provincial Electricity Authority, the Government Pharmaceutical Organization, and the Petroleum Authority of Thailand.

In 1991 the Chulabhorn Research Institute was established with the main objectives of promoting basic and applied research of international importance in particular areas that will improve the quality of life for the underprivileged. Agricultural research is the main area targeted.

Mention should also be made to the National Research Council of Thailand (NRC) which was created in 1959 and is now under the authority of MOSTE. Its main functions or activities are to establish national research policies; to serve as information and reference centre for researchers and research results in the country; to examine and analyze research proposals from government

organizations and state enterprises; to cooperate with various organizations in the conduct of joint scientific research projects; to promote research by granting various research budgets; to develop research personnel through training programs; and to promote joint research between Thai and foreign researchers.

Finally, it must be pointed out that during 1992 two other research funding agencies, besides NSTDA, were established, namely The Thailand Research Fund with the task of providing support and direct research that will lead to indigenous development; and The Health System Research Institute (HSRI) governed by a Policy Board chaired by the Minister of Health.

IV AN INSTITUTE PROFILE

A Distinct Way of Work. The profile of an institute is given in part by the type of services and activities it covers. The size, the location, whether urban or rural, and the specialization field of the companies to be served are additional factors that contribute to characterize a technological centre.

Moreover, the decision to reorient technological institute activities and objectives demands a detailed revision of service offer and development capabilities present in other technological entities, especially in those belonging to the public sector.

A revision made of the fields of activity included in the technological offer of the other institutions of the system shows that the main services required by the industrial sector are basically covered.

Accordingly, a first group corresponds to services related to metrology, material analysis, testing, material characterization and standards. A second group is formed by development-oriented technical support services such as prototype product design, development and testing according to manufacturer's requirements; and design, adaptation and upgrading of production processes, as well as automation.

General information services are widely offered. More specifically, services of identification, evaluation and selection of available technologies are also considered among the offered services. Complementary to the above services, there is the search of information on patents, manufactures, management of industrial property and assistance in contract negociation of technology transfer agreements.

Other institutions develop activities regarding divulgation, dissemination and spread of new technological knowledge into industrial ambits by means of seminars, workshops, courses, training, etc.

To identify needs that are not currently covered by the existing offer is certainly the proper tool when defining the field of action of one institute in process of readaptation. However, with more than twenty or thirty years of public supporting efforts in the area of research and development, it seems difficult to clearly identify an institution whose activities do not compete or overlap with other institutions.

A brief description of the activities covered in Thailand by at least eleven state entities, apart from university capabilities, evidences that overlapping is to some extent unavoidable. But this

by itself does not necessarily imply a negative conditioning factor.

Concerns on resource duplication and dispersion must lead in the first place to an analysis of the extension of both actual and potential domestic demand. On the second hand, the various forms and ways of focus that can be adopted for rendering services as well as for establishing criteria for development projects, must be considered as relevant differentiation factors.

In the case of TISTR, this last aspect is of great significance and must be taken into consideration when the profile outline process is in course. A clearly differentiating sense must be used in order to allow the openness of a proper space. More than fields of specialization, type of target industries or group of services and works selected, it is the manner, style and focus of the institute services, applied project development, goals and objetives, that can build up its own distinct image.

The involvement in joint research efforts and the establishment of strategic alliances with other institutions create to some extent a different style of work within a national context.

Work in Network. On the other hand, the advantages of linking institutions in properly supported networks are as useful as the extent of effort put into them by the participants. General and non-specific institutional agreements seldom lead to a successful joint project. A more valuable asset would be the real knowledge that one has over the other entities' resources and capabilities and based on that to focus a project as an inter-institutional work team.

The ability to handle a cadre of capable researchers and scientists belonging to different centres and to know the exact distribution and location of sophisticated equipment at different institutions constitutes a special skill that is very useful for the planification of complex project execution. Once a project of this nature is properly identified, it is then possible to invite those persons or institutes to undertake the project development as a joint enterprise. This kind of approach and conception defines by itself a distinctive way of action. The work in network starts with the initial apprehension of the project once the process of identification of requirements is in course.

Reliability and Second-level References. Laboratory services, testing and analysis can be offered and performed as a routine task, subject to general market conditions of prices and other applicable comparisons. This kind of analysis services is proper of private sector activities provided that technological demand is progressively growing.

However, this type of offer can be relevant for the institute

during a transitional period. A reduction of the gap existing between institute and industry can be facilitated by means of this type of service offer. Furthermore, it is possible to complement the service concept with an analysis of results according to probable causes.

Another option would be to offer the same set of services, specially the incorporation of analysis of results, but not for mass requirements but for highly reliable measuring needs, acting as a reference laboratory and offering testing services or design of protocols to be applied in serial analysis. Market competition in this case would not be for prices but for an image of excellence and reliability, providing a valuable component in the technological system.

Leading to Technological Socialization. Another distinctive factor of the institute profile could be the implementation of a set of actions oriented to open a new line for entrepreneur participation in the divulgation of specific technological information. The institute can contribute to the creation of an encounter place among manufacturers, industrial material and component users and service companies, linked by the same industry sectorial segment or by a specific technological subject.

The offer of physical infrastructure to support emerging entrepreneurial organization sponsored by the institute, the supply of technical information, and the creation of an atmosphere of cooperation, are factors that contribute to produce a positive cultural change in the attitude of observation, adaptation and innovation. Another benefit resulting as a consequence of this kind of initiative, will be a better appraisal of the institute image within the industrial ambit.

Horizontal Technologies for Multisectorial Needs. A target group formed by various speciality sectorial segments, each one served according to its own technological field of activity, would constitute a way of conceiving the institute profile. This approach implies fulfilling the requirement of having at the same time the critical mass necessary for each sector.

Nevertheless, different sectorial segments can be seen as subjects having common technological requirements. Such would be the case of flexible automation, artificial vision, environmental prevention and treatment, modern management techniques, etc. This kind of technological specialities has a multisector application and can be defined to a certain extent as horizontal specialities or disciplines.

In the same sense, other areas of technological knowledge can be conceived under a horizontal conception, as it may be the case, for instance, of tailor-made electronic applications to meet upgrading needs of different sectors, or solutions of chemical problems for

non-chemical industries. According to this approach, any technological division of the institute could orient its speciality towards the fulfillment of different sector requirements, establishing in this way another distinctive aspect of the institute profile.

Main Target Groups. Considering that one of Thailand's economic policy components gives special emphasis on export-oriented industries, an examination must be done in order to identify some classifications within this sector, specially when a change of the export composition is desired for achieving a higher content in skill, knowledge and added value.

A distinguishable group is formed by national companies involved in export-oriented production activities. These companies, unlike large foreign manufacturing enterprises having their own technological know-how, constitute a target group for the application of the development capabilities and technological services already existing in the country.

Agroindustrial production is affected in general by declining prices, salary increases and growing quality control requirements. Aspects as cost reduction, plague control, post-harvest, packing and packaging, cold storage process, and genetic selection, are some of the issues requiring solution by means of technological support.

Some food industries, small-scale mining, sawmills, fishery and ceramics, face some challenges derived from factors as size, rural location, local materials or climate. Consequently, ready-to-use foreign technologies are adequate only if some adaptation is made.

Small- and medium-size companies acting as intermediate suppliers in the industrial sector form another target group. This is the case of automotive industry suppliers or other manufacturers that are subcontracted by multinational companies that export from Thailand. The needs of these companies and its multiplicative effects in productivity, cost and quality constitute relevant issues for technological support.

Funding Composition. The origin or composition of the institute funding has an indirect relation with its profile configuration. If regular financing comes one hundred percent from the state, this will probably lead to neglecting links with the industry, favoring on the contrary in-house projects and internally generated programs. The fact that no sales are produced, according to the hypothesis of this extreme case, would imply in itself the lack of connection with the industry. Moreover, works generated internally by isolated groups of researchers in very rare occasions produce technological results that reach the market.

On the other hand, if funding comes one hundred percent from sales,

if this is ever possible, the institute will be out of the research and development field, working instead on standard commercial services and consultancies as would be the case of any private enterprise. The reasons supporting the above are widely known, being some of them the uncertainty associated to the exploratory works for research and the fact that no company in particular can appropriate the benefits obtained from these activities.

Consequently, an intermediate composition of the financial resources seems to be reasonable. A wide range of experiences evidences that the break-even point is reached when a range from 30% to 50% of the income comes from sales of services and applied projects made into the private market. Such is the case of many successful institutes in USA, Spain, South Africa, Chile, among other countries. With such a composition it is therefore possible to make long-term activities financed by the public sector compatible with short-term projects developed according to client demands.

A Friendly Image. Entrepreneurs belonging to small and medium industry sector tend to see technological issues as complex, sophisticated, expensive and far away from their own reality. Moreover, entrepreneurs consider state technological institutions as remote entities whose fields of action are difficult for them to understand both in their similarities and differences.

Therefore, it is not easy for this kind of entrepreneurs to associate the problems encountered by them in the production processes with the interest that the technological centres may have in studying possible solutions. A drastic change must be made in order that potential users choose to approach the centers.

Through a communication and dissemination campaign oriented towards small- and medium-scale industry, it is possible to spread the institute image as an entity whose special concern is the comprehension of problems related to the manufacture and design of products and processes without taking into consideration the nature of these problems no matter how simple or domestic they may seem.

Likewise, when entrepreneurs perceive that a possible participation with other technological centres may be required, the institute should manage to present its image as an effective linking element.

TISTR must be seen by the entrepreneurs as a familiar and closely related institution so as to avoid the existence of possible inhibitions. In this sense, TISTR must be seen as an access door to an effective supporting network and as a coordination entity with other technological centres when specific needs require a joint participation. TISTR officials must be seen as professionals specially interested in understanding the entrepreneur technical problems independently of how common or alien to science these may

be.

On the other hand, the understanding of a specific production problem or case could lead TISTR to the identification of a more generalized problem, with the possibility of focusing a solution with multiplicative effects within a given sector.

V STRATEGIC ACTION ORIENTATION

Minimum Size. It is necessary that the institutional design allows for a size that ensures at least the critical mass necessary in each activity or field undertaken, considering not only real capability but also credibility in the market appraisal. Dispersion of efforts and resources should be avoided by means of a careful selection of technological areas and type of services to be offered to clients.

Highly Qualified Staff. The institutional staff must include the highest available level of professionals, engineers, scientists, capable of gaining recognition in the sphere of business and industrial production. A high academic level, a permanent contact with university activities in some specific field and a recognized practical experience in production and research accomplishments are among the most desirable conditions which should be fulfilled by those who lead groups of specialists working in applied technological development.

Regarding this last consideration, part of the working time of this kind of professionals should be used for teaching at university. This grant implies updating, personal motivation, institutional image and connections.

To accomplish this purpose a recomposition and resizing of current staff is advisable in order to allow a salary increase to the key researchers but maintaining the remuneration budget within the same limits.

Also it is necessary to consider the incorporation of new staff with the kind of expertise and experience required to provide leadership in the new type of industry-oriented activities.

Competitive Salary Level. According to general consensus, this matter is of vital importance. However, it should be recognized that to achieve a better compatibility with the labor market, especially regarding high salaries for highly qualified professionals, it is necessary to count on more flexible legal and administrative rules. Nevertheless, decisions on these aspects go beyond the institute's ambits of action.

Even then and as long as the legal system that governs this type of institutions is not conveniently modified, it would be necessary to examine all the possible mechanisms that would allow salary increases. A competitive salary level for the key professionals is an essential conditioning factor to improve effectiveness and requires urgent accomplishment.

The basic plan should not strictly imply a general salary increase

for everybody. On the contrary, the purpose would be to enlarge the staff's salary expectations but using a deeper perspective so as to make the researcher career more associated with future economic improvement.

From Quantity to Quality. This transformation not only involves a reduction of the number of professionals and members of the staff but covers as well the aspects related to the allocation of physical resources in matters of equipment and those associated with the different specialities that are being considered. To this effect, it would be necessary to program a transition oriented towards less fields of speciality but with higher levels of excellence, less laboratories but better equipped. To accomplish this it would be necessary to reorganize and concentrate equipment allocation and to have less but better qualified personnel. It is a matter of keeping the same budget and staff but with less dispersion and more qualification.

Complementary to this, a transitional procedure must be designed and implemented for the retirement of part of the existing staff who may be unable to transform their skill and work orientation in the required direction.

Speciality Field Approach. In the case of multisector institutes, it is necessary to recognize, now more than ever, that it is extremely difficult to cover many branches and maintain a credible image of excellence in every field of specialization. Technological knowledge grows too fast in every speciality and presents multiple forms of subdivisions in such a way that it is not feasible nowadays to offer many fields of action.

A progressive approach could be to focus the work on technologies common to various industrial sectors. This means horizontal disciplines. Such is the case of flexible automation, computing, packing and packaging, environmental technologies, modern techniques of management, total quality and other disciplines with different focuses.

That could be for instance, electronic assistance for non-electronic industries, chemical assistance for non-chemical companies, metalworking consultancies for enterprises with marginal needs in this field, etc. In other words, expertise for non experts.

Internal Technological Development Programs. Future requirements for applied projects and the corresponding fields of speciality involved should be estimated in order to develop adequate capabilities to meet client demands. Consequently, exploratory works oriented towards acquiring knowledge and experience around a line of technology proper to each case must be undertaken.

An exchange of points of view covering technological possible

evolution and derivate needs has to be made with the agent involved in production activities in order to make a useful identification of subjects to work on.

The concept of internal program must cover both the preparatory activities and those related to the final practical testing of any modification or innovation advantages, under the perspective of long- or medium-term national needs. Long-term budgets for these purposes must be ensured from the beginning of this kind of programs.

Applied Projects Reaching the Market. The development of technological projects linked to a supposed commercial application under the in-house project concept must not be a one-sided institute decision. In the technological field, the product-out strategy has proved to be unsuccessful. Very rarely do in-house technological packages reach the market.

By and large the supply of technological projects cannot now be generated by internal groups of researchers. On the contrary, the strategy for developing application projects must be of the market-in kind. The supply should be a response to those demands that the protagonist involved in production identifies from his own view of his field of action. Any proposal for applied projects must start with the client's agreement, understanding that the concept of a project of this kind ties a production problem with its possible solution.

Internal Network. The institute organizational system is made up of several specialized technical units. In consequence, different programs and projects following a specific sectorial view or according to a technological discipline proper of the unit profile are developed in each one of these units. However, several aspects related to the project conception and other technological requirements may exceed the internal capabilities of the unit involved.

Considering that most projects have multi-disciplinary requirements, the institution should encourage the formation of a culture oriented towards a matrix organization of the resources and specialities. The leading unit of the project must get accustomed to consider the other units as suppliers of services and works and at the same time, each unit must consider the other units as potential internal clients and must clearly specify the type of services and works that can offer.

This attitude must be present not only during the project execution period but must start since the initial identification and programming proceses.

Institute Client Network. The laboratories, the equipment and the professional staff of the institute must be perceived by the

company as a physical extension of its plant, in such a way that the execution of the specific project is seen as a true joint enterprise. It is not easy to achieve this kind of relationship with a client as it is necessary first to gain his confidence. However, to promote a cultural change on joint development projects within the industrial sphere is an activity that requires constant efforts.

Associative Network with Consultancy Companies. Another line of action to promote the integration of the country,s capacities and resources is to look for advanced engineering consultancy firms in order to offer joint work combining the market penetration capabilities of these companies with the institute's strength in physical facilities and specialized teams of professionals. The concept of joint work implies two possible alternate forms. In one case, the consultancy company contracts the institute in order to perform some part of the work; in the other case, the institute contracts the consultancy company in order to complement some capabilities. Each of these alternate forms depends on who has the contact with the main client.

Institute, University and Other Technological Institution Network. Due to their non-specific nature, general inter-institutional cooperation agreements do not imply in themselves an efficient interrelationship. On the contrary, specific research projects, whose multiple and interdisciplinary requirements are capable of exceeding the internal capacities of an institution, offer an excellent opportunity to associate for the development of joint works.

The information regarding the capabilities and specialities proper of the different university departments and other technological institutions, must be a part of the analysis of available resources when considering the feasibility to carry out a project. That which the institute is unable to do by itself can not be seen as a limiting factor in the decision process. The assembly of the resources available at a country level in order to build up an inter-institutional architecture of execution constitutes in itself a real specific skill.

International Network. Specially in cases when collaboration efforts, technological information and staff training are needed, bilateral agreements with industrialized countries constitute a useful vehicle to establish an international network. A previous identification of specific agencies must be done in order to define the type of cooperation than can be provided.

A multilateral cooperation agency as UNIDO could be of great help for making preliminary contacts and obtaining any relevant information. This network should mainly focus itself in research and development centres operating in industrialized countries. For the purpose of technical information transfer and possible training

programs, it is vitally important to know in detail the field of activities of these centres.

Building a Consensual Background on Technological Issues. A practical way to produce technological sensitivity and a spirit of cooperation would be to establish permanent groups of enterprises which are invited to discuss and share the institute's information on issues of common interest, and to offer them the opportunity to share with the rest what they may know or what they have already experienced. Enterprises should be adequately incentivated in order to propose other themes.

To offer the building facilities of the institute as a club-house for a group having common technological issues as, for instance, end-of-pipe water treatment problems or new technological improvements in CAD-CAM or potential problems resulting from ISO-9000 standard applications, etc., would also contribute to form an associative attitude among entrepreneurs.

The organization of this type of permanent groups of enterprises makes up the proper atmosphere in which the technological trends that are appearing in international ambits, and that simultaneously represent threats and opportunities for potential competition, can be discussed. Experience in various countries has demonstrated that domestic export companies show a greater willingness to materialize this kind of relationship.

Motivation by Means of Information. As a permanent action, the divulgation, dissemination and spread of new technological knowledge must be carried out by means of seminars, workshops, courses and public releases opened and destined for everybody. Apart from the general benefit involved in this information reaching industrial ambits, the institute has once again the opportunity and the means of offering an image of excellence and constant updating.

New Management Approach. An analysis of the Institute internal administration system evidences a satisfactory management approach. For instance, one of the most important aspects of an efficient administration relates to appropriate levels at which different types of decisions are taken, and in the case of TISTR the levels adopted for each kind of decision are considered adequate.

However, management techniques that are currently applied in the industrialized world in enterprises and in general in every kind of organizations are an issue of constant improvement. New related concepts and theories have been developed during the past fifteen years in countries such as Japan and more recently in the United States.

According to these points of view, the use of total quality concepts for production processes has been expanded to the

administration systems where management itself is considered as the first objective for quality achievement. Recent experiences show that the effect of administrative changes on aspects such as cost, market entry, reduction of defective products, etc., achieves quantitative changes of the order of 20% to 30% without necessarily introducing innovation in hard technologies.

In general, under the total quality management systems it is necessary to keep in mind that management improvement is a permanent process. Under this point of view, it is advisable for TISTR to apply this kind of modern management techniques, including strategic planning and the system concepts implied in the total quality procedures applied to administration.

This means delegation, empowering people, diminishing the number of intermediate levels of decision in order to improve the speed of response, establishing the concept of the internal supplier-customer chain and giving power to the client to act as a medium agent for implementing self-corrective feedback. It should be emphasized that the client is the agent that receives as input what others deliver as output.

Training. As an essential condition, TISTR staff must be perfectly capable of absorbing any new knowledge generated abroad, as well as sufficiently prepared to make practical applications thereof including in-house experimentation. For such purpose, professional updating must be programmed in such a way so as to cover many different forms. Likewise, updating should be oriented towards basic and applied sciences and the cooperation of some qualified university may be useful in this case.

Additionally, attending scientific events and reading technological and scientific publications, both national and international, must be part of the regular activities of the staff.

As a rule, practical training has to be planned individually according to the academic level and experience of each professional member of the staff. Moreover, training should be carried out by means of international cooperation and preferably in industrialized countries, and should cover specific items related to new aspects of disciplines or techniques.

Furthermore, it has been demonstrated that learning by doing or training on the job is the most convenient way to acquire the necessary capability to accomplish the technological transfer process. It is absolutely impossible to learn complicated matters purely from books or publications. Researchers and professionals must be present where the work is actually being performed and must observe how experts develop their job.

When training takes place within the same country, an adequate vehicle would be to deal with specific and applied projects. This

implies the effective incorporation of the most capable and experienced foreign experts. These specialists would work in the field just as if they were working in their original locations and as a result of this, assistants would gain expertise while working with them.

Contact Facilities. It is a known fact that most of the scientific and technological knowledge existing in any country is usually produced abroad. Consequently, all the texts and other published materials are generally available in English and scientists, experts and professionals everywhere have to be prepared to read, write and hold dialogues in this language.

This specific aspect is of vital importance when contacts are being made in order to benefit from international cooperation. Joint work, personal relationships and training are simply impossible if a common language is not present. Consequently, any sciencific and technological institute that is adequately linked to other institutions abroad must necessarily adopt English as a second language and should demand a thorough knowledge of it from every professional. In order to accomplish this a permanent learning program should be considered.

Objective Areas. As it has been previously mentioned, TISTR does not stand alone in Thailand's technology market. As a consequence of this fact, the Institute is therefore compelled to look for target sectors that have significant importance in and are congruent with the national development strategy. Given that one of Thailand's economic policy components is directed towards the promotion of export-oriented industries, an analysis must be made in order to establish some distinctions within this sector. In this regard, a special consideration should be given to those fields of activity that are capable of improving the export composition of the country by means of a higher content in skill, knowledge and added value of its products.

A specific group is formed by national companies involved in export-oriented production activities. These companies represent a different situation when compared to the multinational export enterprises that have their own know-how source. National companies are at least potential users of the application development capabilities and technological services available in the country. This is particularly true in the case of agroindustrial products, that are subject in general to declining prices, salary increases and growing quality control requirements.

Cost reduction, fertilizers, plague control, post-harvest treatment, packing and packaging, cold storage process, genetic selection and micropropagation of species, are specific elements that represent a wide field for technological improvement.

The extent and level of development of the enterprises belonging to

this group are to some extent heterogeneous. Probably some of the small enterprises would act first as intermediate suppliers for the agriculture and fishery export companies, both for fresh and processed products.

Some food industries, small-scale mining, sawmills and other forest-derivate activities, and ceramics, fall in the same category due to their size, rural location, particular characteristics of local materials or climate. As a consequence of the aforementioned differentiating factors, ready-to-use foreign technologies are not usually available.

Nevertheless, to serve these rural activities may in some cases be only a matter of simple technology transfer that is almost ready available in the country but that requires the proper means of approaching the institute. On the other hand, rural development seems to be a field only partially covered by the current offer of other technological institutions.

The main services that will probably be demanded from this sector will be analysis, testing, technical information, certification of quality, technical assistance, training through workshops and demonstrative centres for technology. Corresponding actions could be carried out through regional governmental agencies.

In the case of Bangkok area, some of TISTR main users will probably still be state institutions requesting services and research oriented towards environmental protection and standards information on water, soil and air prevention. Applied projects related to environmental control, transport, energy, etc., will probably be a combination of research and development and engineering studies and the most likely customers will be the central or regional governmental authorities.

Likewise, demands from industries will certainly be greater than they are now, in their search for solutions in order to comply with new environmental regulations that will probably be more strict.

Other factors underlying the companies' lack of technological know-how are two fold. On the one hand, the lack of technological know-how is a direct consequence of the companies' difficulties to recruit competent manpower in the field of science and technology. On the other hand, companies have difficulties in obtaining information on recent technical development.

Regarding this type of limitations, special consideration must be given to small- and medium-size companies acting as intermediate suppliers in the industrial sector, as is the case of automotive industry or other manufacturers that are subcontracted by multinational companies that produce export-oriented goods in Thailand.

Among these supporting industries are the manufacturers of parts and components used in the assembly of electrical and electronic goods, chemicals for use in industrial processes, capital goods as machinery and equipment used in the manufacture of textiles, and other complex products.

These suppliers form a very significant group. The needs of these companies and its multiplicative effects in productivity, cost and quality as reflected on the final producer, imply a challenge that must be overcome. Particularly, automotive industry suppliers need technical support in material and product testing, process design, equipment upgrading and quality control system design. In some cases assistance in contract negotiations of technical transfer agreements can be required.

The small- and medium-size enterprises represent in general a special field of action in which to offer support in the use of computer technology for application in control processes. This support is not necessarily for developing software or designing hardware but to help entrepreneurs to buy and to apply the available software in the appropriate way.

Some large national enterprises or groups of enterprises have established technological departments for research and development. Although this phenomenon is just beginning, it creates an opportunity to complement services, resources and facilities with technological centres and institutes. Professionals involved in technological innovation activities are conscious of institute capabilities and their potential benefits and act therefore as linking agents, allowing that institutes like TISTR may have an active participation in the modernization of the industrial process.

Institute Initiative to Submit Modification Proposals to the Technological System Authorities. Minor modifications in the internal organization, strategic planning, and provision of new resources are obviously necessary, but the acceptance as given of the main institutional structure, its legal status and governmental policies constitutes without doubt a serious restriction for any modification.

A necessary change inside and outside the institutions must be intended with the object of establishing an adequate dialogue with the corresponding authorities in order to make them understand the necessary actions that will help the institute to increase its impact and become fully effective.

To Finalize. The evidence so far is that only an imaginative conception, both on the part of government and the Institute, of the environment conditions, new challenges, culture evolution, globalization and other factors, can positively lead to a change capable of achieving real effectiveness in the Institute actions.

VI. SOME COMPONENTS OF A PLAN OF ACTION

Main Considerations

The experience so far shows that technological institutions are set in such a widely different context and face such distinct environment conditions that only few general rules are really applicable to a specific situation. Some lessons may be taken from other places but a careful consideration should be given to the local circumstances and their aspects so as to establish whether applicability is valid or not. This is not an easy analysis to do.

Keeping in mind the previous consideration, it seems advisable to adopt as a guiding rule that changes from one stage into another must be programmed along a reasonable period of transition. Such is the case of organization stru_tural changes, discontinuance of staff not capable of adapting to the new requirements or reorientation plan, new salary policy, and new administration and budgetary systems, all of which have to be planned under a transition perspective of at least a 5-year period.

Nevertheless, the Board of Directors has to examine periodically the progress of the plan of action and analyze its possible reorientation according to the external changing conditions.

Accordingly, below is described a series of aspects that represent some issues of change or reorientation aimed at achieving a more efficient adaptation of TISTR in order to face the changes experienced by Thai economy as a consequence of its fast overall growth. The suggestions given below do not intend in any way to provide a detailed plan of action.

It must be emphasized that TISTR staff is capable enough to design its own detailed plan of action in case they agree with the basic concept of the changes and modifications that are being suggested here. The issues stated below cover aspects such as structural changes, activity concentration, ways of focusing staff upgrading, salary policy, and other aspects related to the evolution of the Institute profile and the way to offer expertise through an entity that is of a multi-sector nature.

Internal Operative Structure Arrangements

Certain governmental spheres and productive sectors have expressed their doubts regarding TISTR usefulness and ability to reach the market and be of impact and effectiveness. Nevertheless, it is necessary to recognize that similar institutions all over the world receive this kind of criticism, including as well those of the industrialized world. These doubts, however, are not always fully justified and are in some cases rather a consequence resulting from people's lack of perception on what research and development really

are and that small market penetration of technological services obeys to a more complex set of causes.

In the case of TISTR a recognition must be made in the sense that despite the absence of a totally favourable environment and appropriate conditions for technological activity development, important capabilities are present both in laboratories and pilot plant, as well as in current staff, thus enabling the Institute to accomplish its main objective which is to render services to the government and to satisfy industry requirements.

In order to meet industry requirements the Institute needs to be known and credible. This last condition implies the fulfillment of various factors, being the most important the assignation of highly qualified researchers of wide recognition and the setting up of clearly identifiable institute patterns or action profile.

However, it seems that services and development activities are to some extent excessively divided, implying effort dispersion and affecting in a certain degree the feasibility to maintain the critical mass required for the corresponding area of activity of each technical department. According to experiences and opinions collected for the purposes of this report, the existence of many fields of specialities creates in general a non reliable image.

With the purpose of reducing the technical department variety and securing the necessary critical mass, as well as simplifying the Institute external image and concentrating its efforts and resources, it seems appropriate to merge some technical departments and to complement and reorient certain fields of activity that are closely related.

Any common factors resulting from the integration of merged departments or centres can help to define the main fields of activities and services of a new unit. Among various other alternatives it would seem appropriate, for instance, to merge the Agro-technology Department, the Food Industry Department and the Biotechnology Department into a new unit oriented towards microorganism applications for food industry, agriculture, agroindustry and other basic processes as fermentation, lixiviation, etc.

The Pharmaceutical and Natural Products Department and the Chemical Industry Department can be merged into one unit covering chemical processes, specially those linked with utilization of natural products. The Energy Technology Department, the Environmental and Resource Management Department and the Ecological Research Department could be reorganized into one department dealing with energy and its environmental impact, agriculture and industry environmental effects and its prevention.

Likewise, the Metals and Material Technology Department, the Material Property Analysis and Development Centre and the Testing and Standards Centre can be consolidated into one centre that could cover materials development in general, testing and analysis services and standards.

The Engineering Industry Department, the Engineering Consultancy Service Centre and the Special Program Centre can be merged into one unit dedicated to industrial engineering and special programs, including aspects as plant layout design, basic and process engineering in general, and project evaluation.

The Research Service Centre and the Industrial Cooperation and Promotion Centre may be grouped into a technical unit for promotion activities, project arrangement and resources coordination. This unit would act as a linking tool between complex service demands and available resources existing outside of the Institute; likewise, it could serve as a coordination unit for the different departments, specially when the initial programming of a project is in course.

The Electronics Department should widen its field of activities to include instrumentation, electronics, computing and automation. This technological line could also cover upgrading of process equipment, manufacturing machinery and application of computer techniques for production control.

The Automotive Centre could be reoriented towards national supplier development by providing technical support, specially in the field of component re-design for spare parts application; and the Building Technology Department should have a stronger orientation towards materials technologies and practical utilization procedures to be used with new materials in building activities.

The Thai Packaging Centre and the Thai National Documentation Centre are adequately conceived and in any possible reorganization of TISTR they should remain as separate units. Only improvement of their resources and performance should be considered.

Networks

Internal Network. Several aspects related to one specific project may exceed the internal capabilities of a specialized technical unit. Considering that most projects have multi-disciplinary requirements, the institute must implement a system that encourages each unit to consider the others as potential internal clients and must clearly specify the type of services and works that can be offered by carrying out some kind of internal marketing. At the same time, units must also consider the others as eventual internal suppliers.

The system to be established must consider the design of an

internal record in order to register the cost involved in rendering the services and the effective hour cost of the specialized researchers assigned to the execution of the project controlled by the leading unit. These records of cost and time estimated value must follow the same model applied to external sales and must basically reflect the internal sales situation.

University Network. Some specific research projects with inter-disciplinary requirements in basic and applied sciences, may exceed the internal capacities of the Institute. In such a case, an excellent opportunity exists at universities for meeting scientists and researchers who can join in to complement the work. The Institute must try to reach an institutional agreement in order to facilitate joint project accomplishment.

The knowledge and understanding of the major fields and lines of work developed by the different university departments, make up a useful tool when complementary capabilities are necessary for carrying out complex projects. As previously stated, the capability to efficiently assemble the resources available at a country level in order to build up an inter-institutional architecture of execution constitutes in itself a real specific skill.

A system of information permanently updated must be implemented. These records should include as well the curricula of the oustanding staff of the different universities and its scientific departments.

Centres and Institutes Network. As previously stated, the creation of an information system covering the range of capabilities of other centres and institutes is of vital importance. Making prior agreements of a general kind may facilitate the collection of necessary data. The purpose is to be prepared in order to know who are and where are the reseachers capable of doing specific tasks in a project when the Institute internal capabilities are exceeded. A plan to build up a data-base system of information must be implemented and, parallel to this, every technical unit of the institute must make and maintain the necessary contacts.

Consultancies Network. Another line of action to promote the integration of the country's capabilities and resources, as was previously suggested, is to look for advanced engineering consultancy firms or new technology-based companies. The Institute has to invite these enterprises for regular meetings in order to exchange technological news and trends and offer them the possibility to complement their work with the Institute's physical facilities and specialized teams of professionals.

This type of companies can not afford to have high investment resources or researchers in every field. Therefore, from time to time they can find in the Institute what they need. Knowledge in both sides is necessary, but more than just a mere information

input, a regular and close contact plays a much more effective role.

The direct benefit coming to the Institute from this type of firms is not only given by their technical skills but, what is more important, by their market penetration capabilities. The concept of joint work implies two alternative forms as was previously stated. In one case, the consultancy company contracts the Institute to perform some part of the work; in the other case, the Institute contracts the consultancy company in order to complement some capabilities.

Each of these alternate forms depends on who has the contact with the main client. An attractive contract must be designed using the marginal cost criteria for the Institute services, specially in manpower. When the Institute hires the services of these companies, market prices must be followed.

Enterprises Network. This kind of network has a two-fold purpose. First it is a way to produce technological sensitivity and a spirit of cooperation among related enterprises. Second, it is a way to spread a new image of the Institute within the industrial sphere. Each technical unit should select from its client list a group of enterprises that can be invited regularly in order to discuss and share the Institute's information on an issue of common interest, and to offer them the opportunity to share with the rest what they may know or to propose other topics. The participants must feel that they can form their own permanent group hosted by the Institute.

The unit would be responsible of selecting the topics that would be of interest for the entrepreneurs and accepting other topics proposed by the participants. For instance, packing and packaging environmental requirements in countries where exports are made, or new artificial vision technologies for groups interested in pattern recognition, etc.

The Institute should manage to have building facilities available as a club-house for the regular group meetings, offering special attention, coffee and drinks services, comfort, projection of transparencies, etc., and make them feel as if they were at their own place.

This kind of informal meeting creates the proper atmosphere for participants to comment on the technological trends that are constantly appearing in international ambits and that simultaneously represent threats and opportunities. Usually, national export companies show a greater willingness to materialize this kind of relationship.

Institute Client Network. The purpose of this kind of network is to establish a new option for project development. Specially for cases

where the design, construction and testing of a prototype is involved. This is once again a matter of image. An oriented campaign must be initiated in order that potential or actual clients may perceive the Institute laboratories, equipment and professional staff as a physical extension of their own plant.

This joint work for project development facilitates a greater participation of enterprise professionals and allows a wider reliance in the confidentiality of the results. All the same, this form of cooperative work is a slow-maturing process whose fruits will be harvested within a medium-term perspective.

International Network. Multilateral cooperation agencies as UNIDO and bilateral agreements with industrialized countries constitute a useful vehicle to establish an international network of collaboration efforts, specially when information sources and staff training are needed.

Maintaining relationship with other similar institutions in developing countries can create opportunities to implement joint programs or projects, specially if both institutions act as technological sponsors to link complementary industries in the two countries with the purpose of complementing, adapting or improving technologies that are currently being applied in one or both countries. Moreover, as a result of this process joint-venture agreements or trading contracts for materials, parts and components can be reached among the enterprises.

When the object is to acquire advanced technological knowledge or training, the collaboration of the industrialized country research centres can be of great help. It is important to know in advance the fields of activities of these centres as well as all the information necessary for defining the topics that will form part of the cooperation programs.

Professional Updating, Training and Reorientation

Updating. Professional updating must be programmed case by case but covering preferably those candidates who will probably occupy technical leading positions in the future. Updating has to be oriented towards basic and applied science through regular courses at some qualified university. The program should contemplate a one-year duration with more or less six hours per week every four years, according to university course programs and schedules.

Complementarily, attendance to scientific and technological events contributes to the updating of these professionals and on their return they can make an exposition of the subjects discussed in an attempt to share this new information with the other professionals of the Institute and to formalize the obvious and implicit commitment undertaken with the Institute.

Researchers must be required to perform regular revisions of technological and scientific publications and to deliver periodically a record of the material read and examined by them.

As a general scope, TISTR must assure that all researchers and professionals are familiar with the following tools: computer software at a word-processor user level, electronic spread-shit and data-base systems, and concepts of private and economic project evaluation.

Training Abroad. Training programs have to be planned according to the different levels of experience and academic qualifications of each and every member of the Institute staff. Moreover, training should be carried out through international cooperation preferably in industrialized countries. Programs must be practical, specific and related to new aspects of disciplines or techniques of relatively new application.

Training must take place at the same location and under the same operation conditions of the process that is the subject of the technological application. Learning by doing or learning by training on the job is the most practical way to materialize the technological capability transfer. Obviously, it is impossible to learn only by means of books or journals. TISTR researchers and professionals must be where the processes are actually being developed and must observe how the experts work and cooperate with them in order to acquire the necessary know-how to master the subject.

When training is programmed outside of the country, professionals sent for training should be permitted to work directly as assistants in the positions where specific applications of the knowledge or skill are being made. The training process must be supported by real work conditions. This consideration should be a guiding factor when the evaluation of possible alternatives is in course. Furthermore, a practical report or a manual, when applicable, must be prepared by the professional on his return. Likewise, information dissemination among TISTR colleagues and within the aforementioned networks should be made.

Local Training. Specific and applied projects are adequate vehicles when training takes place in the country. This implies the incorporation of capable and experienced experts from outside. Specialists should work in the field exactly as they normally work in their own place. The way in which surgeons prepare other surgeons or pilots prepare co-pilots represents the appropriate form of training.

Training on Research Proposals and Project Management. Top level foreign expertise must be considered not only for specific topics of training by speciality but also for training of project leaders on issues related to research proposal formulation according to

international standards and project management techniques including the budgetary aspects necessarily involved.

Training in Foreign Language. A science and technological institute constantly needs to open new channels of communication with the international community and to extend the existing ones. Better and more opportunities of access to new and multiple sources of knowledge aimed at improving the Institute's capabilities will only be possible if special emphasis is given to the study of English as an essential communication tool with the foreign technological community.

Accordingly, regular courses of English language, preferably three hours per week, must be considered not only for professionals but also for assistants and secretaries in order to facilitate the work of foreign experts, translation of relevant material and joint work in general, particularly when a researcher is in training outside the country.

Reorientation. The reorientation of a professional or researcher is a different matter. It must be seen and designed as an opportunity to widen his basic formation, pursuing at the same time the evolution of a specialist from his technological field to another relatively close field but that is more congruent with the new requirements of the Institute. For example, from chemical process to enviromental prevention of food industry impact. If the Institute decides to make emphasis in one line of action to the detriment of another, staff reorientation must be more intensive. A similar situation will occur when some areas are being merged.

Horizontal Focus

In the case of TISTR, only a reasonable number of fields are oriented to serve specific specialized sectors in the industry as, for instance, Pharmauceticals, Agro-Technology and Food Industry Department . Most of the other technical departments are related to horizontal disciplines that are applicable in various industrial sectors. This is the case, for example, of Testing and Standards, Engineering Consultancy, Enviromental Technologies, Automotive Centre, when dealing with parts and component suppliers, Engineering Industry, Metal and Materials, and Packing and Packaging Technology Department.

A plan could be implemented so as to orient the Institute's capabilities in specialized fields in order to meet industry needs in technological issues that are different from the main field of activity of the enterprise, offering in some way expertise for non experts.

The Electronics Department, for example, by adding instrumentation, computing application to process control, and automation for upgrading purposes, can be a successful offer for non-electronics

manufacturers. Tailor-made printing circuit and PROM chip programming, according to requirements other than for mass production, are examples of market orientation for cross-sector applications.

The Chemical Industry Department can offer its expertise in material and substance selection processes for the non-chemical sector. Technical support for food industry in process equipment design or specification, or in analysis procedures for production control, are fields of interest for a wide range of enterprises.

The Biotechnological Department can be oriented to enviromental applications, agriculture and food industry. The Building Department could focus itself on solving building issues for sectors other than building enterprises.

Many sectors can be seen as subjects having common technological requirements. Such would be the case of flexible automation, artificial vision, environmental prevention and treatment, modern management techniques, etc. This kind of technological specialities has a multisector application per se and can be defined to a certain extent as horizontal specialities or disciplines.

Decisions on what exactly needs to be reoriented or merged can be correctly made by TISTR according to its perception of market evolution and other external changing factors.

Staff Reduction Plan

In matters of professional staff accomplishment or qualification, it is necessary to recognize that institutions normally have a fraction of personnel that is below minimal requirements. If this fact is assumed, a program for staff reduction must be contemplated. Rising average qualification and improving professionals' attitude has multiplicative effects, specially when team work is particularly relevant. Replacement with qualified staff or expenditure saving through the discontinuance of non-efficient personnel are by themselves factors of improvement. In addition, this consideration has special significance when salary corresponding to dismissed personnel is used for salary improvement of other staff members.

On the other hand, people normally retire from an institution due to age or better work expectations in another institution or industry. Some practical strategy may be adopted to reduce staff along a transitional period of time from a segment whose performance is considered as non-satisfactory. When a staff reduction plan is in course, all vacancies should not necessarily be replaced. If necessary, positions could be internally filled in by means of personnel rotation and retraining.

When possible, no salary increase should be granted to those that

are not motivated nor willing to adapt themselves according to the new institutional needs or simply are unable to reach a satisfactory level of perfomance. In case of inefficient personnel, a careful qualification must be made of extreme cases and a retirement encouraging program can be designed. Another way would be to inform in advance the period of time that remains before effective dismissal of personnel is made, for instance six or nine months. Furthermore, a special examination has to be made regarding over-sized administrative staff.

New Staff Incorporation Plan

Recruitment of principally new graduate engineers or other equivalent career professionals should be considered. It is easier to offer attractive conditions and perspectives to a new professional that is just starting to work. Talented candidates must evidence an outstanding perfomance as a student and a clear vocation for a practical and theoretical approach for innovation.

Complementary recruitment of highly qualified and experienced staff should also be considered in order to incorporate an additional capacity to TISTR. This staff incorporation will help to improve the Institute's lobbying activities at governmental levels so as to make it easier to shape the regulatory environment of TISTR according to the changing needs.

Additionally, this will contribute to increase credibility within the other scientific and technological institutions and reinforce the Institute image within the industrial sector. This staff shall reinforce TISTR strength by means of its leadership and communication capabilities based on its widely recognized experience in research management. High academic level formation and successful experience in production innovation are also desirable.

The hiring of this kind of personnel has to be conceived under a plan in which key positions are identified as critical. Four or five strategic incorporations will allow fulfillment of needs linked to internal work and external relationship development.

Salary Increase Plan

One of the considerations that must be taken into account is that more than a general salary improvement it is a better income for the key staff what needs to be accomplished. This approach leads as an alternative to the creation at the top of the current salary scale of three or four higher additional levels which must be comparable to those paid in the private sector for highly qualified specialists.

On the other hand, it is necessary to present this plan within the same budget limits in order to facilitate approval by the

corresponding authorities. This budgetary limitation is not easy to accomplish and requires a necessary coordination between salary increase and staff reduction along a transitional period of time.

Considering that administrative regulations regarding the salary system can go beyond the Institute's ambits of decision, other alternatives must be throughly examined. For instance, to seek possible triangulations with other entities or enterprises. These entities could pay complementary salaries to the leading researchers of an applied proyect and receive a compensation from the Institute by means of lower prices when services are involved. This procedure should be legally consistent with the researcher's contract conditions.

Internal Program Incorporation System

Commercial potentiality of pre-competitive works and exploratory activities must be assured since the beginning. This can be accomplished through different forms of contact, as would be the case of enterprise network as suggested above. A direct selection of enterprises may be useful in order to explore their perception on the market penetration perspective of the proposed technological line.

The Institute should set up more screening procedures to detect at an early stage if works undertaken will be able to reach the market. The group of selected enterprises constitutes a group of potencial clients of future applications, specially if they are regularly informed of the progress of pre-competitive works.

When first exploring the idea of a project or research program, technological reference material must be presented as complementary information for the internal decision-making levels as well as for the external group of entrepreneurs invited to analize the proposal.

No applied project nor technological package development must be initiated without customer contractual involvement. When the cost engaged is higher than the willingness of the customer to pay, TISTR can explore with the enterprise the possibilities for acquiring subsidized funds from the government agencies.

Another financing way would be to transform the project in an Institute project included in its own budget and then to recover the amount that the customer is able to pay. This may be specially effective when the Institute has the perception that other clients may come later for the same application.

Regular S & T News Release Plan

A periodical publication program on science and technology should be implemented by TISTR based on material furnished as a

contribution of the Institute professional staff. Topics included in these publications must cover a wide variety ranging from scientific theoretical news to practical technological application news. This material must not necessarily be of indigenous origin but may also be collected from different international publications. This mechanism allows broad dissemination of generalized updated information, congruent with the objective of increasing the scientific and technological culture.

TISTR image would be thus perceived as an institution contributing to the creation of a more receptive atmosphere for science and technology issues. Moreover, TISTR staff will be encouraged to look for the S & T innovations that are constantly appearing in the world and this will finally benefit their own work.

Divulgation and Dissemination Plan

Annual programs of conferences, seminars and workshops should be established in order to facilitate the divulgation and dissemination of technological knowledge and news. National or foreign lecturers must be considered and selected by TISTR according to a wide recognition in relation with the topics to be treated in the events.

The topics and lecturers have to be announced with a reasonable anticipation for promotional purposes. The industry group selected as main target should consist of at least 30 and at most 50 attendants. Participants have to be charged a reasonable fee in order to cover at least part of the cost of the event.

Budgetary Management and Presentation

The Institute maintains an appropriate accounting system with classified categories to summarize and arrange conveniently items such as income, expenditures, assets and liabilities, so as to adequately reflect activities, project execution and fund transfers.

An additional and complementary budget system should be implemented in order to keep an adequate record of project and program presentation and further analysis of their execution. Joint proposals with companies interested in applied projects must follow a similar record of income and expenditures.

The same applies for programs and projects where the government acts as client. Likewise, technical units or departments must follow the same system of accounting used for the Institute as a whole. Following the same line, technical units must present annual budget programs and keep records of actual expenditures, incomes and investments. In this case, laboratories working on routine services must keep an independent accounting system even when their budget is part of a technical unit budget.

Medium-term project development programs must be treated as units of cost for internal use, keeping execution records and maintaining adequate forecasts. The same criterion must be applied to technical units or departments, centres and laboratories.

Dissemination-oriented activities must be considered in the annual budget programming. Also, internal development programs oriented towards knowledge acquiring and experimentation, and exploratory projects on possible technological applications, must be included in the annual and medium-term budget and forecasting.

Budget management system as discussed above should be one of the main tools for analysis and supervision purposes that can be used by the Board of Directors, the Governor and the first level of CEO. On a similar basis, project leaders have to manage their projects under the same budgetary concepts and guidelines.

Market-oriented Actions

The commercialization process of services, projects and supporting activities in the field of technological research and development can be conceptualized in three stages that are closely interrelated in a circular sequence.

Promotion covers those actions dedicated to create a positive image and position in many spheres of public opinion, including government, industrial sector and the scientific and technological community. The creation of a positive image demands dealing with recognized excellence, adequate selection of target sectors and specialities capable of being offered, and linking mechanisms with all the spheres involved.

Commercialization itself corresponds to activities oriented towards selling what is already available, as for instance testing services, analysis, capabilities for specific research applications and technological packages that are ready for application. In this last case, it is important to consider that internal development of technological packages makes further commercialization a difficult task to achieve, for which reason it is generally not advisable to work in that direction.

Marketing refers to those groups of activities covering both perception of the client needs and decisions regarding design of services, prices, levels of excellence and adequate selection of client sectors and fields of specialities. To some extent, these activities are part of a program that is prior to promotion. In this way it is evident that all three stages are firmly interrelated closing the circular sequence; therefore, the image necessary for promotion must depend on real capability, levels of excellence and adequate choice of fields, services and target groups.

Aspects related to achievement of goals of excellence and appropriate definition of fields of activities have already been commented. Nevertheless, complementary focusing on these aspects and some additional action deserves special attention. At the same time, the fact that reality itself presents a context in which concepts, actions and their effects are not totally separated can be clearly appreciated at this stage of the analysis. Isolated causes produce multiple consequences and some consequences evolve into their own causes. This is true both for positive and negative aspects and their corresponding virtuous and vicious circles. Keeping this in mind, new considerations on the aforementioned strategies and actions can now be developed with respect to marketing and commercialization aspects.

A Matter of Focus. As stated previously, most of the lines of action mentioned above have multiple effects. They were first commented due to the benefits obtained from the positive impact produced as a result of the high performance level of the staff and the orientation of the field of activities undertaken by the Institute.

Some actions or activities significantly affect market penetration capabilities in two different ways. First, through a group of actions oriented to increase quality and efficiency that are proper of excellence itself, but having indirect influence in marketing capabilities; and second, through an additional focus made directly to achieve commercialization capabilities.

Moreover, the objective of commercialization requires a congruent and permanent attitude from everybody when task development at any stage is in course. Consequently, some of the actions herein suggested will represent an additional way of focusing by the organization as a whole during execution of normal activities.

Global Participation. Everyone in the Institute should be conscious of and participate in market-oriented activities. Activities in general must be considered according to their future, direct or indirect impact in commercialization. From the administrative staff when attending persons visiting the institution to the specialist and researcher when screening projects or designing programs, everyone must think in market effects. Any external contact to materialize reciprocal cooperation activities, or supporting activities in research and development, must be based on the principle that knowledge is worth only when it is finally applied and when the user is willing to pay for it.

According to the previous consideration, it is clear that sales perspective should always be kept in mind. Professional training programs should consider this aspect and should be oriented to produce a cultural change in this regard.

Image. Improvement of the Institute building in order to present

an aspect more congruent with what customers have in mind when they think in technology and modernization, design of a short positive slogan, use of an institutional logotype and selection of a uniform set of colors used in catalogues, brochures, presentation cards, special reports and in general in all material for presentation, information or publicity in such a way that any person can easily identify the institution, are useful measures that can be adopted to improve and spread an appropriate Institute image.

Scientific and technological news release through periodical publications, including material collected from different international sources and information about national relevant activities, constitutes another mechanism that facilitates a broad dissemination of the Institute image.

Likewise, annual programs of conferences, seminars and workshops for divulgation and spreading of technological knowledge with the participation of widely recognized lecturers, national or foreign, on the topics discussed in the events, are other opportunities to present an image of excellence and constant updating. A publicity campaign made through public media has to be considered when preparing such events.

Future Clients. To establish a regular program specially dedicated to university students belonging to the last two academic years in careers linked to production or applied science, in order to inform them of the fields of activities in research and development that are carried out by the Institute, would certainly contribute to increase and spread institutional capabilities. These students will probably end as future potential customers when they start working in the industrial sector.

As was previously mentioned, a practical way to create technological sensitivity and a spirit of cooperation would be to establish permanent groups of enterprises which are invited to discuss and share the institute's technological information on an issue of common interest, offering the building facilities of the Institute as a club-house.

Likewise, it was also commented on previous sections that the organization of this type of enterpreneurial groups creates as well the proper atmosphere for discussing the technological trends that are permanently appearing in international ambits. Apart from the other benefits involved in the organization of these groups, a natural opportunity emerges for making applied project agreements with future customers as a consequence of this reciprocal knowledge.

A barrier generally exists between small and medium enterprises and scientific and technological institutions. These enterprises normally see technological issues as complex, sophisticated and expensive subjects that are far away from their own reality. They

do not associate their problems with the interest that the technological centres may have in studying possible solutions for them.

Through a communication and dissemination campaign focused on small- and medium-scale industry, it is possible to make enterprises understand that the main objective of the Institute is to solve common or complex problems related to the manufacture and design of products without taking into consideration the nature of these problems, no matter how simple or alien to science they may seem.

TISTR must try to minimize the possible inhibitions experienced by small enterprises when they look for technological improvement. The Institute should impart a more familiar touch to its image. An interesting field may be opened with this approach and problems found in this sector may lead researchers to solutions that probably will be of general applicability.

Internal Programs, Applied Projects and Customers. As a rule, any applied project proposal must first have the client's acceptance. Furthermore, in-house programs oriented to produce a technological package must not be the result of a purely internal decision; it is a known fact that technological works generated in that way very rarely reach the market. A project of this kind must first of all take into consideration the potential user's opinions by means of a pre-proposal containing technical references and information regarding the possible specific applications.

With respect to internal development programs aimed at enlarging the Institute's knowledge and practical experience on new technological lines or disciplines by means of pre-competitive works, they should contemplate the participation of groups of entrepreneurs in order to get external perception on future application possibilities.

Meetings or workshops with groups of enterprises or different individual interviews could be held in order to get favorable or unfavorable opinions regarding technological line expectations. Besides obtaining a better information on future market opportunities, they create greater probabilities of success when new skills and technological knowledge are applied through these potential users. By keeping them informed on the progress of the research and sharing with them any further knowledge of common interest, these groups of enterprises can eventually become customers.

A similar method could be applied to identify new projects. Ideas must be mainly related to production problems and their possible solutions.

When design, construction and testing of a prototype is involved in

the execution of a project, a new commercialization focus should be given in order to make customers feel that Institute resources are a prolongation of their facilities. Laboratories, equipment and professional staff of the Institute must be offered to potential or actual clients as if they were part of their own plant. A commercialization campaign must be initiated in order to disseminate this form of joint-work and to emphasize the advantages obtained in matters of greater confidentiality and better integration of the enterprise staff into the product or process development.

The advantages of having permanent groups of entrepreneurs or enterprise associations at TISTR facilities have already been commmented on previous chapters. This action, if taken under the market point of view, represents potential commercial benefits for the Institute that go beyond those benefits resulting directly from the exchange of technological information.

Following this line of action and in addition to the specific tasks undertaken with these groups, the technical unit involved should be responsible for having building facilities available for the regular group meetings, offering attention, coffee and drinks services, comfort, projection of transparencies, telephone access, etc. This would certainly help to create an image of efficiency, expeditiousness and modernism. Furthermore, it is an opportunity to make available to enterprises all the material published by TISTR regarding general scientific and technological information, Institute services, accomplishments in technological applications, and current capabilities of the Institute in fields of interest for the industrial sector.

Another line of action that helps to improve commercialization capabilities is to keep permanent contact with the new technology-based companies that are beginning to emerge in the market. The Institute could offer these enterprises the possibility to complement their work with the Institute's physical facilities and specialized teams of professionals.

It is understandable that this type of companies can not afford to have high investment resources or researchers in every field. Therefore, from time to time these companies can find in the Institute what they need. More than just a mere exchange of knowledge and information input on both sides, it is the regular and close contact which gives a more effective impact.

The direct benefit coming to the Institute from this type of firms is mainly given by their market penetration capabilities. The concept of complementary work would imply contracts in which the party having the contact with the client will sub-contract the other party.

Areas, Services and Projects. Together with TISTR, other

technological institutions are present in the offer market of services and development activities. Consequently, this circumstance obliges the Institute to create new commercialization opportunities or to improve the existing ones by placing emphasis on sectors that are significantly important in and are congruent with the national development strategy. To this effect, attention needs to be put on the fact that the promotion of national export-oriented activities is one of the main issues of Thailand's economic policy.

All the same, most of the Institute specialities should be sensed using a cross section approach, meaning with this that a specific technology can always be oriented to industries whose main fields of activities differ from it. That is the case, as was pointed out before, of electronics for non-electronics or more general expertise for non experts. This conception gives a great flexibility and discharges the Institute from depending only on demands from certain specific industrial branches. Therefore, some target areas are proposed below mainly due to the opportunities they represent for future sales.

Rural and export-oriented activities. Agroindustrial activities, some food industries, small-scale mining, ceramics, sawmills and other forest-derivate activities, usually have no availability of ready-to-use foreign technologies.

Cost reduction, fertilizers, plague control, post-harvest treatment, packing and packaging, cold storage process, genetic selection and micropropagation of species are examples of applied technologies that are included in the field of activities of at least five technical units of TISTR, i.e. Agro-technology, Biotechnology, Food Industry, Enviromental and Resources Department and the Thai Packaging Centre.

Some small enterprises of this sector will probably be acting first as intermediate suppliers of agriculture and fishery export companies, both for fresh and processed products.

Consequently, to meet the requirements of these rural activities would probably be just a matter of national technology transfer, only requiring the proper means to deliver information with respect to the benefits of the technological capabilities currently existing at the Institute.

The main services that could be offered to this sector would be analysis, testing, technical information, certification of quality, technical assistance, training through workshops and technology demonstrative centres. The corresponding actions would be carried out through regional governmental agencies who will probably act as main clients.

Large enterprises at Bangkok area. In the case of the area of

Bangkok, some of TISTR's main users, both current and potential, are state enterprises and institutions asking for research services oriented towards environmental protection and standards information on water, soil and air prevention measures. Applied projects related to environmental control, transport, energy and others will be a combination of research and development and engineering studies required by the central or regional governmental authorities.

Demands from large industries will come from the need for solutions in order to comply with new environmental regulations that probably will be more strict. TISTR units of Ecological Research, Enviroment and Resources Management, Energy Technology, and Engineering Industry are mainly involved in this sector.

Small intermediate suppliers. A significant opportunity to produce a multiplicative impact is given by small- and medium-size companies acting as intermediate suppliers in the industrial sector. This is the case of manufacturers that are subcontracted by multinational companies that produce export-oriented goods in Thailand or large national enterprises that produce durable goods.

The production of parts and components used in the assembly of electrical and electronic goods, chemicals for use in industrial processes, capital goods as machinery and equipment used in the manufacture of textiles and other complex products, is a growing process in which intermediate specialization is showing great advantages.

Intermediate industry suppliers need technical support specially in material and product testing, process design, equipment upgrading and quality control system design. Technical transfer agreements are also relevant subjects of assistance for this sector. Other field of commercialization approach would be the application of computers in management and production control processes; in this case, the Institute would simply help enterprises to select, buy and use the available software in the appropriate way, at least on a primary stage.

TISTR technical units of Engineering Consultancy Service, Testing and Standards Centres, Metals and Material Technology and Electronic Industry are mainly involved in the type of services mentioned above. The Electronic unit must particularly be present to offer support in equipment upgrading, covering general items as instrumentation, tailor-made electronic circuits and computer technology applied to production control.

Private Research and Development Centres. As previously stated, there are some large national enterprises or groups of enterprises that have set up their own technological departments for research and development. This new positive trend implies the appearance within the industrial sector of professionals with special

sensitivity and understanding of the real meaning of research and development and the necessary perception to recognize the usefulness of research and development institutes. Consequently, these professionals involved in technological innovation activities can naturally act as linking agents, enabling TISTR to have an active participation in real technology applications.

Special attention must be paid to these centres and professionals and researchers of the Institute should find a way of approaching them in order to acquire reciprocal knowledge of resources, capabilities and physical facilities available in both sides. This evaluation shall create the basis for cooperation by means of services and complementary activities in research and development projects.

Marketing Unit. Commercialization efforts and focus are global activities that engage the whole staff of the Institute rather than an individual task assignable to a single unit. Consequently, participation of researchers and professionals must be coordinated and incentivated in order to share common criteria and experiences. Therefore, a specific marketing unit is necessary to create the integration of commercialization activities and to assume other tasks more fitted to a centralized process.

Among these marketing activities are visits to clients, attention of clients at TISTR premises, project proposal and budget preparation, discussion of technical contents, presentation to the clients of the proposal economical benefits together with technical aspects such as bibliography data, methodology, action plan, etc. In general, the marketing unit must be prepared to give answers to different members of the client's staff, having different background, interests, priorities, etc.

Proposals and negociations should be made using uniform criteria, as reference prices for different items and charge factors. A cost study for negociation purposes should be implemented in order to establish hour prices of different levels of professionals and technicians and standard service prices, which can be used as reference when preparing the proposals.

This centralized marketing unit should be responsible for making decisions whether to charge less than the reference prices if it is a new client or a large potential client, or to charge more than the real cost of execution if the project is similar to a previous one and efforts and time spent on it would therefore be less than they would normally be if it was the case of a first execution.

Decisions whether to charge a lump sum in one or several quotas according to the work schedule, or to establish unitary prices and charge the actual cost on a monthly basis or by stages giving the client the opportunity to audit the components, must also follow uniform criteria for every project of the Institute.

Furthermore, the marketing unit should implement a centralized system to receive data for multi-purpose uses including professional and general staff availability in different fields in order to reorient the marketing program.

The system must provide information to determine where and with whom could the project be developed and whether it is necessary to subcontract people or institutions such as universities, private consulting companies, other state institutes, etc. Staff assignation and task schedule design are important tools when considering opportunity cost charges in a commercial agreement.

Uniform edition models for proposal presentation, edition criteria for brochures and publications, ways to stimulate the participation of more than one Department, and reception of requirements from clients that do not know which of TISTR Departments could serve their needs, are part of the skills that must be handled by this unit.

Finally, collaboration with the Governor when preparing institutional strategies and action plan from a marketing point of view, constitutes another example of typical activity of a marketing unit.

VII CONCLUSIONS

From an analysis of all the strategic actions previously commented herein, an important conclusion would be that salary improvement is by large not only the most urgent action to be undertaken but also an essential and unavoidable condition, to such an extent that if unattended it would imply the failure of any program oriented towards the accomplishment of the Institute excellence levels that will satisfactorily meet the requirements of relevant and substantial technological innovations. In fact, salaries paid by the private sector are much higher than those paid by the public sector, creating in consequence a drain of qualified human resources.

The suggested modifications regarding the regulatory frame that governs the Institute constitute a substantial issue, but within all the desirable flexibility degrees the most critical, urgent and unavoidable condition that requires modification is the freedom to define the remuneration system.

The set of guidelines, measures and actions that have been suggested herein in order to improve the Institute performance must not lead to confusion in the sense that these recommendations may be interpreted as a criticism of the existing technological development capabilities of the Institute. On the contrary, more than real capabilities the problem rests on the Institute image, not on its substance; more than execution capabilities the problem rest on the market penetration capabilities; more than development capabilities it is a matter of selection of appropriate technological subjects and applications. The recommendations provided herein should therefore be understood in this sense. Furthermore, it should be emphasized that areas such as laboratories, metrology and standards services present an excellent level of technical performance.

The actions suggested and their expected effects or improvements should be mainly summarized in salary increase in order to maintain and improve human resource qualification, transformation from quantity to quality, concentration of technological fields of activities, horizontal focus of disciplines in order to achieve excellence and image in industrial and service sectors, and creation of adequate mechanisms to incorporate the users of technological innovations and adaptations, as well as technological transfers, since the first stage of identification of ideas, projects and programs. This would effectively enable the commercialization of the Institute capabilities with the resulting benefits to the country.

Training of professional staff and researchers simply reinforces

the permanent process of maintaining and improving excellence and the capability to bring up to date, to learn and to experiment within the innovative frontiers of the most recent technological applications.

On the other hand, most of the recommended actions should not be necessarily seen as individual priorities. On the contrary, isolated actions do not produce positive isolated effects. Each action is feasible when the remaining actions are also implemented and each of the resulting benefits is therefore a consequence of the application of a harmonious and adequately coordinated set of actions.

Finally, the Institute improvement process, including complex and sensitive issues such as staff reduction, salary system modification, concentration of fields of activities and horizontal focus of disciplines, must be programmed along a transitional period of at least five years.

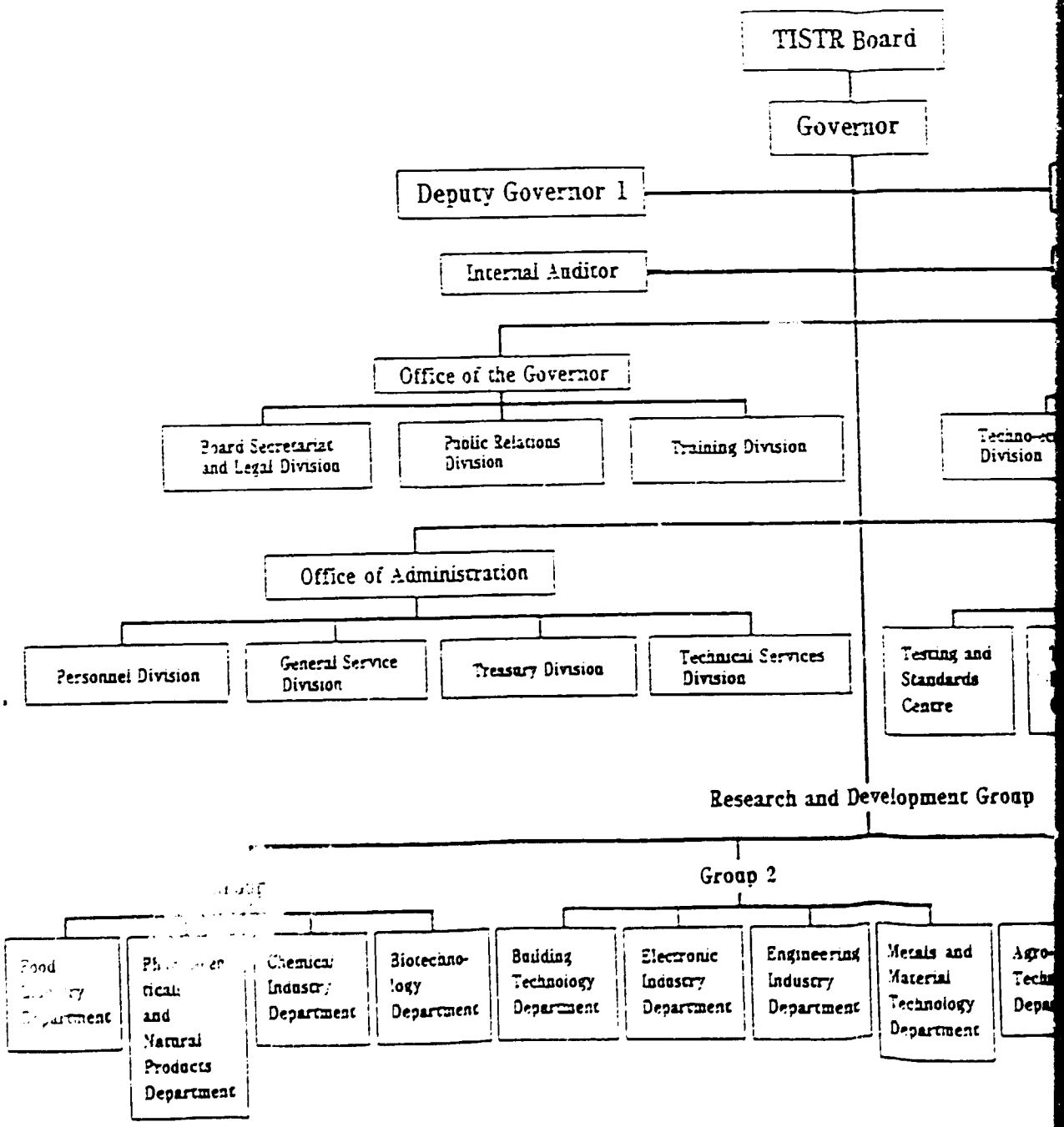
Likewise, the outcoming results, better impact, image improvement and closer relationship with clients and users should also be expected along this transitional period. However, those other actions that basically depend upon governmental decision, as is the case of a greater flexibility of the regulatory frame and salary system, are extremely urgent and constitute a starting point for any improvement program of the Institute.

ANNEX 1

ORGANIZATION CHART

ORGANIZATION CH

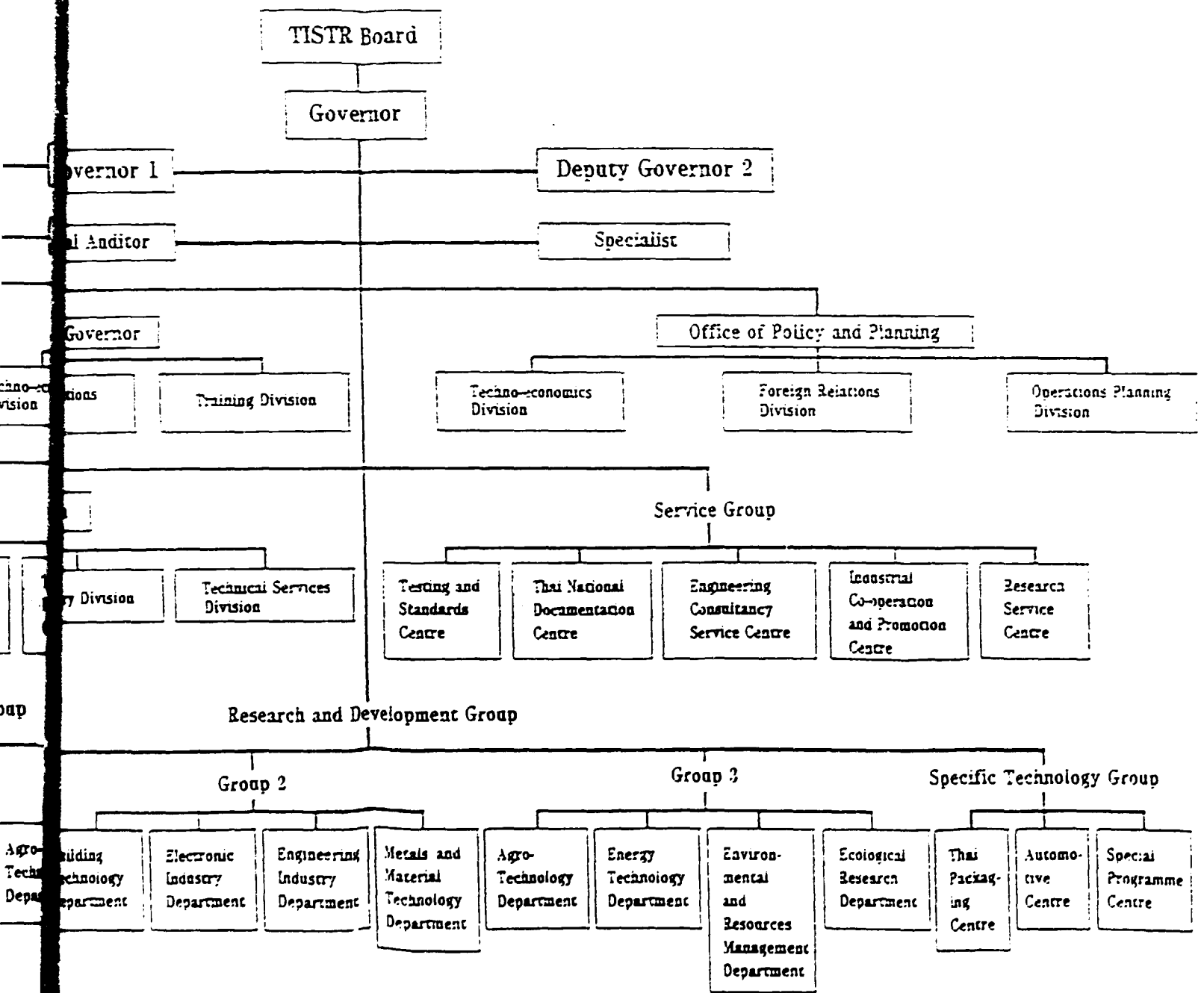
THAILAND INSTITUTE OF SCIENTIFIC AND TEC



SECTION 1

CH ORGANIZATION CHART

TECUTE OF SCIENTIFIC AND TECHNOLOGICAL RESEARCH



SECTION 2

ANNEX 2

LIST OF EXTERNAL INTERVIEWS AND CONTACTS

ANNEX 2

LIST OF EXTERNAL INTERVIEWS AND CONTACTS

N°	COMPANY/INSTITUTION	NAME	POSITION
1	UNIDO BANGKOK	ANDERS PALUDAN MULLER	PROGRAMME OFFICER
2	HI-TECH AGRICULTURE (THAILAND) CO., LTD.	ARAYA ANANTASILP	MANAGING DIRECTOR
3	THE GOVERNMENT PHARMACEUTICAL ORGANIZATION	ASPIRADEE KASHEMSANT	DEPUTY DIRECTOR
4	MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT	CHODCHOI EIUMPONG	DEPUTY PERMANENT SECRETARY
5	DEPARTMENT FOOD, BIOTECHNOLOGY CHEMICAL PHARM.	EKACHAI SUNTORNPONG B.	SENIOR SPECIALIST
6	THE SIAM PULP & PAPER CO., LTD. MANUFACTURING DIVISION	KANEUNG IN-DRATANEE	MANAGER
7	MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT	KASEM INIDVONGS	PERMANENT SECRETARY
8	OFFICE OF SCIENCE, TECHNOLOGY AND ENERGY POLICY AND PLANNING, MINISTRY OF SCIENCE, TECHNOLOGY AND ENVIRONMENT	KOBKEAO AKARAKUPT	DIRECTOR
9	OFFICE OF AGRICULTURAL INPUTS DEVELOPMENT AND PROMOTION DEPT. OF AGRICULTURAL EXTENSION	KUKIAT SOITONG	CHIEF, SOILS FERTIL PROMOTION
10	BIOTECHNOLOGY AND GENETIC ENGINEERING UNIT INDUSTRIAL TECHNOLOGY DEVELOPMENT DIVISION, UNIDO, VIENNA	MALEE SUWANA	CHIEF
11	SAHALOHAKIJ KANCHANABURI CO., LTD.	MITREE NOKLEK	MANAGER
12	UNIDO INDUSTRIAL DEVELOPMENT ORGANIZATION-BANGKOK	MJ MEIXNER	COUNTRY DIRECTOR

13	OFFICE OF AGRICULTURAL INPUTS DEVELOPMENT AND PROMOTION DEPT. OF AGRICULTURAL EXTENSION	MONGKOL CHUNTRAPEN	DIRECTOR
14	PNC GROUP	NARACHET DEJMA	MANAGING DIRECTOR
15	UNIDO	NILS RAMM -- ERICSON	CONSULTANT
16	NATIONAL SCIENCE AND TECHNOLOGY AGENCY THAILAND DEVELOPMENT RESEARCH INSTITUTE (SINCE 1/11/93)	NIT CHANTRAMONKLASRI	DEPUTY DIRECTOR
17	UNIDO VIENNA	PETER ELLWOOD	
18	BETTER LIFE CO., LTD. DEVELOPMENT AGENCY	PRASOPSUK PHUCHONGCHAROEN	MANAGING GENERAL
19	BETTER LIFE CO., LTD.	ROY MIKKELSEN	CONSULTANT
20	THE GOVERNMENT PHARMACEUTICAL ORGANIZATION	TUMRONGWUT KOOTIRATRAKARN	CHIEF
21	THE GOVERNMENT PHARMACEUTICAL ORGANIZATION	WANCHAI SUBHACHATU	DIRECTOR PRODUC

ANNEX 3

LIST OF INTERNAL INTERVIEWS AND CONTACTS

ANNEX 3

LIST OF INTERNAL INTERVIEWS AND CONTACTS

N°	COMPANY/INSTITUTION	NAME	POSITION
1	THAI PACKAGING CENTER	AMORNRAT SWATDITAT	DIRECTOR
2	THAI PACKAGING CENTRE R AND D LAB	ANCHALEE KAMHAENAKUL	
3	TECHNO-ECONOMICS STUDY GROUP	ANEK TAMRATANAPORN	CHIEF
4	ENVIRONMENTAL AND RESOURCES MANAGMENT		
5		CHAIYUTH KLINSUKONT	DIRECTOR
6	TISTR	CHALERMCHAI HONARK	ACTING GOBERNOR
7		EKACHAI SUNTOINPONG	SENIOR SPECIALIST
8	CHEMICAL FORMULATION AND PROCESSING LABORATORY CHEMICAL INDUSTRY DEPARTMENT	KANNIKA STHAPITANONDA	DIRECTOR
9	METAL AND MATERIALS TECHNOLOGY DEPARTMENT	LADAWAL CHOTIMONGKOL	DIRECTOR
10	FIBRE AND TEXTILE CHEMICAL LABORATORY CHEMICAL INDUSTRY DEPARTMENT	NAIYANA NIYOMWAN	DIRECTOR
11	MATERIALS PROPERTIES ANALYSIS AND DEVELOPMENT CENTER	NONGLUCK PANKURDDEE	PROJECT DIRECTOR
12	THAI NATIONAL DOCUMENTATION CENTRE	NONGPHANGA CHITRAKORN	DIRECTOR
13	MATERIALS PROPERTIES ANALYSIS AND DEVELOPMENT CENTER (MPAD)	PRATIP VONGBANDIT	PROJECT ENGINEER
14	ENVIRONMENTAL RESOURCES LAB.	PRAMUK KAEONIAM	
15	FERMENTATION TECHNOLOGY LABORATORY BIOTECHNOLOGY DEPARTMENT	PRAPHAISRI SOMCHAI	DIRECTOR

16	ENVIRONMENTAL ENGINEERING LAB.	PREECHA PLOYPATARAPINYO	CHIEF
17	INDUSTRIAL COOPERATION AND PROMOTION CENTER	SACHEE PIYEPONGSE	DIRECTOR
18	FOREIGN RELATIONS DIVISION	SALAISOPHIN KOMARAKUL NA NAKORN	DIRECTOR
19	PHARMACEUTICALS AND NATURAL PRODUCTS RESEARCH DEPARTMENT	SASITHORN WASUWAT	CONSULTANT
20	POSTHARVEST TECHNOLOGY LABORATORY	SING CHING TONGDEE	
21	PROCESS DEVELOPMENT LABORATORY FOOD INDUSTRY DEPARTMENT	SRISAK TRANGWACHARAKUL	
22	FATS AND OILS LABORATORY CHEMICAL INDUSTRY DEPARTMENT	SUMALAI SRIKUMLATTHONG	DIRECTOR
23	OFFICE OF POLICY AND PLANNING	SUNANTA RAMANVONGSE	DIRECTOR
24	FOOD TECHNOLOGY LAB.	SUWANNA SRISAWAS	DIRECTOR
25	PHARMACEUTICALS AND NATURAL PRODUCTS DEPARTMENT	TAWEESAK SUNTORNTANASAT	ACTING DIRECTOR
26	PROJECT MANAGEMENT OFFICE OF POLICY AND PLANNING	THANAKORN PALACHAI	HEAD
27	INDUSTRIAL COOPERATION AND PROMOTION CENTRE	SACHEE PIYEPONGSE	DIRECTOR
28	MATERIALS PROPERTIES ANALYSIS AND DEVELOPMENT CENTER (MPAD)	WIRACH CHANTRA	PROJECT ENGINEER

ANNEX 4

ANSWERS BY DEPARTMENTS TO THE QUESTIONNAIRE

ANSWERS BY DEPARTMENTS TO THE QUESTIONNAIRE

Dept.	Total Personnel	Profs.	Techs.	Others	Salaries	Infrastr.	Trained people per year	Number of Competitors	Type of Competitor	Brochure	Curric. Depts.	Curric. People
ATC	4	2	0	2	bad	bad	none	many	U	yes	yes	yes
ATD	26	18	4	4	acc	bad acc	few	many	UGP	yes	yes	yes
BID	40	25	13	2	bad	acc	3	4	UG	yes		
BTD	19	15	2	2	acc	acc	none	none	No	yes	yes	yes
CID	23	15	6	2	bad	bad	1	2	G	yes	yes	
ECSC	7	4	2	1	acc	acc	2.5	20	UP		yes	yes
EID	4	3	0	1	acc	acc					yes	
END	13	5	5	3	bad	acc	4	none	No	yes		
ERD	15	13	1	1	bad	acc	2.5	1	G	yes	yes	yes
ERMD	32	17	9	6	bad	acc	7	30	P U	yes	yes	yes
ETD	25	11	4	10	bad	acc	2	12	UPG	yes	yes	yes
FID	26	13	8	5	bad	2.5	acc	9	UG	yes	yes	no
ICPC	6	3	1	2	acc	acc	1.5	6	U O	yes	yes	
MMTD	33	21	12	0	bad	bad acc	5	yes	U P G O	yes	yes	yes
MTC	111	68	19	24	bad	acc	yes	4	G	yes		
PNPD	33	18	12	3	acc	bad	2.5	4	UPO	yes	yes	yes
RSC	2	1	0	1	acc	acc		yes	U O	yes		
SPC	14	6	3	5	bad	bad acc	none	6	G U P	yes	yes	yes
TNDC	30	17	13	0	acc	acc	several	20	UPG	yes		
TPC	16	15	0	1	bad	acc	2.5	4	UPG	yes	yes	yes

No answer

U University

G Government

P Private Enterprise

O Other

acc: acceptable

exc: excellent

ANSWERS BY DEPARTMENTS TO THE QUESTIONNAIRE

							Departments perceptions about customers opinions:				
Dept.	Diffusion Activities per year	People in marketing	Visits to enterprises per month	Visits from enterprises per month	Internal clients	External clients	Quality of Service	Price	Speed	Quality of people	Budget Mill BATH
ATC		2	variable	2.5	no	yes	good bad	low	fast	good	1
ATD	yes	10%	very few	very few	yes	G.P	good	acc	acc	exc	2
BID	yes	30%	0.5	5	yes	G.P	good	acc	acc	exc	36
BTD	yes			4	yes	G.P	good	low	acc	good	5
CID						G.P	good	acc	fast	good	6.4
ECSC						G.	exc	acc	fast	good exc	
EID						yes	good	acc	acc	goc	
END			5	10		G.P	good	acc	acc	good	4
ERD	yes	yes	yes		few	P.G	exc	high	fast	exc	2
ERMD	12	no	no	0.33	yes	G.P	exc good	acc	acc	good	7
ETD	yes		no	2	yes	G.U.P	good	acc	acc	good	2
FID	yes	no	yes	1.5	yes	G.P.U	good	acc	acc	good	6
ICPC	yes		yes	yes		yes	exc	acc	acc	good	0.2
MMTD	3	10%	2	3	yes	G.P	exc	acc high	fast	exc	2
MTC	3		6	8	yes	G.P	good	acc	acc	good	28
PNPD	yes	no	no	no	yes	G.P	exc	acc	fast	good	2.3
RSC				yes		yes	exc	acc	acc	good	
SPC	yes	33%	0.25	3.5			good	low	fast acc	good	3
TNDC	yes		yes		yes	G.P	good	acc	fast	good	1.6
TPC	5		1	1	yes	G.P	good	acc	acc	good	5

No Answer

U: University
G: Government
P: Private Enterprise
O: Other

acc=acceptable
exc=excellent