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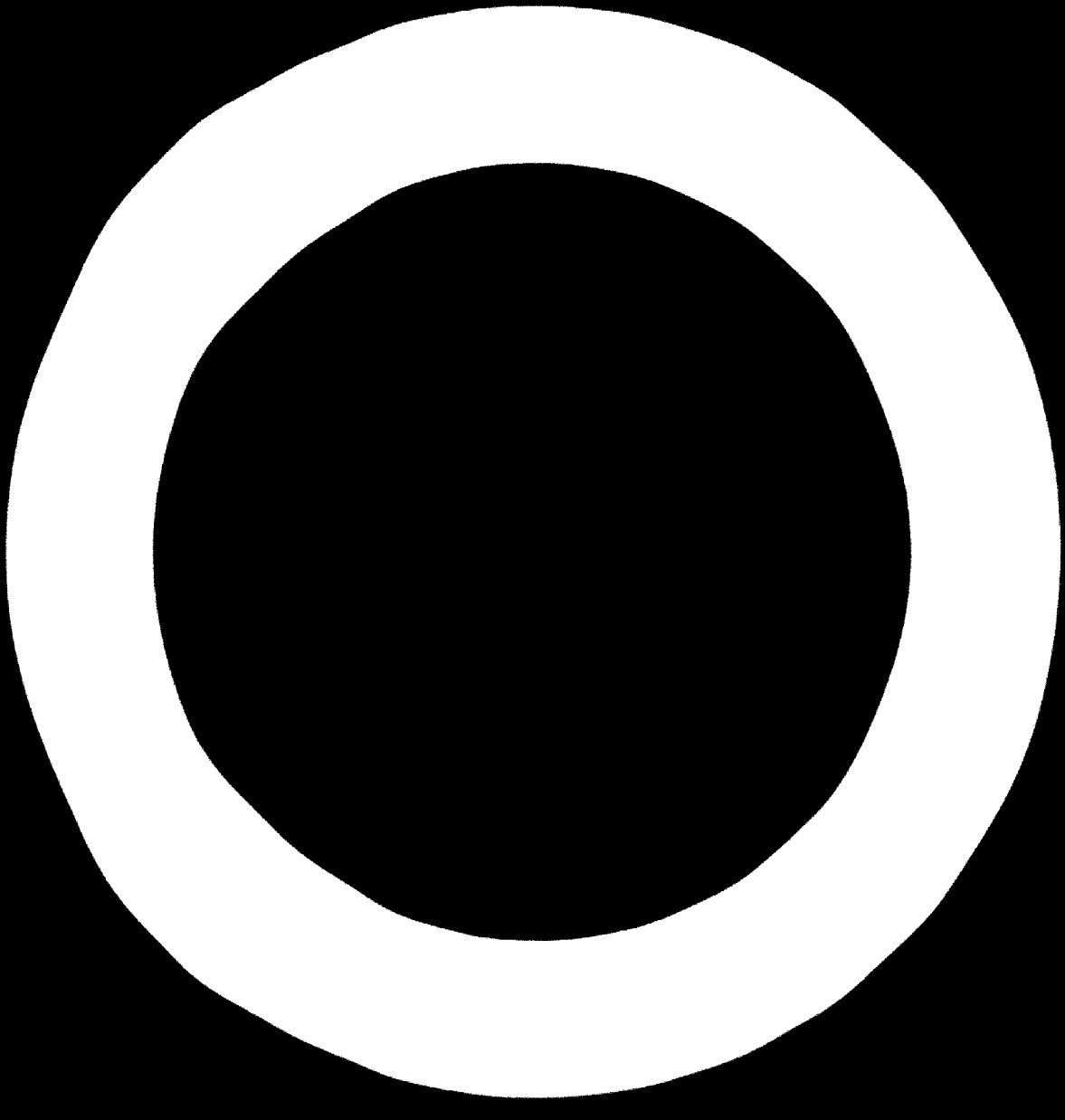

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INTRODUCTION

Industrial research institutes established in developing countries aim at undertaking research and development programmes and at developing technological and similar activities, which could provide various services to the industrial enterprises and other industrial development agencies. Their effectiveness must be measured, inter alia, by their usefulness to the industrial community and the extent to which various industrial undertakings make use of their services and R and D results.

Several governments are investing large sums of money in these research institutes and their research programmes with the anticipation of some return on their investments. Some of the research programmes have produced useful results at a laboratory and sometimes at a pilot plant level. There still exists, however, a big gap between the research work undertaken by most of these institutes and the actual commercialisation of their findings. While considerable efforts are being made by various institutes, governments and international organisations to narrow this gap, only some of the elements involved in the commercialisation of industrial research results have so far been identified. Only a

few centres, mostly industrialized, have had a breakthrough in developing methodologies for the steps to be taken in actually effecting such commercialization.

Since 1971, UNIDO has organized various meetings which have helped to bring together senior executives of industrial research institutes or organizations, representatives of the organized business sector active in the utilization of industrial research results, and high officials of government departments actively involved in planning industrial research activities, to a common forum to discuss practical matters relating to industrial research. Among the recommendations made by the meetings is the need for follow-up action in the form of, say, a workshop on the commercialization of industrial research results.

In the light of the above, UNIDO, in co-operation with the Government of Korea, through the Korean Institute of Science and Technology (KIST), and the Japan Agency of Industrial Science and Technology (AIST), organized a Workshop on the Commercialization of Industrial Research Results in Seoul, Korea, from 3-8 November 1975, and in Japan from 9-10 November 1975.

The purpose of the Workshop was to bring

together executives of industrial research institutes and government organizations involved with the commercialization of industrial research results, to a common forum to benefit from the experiences of Korea and Japan in this field, as well as to exchange their own personal experiences. It was envisaged that this would help the technologically advanced developing countries, and lay guidelines for other developing countries in the commercialisation of the results of their industrial research. It was also envisaged that this would help to cut down on the dependence of these countries on foreign technologies, and reduce the amount of foreign exchange being currently used for the purchase of these foreign technologies; thereby bringing several multiplying effects on the total industrial and economic development of the country.

I. ORGANIZATION OF THE WORKSHOP

The Workshop on the Commercialization of Research Results took place in Korea from 3-8 November 1975 and in Japan from 9-16 November 1975. It was attended by 18 delegates representing 17 countries, 3 consultants selected by UNIDO, observers representing the Asia Productivity Organization (APO), the International Bank for Reconstruction and Development (IBRD), the U.N. Economic and Social Commission for Asia and the Pacific (ESCAP), Organizations in Brazil, Mexico and the United States of America as well as a number of senior staff of KIST. The participants included senior officials of industrial research institutions or government organizations involved with the commercialization of research results. (A list of the participants is given in Annex I.)

Inauguration

The inaugural ceremony was attended, in addition to the participants, by senior executives of KIST and relevant organizations in Korea. After a brief statement by S.J. Hahn, President of KIST, H.S. Choi, Korean Minister of Science and Technology presented the

the opening address. G. Chand, UNDP Deputy Resident Representative in Korea after making short remarks introduced S.N. Ndam, Director of the Workshop to briefly address the audience on behalf of UNIDO.

Mr. Hahn, in his address, said that the highly developed material status of much of the contemporary world is, in general, a direct result of the development of technology by relatively few countries. And yet the results and benefits of this research and development effort have profitably been infused into many economic systems through the process of transfer and commercialisation. The life of the people has become so closely dependent on an international level of cooperation, that no individual, community, state or even nation can possibly stay aloof and unaffected, for better or for worse, by the condition of the neighbors. Because of this interdependence a necessity has now emerged in the international community to share the knowledge of not only the result of industrial research but also as to how best to commercialize the results of such research on a mutually rewarding basis. Mr. Hahn also underlined the important role KIST was playing in the Transfer of Technology in Korea and hoped that it would provide a suitable background for the Workshop.

Minister Choi identified a number of important problems in devising the proper approach to industrial research. These included the lack of institutional frameworks within which people can function, the absence of legal bases for providing the incentives to promote industrial research and, probably most important, the lack of qualified manpower either to carry out the research or to ameliorate conditions to make them conducive to engaging in industrial research. While proper approaches would vary from country to country there are enough common elements to justify efforts to exchange experiences and information. The Korean approach was to establish an independent multi-disciplinary industrial research institute, the Korea Institute of Science and Technology.

Most research institutes in the developing countries have been established directly under the jurisdiction of governments and, as part of government systems, these institutes have failed in many instances to recognize their obligation to produce for all users. Potential users, particularly industry, have not taken any keen interest in whatever developments have come from these institutes simply because they are made available free. The situation might be explained thus: unless the users have to pay out of

their own pockets for research and development, they are less likely to exploit them. This is one reason that the Korea Institute of Science and Technology was established as a contract research organization so that marketing principles would prevail even in the realm of R and D.

The development of suitable ways for the commercialization of industrial research results is by no means an easy task. Nevertheless through frank discussions and exchange of experience on both successful and unsuccessful cases, important elements would be identified for developing an approach, appropriate to each individual country, for the commercialization of its industrial research results.

Mr. Ndam, in his address, spoke of the importance which UNIDO placed on its programme of industrial research and described the assistance being given by UNIDO to developing countries in this field. In this and other UNIDO technical assistance programmes a number of points have been identified as being particularly important in the establishment of a suitable framework for the effective operation of industrial research institutions and the

translation of their research results into commercial operations. These points include

1. The development of a suitable industrial environment which is conscious of the usefulness of industrial research; including the passing of legislations to promote the application of research results in industry;

2. The establishment of a national machinery fully integrating the relevant industrial research institutions and industry to promote and co-ordinate the commercialization of research results. In this connection it is essential for the research institutions to be accorded the highest possible administrative and financial autonomy for them to be able to make an effective contribution;

3. The development of practical national industrial research policies and programmes, as well as the allocation of adequate funds for industrial research and the commercialization of its results;

4. The development of a solid technological capability including the training of the various

personnel required, particularly in industrial research institutions and industry, for the industrial application of research results;

5. The development of methodologies for the selection and evaluation of research projects which might initially be directed towards the adaptation of known technology, but later emphasizing the application of locally developed technologies;

6. The association of the industrial community with the formulation and implementation of legislative policies and programmes to ensure that the results of the various efforts put into industrial research relate to the practical needs of the community.

Election of Officers

J.H. Yang, leader of the host country delegation, was elected chairman of the Workshop. E. Lartey (Ghana) was elected Vice-Chairman and A. Gergatti-Netto (Brazil) was elected Rapporteur.

Organization of Discussions

The provisional Agenda and revised Schedule of work (included as

Annex II) were adopted without ammendment. Each topic for discussion was introduced by the presentation of a short paper prepared by a UNIDO - or KIST - appointed experts. This was followed by discussions on the topic.

Topics for Discussion

Three papers (See Annex) were presented as follows:

1. Commercialization of industrial research results (Document ID/WG-203/4)

2. Governmental Policies and Machineries for the Commercialization of Research Results (Document ID/WG-103/4)

3. International Co-operation in the commercialisation of R and D results (Document ID/WG-103/5)

Country Briefs

One session was devoted to the presentation of country briefs. Some of the participants highlighted the situation in their countries as regards the organisation of R and D and the commercialisation of R and D results.

Study Tours

In Korea Study tours were undertaken to KIST (Seoul); Pohang Iron and Steel Corporation Ltd., POSCO (Pohang); and the Hyundai shipyard (Ulsan).

In Japan, Study tours were undertaken to the Agency of Industrial Science and Technology, AIST (Tokyo, Japan); Research and Development Corporation of Japan, JRDC (Tokyo, Japan); Electrotechnical Laboratory (Tokyo, Japan); National Research Institute for Pollution and Resources, PRIPR (Tokyo, Japan); Tsukishima Kikai Corporation Ltd. (Tokyo and Yokohama, Japan); Nippon Electric Corporation Ltd., NEC (Kawasaki, Japan); Government Industrial Development Laboratory (Hokkaido, Japan); and the Japan Steel Works Ltd. (Muroran, Hokkaido, Japan). (A list of persons met during the Study Tours is given in Annex III.)

Closing Session

At the Workshop's closing session on 15 November 1975, the report of the rapporteur and the Workshop's recommendations were approved and UNIDO was authorized to finalize and edit, reproduce and circulate them in the form of the Workshop's Final Report. The Chairman, vice-chairman and representatives of AIST and UNIDO made brief closing remarks.

Speaking on behalf of the participants, the vice-

chairman said that the experience acquired during the Workshop had been fruitful and should help them in developing follow up action in their countries for the commercialisation of R and D results. He thanked UNIDO, the UNDP and the authorities of Korea and Japan for making it possible for the Workshop to take place.

The representative of UNIDO urged the participants to initiate follow up action in their countries for the implementation of the Workshop's recommendations. He also expressed the willingness of UNIDO to assist their governments, upon their request in their efforts in the commercialisation of R and D results, in particular, and industrial and economic development, in general.

RECOMMENDATIONS

A. The Workshop recommends that the Government of each developing country:

1. Establish, as required, national policies, machineries and programmes, for the commercialization of industrial research results. In doing this, efforts should be made to avoid undue duplication of available resources and facilities, particularly financial and human resources, and equipment. These programmes should be aligned with the development level of the country and its objectives, by integrating them with national industrial, economic and social development strategies, policies and plans. The industrial sector should be fully associated, at all levels, with these developments. The national machinery should include a system for evaluating the national programme and its individual projects before, during and after implementation;

2. Encourage the development of industrial and technological capacity and capability in their countries by inter alia:

a. Allocating adequate funds for industrial research

and development programmes, and the commercialisation of R and D results, at both the national and the institutional levels;

b. Establishing, as appropriate, a development corporation to promote and finance, including risk finance, the commercialisation of research results;

c. Adopting policies and providing incentives to encourage the development of a sound industrial environment;

d. Providing fiscal incentives, particularly to industry, for research and development and for users of local R and D results;

e. Urging transnational corporations, through legislation and other appropriate provisions in joint ventures or transfer-of-technology agreements, to utilize available local technological services;

f. Levying, on the importation of foreign technology, of a surcharge for the development of related local R and D activities;

g. Associating local R and D institutions in the assessment and transfer of imported technology; and

h. Establishing adequate conditions and compensation schemes to attract and retain competent personnel, at all levels and stages for the commercialisation of industrial research results;

3. Establish new industrial research institutions including design and engineering organizations, as appropriate, and strengthen existing ones for the effective implementation of national industrial research policies and programmes and the commercialisation of research results. The institutions should be accorded the highest possible administrative and financial autonomy with accountability. The industrial sector should be fully associated with the establishment of these institutions;

4. Establish, as appropriate, an adequate industrial information system;

5. Provide a conducive milieu when establishing economic co-operation arrangements, for practical co-operation and exchange of experience among relevant personnel for the commercialisation of research results. Special

consideration should be given to experience available in other developing countries;

6. Provide technical staff, at the decision making level, within relevant government agencies to co-operate with appropriate institutions in planning and commercializing R and D results.

B. The Workshop recommends that industry and other users of industrial research results:

1. Participate fully in the development of national industrial research policies, strategies and programmes particularly those related to the commercialization of research results;

2. Associate themselves with the determination of the policies and programmes of industrial research institutions by participating in the work of the institutions at various levels;

3. Encourage the commercialization of industrial research results by, inter alia,

a. Contributing towards financing research programmes at both the laboratory and pilot plant levels;

b. Providing opportunities in their industrial plants for practical training of research personnel involved in the commercialisation of R and D results;

c. Employing technologists, as necessary, in their enterprises to cater for the technological aspects of their operations and to act as liaison officers between the companies and industrial research institutions and technology transfer agencies; and

d. Establishing regular contacts with research institutions in order to acquaint the institutions with their (industry) needs and requirements.

8. The Workshop recommends that industrial research institutions:

1. Establish appropriate mechanisms for making contacts with industry by, inter alia,

a. Associating representatives of industry at various levels of their operations;

b. Establishing contacts between the head of the

institution and the management of its clientele as well as between corresponding levels of staff in both organisations; and

c. Appointing staff members of its clients as members of the respective project teams;

2. Establish close working relationships with pertinent bodies such as universities, design and engineering organizations, development banks and agencies, and industrial organizations in order to minimise undue duplication of efforts and to maximise the utilisation of local resources in the commercialisation of their research results;

3. Adopt a multi-disciplinary approach in the execution of industrial research projects with a suitable staff from the client's organisation being fully associated with its project at all stages of implementation. The pilot and demonstration plants should, as far as possible, be located in industry. Some aspects of the project should, where appropriate, be sub-contracted to industry;

4. Accord particular attention to their industrial information, documentation and enquiry services, which

should be co-ordinated (preferably) by a technologist;

5. Base the selection of their projects on the practical needs of the community through industry, initially directed towards the adaptation of known technologies but later emphasizing the application of locally developed technologies. The projects should also be based on well defined national priorities; be market oriented, and should produce results of social and economic benefit to the society. The presentation of such projects to clients should include information on both technological and commercial aspects and the time they require to produce results should be realistically estimated;

6. Accord high priority to the development of their managerial skills and the training of their technicians. Appropriate incentives should be established to encourage and increase the productivity of research staff;

7. Be involved in the commercialization process from the preparation of the project proposal through the research investigation to the commercial operation. Even after the research results have been put into commercial operation, the research institution

should still maintain contact with the client and provide him with technical advisory services, as required;

E. Establish a methodology for the commercialisation of their research results and a system for the continuous evaluation of their on-going projects. Programmes of institutes should be reviewed from time to time, in the light of the changing industrial and economic requirements of the community.

D. <u>The Workshop recommends, with respect to international co-operation in industrial research, that</u>:

1. Regular contacts be established among research institutions and transfer of technology agencies, particularly in developing countries, for the commercialisation of research results. Such contacts could be effected through exchange of visits by directors and research staff, and exchange of annual reports, research programmes and, where feasible, information on on-going research projects. UNIDO and other relevant international organisations could assist in these efforts and with WAITRO's collaboration, where possible;

2. In view of the results achieved at this Workshop, which has provided an opportunity for participants to be acquainted with the experiences of KIST, organizations in Korea, Japan and each other's countries, and to exchange their individual experiences, it is suggested that similar meetings be organized, say annually, at both regional, sub-regional, and inter-regional levels, on general and selected technical aspects of the commercialization of research results. UNIDO and other international organizations could assist the organizations in developing countries in this effort with the possible collaboration of WAITRO;

3. Developing countries establish joint projects, at the regional, sub-regional and global levels for the development and commercialization of research results so that the experiences of one country may be shared by others, particularly among the developing countries. In this connection, it is suggested, that Governments of the relevant developing countries give their full support to the efforts already initiated by UNIDO, to establish regional programmes which would assist in the commercialization of research results;

4. A guide, based on the available experiences on the commercialization of research results should be prepared to assist the developing countries. UNIDO could, in collaboration with other relevant international organizations, initiate in the preparation of such a guideline. WAITRO should, as far as possible, be associated;

5. UNIDO and other relevant regional and international agencies assist the developing countries in the commercialization of their research results by, inter alia, establishing and/or strengthening

   a. Industrial and patent information systems at the inter-regional, regional and national levels;

   b. National industrial R and D policies, programmes and machineries;

   c. Mechanisms at the national, regional and inter-regional levels for the financing and commercialisation of industrial research results;

   d. Linkages between developing and more advanced institutions both within and outside the developing countries. These linkages should be extended to cover research-institutions/industry

co-operation;

e. Training programmes, at both the national, regional and inter-regional levels, for various categories of personnel involved with the development and commercialization of industrial research results.

SUMMARY OF DISCUSSION

A. Commercialization of Research Results

For successful operation, it is necessary for both the Research Institution and the Department/Company to be fully competent in their own fields. This, however, while necessary, is not sufficient. In addition, they must justifiably respect each other and be able to communicate freely with understanding. For the Research Institution to establish its standing, its staff must endeavor to always maintain the scientific and technical standards in their chosen areas of skill at the highest level practicable. This has to be done without prejudicing the progress of work on projects in which they are involved and called for by their "customers".

The management of projects may be done by the normal line managers of the institution, or, in some cases, by managers or co-ordinators specially appointed for the purpose. Such technologists will also learn through project management to understand better their commercial partners and be developed for more senior positions. The original assembly of the set of projects (the portfolio), as well as the monitoring of progress and the final transfer of results, rests on the ability of the institution to maintain good communication.

This is greatly facilitated if the client includes in its senior members at policy making level a member with an adequate scientific/technological background.

The formal establishment of a project portfolio is a critical operation. Most of the initiative will come from the departments or industries served by the institute expressing desired economic or commercial goals. The institute must then translate these goals into technological goals. The possibilities of the extent of achievement of these goals, and the time and cost needed, should be communicated to the "customer" and confirmed or adjusted in a dialogue. The first of these dialogues should take place even before the project proposal is made; otherwise the technical resource needed will not be there when required.

The project portfolio will not only contain projects of normal commercial value, to an individual firm, industry or department, but also projects of national social value. Thus research leading to successful establishment of a labour-intensive industry might be seen as unprofitable by a company, but, by relieving unemployment, as socially profitable to the country. In whichever sense the projects are accepted, the goal of the institute is profit to the nation and both types of projects must be monitored to the

same standards of goal achievement. A third type of project which may appear in the portfolio is that initiated by a research institution itself with the objective of providing or improving a science or technology which it is believed will be needed but is not now available. These too should be progressed as rigorously.

The "commercialization" process starts before there are any "research results" by seeing that the right research resource is available. This resource (the nature and size of the research teams and their equipment) must be tuned to the overall needs of the country or sector responsible directly or indirectly for its funding. When subsequently the needs are formulated into projects, it becomes possible to estimate the chances of success and time and cost for individual projects. A great degree of honesty and scientific integrity is needed to ensure that over-promising does not lead to false optimism and subsequently cause the institute to loose the confidence of its "customers". Without such careful evaluation, the "customer" will be misled. It must be realised that the market value of a project can change dramatically with time and complete "success" later than needed may be valueless; partial success if timely may, however, be useful if a need is filled or a competitor anticipated.

Short, simple projects do not always get the attention from research that they deserve. Whilst simple when seen by a technologist, they may be of profound significance to the "client". Furthermore when completed quickly and successfully, they make a contribution to the institute's external image disproportionate to their size in the laboratory. This enhanced image can improve communication in more complex areas resulting in still more satisfactory results.

Most projects can be completed given enough time. Successful commercialization, however, demands timeliness. Within a limited resource - and all Research Budgets are limited - this demands a balancing of the portfolio, so that the institution or any part of it, is not over-programmed. Such policy reviews should be conducted regularly, say annually, with a look always to the future; a rolling five-year plan is a target. The individual projects should be reviewed more frequently, say 3 or 4 monthly. At this stage the project manager should also be in discussion with his counterpart, if any, on the customer sides. The latter needs to be preparing long before project completion. In the later stages, the operation should be joint and when the client becomes responsible, the project manager should still maintain contact.

This type of exchange is common in industrial processes involving pilot plant operations. Here the factory people will visit research institutions to familiarise themselves with the process when still in research hands and the research men will assist in initial factory production. There are many variants of this procedure, all with the object of eliminating discontinuity between the research process and the commercializing process. Similarly, in agricultural programmes, the research scientists responsible for the research trials on a new seed or farming method will usually also act as a field advisor when the seed or method goes into actual exploitation.

B. Governmental Machineries for the Commercialization of Research Results

Technologies are usually developed to suit the economic and social conditions of the country of their (technologies) origin. These technologies cannot be transferred to developing countries without further modification or adaptation, since the conditions prevailing in the recipient country with regard to the availability of raw materials and skills as well as the social needs of the people usually are quite different. The Government of a developing country should therefore establish well defined policies because in

many instances the needs and requirements of the country are not necessarily the same as those of the source of the technology, even those developed locally. This is also true when commercializing these technologies. Several developing countries have been establishing several R and D institutions during the last few years to decrease the gap existing between research and development and the practical application of their results.

One of the first things a developing country needs to do is to decide on its needs and requirements for R and D, to clearly define its priorities, since human resources and money are usually limited for R and D work. The next important thing is the training of personnel. Well planned training programmes should be encouraged within the country. Such training could be obtained in the developed countries of the world or in the more advanced developing countries themselves. The third important consideration is the decision with regard to the type of institutions that would be entrusted with the commercialization of R and D results work in the developing country. Here the decisions could be either a number of institutions spread throughout the country each one specializing in an area or a few allied areas or a central institution which is multi-disciplinary and could cater to selected needs of the country. Having taken the decision for establishing

the institutions, it is necessary for the Government to clearly define the objectives of such institutions and the areas of activity, provide them with the necessary resources, qualified staff as well as finances, for achieving their goals. These institutions also include universities and institutions of higher learning; design and engineering organizations, specialized R and D institutions; laboratories of established industries, and foundations and non profit organizations. There is a critical effort below which R and D work may not yield any worthwhile results. It is necessary for funding agencies to provide these critical inputs for making R and D worthwhile.

Governmental machineries for the development and utilization of R and D results must include appropriate agencies specifically created for the purpose. In developed countries the organizations buying technology have resources to assess the technology offered and provide all the inputs necessary for successful transfer of technology like market studies, engineering services, upscaling of the process, erection, operation and selling the product. This is not so in the developing countries. The Government of each developing country must set up a system, including special agencies, for the purpose of evaluating alternative technologies and selecting those best suited for the country's needs.

Depending upon the technology, many inputs need to be provided to the entrepreneur to make the technology a successful commercial success. The entrepreneur in a developing country may need assistance in choosing a process, in conducting a market survey, upscaling, detailed engineering, purchase of equipment, inspection, installation, start up, maintenance, training of personnel, and marketing.

The Government needs to provide policy and institutional support for effecting successful transfer of technology. One way of doing this is through the establishment of an organization to undertake the commercialization of R and D results. Some countries have established a Research and Development Corporation while others have established other forms of organizations. In general, these organizations facilitate the transfer of research results to industry by

a. Granting licences for a number of processes which require relatively low capital investment for their transfer from R and D institution to industry without going through the stage of a pilot plant.

b. Financing laboratory and pilot plant investigations. In some countries such units are being established in collaboration with industry. The organization pays a percentage of the cost of such

a project and industry pays the rest. If the project is completed successfully industry pays back the contribution from the organization without interest but when the project fails, the contribution of the organization to the project is written off. In some projects the industrial partner takes up the organization as a real partner by equity participation.

c. Assisting inventors, not supported by any institution, in patenting their inventions, building of prototypes and models, and in commercialising their inventions.

d. Assisting to transfer technology from one industry to another.

e. Transferring technology developed in R and D institutions to industry even at the pilot plant stage or earlier.

In order to achieve the above, it is essential for the Government to provide adequate finances not only for research work in the laboratory but also for carrying out development work at the pilot plant and demonstration plant stages where this upscaling process is very important to avoid

failure, particularly when the projects are based upon indigneous technology.

C. International Co-operation in the Commercialization of R and D Results

In considering commercialization of research products, a distinction should be made between that intended as an addition or improvement to existing technology and a research product that is novel and may require a much more comprehensive introduction to the marketplace. A further distinction should be made between research products that are intended to enter and compete in the international markets, and products that are essentially intended for the domestic market.

The logical emphasis for research in developing countries for some years to come will be towards those products that are additions or modifications to existing technology, particularly in the manner of adaptations of technologies to meet domestic purchasing power, climatic conditions, cultural preferences, manpower utilization and income distribution. Novel research products intended for international markets will require sophisticated technical, manufacturing and marketing evaluations.

The commercialization of research results does not lend itself to loose cooperation, but is a strictly business venture requiring defined roles, responsibilities, and returns on the part of the members of the partnership and a clear-cut accountability of the operators. Formation of common market areas in developing countries of the world is suggested as a means of increasing the potential for the commercialization of research results in developing countries.

Developing countries need feedback of experience in other developing countries regarding commercialization of R and D results. International organizations such as UNIDO could be helpful in assisting national agencies and the country in the area of technology transfer. It is essential for funding agencies to fully appreciate the need to avoid cutting down on expenses on R and D activities particularly at the crucial points of commercializing its results. They should also recognize the fact that not all projects in R and D field can result in successful commercial operations.

The participation of transnational corporations in the commercialization of R and D results is important. These corporations could provide a package of technical "know-how", management capability, marketing capability and financial strength and are in a position to set up and put into

operation facilities in new locations in minimum time. The motivation of transnationals has, so far, been to acquire sources of raw materials, labour, markets and return on investment. To gain the first three of these in the future, concessions will have to be made on the part of the fourth. In many cases the concessions would require mutual understanding between the transnational corporations and the developing countries being the reservoir of many of the raw materials desired and needed by the transnationals.

An important aspect in the transnational system for technology transfer and product commercialization is the labour use. In the past the practice has been to utilize developing country nationals for manual labour input as contrasted to technical and managerial. An area for cooperation is in the training of nationals for technical and managerial posts, so that the transnational companies take on more and more the aspect of a national company as time proceeds. A means of accelerating and expanding the interrelationship of transnationals with the national population in a developing country is through the mediation of industrial research institutions in those countries which have one. The industrial research institutions have technically trained people with orientation towards application of technology.

The establishment of linkages between developing and advanced industrial research institutions in the developing countries should be promoted. This linkage could be extended to include cooperative working relationship between transnationals and the scientists, engineers and technologists of developing countries. One of the greatest deficiencies in developing countries has been the lack of availability of opportunity for technically trained nationals to acquire useful on-the-job experience in industry. It is only through exposure to practical work that cadres of developing country nationals capable of industrial management can be trained. The most effective route for the commercialization of R and D results is through existing industrial operations. For many of the developing countries in which nationally owned industrial companies do not exist, the only immediate alternative is to use foreign-based companies. In many cases the operating arrangements that have been used by transnationals in the past must be liberalized in favour of developing countries. An awareness of this fact has been expressed in recent years by transnationals as well as developing countries.

STUDY TOURS

A. Korean Institute of Science and Technology (KIST)

KIST started operating in 1966 during which time there were already 300 other institutions established in Korea. These institutions were operating inefficiently due to heavy governmental influence in their activities and because many of the decisions on what the institutions should do were taken outside of the institutions. In the light of the above experience KIST was conceived in such a way as to avoid those interferences, and before its establishment, many visits were made to other successful institutions with experience in the commercialization of research results. Today KIST maintains close contact and have some agreements with many institutions abroad, in order to keep its staff up-to-date with technological developments.

KIST is located in the Seoul vicinity and has an area of about 68 acres and a constructed area of 45,000 m^2 which includes 60 apartments for its staff and 10 apartments for visitors. It has 50 laboratories, several pilot plants for experimental production of many products. The largest laboratory is the one on data processing with a total of 200 people, out of which 100 are system analysts. Its total investment is estmated to be US$30 million, including invest-

ments on machinery and equipment.

KIST has a total of 1,000 staff consisting of 60 Ph.D.'s, 100 M.S., 240 B.S. and 580 Administrative and Supported staff. Besides the 1,000 employees, KIST has an average of 100 professionals hired as consultants on a part time basis.

The annual research contract of KIST is about US$6 million. In 1975, about 70% of this contract came from about 200 projects undertaken for private sector. The remaining 30% was provided through contracts with Government agencies.

Selection of Projects

At the beginning KIST programmed a series of seminars in order to become known within the private sector of the Korean economy and governmental agencies to enable it to make a meaningful assessment of the needs and requirements of Korea. KIST's projects were subsequently selected on this basis. Many Korean industrialists after travelling abroad also brought samples of products for KIST to develop.

KIST has identified the leaders (key men) in each

industrial sector of Korean industry and maintain close contacts with them. KIST is a member of most of the Industrial Associations. KIST staff has taken several trips abroad. These trips have been found useful in maintaining continuous specialization in their fields of activities which permits KIST to become sensible to change of emphasis in the current trend of opportunities and in the identification and selection of priority areas where R and D is necessary.

In this way KIST is deeply involved in the process of technology transfer, by digesting imported technology, adapting it for the needs of the industries in Korea, setting up specifications for materials, and developing the local production processes. In these processes modifications are usually made to adapt the product characteristics or the process for the local requirements.

Development and Control of Projects

At the beginning KIST recruited several highly experienced people on commercialization of projects abroad to start up the development of industrial research projects. Today it uses its own staff and consultants, as need be. A post-graduate program has been developed under the leadership of the Ministry of Science and Technology, and many

KIST staff members are involved in the training of personnel, particularly for the development and control of projects.

Each laboratory of KIST has full authority to control the number of its staff in accordance with its needs. The laboratory head has full authority to decide on the trends to be followed in relation to projects underway, and seniority, salary or age is not considered as major factors for according a leadership role to a staff. Each laboratory also maintains its own accounts and charges other laboratories for work done on its behalf.

Commercialization of Results

KIST has learned over the years that the major cause for delayed commercialization of R and D results is the lack of infrastructure in supporting commercialization, and misunderstanding of entrepreneurs about the stage of commercialization. It is misleading to think that a good R and D result would produce profit right away. One must consider or realize that when a technology becomes really productive in economic activities, it has to go through a number of stages such as research, development, engineering, testing, production, and marketing.

In order to more effectively commercialise its R

and D results, KIST has set up a separate corporation, the Korean Technology Advancement Corporation (K-TAC). The purpose of establishing K-TAC as a separate Corporation from KIST was to facilitate the implementation process of KIST's R and D results, which is its major research goal. The activities of K-TAC include: Promotion of the implementation of R and D results; Sales of by-products of KIST's research results; Sales of patents and know-hows; and financing the commercialization of KIST's research results.

K-TAC also helps local industries in launching new enterprises based on technologies developed by KIST by arranging for the transfer of the technology and by rendering services, based on the needs of clients, for the commercialization of the technology. In return K-TAC receives compensation in the form of equity participation, royalty payments and/or lump sum cash payments. Equity participation is however preferred by entrepreneurs particularly those who do not have sufficient funds for technology transfer purposes but would like to maintain a close relationship with K-TAC. K-TAC also works closely with Korean Development Financing Corporation (KDFC) which is a member of the Board of Directors of K-TAC.

KIST is active in the negotiation of contracts for

the importation of technology by Korean industries. KIST helps the industries in the selection of the technology that is suitable to local needs and draws upon the experience it has accumulated in providing industry with a stronger bargaining position.

For example, one industry was said to be negotiating a technology which included the payment of 5% royalties. Because KIST was involved in the development of such technology to a certain extent the company was able to sign the contract paying 2.5% royalties, which means savings of large quantities of money.

In many other instances KIST has vetted the purchase of technology on a turn-key basis or the so called "black-box" by opening the package and giving orientation to the entrepreneur in obtaining only what is strictly necessary for its industry to become operational.

B. Pohang Iron and Steel Corporation Ltd., POSCO (Pohang, Korea)

POSCO was incorporated in 1968 with headquarters located at Pohang and with an initial investment of about US$ million. It started operation in 1972 when the hot strip mill was completed. The first phase of the construction which includes a plate mill, iron making plant, steel making

plant and a blooming and slabbing mill was completed in 1973 when it was officially inaugurated. Its first phase of expansion is now underway scheduled for completion in 1976 when the plant will then produce about 3 million metric tons of crude steel annually. A second expansion stage is envisaged for completion by 1981 to bring its annual production to about 8 million metric tons.

The plant covers an area of about 7.7 million square meters with about 243,000 m^2 of floor space. Its annual raw material requirments amount to about 3.5 million metric tons and annual production is about 1.3 million metric tons. The corporation employs about 5,300 persons practically all Koreans.

KIST has been associated with POSCO since the original plans for its establishment. KIST currently maintains a resident staff at POSCO mainly for the provision of on-the-spot technical advisory services. Some of the KIST staff are non-Koreans.

C. Hyundai Shipbuilding and Heavy Machinery Corporation Ltd. (Ulsan, Korea)

The corporation which was initially foreseen to engage in shipbuilding was started in 1972 with an initial investment capital of about US$8.3 million. It started building its first ship in 1973 which made its first voyage in 1974. In view of changes in the international market the

corporation's activities are being expanded to include the construction of heavy machinery.

The shipyard contains 2 dry docks and provides facilities for the construction of up to 10 ships for a maximum of 300,000 dwt. each. The total capacity of the yard is 1 million dwt. per annum. It employs a total of about 18,000 persons and benefits from technical assistance from the Kawasaki Heavy Industries, Ltd. of Japan.

D. Agency of Industrial Science and Technology, AIST (Tokyo, Japan)

The AIST was created to promote the mining and industrial technology and conduct R and D concerned as an extraministerial office of the Ministry of International Trade and Industry (MITI) by incorporating various research institutes individually belonged to the Ministry, the Electrical Institute of the Ministry of Communications, and the Industrial Standard Department of the Patent Standard Bureau. With the reformation of the Government's administrative organization the Agency became affiliated to the Ministry of International Trade and Industry and later became responsible for the administrative activities of MITI in industrial science and technology.

The AIST has 16 governmental industrial research institutes under its aegis and also has a number of divisions responsible for co-ordinating, planning and promoting science

and technology. The national standards department is also located under the aegis of AIST. The AIST operates on an annual budget of about US$200 million and obtains its policy direction from the Council of Industrial Science and Technology, the highest advisory council of the Prime Minister. To-day the main functions of AIST include the promotion of R and D of industrial science and technology and the diffusion of the results obtained. The main responsibilities of Headquarters are planning of the comprehensive industrial science and technology, co-ordination and promotion of R and D activities of affiliated laboratories and institutes, promotion of National Research and Development Program, Sunshine Project for new energy development and utilisation support and stimulation for R and D activities of private sector, survey and analysis of R and D in and out of Japan, and promotion of industrial standardisation. The improvement of R and D conditions of affiliated institutes is also a very important function.

In the light of the above AIST's programmes emphasize:

1. Development and utilisation of new energy such as solar energy, geothermal energy etc. (Sunshine project) to diversify the current energy sources and to develop newer energy conservation technology.

2. Development of environment protection technology, social development technology to solve the pollution problems and city problems etc.

3. Development of technology for recovery of oceanic natural resources, bionics technology, new materials technology which could be basic technology for future industries.

4. R and D necessary for converting the present industrial structure to a highly intellectual and advanced technology oriented one.

5. Promotion of technology assessment to keep a good harmonization between technology progress and the living standards of the nation.

6. Promotion of international research cooperation with developing countries.

7. Promotion of industrial standardization in accord with the movement of international standardization.

B. Research and Development Corporation of Japan, JRDC (Tokyo, Japan)

JRDC was established in 1961 under the Research Development Corporation Act. It is a national organization

fully financed by the government and functioning under administrative control of the Science and Technology Agency. The main purpose of the Corporation is to bring to the attention of industry promising research projects and develop them, in collaboration with industry, so that research results are used by industry. The development is 100% financed by the JRDC. If the projects succeed, JRDC gets back its financial input, without interest, in yearly instalments. If the projects fail, JRDC writes off its contributions to the projects.

As of 30 March, 1975, 83 projects have been successful and 7 have failed. It is currently financing 34 projects and its total development costs for the year amounted to about US$1,000.

JRDC operations have been limited to Japan. It has not yet sold a process abroad. Some of the projects financed by JRDC include the production of magnesium oxide from serpentine (failure); the production of high purity iron oxide by chlorine process (success); and disposing agent of waste water and filter aid from diatomaceous earth (success). Generally speaking JRDC takes on the most difficult projects, where financial risks are high for industry to invest in them.

F. Electrotechnical Laboratory (Tokyo, Japan)

This is the largest research institute under the aegis of AIST. The project portfolio is based on pioneering long-term research at the frontiers of their area. This basis differs sharply from that adopted in the developing countries where the main effort goes into adapting known technology. The difference is shown clearly by the practice of the Electrotechnical Laboratory in subcontracting a very substantial part of its programme to industry i.e. the Laboratory is using the known technology which is already commercialized.

One of the projects being carried out by the Laboratory concerns the development of a Pattern Information Processing System (a $100 million project) which will enable the direct input of characters, pictures, three dimensional objects and speech, and provide such built-in functions as parallel operation, associative information retrieval inference and learning capability. The need for computer recognition of Japanese writing is a major stimulus and new methods have been developed. Another project, which is associated with the above, involves speech processing and aims at direct verbal communication with the computer, starting with speech synthesis. A third project involves the development of

intelligent robots which has, to-date, largely concentrated on coupling of a laser tracker with the manipulative mechanics.

G. The National Research Institute for Pollution and Resources, NIPR (Tokyo, Japan)

The National Research Institute for Pollution and Resources is one of the R and D institutions managed by the Agency of Industrial Science and Technology in Japan. NIPR has a central establishment at KAWAGUCHI, an annex at UKIMA (Tokyo) and three branches. The participants visited the main laboratory and the annex.

At present the Institute is concentrating its attention on the study of environmental problems that affect Japan and the utilization of some of the natural resources available in the country. Work is currently being carried out on air pollution control (wind-tunnel experiments on air pollution in Tokyo area), water pollution control (Tokyo Bay etc.), combustion and combustion control (tests being developed for monitoring and control of oxides of nitrogen, etc.), coal and carbon (spherical activated carbon, formed coke, etc.), hydro-carbon processing (hydro cracking of asphalt to synthetic crude), mining and safety (development of tunnelling and boring equipment, development of techniques for under-sea mining) and solid waste treatment (pyrolysis of plastic materials,

recovery of wastes from paper mills, etc.).

The processes commercialized by the Institute include production of spherical activated carbon from coal; paraxylene manufactured by crystalization and separation; and development of techniques on the estimation of air and water pollution. The Institute is largely funded by the government and has a staff of about 400 (Technical 280 and Administrative 120).

H. Tsukishima Kikai Company, Ltd. (Tokyo and Yokohama, Japan)

The company was founded 70 years ago, first to manufacture sugar machinery which was then being imported into Japan. Later the company diversified its activities and now manufactures equipment for many chemical industries, including petro-chemicals, pulp and paper, food processing and metal industries. They have also branched out into equipment for water and air pollution abatement. The total turnover of the company is about US$100,000,000. It has 1350 employees, 570 being engineers.

The technical aspects of the company's work and the underlying principles mainly concentrates on solid-liquid separation processes. This has taken it into various chemical processing, municipal water and sewage treatment and air

and water pollution control equipment. In this connection, a "pyrox" process for pyrolysis of municipal wastes has been developed by the company. This project was carried out, at the development stage, with funding from the Japan Research and Development Corporation. Other R and D projects in which the company has made contributions include the development of better centrifuges for sugar industry and crystallisers.

I. Nippon Electric Company Ltd., NEC (Kawasaki, Japan)

NEC was established in 1899 to make telephone sets and switchboards. Today the company has a capital investment of US$130 million, employs 60,000 people and has entered into all fields of communication including information processing systems (computers) and postal equipment.

The company's activities are organized into six (6) groups: radio, wired communications, electron device, information processing and industrial systems, electrical household appliance, and research and development.

NEC supplies 90% of the domestic market for microwave equipment; 30% of the domestic share of broadcasting systems and equipment and over 60% of the export market and produced the world's first fully transistorised computer.

NEC is also applying its electronic capability to such social uses as medical electronics and environmental protection.

At NEC R and D activities are undertaken not only by the R and D group but also by the different manufacturing groups. The R and D group itself consists of eight (8) central research laboratories: conducting research on materials; solid state; memory (computers); electron devices; quantum physics; communication; computer system; and peripheral equipment. It also has laboratories for production automation development and pollution control technology.

The colour T.V. factory at Kawasaki is part of the NEC Electrical Household Appliances Group. The factory employs about 1,000 people working from 8:00 a.m. to 5:00 p.m. daily (with a one hour lunch break) for 5 days a week and produces 20,000 colour and 20,000 black and white colour T.V. sets per month. The factory exports to over 50 countries and manufactures for more than 20 brand names in the U.S. alone. For this reason a T.V. broadcasting facility is maintained in the factory which is capable of producing 10 different broadcast patterns and 24 different broadcast wave types in order to reproduce the various T.V. broadcast systems used around the world.

The printed circuit boards are mass produced on moving assembly lines and tested. The various T.V. set models are then assembled from the printed circuit boards and other components. There are over 1,200 components in a colour T.V. set and approximately 500 in a black and white set.

There is 100% checking of sets produced for electrical shock safety. In addition, every set is subjected to mechanical shock to check for loose fittings and left to run in for 6 - 24 hours depending on the model. The factory also has facilities for reliability and environmental testing of products including a facility to simulate the earth's magnetic field in different parts of the world where this could affect the "colour purity" of large size screens of colour T.V. sets.

J. Government Industrial Development Laboratory, Giki, Higashi-Tsukisamu (Sapporo, Hokkaido)

The organisation is similar to an R and D organisation in a "developing country". Japan is interested in developing Hokkaido island, and in getting industries to establish plants there. The laboratory considers its chief function to be the development of raw materials present at Hokkaido, and thus encourage its industrialisation.

The GIDL is organised according to a matrix structure. The staff is divided into 3 departments: mineral deposits (including coal); chemical analysis; pollution control; and design and control of chemical plant (including testing of industrial materials). Projects are managed within the divisions, which has a division head. The individual project would have a project leader, and if large enough a project manager in addition.

The total present staff comprises of 107 people. The 1975 budget amounts to $2,533,000, of which $1,139,000 is allocated to personnel. The remainder is allocated for such activities as building and general services, new energy technology, pollution protection, atomic energy, urban waste utilisation and instrumentation. The funds are obtained in the form of federal government grants, through AIST, along with other institutions under the aegis of AIST, on the basis of project proposals. Additional income is received from research contracts with the government and local industry.

GIDL has recently (since 1972) achieved success in a number of projects, some of which have been commercialised. Work on other projects is at the development stage, ment. This is being done in co-operation with industrial enterprises. Some of the individual projects are of such a nature that GIDL has chosen to work with two or three

companies on the basis of different raw materials or on pollution aspect of the projects. The commercialization of some of GIDL's projects was arranged by the Japan Research and Development Corporation (JRDC) while others were arranged by GIDL directly with the relevant industry. Commercial feasibility was evidently established in the laboratory before commercialization was attempted.

K. Japan Steel Works, Ltd. (Muroran, Hokkaido, Japan)

The Muroran plant of the Japan Steel Works, Ltd., which was established over 60 years ago, is one of the four units of the organisation. The other three units are located at Hiroshima, Yokohama and Tokyo. The Muroran plant is specialised in the building and fabrication of very heavy equipment required for power plants, nuclear energy stations, fertilizer and other petrochemical units and hydro-electric projects.

The facilities of the plant include presses of capacity 10,000, 8,000 and 2,000 tons for forging operations; 100 and 130 ton smelters; heavy plate mills; welding and materials shops.

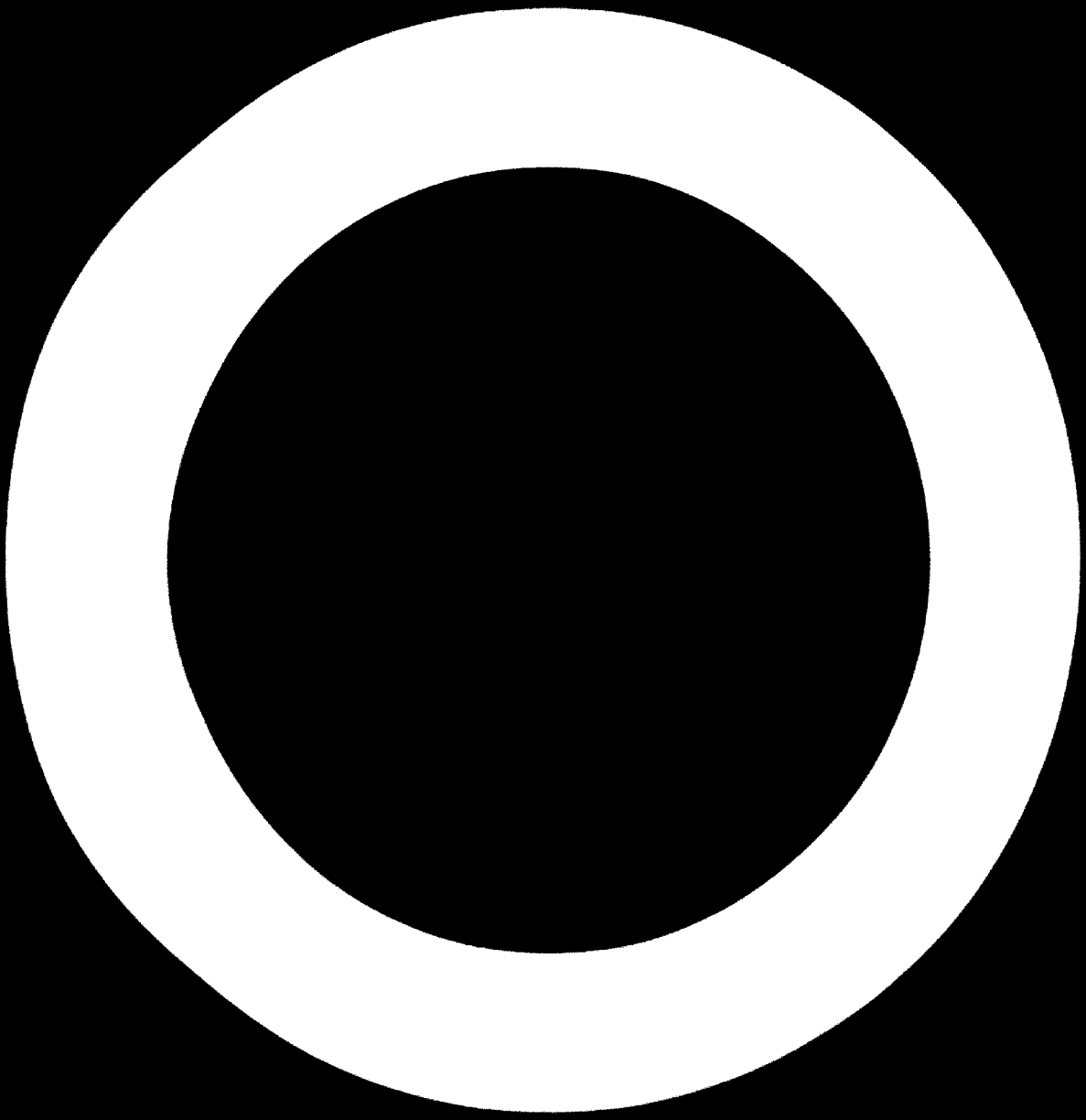
The plant has the best research and development

department of the company and is regarded as one of the best R and D unit in iron and steel in Japan. Its activities cover R and D work in the specialised fields of steel making and metal fabrication.

The R and D unit employs 130 people, about 30% of the total (4,100) employees in the Muroran work plant. The budget of the department is about 1.35% of the total sales value of the company's products. This figure is high when compared with allocations made by other steel companies in Japan for R and D which averages at about 0.8% of the respective company's total sales value. The unit also receives funds from government agencies on some long term development projects.

The R and D results of the department which have been commercialized include the development of processes for vacuum carbon deoxidation during steel ingot making; manufacture of a 247 ton rotor forging out of 500 ton ingot; and manufacture of 245 ton back-up rolls for plate mills. Another project nearing the commercial stage concerns hydrogen embrittlement of steel. The R and D projects are divided into two categories: short term projects (1 to 2 year duration) which concentrates on quality improvement and cost reduction and long term projects (3 to 10 year duration) on the development of new processes and materials. Although the

unit co-operates with laboratories of other companies on joint research projects, its involvement with government research institutions and universities is very limited in view of the extremely specialised nature of its work.



Annex I

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* Participated for only 1 or 2 days of the Workshop.

Annex II

SCHEDULE

Sunday, 2 November 1975

14.00 - 17.00	Registration and Administrative Matters at King Sejong Hotel

Monday, 3 November 1975

08.30	Registration and Administrative Matters (continued) at KIST
09.00	Opening Ceremony
	- Welcome address by S.J. Hahn, President of KIST
	- Opening of the Workshop by M.S. Choi, Minister of Science and Technology
	- Short remarks by G. Chand, Deputy Resident Representative of UNDP in Korea
	- Address on behalf of UNIDO by S.N. Nigam, Industrial Development Officer, UNIDO Headquarters
10.30	Organization of the Workshop
14.30	Introductory remarks and discussion on the "Commercialization of Research Results"

Tuesday, 4 November 1975

09.30	Introductory remarks and discussion on "Governmental policies and machineries for the commercialization of research results"
11.15	Discussion continued
14.00	- Presentation of film on KIST
	- Introduction of KIST Display room
	- Tour of KIST laboratory buildings

Wednesday, 5 November 1975

09.30	Experiences of KIST in the Commercialization of Research Results and Discussion
11.15	Experience of KIST in the Commercialization of Research Results and Discussion (continued)
16.30	Tour of Folk Village

Thursday, 6 November 1975

09.30	Experience of KIST in the Commercialization of Research Results and Discussion
11.15	Experience of KIST in the Commercialization of Research Results and Discussion (continued)
14.00	Introductory remarks and Discussion on "International Co-operation for the Commercialization of Research Results"
15.45	- Country briefs - General discussions

Friday, 7 November 1975

07.30	Travel to Pohang
14.00	Study tour of the Pohang Iron and Steel Company Ltd., Pohang
16.00	Sightseeing tour of Kyung Ju

Saturday, 8 November 1975

08.30	Travel to Ulsan
09.00	Tour of Hyundai Shipbuilding and Heavy Machinery Company Ltd., Ulsan
14.30	Travel to Seoul

Sunday, 9 November 1975

15.30	Travel to Japan

Monday, 10 November 1975

09.30	Study tour at the Japan Agency of Industrial Science and Technology (AIST) Headquarters, Tokyo
14.00	Study tour at the Research Development Corporation of Japan (JRDC), Tokyo
15.30	Study tour at the Electrotechnical Laboratory, Tokyo

Tuesday, 11 November 1975

09.00	Study tour at the National Research Institute for Pollution and Resources (NRIPR), Tokyo, (Ukima branch)
13.30	Study tour at NRIPR, Tokyo, (Kawagachi branch)

Wednesday, 12 November 1975

07.00	Travel to Sapporo, Hokkaido
14.30	Study tour at Government Industrial Development Laboratory, Hokkaido

Friday, 14 November 1975

09.00	Travel to Muroran
13.00	Study tour at the Japan Steel Works, Ltd, Muroran, Hokkaido
16.30	Travel to Tokyo

Saturday, 15 November 1975

09.30	Review and adoption of the Draft Report of the Rapporteur and Recommendations of the Workshop
12.30	Closing of the Workshop

Sunday, 16 November 1975 Departure

Annex III

LIST OF PERSONS MET DURING STUDY TOURS

Korea Institute of Science and Technology (KIST)

Choi, N.S.	Head Biopolymer Laboratory
Chon, B.D.	Co-ordinator Division of Metallurgy
Chung, S.H.	Head Hybrid Integrated Circuit Laboratory
Kwon, T.W.	Research Co-ordinator Food and Biotechnology
Sung, Ki Soo	Research Co-ordinator Computer Systems Development
Yun, Y.G.	President The Korean Technology Advancement Corporation (K-TAC)

Pohang Iron and Steel Corporation, Ltd. (Posco)

Kim, Mok Ki	Managing Director Project and Engineering Division

Agency of Industrial Science and Technology (AIST)

Fujisawa, O.	Senior Officer for International R and D Co-operation
Matsumoto, K.	President
Takagi, T.	Head of Research Department

Research and Development Corporation of Japan (JRDC)

Nakagane, M.	Vice President

Electrotechnical Laboratory

Inoue, Y.	Director
Nakajima, T.	Chief Speech Processing Section
Nakayama, K.	Chief Planning Section
Nishino, H.	Chief Information Sciences Division
Sato, K.	Chief Automatic Control Division
Tsuchiya, S.	Chief Systems and Control Section

National Research Institute for Pollution and Resources (NIRPR)

Ashida, S.	Director

Tsukishima Kikai Company Ltd.

Kureita, K.	Executive Director International Operations
Kureita, S.	President
Morita, M.	General Manager

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Tomogane, M.	Supervisor Sales Co-ordination Section Consumer Electronics Overseas Marketing Division

Government Industrial
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Sato, T.	Chief Second Research Division
Yamaguchi, M.	Research Planning Director
Yoshida, Y.	Director

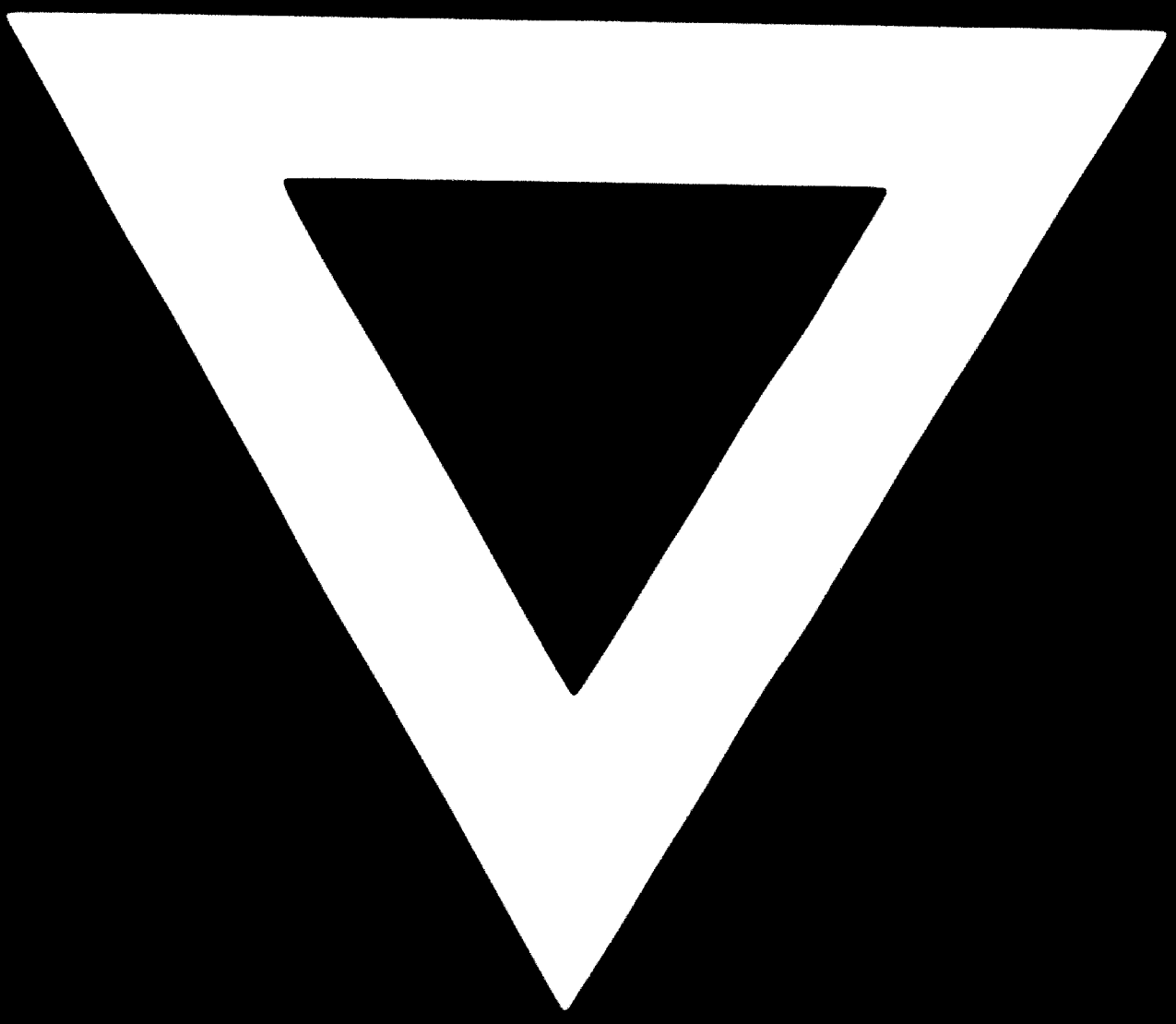
The Japan Steel Works, Ltd.

Onodera, S.	Deputy General Plant Manager

Sato, T.	Chief Second Research Division
Yamaguchi, H.	Research Planning Director
Yoshida, Y.	Director

The Japan Steel Works, Ltd.

Onodera, S.	Deputy General Plant Manager and General Manager of Atomic Energy Department
Adachi, K.	General Manager of General Affairs Department
Sato, S.	Research Laboratory
Suzuki, K.	Manager of Research Laboratory
Sawada, S.	Research Laboratory
Taniguchi, K.	Research Laboratory
Sagawara, Y.	General Affairs Department



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