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Vienna, Austria, 29 November - 3 December 1976

CO-OPERATION BETWEEN RESEARCH INSTITUTES FROM DEVELOPING COUNTRIES AND SIMILAR INSTITUTIONS FROM INDUSTRIALISED COUNTRIES AGAINST THE BACKGROUND OF MATERIALS RESEARCH AT MARMARA SCIENTIFIC AND INDUSTRIAL RESEARCH INSTITUTE[1/]

by

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1. INTRODUCTION

In the broad scope of the theme of this meeting, which was defined as co-operation among universities, industrial research institutes and industries, and the role of UNIDO in promoting this co-operation; this paper will treat certain aspects of co-operation between the industrial research institutes, as based on the Author's experience in developing his Research Division during the course of the last 8 years. Special emphasis will be placed in two areas: The first being co-operation between the Institutes from developing countries, and secondly, the relationships between Institutes from developing countries and similar institutions from industrialized countries.

Since the first decades of this century, the fact that industrial development can be helped and stimulated by scientific and industrial research has generally been recognized by industrial management as well as by government authorities. The history of development in most countries is full of success stories providing ample proof for this statement, especially in highly industrialized countries. Scientific and Industrial Research Institutes in developing countries are relatively new developments. Nevertheless in the last decades it is being realized, that the availability of indigenous technical and investigative services is as essential for the industrial development as the availability of investment capital. Consequently more and more research establishments are being founded in developing countries. However, the degree of success these institutes demonstrate in assisting the industrialization process in their home countries varies greatly from case to cass. There are very successful ones besides those in the early stages of success, sometimes giving rise to such hasty generalizations as such Institutes not being successful in developing countries. Therefore, there exist a great challenge in successfully integrating such

Institutes into the industrialization process in developing countries, in developing its methodology.

Special conditions notwithstanding, goals of nearly all industrialization programmes of developing countries are more or less similar. Namely, more local manufacture, greater diversification of products, more efficient production and better competitive market position both at home and abroad. Therefore, these countries face similar handicaps, differences being mainly in degrees rather than in nature. As a result, Research Institute in these countries are called in to fill similar gaps in the industrialization process. The services they offer are not too different from one developing country to another. Since the success of an industrial research institute depends upon making a rate of progress satisfactory to the client, co-operation between the institutes from developing countries may prove very useful in accelerating this rate by filling gaps existing in one country with the experience and expertise obtained during the industrialization process of the other.

On the other hand, whether a developing or a highly industrialized country, ever simple problems of trouble shooting require the use of sophisticated research techniques for reaching effective and speedy solutions. A developing institute in a developing country may profit to a very large extent, from the established scientific capacity of institutions from industrialized countries. In addition, universal requirements of industrialization being not too different the world over, as the level of industrialization rises, research institutes in developing countries start to offer services not too different from those in industrialized countries. Hence another reason for promoting co-operation between institutes from developing countries and those from industrialized ones.

Author, in elaborating on these types of co-operation, intends to draw upon his experience in developing Materials Research Division of the Marmara Scientific and Industrial Research Institute. He

also expects this paper to be instrumental in demonstrating the capabilities of Marmara Institute in general and Materials Division in particular for international co-operation, specially with institutions from developing countries. Therefore, at the beginning, both Marmara Scientific and Industrial Research Institute and Materials Research Division will be described in the light of the general theme of this meeting. In subsequent sections international experience gained in co-operating with other institutes will be described to pave way for a general treatment of this topic and the role of UNIDO. The paper will end with international co-operation possibilities offered by Materials Research Division, and the general conclusions to be drawn from this paper.

2. MARMARA SCIENTIFIC AND INDUSTRIAL RESEARCH INSTITUTE

Scientific and Technical Research Council of Turkey which is connected with the Office of Prime Minister was founded in 1963 by a special law, for the purpose of developing, promoting, organizing and co-ordinating fundamental and applied research in science and engineering. The Council among its many other activities, has decided shortly after its establishment, in 1966, to found a research institute to promote industrial development through scientific and industrial research. In 1968 several research teams were organized at Turkish Universities as nuclei of future departmental Units of the Institute, so that they could begin to accumulate experience by the time the Institute becomes operational, and to help in design of laboratories and prepare specifications for the equipment to be purchased in order to carry out the type of research activities envisaged at the time, after numerous surveys of the Turkish Industry. Ground was broken for the construction in 1969 and by 1972 first buildings were ready. The Institute has been built on a site near the town Gebze (Kocaeli) 47 Km. east of Istanbul on the Istanbul-Ankara Highway, and is centrally located in a growing industrial

area between Istanbul and Izmit. Marmara Scientific and Industrial Research Institute comprises at present Materials, Electronics, Applied Mathematics, Industrial Chemistry, Operation Research, Food Technology and Nutrition Research Units. Two other Units, namely, Mechanical Engineering, and Applied Physics are being started. At present closed area of the Institute is 25,800 m^2 with 14,900 m^2 under construction and the total number of staff is 349. Out of these 98 are Scientists with University degrees, and 44 are Technicians. 15 professional technical staff and 56 technicians are charged with the running and maintenance of the technical installation of the Institute. The number of administrative personnel including secretarial staff is 59; and other support personnel total 77.

2.1. Goals and Objectives of the Institute

The basic goals and objectives can be described as follows:

(a) To create competance in a particular discipline or in an interdisciplinary area and co-operate with Universities and other research Institutes.

(b) Undertake research for the development of new materials, products, processes, methods, technological systems and management systems, in order to accelerate technology transfers to the Country, and to conduct applied and development research to improve existing products, processes, methods, and systems.

(c) To provide conditions for successful application of research findings.

(d) To provide following general services to the industry:

i. quality and process control.

ii. improved production and management methods.

iii. Mechanical, Physical and Chemical tests.

iv. to solve problems in methodology, materials change or substitution brought about by technological adaptation.

v. repair and calibration of the sensitive instruments.

vi. dissemination of scientific and industrial information.

vii. to help industry in systems analysis, programming, and data processing.

(e) To train and educate its own research and technical personnel, as well as those in Universities and Industry.

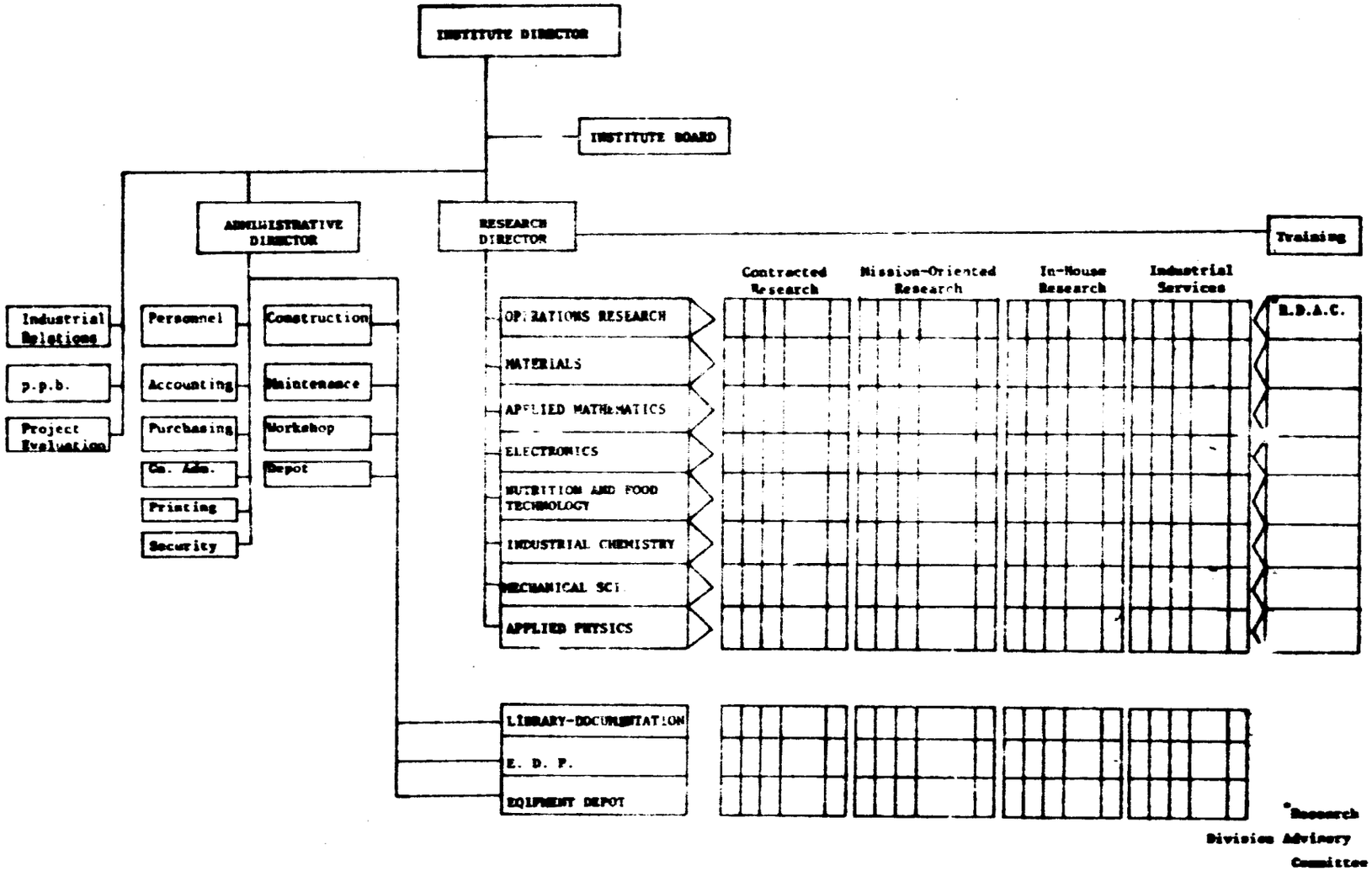
(f) To undertake all other work not listed above but necessary for the scientific and industrial development of the Country.

2.2. Organization of the Institute

The Institute has a matrix-type organization suitable for all trans - and inter - disciplinary activities in research, development, and industrial services undertaken on a project basis. (TABLE-1). Thus, in the Institute principle of unity rather than independantly functioning departments or divisions is valid. This eliminates the boundaries between the Units, and allows unification towards a common goal, providing for an optimum utilization of resources.

A study of the organigram given as TABLE-1, will reveal several details, which will not be further amplified here.

TABLE - I



ORGANIZATION CHART OF MARMARA SCIENTIFIC AND INDUSTRIAL RESEARCH INSTITUTE

3. MATERIALS RESEARCH DIVISION AT MARMARA SCIENTIFIC AND INDUSTRIAL RESEARCH INSTITUTE

3.1. Establishment and Development of the Division

The Division was started in mid 1968 by the appointment of a founding director. The initial staff of the Division worked primarily on industrial surveys to determine future research programmes, advised the architects in the planning of buildings, prepared specifications for laboratories and equipment, and was kept below 10 until January 1973, when the present premises in Gebze where taken into service. Staff number doubled in 1964, was about 40 in 1975. Today there are 24 scientists at the Division, out of which 11 are Ph.D.'s. 25 technicians and 2 secretaries raise the number of staff to 50 at present.

Division has 8500 m^2 closed area composed of a 4 story theoretical studies and administration building of 1900 m^2 surface area, a standard laboratory building occupies 5000 m^2 in 3 floors. A pilot plant building of 1600 m^2 has a high-bay area where height is 10 m under the hook. Adjoining the high-bay area there are 3 floors of laboratories designed for special investigations.

3.2. Equipment and Laboratories

The Materials Research Division is equipped with modern equipment suitable for:

(a) chemical and structural analyses of materials,

(b) synthesis of metals, alloy and ceramics and their composits,

(c) forming, deforming and shaping of materials, and

(d) determining all types of physical, chemical, mechanical properties of materials.

Mentioning some of the equipment might give an idea about the nature and size of the research effort: X-Ray Spectrometry and Diffractometry unit, Transmission Electron Microscope (100 kV), Scanning Electron Microscope (30 kV) with Wave Length and Energy-Dispersive X-Ray Spectrometers, Differential Thermal and Analyses unit with Dilatometer and evolved gas analyses chromatography, Recording Micro-Balance, Optical Metallography Equipment, Atomic Absorption Spectrophotometer, automatic equipments for H, C, N, O, P, S analyses; Salt-Spray Chamber for corrosion testing, equipment for galvanoplastic studies, Vacuum Induction Furnace (1,2 kg Steel), Vacuum Chamber for arc melting small specimens, Zone Refining equipment (50 kW), Induction melting in air (100 kg Steel), Arc Furnace (500 kg Steel), Experimental Hot and Cold Rolling Machine for bars, flats and strips, complete sand testing laboratory equipment, plasma and flame spray equipment, powder metallurgy laboratory equipment, electronically controlled 10 tons tension-compression mechanical testing equipment, 40 and 100 tons Hydraulic Universal Testing Machines, 20 tons Electro-Hydraulic Servo-Controlled Close-Loop Testing System, Automatic sheet metal Testing Machine, Swaging Machine, Impact Testers of 5 and 30 kgm capacities, fatigue machines, mechine shop, Ore Beneficiation Laboratory equipment, liquid Nitrogen producing plant, etc.

Pilot plant scale laboratories are being set-up at present for industrial development research. A second pilot plant building is being planned, and additional equipment valued at US$ 2 million are going to be purchased in the next few years.

3.3. Research Programme

As general guidelines the Division spends its efforts roughly in the following proportions:

10 % basic research.

20 % applied research.

70 % development research, trouble-shooting, tests, analyses, etc.

A present, major sponsored (with sponsored budgets shown in paranthesis) research and development projects of the Division are:

- "Beneficiation of Calcined Pyrite of Turkish Origin". (TL. 4,387,000.-).
- "Design of Process and Quality Control System at Karabük Iron and Steel Works". (TL. 4,312,000.- plus US$ 125,000).
- "Development of Prototype Arc-furnace Electrode Holders from High Conductivity Copper Castings". (TL. 1,600,000.-).
- "Internally Oxydized Silver-Codmium Electrical Contact Material Development". (TL. 188,000.-).
- "Corrosion Control of Bosphorous Bridge". (TL. 120,000.-).
- "Non-Destructive Testing" totaling more than TL. 1,000,000 among the important project "NDT Testing of Bosphorous Bridge", "3. Bridge on Golden Horn", "Petro-Chemical Plant in Yarimca" can be mentioned.
- Industrial Services in the form of trouble shooting, mechanical testing, chemical, metallographic analyses, passed TL. 1 million mark recently.

Materials Research Division conducts several in-house projects. Most noteworthy of these are:

- "Survey of the Properties of Turkish Bentonite Clays".
- "Development of Selected Bio-Materials". (Dental amalgams were first to be developed).
- "Survey of the Properties of Turkish Foundry Sands".

- "High Temperature Low Cycle Fatigue of α-Brass under reversed Torsion".

- "Orientation Relationships Between Matrix and Whiskers in in-Situ Composites".

3.4. UNIDO Technical Assistance

Materials Research Division of Marmara Research Institute has been receiving Technical Assistance from UNIDO since 1974. The first phase of the programme had the general objective of strengthening of the operation of Materials Research Division; equipment, expert and training inputs have played an important role in raising total volume of sponsored research from TL. 273,000 in 1973 to TL. 11,000,000 in 1976. A second phase of this technical assistance foresees the development of pilot plant scale research and development capacity in order to assist Turkish Iron and Steel Sector to reach targets set by National Development Plans, by creating the necessary know-how within the Country, and by solving production and manufacturing problems.

3.5. Industrial Contacts of the Materials Research Division

The Materials Research Division started to operate at its present premises since early 1973. Therefore, all his research activities developed in the last 4 years; along with purchasing of equipment and commissioning of new laboratories, an activity which is still continuing. From the very beginning, it has been the policy of the Division to contract a few large scale projects, and then to gear all development efforts to the on-schedule implementation of these projects. Such big budget and big name projects, while imposing a high rate of develop-

ment on the research capability, give identification to the efforts of the Division, and allow smaller sponsored or in-house projects to be carried out in its wake. At the same time they pave way to other large scale projects, whenever laboratory and staff capabilities allow an expansion.

Industrial contacts of the Division take place with frequent visits to and surveys in the industry, on the one hand, and often invited visits from individual industries, industrial Associations and Government Agencies to the Institute, on the other hand. For every industrial contact, which can take place in industry, at the Institute or by telephone, a report is filed by the responsible Division staff member, as to the content, outcome and action to be taken. These reports also constitute reliable references when future contacts are planned with a particular plant or establishment.

The projects are set up around particular problems faced by the industrial enterprizes, in close co-operation with their managers, often after lengthy negociations. Major policy direction is to build confidence in the industry towards the Institute. Therefore, care is given to contract such research work which is within the capability of the staff and the laboratories; never sign a contract where chances of success seem precarious. Care also is exercized to have reserve scientists for each project contracted; so that when one leaves others may set forth the work. In all the projects costs are calculated on the basis of personnel salaries, direct purchases, travel expenses and a general overhead of 110 % of the salaries. Following an initial down-payment, the cost of research is payed by the industry against monthly invoices. In case a particular research and development work is found to be of general national interest or where another Government Agency is involved as the sponsor, the Institute may ask a payment below the actual cost; but still high enough to keep the interest of the client alive

on the work performed, in order to ensure, as much as possible, its future implementation.

In development research, in the areas where Division capability has not previously been tested, after the identification of the project in the Industry, it is the preferred policy to make the initial development as an in-house project. After the demonstration of the preliminary results, a contact is signed for the sponsored project (e.g. Development of Electrode Holder Prototype). In other types of research the policy of the Division has been to guarantee its best effort, but never the results (e.g. Beneficiation of Calcined Pyrite).

So far, Materials Research Division has always had sponsored research projects in areas where it had developed a research capacity. This must be attributed to the awareness on the part of Managers in industry as to the importance of research and development for their establishments, and to the level of development in the industrial enterprizes.

4. EXPERIENCES IN CO-OPERATION WITH INSTITUTIONS FROM INDUSTRIALIZED AND DEVELOPING COUNTRIES

At the initial stage of development of the Materials Research Division, visits to similar establishments in other countries were arranged for its Head, in order to enable him to collect information for possible use in the planning of the new Division and, in some cases, of the Institute. Attention was focused on the following points in the institutions visited:

i. Historical development.

ii. Internal organization.

iii. Recruitment of research and administrative staff.

iv. Management of research activity.

v. Organization of industrial contacts.

vi. Planning research buildings and laboratories.

vii. Active research projects.

viii. Research equipment in the laboratories.

ix. Planning for future development and research policies.

x. Possibilities of future co-operation.

The arrangements for the visits were made by OECD. The list of the institutions, which were visited in two separate trips is given below:

HOLLAND	Metaalinstituut, TNO
U.K.	National Engineering Laboratory National Physical Laboratory BISRA Sheffield University Glasgow University Imperial College of Science and Engineering Cambridge University Fulmer Research Institute
F.R.GERMANY	Max-Planck Institut für Eisenforschung Max-Planck Institut für Metallforschung
U.S.A.	Mid-West Research Institute South-West Research Institute Battelle Memorial Institute (Columbus)

The first observation to be made from this list is that, institutions visited at the planning stage where from highly industrialized countries. Although these initial contacts provided very useful information on research management, and data for preparing specifications for laboratories and equipment; in later years the author had occasions to observe that, it would be of great benefit to include newly established institutes from advanced developing countries into the above list.

Another result of these contacts was the identification of places for trainees and of experts for the required consultancy assignments. TABLE-2 summarizes the inter-institutional co-operation in training research staff, TABLE-3 illustrates co-operation in providing expertise and consultancy. It will first be noticed, that after 1974, OECD is replaced by UNIDO as the international agency sponsoring these co-operations. This is due to a change policy as to the fields to be supported on the part of OECD; and also to the start of UNIDO technical assistance to the Division. It is also evident that both training and expertise fields at the start are related with the development of research techniques and laboratories; whereas at later years, co-operation is in the areas concerning the research projects of the Division. Finally increasing co-operation between the Materials Research Division and the Institutions from developing countries can be observed from both of these tables. Present experience shows that comparable levels of development of the co-operating Institutions and of the countries to which they belong; in addition to the considerations put forward in the first section of this paper, may pave way to many other instances of Technical Co-operation among developing countries. One such case of co-operative research will be described in greater detail later in this paper.

5. CASE HISTORY OF A CO-OPERATIVE RESEARCH BETWEEN MATERIALS RESEARCH DIVISION AND METALLURGICAL INSTITUTE HASAN BRKIĆ

During the Consultancy Mission of the Director of Hasan Brkić, several joint field trips to the Turkish Iron and Steel Industry along with the Head of Materials Research at Marmara, for the purpose of formulating a research programme for Marmara in the Iron and Steel field corresponding to the needs of Turkish Industry, resulted in the identification of several research areas, among which a Proposal on the part of Karabük Iron and Steel Works Management for

TABLE - 2

CO-OPERATION WITH FOREIGN INSTITUTIONS IN TRAINING RESEARCH PERSONNEL

YEAR	No. of Trainees	SPONSORING INTERNATIONAL AGENCY	AREA OF TRAINING	DURATION (months)	INSTITUTION	COUNTRY
1969	1	CENTO	Non-Destructive Testing	¼	Lahor Atomic Energy Centre	PAKISTAN
1971	1	OECD	Non-Destructive Testing	12	Röntgen T.D. Unit Insp. Co. Harwell A.E.C. Fa.Krautkrämer	HOLLAND U.K. U.K. F.R.GERMANY
1973	1	OECD	Foundry Sand Testing.	3	Metaalinstituut TNO	HOLLAND
	1	OECD	Mechanical Behavior of Materials	3	M.I.T.	U.S.A.
1974	1	OECD	Vacuum Techniques	3	M.I.T.	U.S.A.
	1	OECD	Electron Microscopy	3	Imperial College	U.K.
1975	2	UNIDO	Pelletizing, Direct Reduction	1	N.M.L.(Jamshedpur)	INDIA
1976	1	UNIDO	X-Ray Spectroscopy	2	MIHBZ* Max-Planck Institut für Metallforschung	YUGOSLAVIA F.R.GERMANY
	1	UNIDO	Metal Casting	1½	MIHBZ* Inductotherm	YUGOSLAVIA U.K.
	1	UNIDO	Blast Furnace Operation Optimization	3	MIHBZ*	YUGOSLAVIA
	1	UNIDO	Ore Beneficiation	1	MIHBZ*	YUGOSLAVIA
	1	UNIDO	Mechanical Forming	3	Battelle M.I. MIHBZ*	U.S.A. YUGOSLAVIA
	1	UNIDO	Non-Destructive Testing	6	Automation Ind. Bundesanstalt für Materialprüfung	U.S.A. F.R.GERMANY

* *Metallurgical Institute Hasan Brkić in Zenica.*

TABLE - 3

CO-OPERATION WITH FOREIGN INSTITUTIONS - EXPERTS AND CONSULTANTS

YEAR	AREA OF EXPERTISE	SPONSORING INTERNATIONAL AGENCY	DURATION (months)	INSTITUTION OF THE EXPERT	COUNTRY
1967	Materials Research Institute Planning	AGARD	2	National Aerospace Lab. (NLR)	HOLLAND
1971	Materials Research Institute Planning	OECD	½	Faculty of Materials University of Sheffield	U.K.
1973	X-Ray Diffraction and Spectrometry	OECD	1	Metaalinstituut TNO	HOLLAND
1974	X-Ray Diffraction and Spectrometry	OECD	2	Univ. of Denver	U.S.A.
1974 -1975	Materials Research Management	UNIDO	12	Battelle Memorial Institute (Columbus)	U.S.A.
1975	Scanning Electron Microscopy	UNIDO	3	S.E.C. of Victoria Scient. Div.	AUSTRALIA
	Pelletizing and Direct Reduction of Iron Oxide	UNIDO	1	Private Consultant	U.S.A.
	Iron and Steel Metallurgy	UNIDO	2	Metallurgical Institute Hasan Brkić	YUGOSLAVIA
1976	Research Contract Accounting and Management	UNIDO	2	Metallurgical Institute Hasan Brkić	YUGOSLAVIA

a co-operative project for the development of quality and process control system in their works, seemed most important from the standpoint of its impact on the industrial development in the Country. A proposal was submitted by Marmara to Karabük for this work, with the provision that part of the work would be sub-contracted to Hasan Brkić. There being no means of paying this sub-contract from the budget of Marmara ; UNIDO was approached by Marmara to provide funds for this purpose. When this was agreed upon in principle by UNDP in Ankara; a protocol was signed between two Institutes as to the scope and mode of collaboration. According to prevailing UNIDO rules; substantive terms of reference was drawn up for this contract and the contract was opened to international bidding. However, International bidding resulting in any other Institute than Hasan Brkić as sub-contractor would not be acceptable to both Karabük and Marmara. Therefore, International bidding was waived by Ankara in favor of Hasan Brkić. After signing of the contract, following the mode of operation established in the original protocol and substantive terms of reference, 10 Hasan Brkić Experts arrived for a two week stay in Karabük in mid September 1976, accompanied by 10 counterparts from Marmara to work in collaboration with the engineers of Karabük on the implementation of the work programme; which very briefly requires:

1. *Drawing up of Flow chart of the works.*
2. *Indicating control points on this chart.*
3. *Determining type of control and materials to be controlled at each point, together with their frequency.*
4. *Calculation of total numbers of samples and tests within various time intervals.*
5. *Choice of equipment to do these controls together with organization to carry it out.*
6. *Preparation of specifications and lay-out plan for a central laboratory.*
7. *Preparation of data recording system.*
8. *Preparation of Internal Standards of materials.*
9. *Preparation of technological instructions for selected products.*

The implementation on the first 3 points is continuing at present after the return of Hasan Brkić team. In 3 months time Turkish team will pay a week long visit to Hasan Brkić with the accumulated data, to start work on the rest the work programme. The work will continue for 3 years with reciprocal visits, already foreseen in the protocol. So far the work has been progressing very satisfactory.

Excellent accord was established between the personnel from the 3 establishments concerned. Language requirements among the counterparts presented no great difficulty which is a prerequisite for the progress of the work. It is hoped that this will set forth a successful example for collaboration between the Institutes from developing countries.

However, one difficulty encountered in making this arrangement should be mentioned here, for possible action on the part of UNIDO. This difficulty arises from the prevailing rules of UNIDO requiring international bidding in awarding sub-contracts. It is obvious that if a co-operative research programme is already established between two institutions, present sub-contracting procedure resulting in any institution other than the original two, would change the whole scheme.

6. GENERAL CONSIDERATIONS ON THE CO-OPERATION AMONG RESEARCH INSTITUTES AND THE ROLE OF UNIDO

The experience gained by the Materials Research Division in its co-operation with foreign Research Institutions can be summed up as follows.

In the initial stages of development of a research establishment, development of competance in advanced research techniques and setting up of laboratories capable of projected industrial research

are the most important activities. This requires sending of trainees to and inviting of experts from, Institutions where such expertise is available. In these instances well established Institutions from industrialized countries can offer help in both categories through International Organizations, or through bilateral agreements. Industrial Research Institute, or University laboratories can be used for this purpose. At Marmara adopted practice of establishing a laboratory in research, is to make preliminary preparations by training laboratory staff and commissioning of laboratory equipment, and then to invite well known, internationally recognized experts to conduct nation-wide workshops, open to researchers and scientists from Universities and other Institutes in the Country. This not only provides a forum for the recognition of Marmara in a particular field but also helps other Institutions.

In trying to secure the co-operation of Institutions from other countries, reactions received differed according to the type of establishment. In order to clarify this point Institutions will be classified from 3 different aspects.

The first classification is according to the affiliation in which case one can distinguish the following types:

(a) Research Institutes connected with Industrial firms.

(b) Research Institutes operated by Industrial Associations.

(c) Research Institutes established by consulting firms.

(d) Research Institutes connected with Universities.

(e) Government Research Establishments.

According to their financial policies Institutions fall into one of the following categories:

(a) non-profit organizations.

(b) not-for-profit organizations.

(c) profit-making organizations.

A third classification which is specially important for the theme of this paper is:

(a) Institutes from Developing Countries.

(b) Institutes from Industrialized Countries.

In all categories of institutes and organizations; co-operation must be based generally on the prevailing mode of operation. In other words if it is a profit-making organization or not-for-profit organization services rendered should be compensated accordingly. In our experience greatest reluctance to co-operation is shown by company research laboratories for understandable reasons. The services of profit-making institutions are available on purely commercial basis; but that does not come under the heading of co-operation between the research institutes.

Best co-operation possibilities exist with University and Government Institutes and those working as non-profit or not-for-profit organizations. In general it has been our experience that, Institutes of the developing countries are more amenable to any type of co-operation.

One of the most important topics in inter-institutional co-operation is the co-operation between Institutes from developing countries. Most of the time these are also developing institutes. Like the countries themselves they can be at various levels of development. Such a co-operation would benefit both the Institutes involved and their countries. UNIDO can play an important role in bringing key staff of these Institutes into frequent contact by arranging mutual visits to the establishments involved or by arranging meetings on

the problems common to developing countries. The role of UNIDO in organizing co-operative research and development projects between two or more Institutes may also be another important contribution in this direction. Since the process of industrialization follow similar goals in various countries, experienced freshly gained in one country can be made available to another country through the co-operation of research Institutes in the respective developing countries. The same experiences were perhaps obtained in industrialized country half a century or more ago; but these problems of development most probably are not actual anymore, and people having had these experiences are no longer on the scene.

Before ending this section co-operation through international organizations like EEC, OECD, WAITRO should be mentioned as avenue open to research Institutes from all countries. However our Division had not had any experience worth reporting in this area.

7. CO-OPERATION POSSIBILITIES OFFERED BY MATERIALS RESEARCH DIVISION

Materials Research Division equipment, laboratories and research programme were given in section 3. It will be seen that modern analytical techniques are being used; so that training can be offered in laboratories concerned for the research staff from other Institutes on a reciprocal basis. In certain cases tests can be carried out for foreign Institutions on basis of a contract not different from the ones used in domestic work. As actual examples, an offer for analysis of clays used in Brick-making was received from a UNIDO/UNDP Project in Afganistan, and another offer from Yugoslavia for scanning electron microscopy pictures of non-metallic inclusions in steel can be mentioned.

An area where considerable experience was accumulated at Marmara is that of beneficiation of pyrite ashes (calcined pyrite). This

is a waste product of sulphuric acid and artificial fertilizer plants predicated on pyrite. This material consists of some 50 percent iron containing Cu, Zn, Pb, As, sometimes Co in oxide or other compound forms as impurities. If not used it pollutes the nature as a red dust. In Turkey presently close to 500,000 tons per year comes about; with planned expansions this is going to increase to more than 1,000,000 tons per year. In order to use this material in iron and steel production and to improve the economy of the process one has to separate non-ferrous impurities from the calcine. The methods used for this has to be different in industrialized countries where transport systems and possibility of collecting calcines in one central plant for treatment contrasts with smaller amounts available in individual developing countries. Necessity of treating this waste in smaller amounts, energy prices in developing countries require methods different than the ones used in industrialized countries. This can best be solved by institutes in developing countries and with co-operation among them. Marmara Research Institute can contribute his experience, or can conduct bench and pilot plant scale tests on materials from different countries to develop methods best suited to local conditions.

In near future with the help of UNIDO Technical Assistance Programme pilot plant for alloy and product development will be operational in Marmara capable of casting ingots up to 500 kg's and for forging, extruding, rolling, drawing, etc. research. This will constitute another area of co-operation important for developing countries.

8. SUMMARY AND CONCLUSIONS

This paper has treated the timely topic of technical co-operation among the Institutes of developing countries and the Institutes from Industrialized countries, and was based on the experience gathered in the last 8 years in developing Materials Research Division at Marmara Scientific and Industrial Research Institute. Following points summarizes some of the important conclusions of the paper:

1. Technical co-operation among the Institutes from developing countries is important from the standpoints of their own development as well as a means of technology transfer from one country to another.

2. In developing advanced research techniques and capabilities, co-operation with well established Institutes from industrialized countries may be preferred. Sending fellows for training followed by inviting experts for workshops proved very effective in numerous instances.

3. For industrial development projects, co-operation between Institutes from developing countries can be most effective because of similar nature of problems and existence of newly acquired experience.

4. An important avenue for co-operation is jointly executed research projects in a country where one of the institutes resides. This may be realized as a sub-contract, which can be arranged through UNIDO. However, change in the rules of operation of UNIDO seems necessary for an effective organization and speedy implementation of this scheme.

5. An important role can be played by UNIDO in promoting co-operation by arranging mutual visit of key personnel between Institutes of developing countries; also by arranging meetings where common development problems can be discussed.

6. UNIDO can play an important role in encouraging Institutes in developing countries to bid for international research contracts.