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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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SOME REFLECTIONS ON THE PROBLEM OF CHOICE OF TECHNIQUES FOR INDUSTRIAL PRODUCTION AND DESIGN OF INDUSTRIAL EQUIPMENT

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CHAPTER I

INTRODUCTION

1. The Advisory Committee on the Application of Science and Technology to Development (ACAST) decided at its seventeenth session in Geneva from 23 October to 1 November 1972 to consider at its next session in New York in April 1973 the question of design of industrial equipment. It was noted that most industrial equipment is designed by engineers, inventors and others in the developed countries, almost entirely in terms of the need for labour saving methods of production. While the less developed countries, through various institutes, have begun to give consideration to drawing up new designs of a labour intensive equipment, the ACAST noted that the bulk of the research, development and engineering work on the design of industrial equipment is being carried out in the developed countries. Consequently, at least a fraction of the efforts and talents in these countries could be devoted to the design of labour intensive, but nevertheless efficient types of equipment in co-operation with experts from the institutes from the less developed countries. The ACAST wishes to consider formulating a global project under the leadership of UNDP to organize systematic research, possibly through a consortium arrangement. 1/

2. The World Plan of Action for the Application of Science and Technology to Development, 2/ as well as the International Strategy of Development for the Second United Nations Development Decade, indicate broadly the amount of resources required to adequately apply science and technology for the benefit of the developing countries. It has been stated that the developing countries should endeavour to attain an expenditure level by the end of the decade of a minimum average level equivalent to 0.5 per cent of their gross product. While the International Development Strategy did not specifically mention the precise percentage for the direct support of science and technology in developing countries during the second decade, as it would be specified during the first biennial review, the World Plan of Action, on the other hand, recommended a target of 5 per cent of non-military internal research and development of developed countries. These are essentially broad magnitudes in financial terms of the totality of efforts required, including the development of appropriate technologies for industrial development, as well as the building up of an adequate infrastructure to sustain the technological efforts of the developing countries themselves. The proposal of the ACAST to consider the question of design of industrial equipment in this context and to stimulate the interest in this subject is, therefore, a welcome development.

3. The question of the design of the industrial equipment so as to make the best use of the human and material resources available in the developing countries is indeed a very complex one. The subject is closely linked to the strategy of development, factor endowments, the choice of appropriate technologies, appropriate processes, etc. Any examination of

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1/ Report of the Working Group on Appropriate Technology, ACAST/XVII/CRP.4, 27 October 1972, page 3

2/ World Plan of Action, New York, 1971, page 3
Sales No. E.71.II.A.18.

the design of industrial equipment cannot be divorced from the much broader considerations of strategic priority setting, economic, social and environmental constraints and advantages of various technical considerations and, last but not least, from the experience gained in the course of time on the technical and economic viability of the various design concepts. This last point is mainly responsible for the very marked tendency that the design of most of the equipment depends largely on the imitation and cautious improvement of once proven design rather than taking advantage of the possibility to design equipment based mainly on the potentially useful techniques and innovations as they become available from the enormous R and D activities.

4. Considerable literature exists on the subject of appropriate technology, methodology for project evaluation and appraisal, problems in regard to transfer of technology, etc. However, very little literature deals with the problem at the macro-level, analysing the different aspects of structure of production in specific industrial branches. The material which does exist on the subject is not adequately co-ordinated and synthesized with the concepts, terminology and analytical tools developed at the macro-economic level.

5. The objective of this paper is to review briefly some of the published material as well as the unpublished reports of some experts who have advised various governments at their request on related questions of technology. It is hoped that such a review will assist ACAST to evolve the lines for further research and action, and will also provide a basis for the preparation of an overall global project, as indicated in the previous session of ACAST.

CHAPTER II

CHOICE OF APPROPRIATE TECHNOLOGIES

6. The problem encountered with regard to the choice of appropriate technologies has been comprehensively covered in a document entitled "Technologies appropriate for industrial development", 1/ prepared by ACAST. It is noted that the developing countries are faced with selecting industries and technologies in the light of the problems faced by them, namely, untapped natural resources, shortages of capital, and particularly of foreign exchange, lack of skills, including the serious problem of unemployment and under-employment. Although the choice between techniques requiring more or less capital and special skills per worker is not the only choice to be made in such a selection, it is considered, however, the most relevant in view of the rising pressure on unemployment. It is recognized, on the other hand, that while it is possible to meet the unemployment problem by selecting for development those industries with labour intensive technologies or industries in which different combinations of labour and capital intensity exist side by side, there exist cases in which technological alternatives are not available and where, if a particular industry is to be established at all, there remains no other choice than to adopt any technology even though it may be a capital intensive technology employing relatively little labour.

7. The report further indicates that there exists a spectrum of possible industries ranging at one extreme from industries in which there is no practicable or efficient alternative to the capital intensive technology used in developing countries to industries at the other extreme in which labour intensive technologies are prevalent. Between these two extremes, there are industries in which there exist a scope for choice among several different technologies, some of which are most suited to the conditions in developing countries. However, even in capital intensive industries there is often scope for utilizing ancillary processes which would not be economical in those developed countries which are facing labour shortages, but which may well be acceptable in developing countries because they provide not only more employment, but are also efficient in conditions ruling there. What is needed, therefore, is a proper selection of technologies with varying ratios of capital and special skills per worker in order to enhance the fuller utilization of the natural and financial resources available to each country as well as its economic and social development. The question of appropriate technologies which could be adopted in a given production process should also be viewed within the dynamic context of economic growth and social change. Such technologies will inevitably have to meet the requirements of given situations as well as their long-term perspective. 2/

1/ "Science and Technology in Relation to Industrial Development: Technologies appropriate for industrial development", E/4967, pages 4-5

2/ The role of industry as a generator of direct employment, although important, is not considered in this paper. It is clear that, if employment creation is to be the main objective then manufacturing industry does not afford a large scope for direct employment. On the other hand, indirect employment generated by industrialization is substantial. Furthermore, industry brings with it the capacity to innovate, to transform, to develop work habits, and to inject dynamism into the economy and society.

8. At the other end of the scale, the report points out the number of considerations which severely restrict the ability of the national planning authorities and other decision-makers of the developing countries to make a proper choice of technologies. These refer to contractual arrangements with private foreign companies, the organized efforts of equipment salesmen to sell the most expensive and labour-saving equipment, tied to purchases of capital equipment manufactured in a particular industrialized country under bilateral financial arrangements, etc. The decisions of the engineers and the plant managers, who consciously select and show preference are the most significant factor in the choice of appropriate industrial equipment and machinery in the developing countries. There are also instances of erection of overly ambitious plants, largely for prestige reasons, and out of proportion to the real needs and resources of the economy of the country concerned.

9. Thus there appears to be a dichotomy in regard to the approach used by the planners on the one hand and by the engineers on the other. There exists a need to bridge the gap between the two approaches that are prevalent in the selection of appropriate technologies for specific industrial branches.

10. Generally speaking, the macro-economic approach uses broad aggregate data which has been collected for other purposes than the specific aspects of the choice of appropriate technology. This data covers information on averages for industry or groups of enterprises in different countries for different time periods, different forms of industrial organization and other different characteristics. Comparisons are generally made on the basis of amount of capital per worker, value added, employment, value added per employee, by specific industrial branches in one country or in terms of developed or developing countries.

11. Another classification exists in terms of capital intensive industries, labour intensive industries, or alternatively, the modern sector, traditional sector, other manufacturing, etc. Conclusions are sometimes drawn as to industries where capital intensity is either required or inevitable and the available economic literature often presents broad general conclusions to the effect that consumer industries are generally labour intensive and the small industries are more so, etc. There exist also studies which are based on historical series in a given country and comparison of such data with other countries at different levels of development, and which indicate changes over a given period of time in terms of structure of industry and also the changes of the different components within it. The analysis inevitably is in highly aggregate terms and the data used in terms of broad averages. While an analysis of this type provides a broad picture of growth over a period of time, information on changes of importance of relative sectors, changes in factor proportions, etc., this may not be entirely appropriate for the understanding of the subject in question, namely design and use of equipment whose aim is to permit employment of larger numbers and to promote efficiency in production.

CHAPTER III

MACRO-ECONOMIC APPROACH TO CHOICE OF PRODUCTION TECHNIQUES

12. Industry is not only a dynamic sector of the economy, it is also the most complicated sector if one considers that the number of industries and manufactured products is considerable. The ISIC four digit classification identifies some 84 major manufacturing branches. Within a given industrial branch, production can perhaps be organized with different degrees of capital intensity. Production may often be organized on a large scale and in a highly automated way and alternatively in small industrial units using simple machines. There are also differences in the machines and machine capacities depending on the purpose for which and when they were designed. Furthermore, the technical and engineering developments are taking place at such a rapid rate that the assessment as to their application and use considering the different problems of the developing countries in mind also need to be undertaken.1/ Industry thus presents a kaleidoscopic picture which requires reasonably refined tools for analysis and adequate data, not mentioning the importance of the availability of trained personnel to make an assessment.

13. Probably the more practical approach in examining the problems of appropriate technologies and design of industrial equipment would be the macro-economic approach, consisting of detailed analysis by specific branches, making use of technological information on the alternative processes available. In order to reveal possible technological combinations to achieve a much higher degree of disaggregation, it is necessary to approach the question by industrial branches. This approach requires considerable resources as well as appropriate methodology. An effort is made here, therefore, to refer to some case studies, which may provide a basis for further work. The reference to these studies does not in any way imply the acceptance of the methodology, but only an indication of the type of work that could be undertaken, assuming the data were available.

14. A study which was conducted by the United States Department of Agriculture outlined six methods of material handling, providing the labour and equipment costs corresponding to each technique. According to the analysis given in table 1 below, some of the methods require not only more capital, but also more labour than others. It is evident that at any price of labour and capital, methods employed under A, B, C and E are more expensive than under F. For certain relative labour-capital prices, especially for relatively high labour costs, D may be cheaper than F, while for other price rations F will be cheaper. 2/

1/ Report of the Expert Group on Secondhand Equipment for Developing Countries, New York, 1966, Sales No. E.66.II.B.9

2/ "An analysis of some methods of loading delivery trucks of produce wholesalers", Marketing Research Report, No. 15, Washington, D.C., May 1952

TABLE 1 Data on six methods of loading delivery trucks of produce wholesalers (dollars per ton loaded)

Method	Cost of Loading one ton	
	Labour	Equipment
A. Low-lift platform trucks and dead skids for assembling and belt conveyors for loading	1.74	0.44
B. Two-wheel hand trucks, semi-live skids and jacks for assembly, belt conveyors for loading	1.46	0.12
C. Semi-live skids and jacks for assembly and elevating and horizontal belt conveyors for loading	2.02	0.18
D. Fork-lift trucks and pallets for assembly, belt conveyors for loading	1.19	0.31
E. Four-wheel hand trucks, fork-lift trucks and pallets for assembly, gravity conveyors and manual handling for loading	2.13	0.14
F. Four-wheel handtrucks for both assembly and loading	1.41	0.02

15. A case study prepared by the Netherlands Economic Institute and the Training and Research Foundation 1/ refers to the manufacture of certain parts by three alternative techniques involving use of three types of lathes: an engine lathe, a turret lathe and an automatic lathe. The machine parts are three simple workpieces machined out of bar steel, and produced in fixed proportions to each other. The study comes to the conclusion that two factors are particularly important for the economic choice of lathes: the number of types of different machine parts and the desired number of machine parts of each type per year. With a small production run, a general-purpose lathe will be cheaper as compared with a special purpose machine. With a large production run, special-purpose equipment will have lower production costs.

16. A study prepared by ECLA entitled "Choice of Technologies in Latin American Textile Industry", 2/ classified machinery into three broad groups relating to technology current in 1950, 1960 and 1965, as referred to in levels A, B and C respectively in table 2. The three levels were then applied in models of spinning mills containing about 15,000 spindles. The exact production capacity of each model was, however, determined by the size of the machinery available at the relevant level of technology, so as to produce conditions of optimum

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1/ "Alternative Techniques of Production" - A Case Study on Techniques of Lathing", Rotterdam, May 1957

2/ "Choice of Technologies in Latin American Textile Industry", 1966 (ST/ELCA/CONF.23/L.33)

balance. Since the object was to illustrate the effect of technology on cost, it was implicitly assumed that the full output could be sold in all cases. It was further assumed that a single type of cloth, of plain weave, would be produced. Table 2 provides information on the capital investment in each case, including pre-operational costs and working capital, plant capacity, output, numbers employed, cost and profitability.

TABLE 2 Data for integrated cotton mills in Latin America

	Level A	Level B	Level C
Capital investment ($1,000)	4,453.3	5,658.5	6,507.6
Number of spindles installed	13,600.0	15,200.0	14,800.0
Number of looms installed	534.0	530.0	524.0
Yarn output (tons p.a.)	2,265.0	2,643.0	2,895.0
Cloth output (1,000 metres)	16,800.0	19,600.0	21,500.0
Number employed	668.0	446.0	315.0
Cost of cloth ($ per 1000 metres) *)	176.0	156.0	149.0
Return on investment (percentage)**)	28.1	32.6	33.3

*) excluding any allowance for remuneration of the entrepreneurial skills exercised and the capital invested

**) gross margin before tax, assuming cloth is sold at $250 per 1000 metres. The return compares with an average interest rate for long-term credits of 12 per cent.

In setting up a mill, the entrepreneur will have to balance the difficulty of acquiring the larger amounts of capital required for levels B or C compared with level A against the reduction in costs which might be achieved; he may also be less confident that the domestic market could absorb the higher output obtainable in the latter two cases. In those cases where the government of a developing country is participating in the establishment of a mill, it may be anxious to secure employment opportunities; from this point of view level A clearly offers the greatest advantages. The ECLA report judged that level B was likely to be the most advantageous to Latin America, on a balance of considerations.

17. In a study prepared by the United Nations entitled "Capital Intensity in Heavy Engineering Construction" 1/ an analysis was undertaken of the costs involved in earth-moving operations by using different types of machines. Data of earthwork on reclamation projects, construction of hydro-power stations and road excavations in the United States and in Sweden were examined and compared with the requirements of the developing countries. The results indicated that in the excavation operations in the developing countries, the use of highly mechanized techniques is

1/ "Capital and Intensity in Heavy Engineering Construction", UN, Industrialization and Productivity, No. 1, pp 35-48, New York, April 1958

likely to result in unit costs of operations which are substantially higher than in the more advanced countries for similar levels of mechanization. The major factors contributing to this higher cost appear to be such elements as poor rate of utilization of equipment, over its lifetime and on the job, inadequate maintenance, costly repairs, etc. The results of this analysis also indicate that external economies are, at least in the particular industry under consideration, but probably also in many other industries, a key factor in determining the economic level of mechanization. It would also appear that the problem of the level of mechanization involves not so much a choice between alternative techniques of greater or lesser capital intensity as the proper selection of the capital itself. In other words, the problem of capital intensity raises qualitative as much as quantitative considerations. The study, in conclusion, called for a comprehensive and accurate cost recording of construction projects in order to provide reliable statistical data for further research.

18. The above-mentioned case studies serve to indicate that more research is needed in the examination of a combination of different factor proportions. Some broad outlines may be formulated to further research as follows: the available alternative methods of producing a number of well-defined goods are described in terms of required quantities of labour and capital. Subsequently an attempt will be undertaken by appropriate groupings to elicit the underlying factors which determine the possibilities of substitution. The data to be used could also relate to the nature of the product including quality output per unit of time, types and amount of labour involved, quantity of capital used including methods of evaluation, depreciation allowances, etc. The data required for such an analysis is difficult to obtain readily. Recourse has to be made to individual enterprises who often have to engage in comparative studies of different methods of production as well as to foreign subsidiaries and enterprises which in turn work with a large number of small sub-contracting independent firms.

CHAPTER IV

STUDIES AND RESEARCH UNDERTAKEN BY UNIDO

19. In order to provide some basic data on the structure of production in individual industrial enterprises, UNIDO has initiated action to compile data from selected countries, both developed and developing, in regard to industrial establishments that are actually in operation. The data has been published in the series entitled "Profiles of Manufacturing Establishments". The purpose of collecting and publishing this data is not to construct rigid theoretical norms in a pre-conceived framework, but rather to prepare a kind of reference material which would show the user the variety of possibilities, both technological and organizational that occur in actual industrial production operating in varying environmental conditions. The data contained in the profiles is intended to assist, not only in the preparation of economic feasibility studies, but also in the viability analysis both of pre-project and actual project contexts, including the type of analysis mentioned in some of the case studies above.1/

20. The data presented for a given industry contains information on fixed capital assets, inventories, labour, annual production, output, intermediate inputs, value added and expansion. It also contains information on selected coefficients such as equipment per employee in direct production, value added per employee, annual wage per employee in direct production, level of production at break even point, etc.

21. UNIDO has not attempted in depth the type of analysis mentioned in the case studies above. It is possible, however, that a research organization could continue the work of further collecting the available material and would also systematically develop an analytical framework for an examination of alternative techniques in industrial production.2/

22. UNIDO has published recently a study entitled "Guidelines for Project Evaluation" which provide yet another approach to the problem of choice in regard to industrial projects.3/ The approach contained in these guidelines involves a definite commitment to the simultaneous pursuit of more than one objective or dimension of welfare in project formulation and evaluation. The guidelines are based on the belief that the expansion of aggregate consumption and progress towards a more equal distribution are the accepted goals of development. Other dimensions of welfare are taken as instruments to achieve these goals: for example, employment is stated as a goal of development. To a great extent, however, the expansion of employment opportunities is simply a means to ensure a better distribution of income or the expansion of aggregate consumption. The methodology contained in the

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1/ "Profiles of Manufacturing Establishments", Volumes I and II, Sales No. E.67.IIb.17 and E.68.IIb.13.

2/ In the discussion during the November 1972 session of ACAST on the design of equipment, reference is made to the establishment of a research organization as a part of the global project on equipment design.

3/ "Guidelines for Project Evaluation", Sales No. E.72.IIb.11, New York, 1972

guidelines is thus sufficiently flexible to incorporate these and other distinct objectives inasmuch as it stresses the national profitability approach; it also offers a practical approach in defining the weights that are the quantitative expression of the relative importance attached to various objectives.

CHAPTER V

UNIDO'S PROGRAMME OF TECHNICAL ASSISTANCE FOR THE DEVELOPING COUNTRIES IN THE FIELD OF TRANSFER OF TECHNOLOGY AND EQUIPMENT UTILIZATION IN INDUSTRY

23. The General Assembly assigned to UNIDO, in resolution 2152 (XXI), certain specific functions with regard to the most effective adaptation of modern industrial methods of dissemination of information on technological product innovations, adaptation of existing technology and the development of new technology specially adapted to the particular physical, social and economic conditions of the developing countries. Within this framework, UNIDO has provided, during the five years of its existence, at the request of the developing countries, a number of experts to assist them in the planning, establishment and operation of different industries. At present, UNIDO has some 800 experts in the field, who are providing advice to a number of developing countries on industrial technology, industrial services and institutions, and industrial planning and programming. Of these, almost 60 per cent of UNIDO's programme of technical assistance is in the field of industrial technology, which comprises engineering industries, metallurgical industries, construction and building materials industries, chemical industries, fertilizer and petrochemical industries, light industries, etc.

24. The technical assistance programme of UNIDO in the field of engineering industries is mainly concentrated on the transfer of technology in the areas of agricultural engineering, mechanical engineering, electrical and electronic engineering and transportation equipment. The major objective of UNIDO in this area of work is to assist the developing countries to establish an effective utilization of manufacturing facilities and engineering services. In addition to promoting the manufacture of capital equipment and other engineering products, UNIDO is increasingly promoting repair and maintenance services in all fields of engineering. Another important activity is the promotion of local design capabilities, since a good design is fundamental and indispensable to the proper execution of any engineering project. Over a long term, local design capabilities are vital to the process of industrialization. In an effort to achieve these objectives, a wide range of technical assistance projects has been executed by the staff of UNIDO and its experts.

25. The pattern of requests which UNIDO has received from the developing countries over the past years for technical assistance to their metallurgical industries reflects three main objectives:

(a) the promotion of industrial utilization of promising resources of metallurgical raw materials;

(b) the creation and expansion of local production of needed metals; and

(c) the establishment of indigenous sources of metallurgical expertise so that problems related to metal production and application can be solved locally.

26. Although the requests received by UNIDO cover a variety of problems related to the production and application of metals, several priority areas have been identified, and to these UNIDO is directing its main efforts and resources, i.e. establishment of alumina and/or aluminium production facilities; smelting of ilmenite concentrates with production of pig iron and a slag rich in titanium oxide; copper, lead and zinc production; development of the iron and steel industry; establishment and improvement of foundry facilities, and creation and transfer of metallurgical know-how. The assistance provided by UNIDO in other industrial areas follows similar lines.

27. The technical assistance provided by UNIDO over the past years, as mentioned earlier, has been primarily directed at the request of the developing countries to the establishment and efficient operation of industries. The examples of assistance provided, particularly as related to industrial equipment and its design and maintenance, are contained in the table attached as Annex 2 to this paper. It provides merely a sample of the type of assistance provided by UNIDO rather than the totality of assistance, which is much broader in scope and in numbers. A detailed account of all the reports prepared by the different UNIDO experts working on the programme is contained in a series of documents entitled "Industrial Development Abstracts" (ID/SER.B/1-3).1/

1/ See also: Programme of Work of UNIDO for 1973, Report of Activities in 1971 and Updating of 1972 Programme, Part Three. ID/B/97 (Part III)

CHAPTER VI

ANALYSIS OF SELECTED REPORTS ON THE SUBJECT OF APPROPRIATE TECHNOLOGY AND SUCH OTHER SUBJECT PREPARED BY UNIDO'S TECHNICAL ASSISTANCE EXPERTS

28. The reports prepared at the conclusion of their assignments by some of UNIDO's experts on their experiences on advising the developing countries provide an interesting account of the cross section of viewpoints on the subject of choice of techniques, appropriate technologies and instances of where mechanization is needed and where it is not, so as to indicate the future requirements of the developing countries in these areas. While it would require a massive research effort to go through all these reports in order to collate and to analyse the information therein in a systematic way, it might nevertheless be pertinent to refer to a cross section of views contained in the reports of these experts. The information summarised below is based on a review of a cross section of opinions expressed in the reports of a number of UNIDO technical assistance experts.

29. In these reports, abundant reference is made to the adoption of both labour intensive and capital intensive industries. The arguments presented, however, follow broad aggregative lines, suggesting policy orientation rather than how this could be achieved. The advocates of labour intensive policies base their recommendations on social and economic grounds, namely the provision of employment and distribution of income. Reference is also made in these reports to the development of numerous decentralized small-scale, labour intensive industries of exceptional efficiency which allow for a relatively low degree of mechanization. The establishment of small-scale labour intensive industries, it is argued, would not give rise to an undesirable increase in urban population and a concomitant rise in social overhead expenses. The advocates of capital intensive policies argue that no country has ever succeeded in solving its economic problems by favouring low efficiency. It is suggested that it is necessary to achieve higher and continuously increasing labour productivity in order to bring about a cumulative process of increased production, national income, savings and investment. As a result of its higher productivity, industrialization along capital intensive lines will yield a larger surplus of products over consumption, which in turn will be available for capital formation and in the long run lead to higher employment.

30. It is also argued that a developing country could have both types of industries, namely capital intensive and labour intensive, and that the degree of mechanization or the capital intensity would be determined by the markets to which the products are destined. In order to promote exports of manufactures to the developing countries, one cannot but establish large-scale efficient units of production while, at the same time, taking advantage of the low wage rates, so as to enable them to compete in the external markets. The industries supplying the domestic market could use more labour intensive methods, and it is also suggested that rural industries be encouraged so as to support the local demand and to permit better distribution of incomes.

31. Some of the UNIDO technicians and engineers working in specific branches of industrial production bring out the fact that even the larger-scale industries, using up-to-date methods of production, tend to employ more labour than similar units in the developing countries. For example, it is stated that in a fertilizer plant in the United States, with 70,000 tons of nitrogenous capacity producing urea and ammonium sulphate, less than 500 technical and other personnel are employed. On the other hand, in a plant of a similar capacity in India, manufacturing similar products, the number of technical and other personnel employed varies from 1,138 in one to 1,947 in another plant. The ratio of the engineers to non-engineers is also sharply different in plants with similar capacity and product mix in the developed and developing countries. While many experts continue to advocate the reduction of the number of the personnel required for the sake of efficiency, it is also clear that much of the variations in the numbers employed will depend on the mechanization after the ammonia synthesis. Apart from the cost of the equipment which varies from 35 per cent to 50 per cent of the total project costs depending on the industry, there exists the whole range of operations in materials handling and administrative operations, which are mechanized in the industrialized countries, but need not be so in the developing countries.

32. In the field of processing industries, this factor is quite pronounced in the sense that the basic material such as PVC or other similar products involve sophisticated technology and equipment, involving low labour requirements. The fabrication of plastics into finished articles, for instance, is highly labour intensive and does not require high skill. The main areas permitting employment of high proportion of labour with certain degrees of skills are in the fields of repair and maintenance of equipment, finishing processes, quality control and inspection, packaging, components assembly, etc. Examples of these areas are given by one expert as follows:

1. Glass reinforced plastics (unsaturated polyesters) for fishing boats, furniture, containers using the hand-lay up technique;

2. PVC for artificial flowers;

3. Various thermoplastics (PVC, polyethylene, polystyrene) for toys and souvenirs;

4. Plastics components for building and construction (waterpipes, hardware, profiles, window frames, floor covering, roofing, insulation foams), all of which require considerable labour for assembly purpose;

5. Synthetic fibre for textile use, artificial leather, plastic clothing and footwear;

6. Paints, varnishes and plastic glues;

7. Assembling and packaging of electrical and household goods using plastic components.

33. The current trend is, therefore, for investors to set up plastics fabrication plants in some developing countries, taking advantage of the relatively cheap labour and then export the finished products. For example, Hong Kong with over 3,500 plastics fabrication plants, exported in 1971 US$270 million of finished plastics goods. Singapore, Thailand and the Republic of Korea are following the same pattern.

34. Another expert in examining the considerations of machinery design in metal-working industries suggested that the gradual transition from adopting universal machines to automatic machines should be as follows: universal machines, machines for batch production, sequence controlled machines, automatic machines. The universal machines which are most frequently used in factories combine precision, versatility and relatively low price. This machine is well suited for a large variety of jobs and provides "every possible concession to the operator". The most popular example of the universal lathe is the regular type of engine lathe which permits the use of skill and ability in determining the accuracy of the work pieces as well as the life and precision of the machine. In providing designs for machines for batch production, it is indicated that the machine could be composed of pre-fabricated units. In this way, a factory with a relatively small number of machines could adapt itself to a new series of parts in a short time. The same expert also makes reference to the design of other types of machines which are suitable for the developing countries. The overall conclusion drawn is that the question of suitable machine tools for a developing country should be answered individually for each case, taking into consideration not only the employment facotrs, but also skill levels.

CHAPTER VII

INFORMATION SERVICE OF UNIDO ON APPROPRIATE CHOICE OF EQUIPMENT (ACE)

35. UNIDO has, for some years, been operating an industrial enquiry service for the benefit of the developing countries. During 1971 alone, some 2,000 enquiries were received from 61 developing countries, of which 520 referred to the provision of information on different aspects of transfer of technology and know-how, advice on machinery and industrial equipment. In 1972, UNIDO received some 2,500 enquiries of which a quarter referred to the areas mentioned above. Most of the enquiries were made from the governmental organizations, productivity centres, development banks, etc. The enquiries received from private enterprises were relatively few. A large number of requests came from a few countries only, namely Brazil, Chile, India, Mexico, Philippines and Turkey, which are also relatively more industrially advanced than the other developing countries. Most of the enquiries in the field of equipment were for names and addresses of firms manufacturing equipment, specifications and price, etc. There were no enquiries strictly in the field of design of equipment or enquiries related to the choice of equipment permitting larger employment of labour resources.

36. Within the framework of the enquiry service, UNIDO has initiated on a pilot basis in January 1972 an information service on supply and alternatives for the choice of industrial equipment. The need for such a service arose out of a recommendation made by a group of experts convened by UNIDO in 1967. It was suggested that this service should cover all aspects of supply including technical, economic and financial information, as well as on sources of supply of industrial equipment. Such a service should also survey conditions pertaining to the purchase and use of industrial equipment and maintain a close watch on prices.

37. In 1971, the Advisory Committee on the Application of Science and Technology to developing countries took up the matter again and proposed in a report to ECOSOC to:

> "promote action on an expanded information system designed particularly to improve the flow of more appropriate industrial technologies to the developing countries: (a) assist in the establishment of technology information activities in both the developing and the industrialized countries. (b) further develop and implement as soon as practically possible UNIDO's proposal for the establishment of an international equipment specification service operating in co-operation with the developing and industrialized countries".1/

1/ Document E/4967, 17 March 1971, page 35

38. In resolution 1636, adopted on 30 July 1971, ECOSOC recommended that a number of international organizations including UNIDO should study, in close co-operation, ways in which reliable information - including relevant data on the requirements for capital, labour, raw materials and other factors of production - on known alternative technologies for selected major industries of interest to developing countries could best be furnished in a systematic way to Governments, enterprises and industrial consultants.1/

39. The interest in, and the need for, an equipment information service is enormous. This service when effectively undertaken may produce a practical solution to many questions connected with the problems of transfer of technology and the choice of appropriate technologies for the developing countries. Details on the progress made in this project are included in UNIDO's programme of work2/ and in two interim reports which have been distributed. The Appropriate Choice of Equipment service will provide major assistance to the developing countries in enabling them to make their own decisions as to the most appropriate equipment and technology to be introduced in their industries. In addition, the service will also establish a basis for the dissemination of information on suppliers of industrial equipment from developing countries so that their products may become known to other developing countries and to the traditional markets. With the growing problem of unemployment and the need to find capital saving technologies, the service to be provided by the Appropriate Choice of Equipment Service will become of added importance.

40. Initially it is intended by UNIDO to take up only a limited number of industrial branches such as textiles, leather, woodworking, metal-working, repair and maintenance shops and construction industry. In view of the manifold difficulties inherent in the operation of the project, particularly related to the alternative choice of equipment with employment considerations, etc., the ACE project in the initial phase will be limited to provision of information relating to suppliers, specifications, price, etc. Also a limited number of supplier countries will be asked to participate and equipment data will be collected and processed only in a few selected subject fields so that the flow of information can be controlled and the procedures and results properly evaluated.

41. A beginning has been made by UNIDO following a contribution made to this project by the Government of Japan and promise of co-operation has been received from a number of developing countries both as donors and recipients to this service. It is hoped that more resources will become available to this project, not only through contributions made by Governments, but also, hopefully, through a global project which ACAST wishes to formulate on the subject of design of industrial equipment suitable for the developing countries.

1/ Economic and Social Council resolution 1636 (LI), paragraph 4

2/ Document ID/B/97 (Part II), Add.1, paragraphs 193-197

ANNEX 1

SELECTED BIBLIOGRAPHY

1. Industrialization and Productivity Bulletin; United Nations, Nos. 1, 2, 3 and 6:

   - Capital Intensity in Underdeveloped Countries, Bulletin No. 1
   - Choice of Technology in Industrial Planning, Bulletin No. 1
   - Capital Intensity in Heavy Engineering Construction, Bulletin No. 1
   - Problems of Size of Plant in Industry in Underdeveloped Countries, Bulletin No. 2
   - Capital Intensity and Costs in Earth-Moving Operations, Bulletin No. 3
   - Choice of Industrial Technology: The Case of Wood-working, Bulletin No. 3
   - Choice of Techniques, Bulletin No. 4
   - Adaptation of Processes, Equipment and Products, Bulletin No. 6

2. Technologies Appropriate for Industrial Development; United Nations, E/4967 of 17 March 1971.

3. Report of Expert Group on Second-hand Equipment for Developing Countries; United Nations, Sales No. 66.II.B.9.

4. Manufacture of Industrial Machinery and Equipment in Developing Countries; United Nations, E/C.5.43 of 21 January 1964.

5. Creation of Transfer of Metallurgical Know-how: Report of the Workshop held by UNIDO from 7 to 11 December 1971, ID/103

6. Profiles of Manufacturing Establishments; Volumes I and II, United Nations, Sales Nos. E.67.II.B.17 and E.68.II.B.13.

7. Guidelines for Project Evaluation; UNIDO, Project Formulation and Evaluation Series No. 2, United Nations New York 1972, Sales No. E.72.II.B.11

8. Industrial Development Survey, Volumes 1-4, Chapters III and IV dealing with manpower aspects of industrialization; United Nations, Sales No. E.68.II.B.18.

9. Planning for Advanced Skills and Technologies; UNIDO Industrial Planning and Programming Series No. 3, United Nations, Sales No. E.69.II.B.8.

10. Guidelines for the study of the transfer of technology to developing countries; United Nations New York 1972, Sales No. TD/B/AC.11/9.

11. Major Issues Arising from the Transfer of Technology to Developing Countries; TD/B/AC.11/10 of 18 December 1972.

12. World Plan of Action for the Application of Science and Technology to Development; United Nations New York 1971, Sales No. E.71.II.A.18.

13. New Dimensions and Opportunities in the Application of Science and Technology to Development and the Role of the United Nations Family; E/5238/Add.1 of 26 January 1973.

14. Development of Metal Working Industries in Developing Countries; United Nations New York 1969, Sales No. E.69.II.B.2.

15. Planning and Programming of the Metal Working Industries with a Special View to Exports; United Nations 1972, Sales No. E.72.II.B.7.

16. Report of the Inter-regional Seminar on Industrial Location and Regional Development; United Nations New York 1969, Sales No. E.69.II.B.22.

17. Report of the Expert Group Meeting on the Selection of Textile Machinery in the Cotton Industry; UNIDO, Vienna 1968, ID/WG.8/1.

18. Processing Problems and Selection of Machinery in the Woollen and Worsted Industry; United Nations New York 1970, Sales No. E.70.II.B.12.

19. Bicycles: A Case Study of Indian Experience; UNIDO Small-Scale Manufacturing Studies No. 1, United Nations New York 1969, Sales No. E.69.II.B.30.

20. Fertilizer Manual; United Nations New York 1968, Sales No. 67.II.B.1.

21. Fertilizer Production, Technology and Use; United Nations New York 1968, Sales No. E.68.II.B.1

22. UNIDO Monographs on Industrialization of the Developing Countries: Problems and Prospects;

- Non-ferrous Metals Industry
- Construction Industry
- Building Materials Industry
- Engineering Industry
- Iron and Steel Industry
- Fertilizer Industry
- Textile Industry
- Chemical Industry
- Food Processing Industry

23. International Seminar on Technology Transfer (seminar papers) organized by UNIDO and the Council of Scientific and Industrial Research of the Government of India, New Delhi, from 11 to 13 December 1972.

24. UNIDO Abstracts.

ANNEX 2

SELECTED LIST OF UNIDO PROJECTS OF ASSISTANCE TO THE DEVELOPING COUNTRIES IN INDUSTRIAL MACHINERY AND EQUIPMENT
(in thousands of US dollars)

AFRICA		1972	1973
Algeria (ALG/69/12) TA	Maintenance and repair of industrial equipment	15.0	
Cameroon (CMR-19) SF	Pilot programme in maintenance and repair	108.7	76.0
Egypt (UAR-55) SF	Engineering and industrial design	Duration: 5 years Operational: 1968 UNDP: $1,035,100 Government: $1,224,000	
Senegal VC/1/18 GTF	Central pilot workshop for general repair and maintenance (equipment)	35.0	
Tunisia (TUN-27) SF	Centre for the development of prototype tools, Sousse	Duration: 4 years Operational: 1971 UNDP. $681,600 Government: $746,000	
Zaire (CON(K)34) SF	Central services for maintenance and repair of industrial equipment	Duration: 2½ years Approved: January 1970 UNDP: $191,300 Government: $ 55,000	

AMERICAS		1972	1973
Brazil (BRA/69/19) TA	Assistance to National Design Centre in research and design of machine tools	15.0	
Columbia (COL/71/5) IPF	Maintenance and repair of transport equipment	30.0	77.0
Jamaica (JAM-14) SF	Repair and maintenance training and demonstration unit	109.8 Approved: June 1971 Duration: 3 years UNDP: $468,900 Government: $353,000	178.9
Regional 70/984 LAL-8 SIS	Assistance to the Junta of the Andean Integration Group in textile engineering, non-ferrous metallurgy, machine tool production and mechanical equipment fabrication	14.0	

ASIA AND THE FAR EAST		1972	1973
India (IND-67) SF	Design Centre for electrical measuring instruments	251.2 Operational: April 1969 Duration: 5 years UNDP: $833,000 Government: $739,000	77.4
India (IND/01/2/1) RP	Industrial design (followship)	3.4	
Malaysia (MAL/68/6) IPF	Assistance in foundry, tool, dye and mould making		(34.5) Beyond 1973 (1,750.5)
Nepal (71/1305 NEP-8) SIS	Design, production and marketing of agricultural machinery and implements (1/6 m/m expert services)	12.0	
Pakistan (PAK/01/2/3) RP	Mechanical industries	5.8	
Korea (KOR/69/16) TA	Manufacture of knitting machines	3.7	
Thailand (71/1163 THA-27) SIS	Manufacture of small internal combustion engines (consulting firm)	26.0	

EUROPE AND THE MIDDLE EAST				1972	1973
Bulgaria (BUL-3) SF and IPF	Research Institute for Instrument Design				
	Phase I:	UNDP:	$298,000	93.0	73.7
		Government:	$550,000		
	Phase II:	UNDP:	$605,000	(100.0)	305.0
		Government:	$485,000		Beyond 1973 200.0
	Approved: January 1971 Duration. 1½ years				
Hungary (HUN/14(1)1) IPF	Development of machinery production engineering			14.0	14.9
Romania (70/770 ROM-9) SIS	Design of and research in diesel engines for industrial, railway and naval use			14.0	

PROGRAMMED

Kenya IPF	Engineering design development centre ($896,000)
Chile IPF	Assistance in the planning of a design and consulting centre (PAG) ($7,500)
Jamaica IPF	Assistance to Toolmakers Institute ($175,000)
India IPF	Electric drives laboratory ($39,400)
Israel IPF	Centre for testing, adaptation and design of farm machinery ($40,000, fellowship and equipment)

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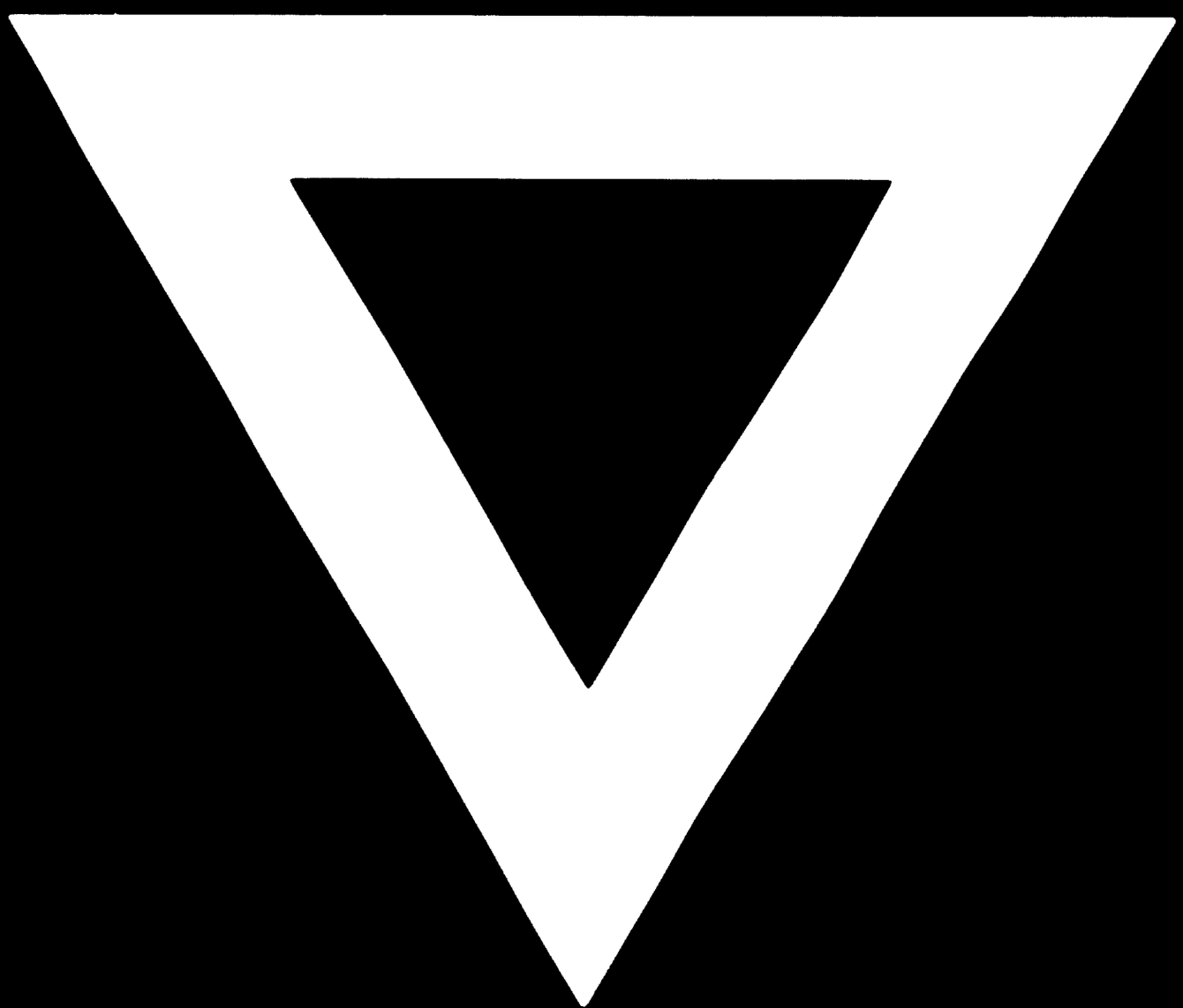

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