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CATEGORIES OF TECHNICAL KNOW-HOW IN INDUSTRIAL DEVELOPMENT

(The Transfer of Technology in the Industrial Development of Brazil -  
General Aspects of the Problem; Chapter II of ECLA document  
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## Chapter II

## CATEGORIES OF TECHNICAL KNOW-HOW IN INDUSTRIAL DEVELOPMENT

The terms technical knowledge, technology, or technical know-how are used interchangeably in this paper since it is considered that they all describe the same concept, namely the sum of applied or technical scientific knowledge that is required to establish a given industrial activity and maintain it in operation.

The inclusion in this basic category of know-how relating to economic or administrative techniques concerning the internal organization of the enterprise, side by side with engineering know-how and know-how falling in the general sphere of the exact or the experimental sciences, is to a large extent arbitrary and depends on the initial definition adopted. The proper organization and management of the enterprise in economic and financial matters and in other aspects not directly related to production engineering are, of course, of great importance to industrial development, and in some sectors of industry, such as those that have been in existence for some time in Brazil (textiles, processing of foodstuffs and other consumer goods), these factors are of paramount importance - more important even than purely technical matters relating to production processes and equipment.<sup>1/</sup> Nevertheless, such non-technological (in the strict sense) know-how does not raise the same problems with respect to transfer from abroad; as a general rule it is not subject to licensing agreements or similar arrangements between enterprises, nor does it have the same type of relationships with over-all economic policy as technical know-how proper. Accordingly, it was decided in this paper to exclude techniques relating to administrative, economic and financial organization from the systematic analysis of the issue, although many references are made to them, in passing.

The technical know-how required for industrial development can be classified into a number of general categories according to whether it relates to feasibility studies, preparation of projects (i.e. investment plans of individual establishments)

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<sup>1/</sup> See The textile industry in Latin America. II. Brazil (United Nations publication, Sales No. 64.II.G.2), and ECLA, "Algunos comentarios sobre los problemas relativos a la productividad en la industria latinoamericana" (ST/ECLA/Conf.14/L.2; LAMP-62/2) which stresses the importance of organizational aspects in industrial promotion measures.

basic manufacturing processes, product design, construction of plant installations, and operation of industrial plants.<sup>2/</sup>

Each of these categories can obviously be subdivided into other more specific categories in accordance with the characteristics of the branch of industry considered and the purposes of the analysis. In the present study, it is considered appropriate to examine individual types of know-how separately whenever the method of transference from abroad and the concomitant problems have features that are worthy of special mention.<sup>3/</sup>

2/ Manuals and other documents relating to the preparation and evaluation of projects usually contain an analysis of the know-how needed for industrial development. The following are particularly useful in this respect: ECLA, Manual on economic development projects (United Nations publication, Sales No. 58.II.G.5); OECD, Manual of Industrial Project Analysis in Developing Countries (Paris, 1968), particularly the introductory chapters in volume I; ILPES, "Notas sobre la formulación de proyectos" (Santiago, Chile, 1970); Fernando Caldas and Felix Pando, Proyectos industriales (Quito); Banco do Nordeste do Brasil, Manual de localização industrial (Fortaleza); certain monographs presented at the United Nations Seminar on Industrial Projects (Prague, 1965); UNIDO, "Manual on the use of consultants in developing countries" (New York, 1960). The study prepared for ECLA by Eros Orosco, "Conocimiento técnico necesario para la industrialización de países poco desarrollados y obstáculos que se oponen a su transferencia" (ST/ECLA/Conf.23/L.12, Santiago, 1965), is worthy of note because it was one of the first studies in this field.

3/ It should be remembered, however, that any classification of this kind is inevitably arbitrary and is also influenced decisively by the specific objectives of the analysis. This latter fact is clearly evident in the three sectoral monographs which complete this series of papers on the transfer of technology in the industrial development of Brazil. While the studies on the textile and steel industries follow almost to the letter the categories given in the present paper, the study on the machine-tools industry differs appreciably (at least on the surface) from the classification not only because it covers administrative know-how, but also because it explicitly includes additional categories that do not occur in the other studies. This is attributable to the fact that the study on machine tools devoted greater attention to local know-how, which it considered a feasible and essential factor. The more comprehensive approach taken thus forms a backdrop against which the specific problems of the transfer of know-how from abroad must be viewed. A similar situation occurs to some extent with respect to the steel industry, but not with respect to the textile industry or the chemical industries.

The technical know-how required to establish an industry, as analysed in the present study, hence corresponds to the categories described briefly below, which are used as a basis for the examination, in the chapters that follow, of the mechanisms for transferring know-how. Brief attention is also given to personnel training, which is often a factor of great importance in establishing a new industrial activity or introducing new processes into existing plant.

### 1. Feasibility analysis

This category covers the technical know-how required for undertaking a preliminary analysis of the economic and technical feasibility of a given industrial enterprise. The analysis usually includes studies on the productive resources to be used, the demand and geographical coverage of the markets to be satisfied by the enterprise, manufacturing techniques, investments and costs - both unit and total - corresponding to different scales of production, etc.

At this stage, the analysis generally concentrates on economic and financial aspects, which are of key importance in determining the profitability of the enterprise, rather than on technical issues, which are generally estimated in an approximate manner on the basis of general technical data that have not been prepared specifically for the enterprise concerned.<sup>4/</sup> In the light of the conclusions drawn from the feasibility analysis, the decision whether or not to initiate a complete investment project is taken. If this decision is favourable it necessitates studies of processes, raw materials (in some cases including special detailed prospecting), alternative sites, and equipment (which very often has to be specially manufactured). These studies are very expensive and are only of any use if the enterprise is actually set up.

<sup>4/</sup> Such general technical data can be classified normally into two categories: real data obtained from statistical observation of existing industries (an effort being made to ensure that they are as typical as possible), and theoretical data or industrial profiles, normally obtained from simplified engineering studies and generally consisting of physical unit coefficients that can easily be converted to the monetary values of the country concerned. Information of the first type can be obtained, for example, from the UNIDO document, Manufacturing establishments, while information of the second type can be found in the profiles included in the annex to OECD, Manual of Industrial Project Analysis in Developing Countries, and in the many studies prepared by the Industrial Development Division of ECLA on the steel, chemicals, pulp and paper, copper manufactures, aluminium refining and processing, machine-tools, boiler-making, steel tubes and cotton textiles industries. All these studies, which it would take too much space to list here, are based on engineering estimates and not on statistical data or information obtained from existing industries.

Current practices as regards feasibility studies and pre-investment analysis in the textile industry are typical of many sectors of industry in which the technology used is fairly simple, such as food processing and the processing of wood and other natural raw materials.

It is now very rare in Brazil for a large or medium-scale textile plant to be set up without a project first being formulated to analyse the technical and economic feasibility of the enterprise and define its basic technical, economic, financial and organizational structure. Virtually all the financing agencies require a feasibility study, which is prepared by firms of consultants or firms specializing in studies and projects of which there are now many in Brazil. Many of these firms are not specialists in the textile or clothing industries - or in any of the other industries mentioned - but they enlist the temporary assistance of one or more technicians who have specialized knowledge of the industry concerned. However, when a new plant is to be set up by an existing industrial group simply for the purpose of diversifying its production, the entrepreneur himself undertakes the necessary preliminary studies and takes all the decisions on the preliminary alternatives on which the final form of the project depends. In such cases the group must have a team of specialists covering a wide range of professional skills and capable of compiling and evaluating all the data, as well as of evaluating all the alternatives as regards location, selection of projects and equipment, scale of plant, etc. Even so, however, when the group wishes to seek financing or to qualify for fiscal exemptions or other development incentives - which is very often the case - it is also necessary, even with new plants belonging to industrial groups already in operation, to have a firm of consultants prepare a feasibility study. The firms of consultants used are usually Brazilian when the plans are for the establishment of new textile and clothing plants or plants producing other traditional consumer goods. Some of these firms have entered into assistance agreements with foreign firms that have a greater fund of experience, and this has enabled them to strengthen local capacity for advisory assistance and consultancy. It is, however, unusual for the textile or clothing industry to have to resort at the feasibility or pre-investment study stage to outside assistance in the form of more specialized know-how.

The above does not apply to the small isolated spinning or weaving mills which are still managing to survive despite difficulties. These are mostly small weaving mills producing short runs of a number of special items that it would not be feasible to produce in large plants even if they were very efficiently organized. There are also small spinning mills producing thick yarn for sale in small quantities to artisan-type weavers or for use in the production of cord and rope. These small enterprises usually begin by using second-hand equipment and the basis for their operations is the practical experience accumulated by the entrepreneur himself during many years of work in the textile industry as an employee. As might be expected, firms of this type use rather outmoded techniques and completely depreciated equipment, which is in line with their objective of covering those parts of the market that are of no interest to the large plants.<sup>5/</sup>

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<sup>5/</sup> ECLA, "The transfer of technical know-how in the textile and clothing industries in Brazil" (E/CN.12/919), September 1971.

The most striking examples of these small enterprises are to be found in the textile industry in the Americana region of the state of São Paulo, which will be examined in detail in a later section. They are generally set up and expanded without any study being made of their technical or economic feasibility. The credit institutions either do not provide them with credit or, in the rare event that they do, they reduce their requirements regarding studies to a small amount of background information, mainly of a financial nature. Mention may be made in this connexion of an innovation which has been introduced by the Development Bank of the state of São Paulo and which consists of offering small plants substantial assistance in the preparation of the feasibility study on which the project is to be based. Indeed, in the case of the small-scale textile industry in the Americana region, the bank even goes so far as to consider the possibility of covering the cost of project preparation by private consultants working under the supervision of the Productivity Centre established by the bank in Campinas.

## 2. Project preparation

The preparation of a complete project should cover, in addition to a more detailed and thorough review of many of the points considered in the feasibility study (demand, resources, transport, location, etc.), two main issues: selection of production techniques and equipment, and the design of the production installations as a whole.

This first issue generally does not involve the type of technical know-how which certain firms<sup>6/</sup> specialize in developing and marketing, especially for the continuous-process industries (chemicals, pulp, certain processed foodstuffs, etc.). In some industries, however (especially those using discontinuous processes), the selection of production techniques and processes is not separate from the design of plant installations and the specification of equipment, and such enterprises select the production processes when planning new plant.

### (a) Selection of production processes

The selection of processes, either as a separate operation or as an integral part of the general engineering planning operations, is a key element in the proper preparation of an industrial project. Moreover, the importance of this aspect of plant installation is not confined to such manufacturing activities as the chemicals, petrochemical, metallurgical, metal-transforming and electrical machinery industries which, because they are going through a period of rapid technological change, offer a wide and varied range of options. In other sectors of industry, too, even though they may be subject

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<sup>6/</sup> Frequently, the development and the marketing of such know-how are carried out by different firms which specialize in only one of these two aspects of technological development.

to less rapid change, a number of options are likewise available, and this raises the problem of selecting the right production process. The study in the present series covering the textile industry states the following in this connexion:

"There are many options open to the textile industry today as regards the choice of the production process to be included in the final project. Many new processes for combining synthetic and natural fibres have been patented. There are various new production techniques for producing similar articles or substitutes: woven or knitted fabrics, circular or longitudinal machines, non-woven fabrics, textured and non-textured yarns, etc." 7/

The fact that a technique has been selected does not always mean that the problem of selecting equipment has therefore automatically been solved. In the continuous-process industries, such as the chemicals industries, once a given process has been chosen this almost always determines the choice of equipment. But in the industries using discontinuous processes such as the metal-transforming and textiles industries, for example, very different equipment can be used to apply the same process, so that it is the practice, after the production processes and techniques have been selected, to call in mechanical engineering experts to indicate which equipment should be used and, if necessary, to design equipment (as for example in industries using equipment made to special order) 8/.

(b) Product design

Product design, particularly when protected by registered trade marks or manufacturing licences, is a key aspect of the know-how that has to be acquired before setting up new industrial activities. This is true for most metal-transforming activities particularly when the product has sophisticated characteristics. In such cases, authorization to use the design is accompanied by detailed manufacturing specifications including an indication of the appropriate machinery and equipment.

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7/ ECLA, E/CN.12/919, op cit.

8/ It should be noted that the alternative technologies available to the continuous-process industries generally cover physical or chemical processes and are normally associated with the use of different raw materials. In the industries using discontinuous processes, however, they cover the production equipment and the successive stages of automation of equipment, which is usually a function of the degree of specialization of such equipment. Furthermore, as the flexibility of the available technological options varies in each case, the selection can only be effected on the basis of an economic analysis of costs and investment.

In recent years, product design has become a more and more important factor and has to satisfy requirements that are often at variance with the fact that design know-how is of foreign origin. Thus, export promotion policy increases the need for originality in product design, while, it has been found in practice that modifications made to simplify product design in order to cut manufacturing costs have sometimes been of decisive importance.

(c) Design of industrial plant

The plan for the production facilities as a whole includes the detailed design of the factory and hence covers civil engineering, siting of machinery and equipment, establishment of flow patterns for the movement of materials, and design of ancillary installations (electric power, water, steam, transport links, etc.).

Another important aspect, directly related to production equipment, which is sometimes included in project preparation and sometimes dealt with separately concerns the selection of suppliers, the placing of orders, and the inspection and control of deliveries.

The project for an industrial plant is frequently more than just an enumeration of the various types of special know-how mentioned (civil engineering and building, ancillary services, siting of machinery and equipment, establishment of flow patterns for the movement of materials and products, etc.) in which each in isolation is not of great importance and is almost always entrusted to a subcontractor. Taken together, these aspects represent a specific and very important form of technical know-how, namely, the over-all scaling and proper balancing of the different categories of operations making up the industrial activity, and this technical know-how is usually the explicit complement of the design of the industrial facilities.

3. Construction of the factory

The construction of a factory is not a simple task of civil engineering, since it also includes the installation of equipment and the solution of a great many problems regarding size and internal balance which are vitally important if it is to operate efficiently. Such problems, as for example those found in the steel industry which are examined in detail in a separate study,<sup>2/</sup> arise only in the construction stage and cannot be foreseen during the preparation of the project.

In other words, in large-scale enterprises (particularly primary metallurgy, both ferrous and non-ferrous, and petrochemicals) this stage of construction and assembly, which strictly speaking forms part of the project, in practice represents an extension of the preparation and, more especially, the review of the project. This is because in highly complex projects of this kind it is virtually impossible to reach such a degree of detail as to be able to foresee all the problems and difficulties that may arise in the construction stage. Thus the project is gradually adapted during this stage, as progress is made in its practical execution.

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<sup>2/</sup> See "The transfer of technical know-how in the steel industry in Brazil", op cit.



The problems which tend to arise in the case of steelmaking are connected with adjustments to the general layout of the installations, the balance between all the internal flows of materials, products and power,<sup>10/</sup> and the synchronizing of the completion of the various production installations and their entry into operation.

For this reason, when large plants are built it is quite usual to contract for the general supervision of the construction separately from the physical construction, as an extension of the stage represented by the final project.

However, it is not only in highly capital-intensive industries that problems arise during the construction of the installations. Here again, the textile industry can be taken as representative of a wide range of activities of simple or only moderately complex technology. The technical know-how used in this branch of industry is almost exclusively of local origin, both as regards plant design - which includes civil engineering, auxiliary installations and the layout of equipment - and actual construction. This know-how is contributed partly by the local entrepreneur (who instructs the specialized companies responsible for the design and construction regarding the characteristics of the architectural project and the industrial activity to be installed) and partly by civil engineering and industrial assembly enterprises, which are nearly always Brazilian. However, there are two instances in the design and construction of a plant where technical know-how is still imported from abroad. The first relates to the advisory assistance required by the architect-engineer responsible for preparing the plans in regard to the movement of personnel; the internal transport of materials and finished products; ventilation, temperature, humidity and lighting conditions in the various sections; minimum free space, and many other kinds of information which come within the competence of a textile specialist and which can be provided only by firms with wide experience in the matter.

Since advisory services of this kind are still somewhat inadequate in Brazil, these services are sometimes contracted abroad, either through a technical assistance agreement with a firm of textile consultants or through the direct recruitment by the local entrepreneur of a highly qualified technical expert for a limited period.

The second instance relates to a vital part of the construction of a plant, i.e., the assembly and adjustment of the equipment.

"The assembly and adjustment of equipment is always the responsibility of the specialized staff of the machine manufacturer, who charges separately for their services. Here there is a substantial transfer of know-how from those who are installing the plant to the local staff who help them to do it. If the local staff have been selected well,

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<sup>10/</sup> It is particularly difficult to achieve this theoretical balance in the project stage and it is even difficult in the construction stage, since the various types of equipment have different characteristics with regard to performance which cannot be known in detail until after the specifications are issued, the bids called for and approved, the manufacturers known, and precise and detailed information regarding the relevant performance obtained. Moreover, the actual performance always differs to a greater or lesser degree from the rated performance (Ibid.).

they will accumulate a detailed knowledge of the construction and operation of the machines during assembly which will be valuable for subsequent adjustment and maintenance. Neglect of this opportunity for training staff, which does not involve any extra cost, has led to serious losses for many factories, whose machines often break down or lose their efficiency owing to faulty adjustments".<sup>11/</sup>

In other sectors of industry - especially in small- and medium-scale enterprises -- problems arise owing to technical faults in the stage of the construction of the plant and the installation of the equipment. These problems could be solved in part if the analysis of projects by financing agencies were not confined to financial aspects but included a detailed appraisal of the technological aspects of the enterprises. Such a procedure, which would gradually result in the provision of a certain amount of technical assistance by financing and development promotion agencies, would be especially useful in those branches of industry in which many small- and medium-scale plants still exist. The pulp and paper industry is a case in point. The lack of technical assistance is felt in small plants right from the stage of assembling the equipment, which many entrepreneurs undertake themselves in order to save on this item of their investment programme. In so doing they introduce into their plants structural errors which have continuing adverse effects on their operations. In such cases, a large part of the blame may be laid on development financing agencies which fail to give due importance to the analysis of the assembly and engineering side of the projects, thus indirectly encouraging this superficial "saving" whose harmful effects are perpetuated in the structures of the manufacturing units installed.<sup>12/</sup>

#### 4. Operational know-how

Technical know-how relating specifically to the operation of an industrial enterprise is of basic importance in the more complex industries where the manufacturing process consists of operations which are not merely repeated over and over again in exactly the same way, but require constant intervention according to varying technical circumstances.

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<sup>11/</sup> ECLA, "The transfer of technical know-how in the textile and clothing industries in Brazil", op.cit.

<sup>12/</sup> See Relatorio da pesquisa sobre a estrutura brasileira de producao e consumo de celuloose e papel, Leone e Associados, Rio de Janeiro, 1968, page 208. This study points out that there is a typical vicious circle in that the "technology" used in small paper plants is generally reduced to the basic characteristics of the machinery purchased. If his investment possibilities do not permit him to supplement his production machinery with other equipment particularly that intended to reduce costs rather than increase production), the small manufacturer remains a prisoner of the inadequate equipment originally installed, and must operate at costs which prevent him from increasing his capital in order to rationalize his production facilities.

The three sectors of industry studied from the standpoint of the transfer of technology present very different characteristics in this respect.

In steelmaking, operational technology is a vitally important factor throughout the life of the enterprise, which thus has to have frequent recourse to foreign assistance for a long time after the start of operations.

Although in the machine-tools industry technical know-how continues to be of great importance, it is essentially repetitive and does not need to be imported.

In the textile industry, the manufacturer supplying the equipment accepts responsibility for handing over the plant in perfect working order with a pre-established level of production for each machine, which is verified by means of tests. Thus, before the start of regular operations, tests are carried out to make sure that the actual performance of the equipment is that indicated by the suppliers. With these tests the manufacturer fulfils his commitment to deliver the equipment operating at a pre-established level of efficiency and to transmit the specific know-how on the adjustment and maintenance of the machines to the local technical staff.<sup>13/</sup>

#### 5. Personnel training

Although normally personnel training should be separate from the installation of individual enterprises and should follow the same lines in a whole sector of industry, in practice - especially in the initial stages of an industrialization process (as, for example in the North-East of Brazil) - a different procedure may have to be adopted. When an enterprise is the first of its kind in a particular area, it may be necessary to establish a training programme to meet the specific needs of that enterprise in terms of skilled personnel. In many cases, therefore, technical know-how must be imported through training, either by sending personnel for training abroad or by organizing their training in the country concerned with the help of foreign technical experts. Both these systems were used in Brazil's industrial development during the post-war period and are still frequently used. In the more advanced South-Central area, however, there is an increasing trend to replace external by local elements in training activities.

The training of the personnel directly in charge of the more technologically advanced equipment is always a key point in an efficient industry, even in such a well-established branch as the textile industry. In fact, it is the second crucial stage in the transfer of technology in this branch of activity, the first equally critical stage being the assembly of the equipment, in which, as noted previously, the local staff who assist in the assembly operations carried out by technical experts sent by the suppliers initiate their training.

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<sup>13/</sup> "The transfer of technical know-how in the textile and clothing industries in Brazil", op cit.

after the transfer of "know-how on the performance, running, adjustment and maintenance of the equipment", which constitutes the assembly stage, comes the testing phase prior to the start of operations, in which such knowledge is deepened and broadened and the local staff learn the special features of the processing of the raw material with the machinery installed. "This is one of the most important phases in the transfer of know-how when new factories are being set up, and the alert machine manufacturer will devote sufficient time and effort to this task to be sure that his machines are left in the hands of competent staff; otherwise his reputation as a manufacturer would suffer".<sup>14/</sup>

Machine purchasers and users do not always have quite the right attitude, however, and it frequently happens, especially among medium-scale industries and among entrepreneurs having experience in trading in textiles rather than sound experience in manufacturing, that proper care is not taken in the assembly and pre-production testing phases.

It is wrongly assumed, in these cases that, the rated performance indicated by the manufacturer will either be attained easily and almost automatically without any special effort of adaptation, or that it will at any rate be attained quite rapidly as the local staff gains experience after the tests prior to the start of operations have been completed. Consequently, the local manufacturer fails to pay proper attention to this crucial phase in the transfer of know-how from abroad, and this has various adverse repercussions, the most important being the failure to engage sufficient properly qualified local technical staff to participate fully in the assembly work and tests prior to the start of operations. This is one of the main obstacles to the efficient transfer of technology from abroad in the textile industry.

A fair amount of training of local staff takes place, albeit spontaneously during the assembly and pre-testing phases. "However, staff training cannot be limited to this transfer of know-how by the manufacturer; on the contrary, it must take the form of a regular programme of in-service training, both during the installation of the plant and during its normal operation."

"This programme provides for on-the-job training during normal working hours, using instructors who have regular jobs in the enterprise, and for sending staff from the factory to training centres or to the workshops of the machine manufacturers. In fairly large factories with an energetic administration, it is common for some high-level technicians to be sent to gain practical experience in factories abroad. The transfer of know-how thus obtained is remunerative and relatively cheap when the staff are selected properly. However, the staff to be sent abroad are not always rationally selected. In fact, it often happens in private companies and family concerns that staff who do not have the necessary experience and technical background are selected and sent abroad supposedly for training, returning afterwards to become technical managers of their firms. In such cases, there is no transfer of know-how, since the staff chosen do not have the minimum qualifications to assimilate it."<sup>15/</sup>

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<sup>14/</sup> Ibid.

<sup>15/</sup> Ibid.

## 6. Other aspects of industrial operation

It is worth while making some observations concerning quality control and the preventive maintenance of machines. The technical know-how relating to these two activities plays such an important role in the textile industry that in the study on this sector they are dealt with separately from the general know-how relating to the normal operation of the plant. The same also applies to other sectors of industry where the capital-intensity is rising fairly sharply and the number of working shifts is therefore having to be increased.

The methods used in the textile industry controlling the quality of raw materials, intermediate products and finished products and for the preventive maintenance of machinery and equipment are usually inadequate and constitute another unsatisfactory item of some significance as regards the process of importing technology. Even when new plants are established - except in the case of large-scale enterprises belonging to groups with a long tradition and wide experience in the sector - insufficient attention is paid to these activities, not only for want of quality control equipment but also because the staff lacks the necessary knowledge to operate such equipment and interpret its results.

Lastly, very few plants have a programme for the preventive maintenance of their equipment based on the machine manufacturers' instructions on the behaviour of the various units and the minimum requirements as regards cleanliness, lubrication and adjustment. In addition to detracting from the overall efficiency of the installations, the lack of preventive maintenance programmes constitutes an almost insurmountable obstacle to the introduction of a continuous system of working, with three eight-hour shifts a day. This rate of utilization is essential if the introduction of more capital-intensive equipment in Brazil's textile industry is to be economically justified.<sup>16/</sup>

## 7. General considerations

The technical know-how described above may be grouped in four main categories: analysis of feasibility or preparation of the preliminary project, preparation of the final project including the engineering project, construction and assembly, and start of operations.

There is, however, a very important earlier stage, particularly in the preparation of projects by public bodies, in which there have also been certain forms of transfer of know-how from outside Brazil. This is the preliminary selection stage which entails the carrying out of a number of sectoral or regional analyses, somewhere between the macro-economic analysis and the project itself, or of preliminary multidisciplinary studies on specific problems such as training, technological research or transport. These studies are intended merely as a frame of reference for continuing the pre-investment activities with a more specific orientation or, in other cases, for obtaining subsidies of a relatively general nature for defining policies or organizing the structure of institutions.

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<sup>16/</sup> Up to a short time ago, by a decision of the Industrial Development Committee of the Ministry of Industry and Trade, it was forbidden to set up new plants or reorganize existing ones so as to increase their production capacity. This restriction was lifted in May 1971.

From the industrial development point of view, the most important categories in which there is most need for collaboration from abroad, are the selection of processes (process engineering) and the plant design (project engineering).

The subdivision into independent categories clearly depends on whether the industries concerned are continuous-process industries such as chemicals, cement, pulp and paper, or discontinuous process industries such as metal-transforming and textiles.

In the chemical industries, the selection of processes is the crucial step in the establishment of a new plant. In the metal-transforming industries, however, where the processes are less varied and are necessarily continuously repeated in the different production lines, the choice and size of the production equipment is more important and forms an integral part of the preparation of the project.

In process engineering for the chemical industries it is sometimes necessary to deal separately with the know-how on the basic processes and that on the equipment for applying those processes. The first type of know-how relates to the technical data and details concerning the nature and characteristics of the chemical reactions applicable in the manufacturing process, while the second concerns the determination of the size of the equipment and the specifications of the machines and materials required for the industrial application of the chemical processes.

According to Professor Politzer <sup>17/</sup>, a large part of the technical know-how on chemical engineering is provided by the manufacturers of the equipment and materials, so that it is only necessary to have decided upon the processes to be used, in order to be able to specify and order the appropriate equipment and materials. Only when highly specialized practical knowledge is required, because the equipment must operate under special conditions (extremes of temperature or pressure, chemically reactive atmosphere which is highly detrimental to construction materials, etc.), is it necessary to obtain original technical know-how, which is often outside the scope of the equipment manufacturers. However, the collaboration of these manufacturers is always an important source of the technology required for the establishment of new units in the chemical industry.

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<sup>17/</sup> Kurt Politzer, "O nível técnico e as modalidades de transferência de conhecimento técnico do exterior na indústria química do Brasil" (ECLA, 1966).