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CREATION OF A MACHINE TOOL INDUSTRY  
IN A DEVELOPING COUNTRY  
STUDY OF VARIOUS PHASES<sup>1/</sup>

by

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<sup>1/</sup> The views and opinions expressed in this paper are those of the author and do not necessarily reflect the views of the secretariat of UNIDO. This document has been reproduced without formal editing.

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The various steps which will be studied in this statement are a logical succession of studies which every implantation of machine-tools in a developing country must necessarily undergo to have the greatest chances of success.

We shall define successively :

- what is existing at the time of the study,
- the aims relating to the market, products lines and technology,
- the choices necessitated by the realization of the project,
- the governmental helps.

#### **I - Study of what is existing**

Before any decision, i.e. before any choice which will engage the future, it is indispensable to study carefully the situation such as it actually appears from every point of view, and that is perhaps one of the most difficult points. As a matter of fact, in a great number of developing countries, the information necessary to that study, which are generally statistics, are not existing or they are incomplete. The administrative structure is generally light and particularly absorbed by the daily business.

Two cases may occur :

1/ there is no machine-tool industry in the country considered. This is the ideal case for the creation from nothing of a local industry, but it is also a very rare case. As a matter of fact, it is very easy to a small industry having at disposal imported machine-tools, to manufacture a copy of a centre lathe for instance. Thus, in many agricultural countries, agricultural machine manufacturers undertake to build very simple machine-tools.

2/ machine-tool firms are already operating in the country. The main characteristics of that industry are generally its youth and a technology often hardly developed. Such is the situation in a great number of countries, for the above-stated reasons.

The machine-tools built are then generally centre lathes, shaping machines or drilling machines, the technology of which incorporates simple notions of mechanics and electricity but very scarcely hydraulics and almost never electronics.

The study of the existing situation leads to the definition of :

- a) the quantitative evolution of the supply and demand in the past,
- b) the evolution of the machine-tool park in the past,
- c) the present structures of the existing firms,
- d) the structures of the manufacturing costs,
- e) the level of technology presently used in the country.

These studies, which are long and costly, must be carried out by official organisations, either governmental or international, to be as objective as possible. It is understood that, as far as they do not have at their disposal the necessary staff, they may require the help of specialists of that kind of investigation, but they should however control them and keep the responsibility for the final conclusion.

a) quantitative evolution of supply and demand in the past

The subject matter at this point is the study of the national production, the imports and exports over some years (between 5 and 10 years). The apparent consumption of machine-tool in the country i.e. the algebraic sum of the national production plus the imports minus the exports, will thus be deducted from this study. The information will come either from official statistics or from enquiries made to the national machine-tool makers and consumers. As far as possible, these information will be tentatively obtained by groups and lines of products :

- Group of metal cutting machines :  
lathes, milling machines, boring and milling machines, drilling machines, planing machines, broaching machines, sawing machines, grinding machines, tool grinders ...
- Group of sheet metal working machines :  
presses shears ...

For each of those groups, an attempt will be made to obtain the following information :

- the number of machines yearly produced,
- the tonnage represented by that production,
- its value in a stable currency.

That study of the quantitative evolution over some years should point out the main lines of the evolution of the weight and price of the machines produced in the country ; then, it is easy to compare them with imported machines. It is generally noted that imported machines are heavier and more costly by a ton than home-manufactured ones.

b) evolution in the past of the machine-tool park

Taking as a basis available statistics or enquiries made by governmental organizations, we shall try to define, by groups and lines of products, the number of machines existing at different dates and particularly at the time of that study. In the developing countries, two of the main machine-tool consumer are generally engineering schools and military arsenals, the latter being often entrusted with the promotion of new technics ; it is advisable not to forget them in those investigations as they may represent approximately 25 % of the national park. They will be important prospects or even valuable partners in the future.

That analysis of the machine-tool market enables us to determine the percentage represented by each line of machines in the national park and to make conspicuous the eventual distortions in comparison with an optimum park. Without intending to state general rules, we notice that developing countries are often over-equipped with centre lathes, shaping machines and drilling machines, whereas they are largely under-equipped with milling machines and still more with grinding machines. For instance, it often happens that some countries have one milling machine against 5 lathes, when it is generally admitted that the optimum ratio is about one milling machine against three lathes.

e) present structures of existing machine tool manufacturing firms

The aim of that study is to draw up the inventory of the national potentialities in manufacturing machine-tools. We shall try to identify all machine-tool manufacturing firms. This is not always easy as we already mentioned. Some mechanical firms occasionally manufacture small or very small quantities of machine-tools and are only devoting a small part of their potentialities to that production.

A study of their geographical position will show how these firms are located on the industrial map of the country, regard to :

- raw material sources,
- present and potential industrial centers,
- districts likely to offer available labour.

On that occasion, it will be necessary to determine the number of workers employed by the firms actually manufacturing machine-tools and, if possible, to get a separate valuation according to the professional groups (direct labour, indirect labour ...). This information will enable us to get some figures (for instance the number of productive hours spent for each machine-tool ...) which are important to know, and which have to be compared with the results obtained in other countries. It will be noted that very often the figure relating to the direct labour is proportionally very high; that generally means that the executives are scarce and that the drawing department is either missing or very small.

This study will also enable us to make conspicuous the concentration of the national machine-tool industry in sorting for instance the firms according to their number of employees.

On that occasion, we shall estimate the potentialities of engineering of the national firms by a determination of the staff of their drawing departments (engineers, technicians, drawers ...).

d) structures of manufacturing costs

The object of that study is to lead to a precise estimation of the present manufacturing costs of the machine-tools produced in the country. This will help to determine the lines of products which will be manufactured and the action to be undertaken in order to bring the development of the national industry to a successful conclusion.

The manufacturing costs consist of 4 main headings :

- labour,
- raw materials,
- components,
- sundry expenses.

This structure is also very changeable but the labour is always representing a large percentage of the manufacturing cost. Its value is all the higher as it is often indispensable to manufacture in the plant itself a great number of components which should be advantageously subcontracted or purchased from the national market but cannot be found for want of subcontractors and manufacturers.

That is why the amount of raw materials is also important : the prices of the components which have to be manufactured being made of labour and raw materials. Yet the manufacture of machine-tools of low technology does not require cast-iron neither steel, which are essential raw materials of a very special quality. This is not true as far as the manufacture of machines incorporating a more sophisticated technology is concerned ; then, the notion of homogeneity and invariability in the characteristics of cast-iron and steel is to be taken into account.

By components, we mean everything bought by the firm except for raw materials (ball-bearings, electric and hydraulic devices, small mechanical devices ...). As already mentioned, some of these components, generally mechanic and hydraulic ones, are manufactured by the firm.



Among the other costs, selling and after-sales costs represent high percentages of the price of the machine. Indeed, the firms being small and the production limited in quantity, the commercial channels cannot be used at their optimum, all the more as generally the distances are long and industrial areas far from one another.

a) level of the technology used in the country

It is not possible to quantify the level of technology or to give its precise formula, but it can be determined by comparison with international standards (Salmon, Schlessinger ...); for instance, it is possible to classify the firms in three groups of technologic level :

- those whose all machines are in conformity with international standards,
- those whose part of the machines is in conformity with international standards,
- those whose none of the products is satisfying the international standards.

That notion of technological level of the machine-tools manufactured is all the more important as the country wishes to promote its exports of machine-tools. Indeed, it is illusory and even dangerous for the reputation of the national industry to insist on exporting machines which are not in conformity with international standards.

**II - Objectives : market, line of products, technology**

Having studied in the previous paragraphs the present situation of the local machine-tool industry, it is now advisable to face the future in studying the prospective market of the national production.

Taking as a basis that a machine-tool industry must be next to its present or potential customers, it is obvious that the national market of the different machine-tools lines must be studied first. Indeed, the more complex or technologically

sophisticated the machines are, the more frequent and close must be the contacts between the manufacturer and the user : as regards its study, adjustment and technical evolution in time.

Thus, we shall study, concerning the national market :

- the future evolution of the demand,
- the future evolution of the machine-tool park.

We have seen in the last paragraph that the distribution of the different types of machine-tools could show some aberrations. There is no reason why those distortions should naturally tend to disappear, if no effort is made on purpose. It is even possible that some disparities go on increasing and such is the case of firms manufacturing machines of very different technological levels. Indeed, the firm which is familiar with machines of a high technical level should rapidly improve and tend to catch up its delay, while another, using and making but simple machines, should have no approach to those costly studies and yet the country needs all the potential of machine-tools production.

In a first stage, we shall attempt to precise the demand expected for the different types of machine-tools in projecting on the future the conclusions of the past. At this level we should consider the schemes for the development of the country which supply the main figures : mechanical industry progress, steel consumption, car production ...

At that point, the competent authorities have to intervene to proceed to the necessary choices and give the main trends for the transformation of the national machine-tool industry. Besides, those choices are dictated by economical (industrial development ...) and political considerations (national freedom ...) and have to define :

- the markets to be contacted,
- the type of machines to be manufactured,
- the level of technology used.

These three choices are in close connection and it is not possible to study one of them separately from the two others; indeed, it is possible, for instance, to decide the manufacture of one type of machine of a high technological level ; it will thus be necessary to aim at a very large international market and consequently to secure the assistance of an important commercial network. Reversally, it may be decided to meet with the requirements of the local market for all types of machines and it will be necessary to keep to an average technological level, the country not being able to make an enormous effort for all types of machines.

### III - Realisation

We have seen previously what the present situation of the machine-tool industry was, and we have determined the ends to be aimed at concerning the market, lines of products and technological level. We are now entering the phase of realization. In this chapter, we shall examine the different problems which arise when passing from theoretical studies to practical realizations.

It is quite impossible to give an ideal solution valid for everyone, in all cases and for all types of machine-tools.

Indeed, we have seen that the existing situations were different from one country to the other and that the choices made by those different countries could also be very different. It is possible to imagine two lines of action in radical opposition, one of them consisting in the progressive creation of a local machine-tool industry in using the existing means and calling for a limited help from abroad, the other one consisting for a country wishing to promote quickly its machine-tool industry to invest massively in order to obtain a spectacular progression.

However, in all cases, we meet the same problems which are of three kinds :

- labour,
- technology,
- means of production.

Contrary to what has often been written, I do not think that, to create or develop a machine-tool industry, it is necessary a priori to have highly skilled mechanics. Indeed, although machine-tool is a very special and highly precise technics, it should be possible to train, within a few years, in a country which has no machine-tool industry, the mechanician labour characteristic of the main industrial countries. It is obvious that, such a skilled labour being non-existent, it will be necessary to make use of the available basic labour and to replace its technicity by a very numerous, most reliable and highly technical executive staff.

That executive staff will constitute the strenght of the new-born machine-tool industry and will have to teach the workers good reflexes and particularly that of the control. Machine tools consisting of piled machined components, it is necessary to look after a correct machining and to check, in the course of the assembly, if the geometry is correct. If such cares are taken and if, in addition, good automatic machines may luckily be bought, it is possible to have high grade machine-tools built by a labour who was not a priori intended to manufacture machine-tools. The technical executive staff will have to be all the more large and qualified as the labour will be unskilled, for in addition to rigorous checkings, they will have to look after the quality of raw materials and the geometry at all stages of the assembly.

The problem is not to know what type of labour use, as it is a basis data, but to know if the training of mechanics has to be planned before any action is possible or if we can replace that investment by the higher expenses involved by the numerous executive staff managing a low-skilled labour.

The level of technology applied to the machines built has been chosen together with the type of machine and the markets they are intended to. It is unlikely that the teams of technicians and engineers able to study prototypes and to assimilate quickly that new technology, may be locally found. It will thus be advisable to acquire from outside the technology required, either simple or complex. It is very important to control at such a stage that the technology can be adopted by the new industry, i.e. that the manufacture of those new machines will enable national technicians to make progress ; unconditional reproduction of machines built in other countries is not sufficient; the technological gap must tentatively be filled by a thorough assimilation of the solutions proposed and an attempt to develop new ones.

A great number of reliable machine-tools manufacturers or specialised research centres all over the world are wishing to share the results of their work. It is possible to choose between purchasing a licence of manufacture from a foreign builder, or creating a pilot unit with the real participation of foreign builders, or settling subsidiary of foreign firms ...

As a matter of fact, that acquisition of technology should be an actual transfer of technology and the firms which shall take advantage of this, the national firm, the pilot unit or the subsidiary, shall have to serve as a catalyser, a re-grouping pole and a centre of radiation.

More than labour and technology, the amount of investments that the country wishes or is able to devote to the development of this machine-tool industry will be of paramount importance. As a matter of fact, the country may wish to start from nothing and to create entirely an integrated pilot unit, i.e. consisting of a foundry, a machining workshop, an assembly workshop; it is also possible that, owing to its limited means, in a first stage, local or outside sub-contracts may be planned for complex machinings or for some manufactures the profitability

of which is not certain. However, it will be advisable to integrate a foundry as soon as possible to be sure of the quality of cast-iron, an element indispensable to the accuracy of the final machine. In addition, a foundry enables quicker modifications on the types of machines in process and allows us to conclude. Concerning the means of machining, it is possible to choose either simple machines if the labour available has been trained to make a precise job on such kind of machines, or automatic or N/C machines if a rapid progress is wished and if the skilled labour necessary is not available. Indeed, the N/C machines enable a rapid production of accurate parts with untrained labour (this involves problems of executive staff as seen previously, and of maintenance of N/C machines).

Besides, technics of final assembly of the machines are in quite close connection with the investments which will have been made concerning production machines. As a matter of fact, if accurate machines (lathes, milling and grinding machines) are already operating, the final assembly is relatively easy and little adjustment is needed; reversely, if the machines available are not very accurate, it will be necessary at the final stage to proceed to considerable scraping to secure a correct geometry of the components turned out.

It will thus be necessary to train scrapers, who are indispensable to the quality and accuracy of the final product. This is not an obstacle and will enable to produce rapidly machines of quality with reduced investments. However, in any case, it is not possible to do without considerable means of control and metrology. This does not signify that it is necessary to invest in the most modern and complex metrological devices but to have a sufficient number of elementary tools : marble, rulers, comparators ... In any case, the executive staff should aim at a control of the quality of each part of the machine and of its final geometry.

Governmental line of action for the creation of a national machine-tool industry

More than for any other action, it is impossible to give one valid solution for every case. In this paragraph, we thus shall only point out a number of possibilities and draw attention on some errors to be avoided. A government having decided to promote in its country a machine-tool industry or to develop the existing one, may choose one of the following lines of action :

1) to promote mergers of existing firms and, in that way, to attempt to gather the human, technical and material potentialities in order to manufacture a greater number of machines and to avoid a dispersion prejudicial to efficiency. These mergers are not always easy since they are including a considerable number of opposed factors : human, technical, commercial, geographical factors ... Considering these difficulties, it has sometimes been decided to promote pilot units gathering several national builders who had recourse to a foreign partner.

2) to promote the re-equipment of the existing firms in machines, i.e. to enable them by appropriate measures, to be equipped in highly technological machines of production likely to turn out products of international standards and in sufficient quantity to the market chosen.

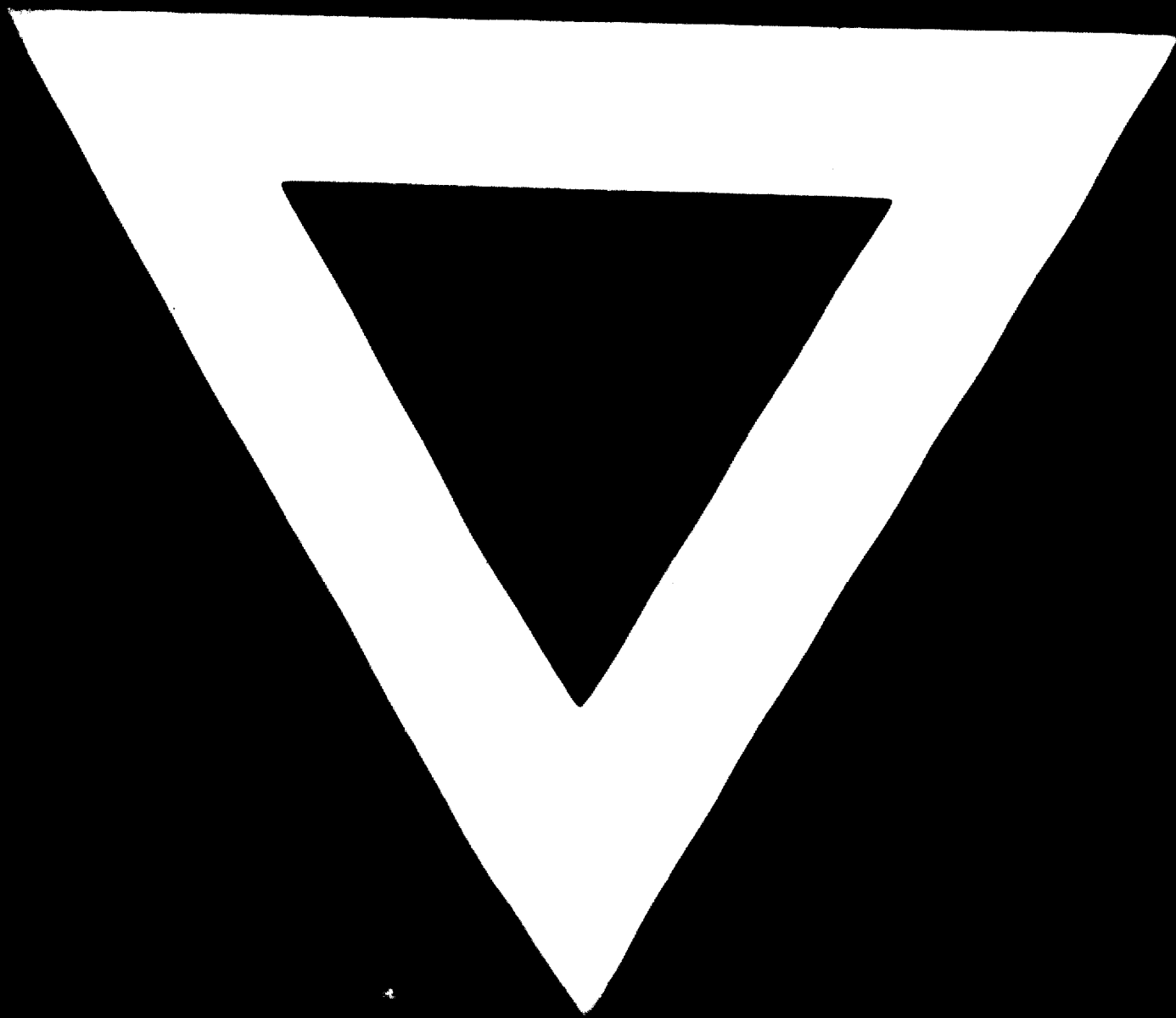
3) to promote the acquisition of technologies. If the machines locally produced are not supposed to be technologically apt to compete with foreign ones, an attempt will be made to obtain a modern foreign technology and the national authorities may intervene in such a case to make that acquisition easier and to ensure that a transfer of technology has actually been made. Indeed, the national firms should not copy unconditionally an existing or outdated machines but, reversely, with the help of a partner, turn out a modern machine and train technicians for engineering and manufacture of machine-tools incorporating advanced technical. To reach that aim, the acquisition of drawing or of a licence of manufacture is not enough; it is also necessary to secure the technical assistance of the supplier of technology.

4) Customs protection : from the very moment when a machine is manufactured in the country, it is important to protect its national market and this will easily be done in imposing high custom duties but the different authorities must be advised to mind the risk of uniform and too high custom duties. As a matter of fact, it is normal to protect a line of products locally manufactured in discouraging the importation of similar machines but the importation of machines complementary incorporating a different technology should not be forbidden. If such an extreme solution was reached, the national market would be considered, practically speaking, as a monopoly and the foreign competition would no longer be an incentive to a progression in quality and in technology for the local industry. Importation of machine-tools is thus to be considered as necessary to the development of the country and indispensable to the progression of the national machine-tool industry.

5) Help to exportations. One of the aims is the promotion of the exportations of machine-tools, the national market not being sufficient to make the investments needed profitable; in a first stage, it will thus be advisable to help the new industry to export its products which should compulsorily be in conformity with the international standards. Many ways of helping exportation may be planned, they are employed by all countries and it is not necessary to emphasize them.







**74. 10. 11**