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**The purchase of a foreign production system
The role of Ergonomics and Anthropotechnology
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The technology transfer

The technology transfer is an activity that is very old. But it has taken on considerable dimensions over the last 50 years. What is actually involved is an exchange. Although India is a major importer of technology, it is also a major exporter, hence its membership of the exclusive club of the New Industrialized Countries (N.I.C.) distinguished some 20 years ago by MacNamara. Here, we shall only mention the problems raised in India by imports of foreign technology.

Cultural machines and the Art of the Engineer

Although science is universal, the technology transfer raises particular problems due to the fact that machines, and even more so machine systems, are cultural in as much as the engineers and technicians who design them think of the companies, managers and workers of their own country when they design a new technical system. Furthermore, the engineer who designs a system imagines it working in the industrial environment of his own country.

More often, a good engineer works through analogy with the situations he knows or thinks he knows according to his own engineering logic - the logic of design - which is unfortunately different from the logic of use which will be that of the users in the real situation of the installed technical system.

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Diversity of technology installation situations

Numerous aspects separate the conditions of use of a technical system in the buyer country from those that exist in the seller country. These differences are due to various parameters:

- geographical: climate, seismic risks, ports, road and rail networks, water resources, electricity supply, etc.
- technical competence: engineers (India trains a large number of top-level engineers), technicians, skilled workers, technical and university centres and experts.
- social resources: housing, schools, nourishment, health system, the extent of endemic parasitic or infectious diseases.

The countries, and sometimes the provinces in a country as large as India, differ from each other both historically and culturally. The age and the level of traditional craftwork and the constitution of a relatively dense industrial fabric are the main elements which play an important part in the success of a technology transfer.

Criteria for a successful transfer

The success of technology transfers can vary considerably depending on diverse criteria.

- Quantity of production. Without aiming to achieve nominal-level production - which is dangerous from the viewpoint of keeping the production system in good working order - there can be deceptions in the field of production volume.
- Production quality. In certain cases, the production quality does not reach a level necessary for it to be exported. This is a situation which leads industrialists to claim protectionism which - in time - is dangerous for industrial expansion. To obtain international-level quality, the technical system must not be downgraded or, worse still, atrophied.
- Keeping the technical system acquired in good condition, often at the price of considerable financial and human effort. Keeping the production system in good condition and preventing its deterioration or its atrophy not only means that great attention must be paid to maintenance - which is not always part of the culture of regions that are little industrialized - but also necessitates customs

regulations and financial resources which enable acquisition of the necessary raw materials and spare parts. Sometimes, such a practice is too expensive. But since maintenance remains a major concern in order to achieve a good level of quality and endurance of the installations, it is necessary to search for local supplies of replacement raw materials and to discover the processes for local production of the necessary spare parts. As such, the main demand is that of maintenance, requiring an effort that is sometimes considerable but well within the reach of a country as educated and industrialized as India.

All these considerations show that the purchase of a technical system is not enough to overcome all the difficulties which this purchase is expected to solve. A transfer is only successful if it is active. Therefore a theoretical framework and a methodology must be available in order to achieve the success of this active transfer.

Accompanying the foreign technological system. Comprehension of the system whose purchase is planned requires a considerable amount of work, not only from the technical viewpoint, but also from the viewpoint of the resources used in the country of origin: quality of raw materials, water supply, electricity supply, the extent of use of subcontracting, the maintenance done by suppliers of measuring and analysis equipment, the frequency of use of experts of all levels and the degree of initiative of managers and operators.

Negotiation of the specifications

After this considerable work of comprehension, the buyer is ready to negotiate the specifications so that the system can be adapted to the particularities of the region of India where it should be installed. The modifications requested may be important for the workers, but negligible for the manufacturer. For example: the dimensions of the workstation intended for operators who, on average, are 10 cm smaller than the "standard" operators for whom the system was originally designed. The modifications may be minor relative to the alphabet or the symbols used to guide operators, while bearing in mind that, in all probability, very few of the workers can read English.

The modifications which appear necessary are sometimes more extensive when the raw materials used in India are different from the country of origin and where the water or electricity supplies raise particular problems in the region of India where the system is installed. The reluctance or refusal of

the seller to satisfy these modification requests is linked to the fact that, where it agrees to an excessive amount of modifications, it could lose all its profit on the operation which mainly comes from reuse of the hours of study and drawings that were necessary to design the system offered for sale.

It can be seen that this phase prior to purchase is of great importance. It should include:

1) A specific definition of the reason why the system is purchased

2) An in-depth study of the resources of the Indian region where the installation is planned and the difficulties that could be encountered when the system is used in the planned installation. The best way to find out future difficulties is to carry out ergonomic work analysis (E.W.A.) in a similar company in the planned region or a neighbouring region. It is dangerous to imagine that all difficulties, or combinations of difficulties, can be envisaged through a top-down approach. It is much safer to carry out a bottom-up approach in which an in-depth analysis is made of the activities of operators in some key jobs in the company and where the origin of the difficulties of these operators can be found.

3) A study of the technical system whose purchase is planned. This should be done either in the seller country where the system was designed, or in a country similar to the buyer country. It would be wrong to blindly assume that the system works perfectly well in the seller country and that any difficulties that could arise in India are necessarily linked to the transfer. They could quite simply be linked to the inherent weaknesses of the technical system itself.

When one thinks about the questions raised as such, it is obvious that the purchase of a technical system by persons who have no knowledge of its industrial use could have disastrous consequences. As I see it, the Carbaryl plant in Bhopal was a terrible illustration of this. The determination of certain areas of India to industrialize and the search for arrangements that are apparently advantageous from the financial viewpoint, can lead to unfavourable and inextricable economic situations, the result of which can be tragic or, at least, negative.

The place of organization of the company and the work

In favourable cases which, luckily, are the vast majority, the result is only obtained by paying the greatest possible attention to the organization of the work and the company that will be created to adapt the technical system to Indian society. In a way, the organization is the bridge that links the machines coming from another country and another culture to the situation of the buyer country, to India and, more particularly, to the part of India where the plant will be installed. From the viewpoint of the theory of contingency, the fact that the company is located in India should be included as a dominant contingent element of the situation. However, when it is a foreigner who has to produce and take the data into account, there is a risk of the situation being complicated even further due to the superficial representation which this foreigner could have of Indian culture.

Therefore, it appears vital for the organization of the work and the company to be done by a team which includes a majority of Indians. However, we now know that a successful import is that of a system whose various technical elements are compatible and where - even more so - the organization corresponds to the requirements of the system. Therefore, there are two contributions which, in a way, are contradictory. Firstly, the ideal organization according to the designers and, secondly, the organizational characteristics that best correspond to Indian culture, more particularly to that of the region where the installation is planned.

This is only a question of principles, as demonstrated by the Finnish school of engineers with Engstrom following the work of the Russian school of Leontiev. For these authors, activities are performed through actions that can be broken down into operations. In a stabilized system, the actions then the activities themselves take place in a regular way and, to an extent, become automatic, taking on the status of an operation regardless of the complexity of human functioning. But if an anomaly disturbs the situation, the operator, once again, has to break down his activity into actions, or even operations. Yet, in transferred systems, such anomalies often arise. Perrow proposed the means of evaluating this complexity which can provoke defective operation, or even deterioration of the system. The transferred system can suffer from the very difficulties of the transfer which provoke an increased complexity of the task for the operator and, due to this, require an operation that is different from the one planned by the designer that worked rather well in the seller country or in similar situations.

Start-up of the transferred system

It is not simply a matter of forming a mixed seller-exporter team before the transfer. Such a team has to be maintained during the installation period of the new technical system and also during the first period of normal operation.

The normal character of operation conditions should be stressed since optimal conditions can be obtained artificially for the limited period of the test-run by cutting off the water and electricity supplies of the neighbouring town and by doubling the number of specialists. Of course, this is not a normal situation and, once this period is over, the dissociated installation team and the Indian operators can be faced with problems that are impossible to solve.

Often, the possible seriousness of the difficulties encountered with installation of the technical system on a particular site cannot be reduced without the aid of the national, regional or local authorities. The insufficiency of electricity and fresh water supplies, insufficient dimensions or poor equipment of the port, not to mention the poor quality of the roads linking the plant to the port or the state, or the limits of the education or social system, are generally questions which the company cannot solve on its own. Sometimes, they are the subject of tough negotiations with various authorities and the company cannot be satisfied with promises.

Conclusion: the technology transfer is a difficult operation

As such, the technology transfer is always a difficult operation, even if the supplier is Indian and is located in a major industrial region and when the new system is to be installed, for example, in an agricultural region which has a less reliable social and industrial fabric. But, as we have seen, a systematic approach is possible ... and efficient.