OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

FAIR USE POLICY

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

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

We regret that some of the pages in the microfiche copy of this report may not be up to the "proper" legibility standards, even though the best possible copy was used for preparing the master fiche.

07282

United Nations Industrial Development Organization

Distr.
LIMITED

ID/WG.237/5
12 November 1976

ENGLISH

Meeting of Top-Level Industrialists
on Factory Establishment Projects
in Developing Countries

Vienna, Austria, 18 - 20 November 1976

SOME REFLECTIONS ON PROBLEMS OF TRANSFER OF TECHNOLOGY[1/]

by

Silvère Seurat*

* President-Director General, Eurequip - Paris/Vaucresson.

1/ 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 paper has been reproduced without formal editing.

id.76-6565

Ever since the beginnings of trade movements, men have been concerned mainly with exchanging products: that is, by way of example, salt by caravans in ancient times, spices from the East India Company and so on. And in our own times, the complex permutations which take place between the nations of the world, in raw materials, semi-finished products, consumer products and, to a certain extent, services (as for instance, data processing, insurance, banking services, engineering consultancy etc.).

In the matter of know-how, on the other hand, it seems that exporters have more or less intentionally held back on such exchange. Thus the artisans of Venice and of Florence had to vow never to reveal their working secrets to a stranger. Indeed it would seem in the nature of things that those who have worked for a long time on elaborating a sophisticated product should protect their know-how, at least until the time when their investment has been paid back.

No doubt the case of producers of services is somewhat different. The organizations - or individuals - who perform some activity with competence over a period of years (as for instance a physician or a firm of engineering consultants) acquire a background of experience and a reputation such that they are at least partly protected de facto against competition from newcomers. Obviously such protection is entirely provisional, and we all know it is necessary continually to improve the price/quality ratio of the service if one wished to remain in business.

We may note then that the law of the market place acts in such a way that some know-how is better protected than others. A case in point is an industrial process for making a special steel which is covered by a patent, while the discovery however brilliant of a mathematician or a biologist immediately falls into the domain of humanity's patrimony.

The matter of the cost of patents is often encompassed in the term "technological transfer", but for our sub-group this would not for the present appear a matter of great urgency.

We could perhaps, in a first phase, restrict ourselves to methods and means of transferring technology i.e. analysing the operations of the training and organization called for in order that at a given moment, a body of men become capable of performing some industrial operation which other men in other places are already able to accomplish.

Moreover, we shall at some time certainly be called upon to tackle the problem of technological transfer in liaison with sub-group 2.

Understandably, today the problem of technological transfer has become a world-wide one. Up to now it had always been viewed - and this was already a considerable progress as compared with a total secrecy - as a matter of industrial architecture.

In other words:

> Rather than let you rediscover by a method of successive trial-and-error how to build a complex industrial facility, the industrial architect (the engineering consultant) will offer you the fruits of his experience in the form of a series of services going all the way from the design office to the sending of specialists who will check the erection of your plant until it works. Then on the given day he will hand over to you the keys of a house which only remains to be lived in, and the tools of machines whose operation he has briefly explained to you.

Naturally, some at least of the architect's know-how is transferred in such an operation, to a varying degree depending on the interlocking of the teams and the amount of technical assistance and training covered in the contract. But experience has shown abundantly that with such a system the transfer of technology is far from adequate. In a number of unpleasant cases, the plant breaks down, meaning that following the failure of some link in the processing chain, one production unit drops out, sometimes over a fairly long period.

In other cases the rise in production is slowed down, as maintenance problems have been poorly solved, and the loss of profit is considerable during the first months or first years of the plant's operation. This may have very grave consequences, since it may completely falsify the calculations of the economists who had estimated that the project would be profitable.

Starting from the above considerations, some groups of European engineers and economists have for the past fifteen years grappled with the problem of identifying a new kind of job, complementary to engineering consultancy, and of which it would borrow some of its techniques.

This job could be designated "architect in technological transfer" (in French, "architecte en transfert de technologie"). It could very well undergo considerable impetus between now and the close of the 20th century.

In the compass of the UNIDO activities we often meet up against the possible transfer of technology between some highly industrialized country and a less developed but rapidly developing country. This should not however allow us to forget that such a transfer is often necessary inside a country itself, and even inside a same firm, as technological transfer is one of the essential characteristics of human activity.

Nor indeed are the problems encountered and the methods employed very different in each of these cases. The process outlined below must be understood more as that of a practitioner than of an academician. While it has tested and proven some successful operations of technological transfer, it has no other aim than to serve as starting point for the reflections and debates of our sub-group.

In the following two distinct parts will be found:

1. A brief note outlining some of the more frequently encountered problems in an operation of technological transfer.
2. An approach to a general procedure emerging on the transfer of technology.

2. ANALYSIS OF PROBLEMS

Without pretending to mention all of them it is possible to draw up a quick list and to break them down into eight major areas:

2.1. Difficulty in agreeing on the precise content of the expected transfer

Faced with the necessity to agree on the content of the transfer, there generally emerge two trends among firms and countries we may term "emitters" both of which are equally dangerous:

- First, that consisting in transforming demand by magnifying it.

  Some Middle Eastern country, say, raises the question: "How to train 2,000 additional teachers for technical training?". The natural tendency is to answer: "That's not the problem that requires answering. What is wanted is total restructuring of your technical education system to better adapt it to the requirements of the present economic boom". Now if an additional 2,000 technical teachers are required, it is because the previous studies and analyses of a given situation have led those responsible to formulate the problem in that manner.

- As against this, there is the tendency consisting in downgrading the demand.

  In some other country, another request would be framed, say: "We hope that on the occassion of the construction of the apartments, we may acquire capability in the latest techniques of prestressed concrete or in modular construction", and the emitting firm's only reply would be to furnish the number of turnkey apartments contracted for, without having tackled the problem of "access to technological capability".

The act of technological transfer is never an isolated operation. It forms an integral part of an extremely complex fabric of operations of technical training, themselves linked to the syllabus, to the school's policy, to various private and public initiatives in connection with adult training, etc.

It is never easy to identify the precise scope of the service to be rendered.

2.2. Problems of organizing technological transfer

While it is necessary to build some plant, or build some ships, to proceed in such manner that the receiving country not only knows how to operate the plant, or acquires total mastery in the construction and operation of the ships, the following questions must be put:

- How to attract in sufficient numbers, in time (i.e. not too early and not too late) the men suitable for holding down the new jobs?
- How to ensure in time the training of men, the on-the-job training and, where appropriate, the upstream training as well?
- How, after this, to ensure that the recruitment and training phases, while providing the operational capability of the trained personnel, will be the least burdensome and least costly possible?
- How to proceed so that the barriers of languages and of varying mentalities are overcome, both during the training and the operational phases?

And so on.....

2.3. Problems of specifying the contract covering the technological transfer and of the price of the transfer of know-how

Typically, the receiving country or firm does not wish to be furnished merely walls or facilities, but that the plant in fact produces, and in general, produces with local personnel.

Although such a requirement is sound, it is often difficult to translate it into the contract. To force the emitting firm to bind itself by a single contract known as a turnkey contract is a sensitive matter. The reason is, a large share of the training process devolves on the buyer himself; and it is difficult to evaluate just how efficient the latter will be. To bind the two parties by a contract covering furnishing the equipment plus transferring the know-how may lead to prolonged litigation.

Although there is no problem in assessing the price of selling materials and equipment, it is not easy to assess the cost of the know-how to be sold. Some firms sell their know-how as an accessory to the main product, as for instance in the form of patents or technical assistance missions. Now, selling know-how at the cost of the salary of the expert or trainer is an economic aberration and in no way corresponds to the real worth of the service rendered.

If so, then what price the service of an architect of technological transfer?

2.4. Problems of motivation of expatriates

It is up to the emitting firm to have initiated a policy fostering the expatriation of its good members. As things stand, most firms have no such policy. Nor is it at all advisable to embark on expatriating the best or the good members if nothing has been provided beforehand:

- To ensure that their careers will be in no way affected but on the contrary it will be of benefit to them when they return after a few years' expatriation,
- To guarantee them social security and benefits, retirement schemes etc.,
- To ensure the schooling of the expatriate children,
- where applicable, to offer a job to the expatriate's wife,

And so on.

2.5. Problems of welcome by the receiving country or firm

The receiving firm or country should facilitate all administrative problems, and this is not always easy.

It is indeed entirely natural that the legislators be sensitive to the protection of the firms and experts of their own countries, yet it is necessary to develop a coherent policy of opening out on the external world whose assistance is desired.

2.6. Problems raised by the buyer's own appreciation of requirements

It requires a high-grade industrial culture for an administration or a firm to judge of the importance of buying "know-how-to-operate" as much as that of the machines. Machines are tangible, they can be seen. Know-how is not directly perceptible and one hesitates to buy what cannot be seen. The risk of making a bad bargain is all the more acute, and the warranties one will be able to obtain for the proper execution of a given service are all the more difficult to assess.

2.7. Tendency on the part of the seller to save on the technological transfer in order to remain competitive

Competition is lively. To latch on to a contract, architects and industrialists often resort, as is natural, to submitting competitive tenders. It is often tempting to save on the expenses, to compress the "personnel" section and trust to luck. Once the contract is obtained, so the hope goes, one will find competent persons and adequate means of training. One will learn while doing - which is not a bad method, but often a long and costly one.

2.8. Problems posed by the size of the projects

The size of projects, and the imprecision as to when they are supposed to start, often result in the problem of men being tackled only at the last moment.

This undoubtedly is one of the major problems encountered by architects in technological transfer.

3. METHODS AND MEANS*

The operations described below are generally encompassed in the action of transferring technology. Naturally, all these operations are not necessarily involved in each case, and moreover, it may sometimes be necessary to include some not on this list. Technological transfer is always an "à la carte" matter which requires lengthy prior reflection and minute preparation.

We may distinguish between twelve families of operation:

3.1. Situation study at the receiver's

The first thing is to identify and investigate the sources of labour and executives at all echelons, meaning in other words the labour market. What kind of people are available; what have they learned; how may one reasonably hope to motivate them? What wages and salaries are current; what teaching systems are available? Are there any competitive projects to yours which could drain the human labour pool? Is there an adequate industrial system to generate, say, men having a certain familiarity with maintenance problems? In what way could the policy decisions already arrived at in the matter of employment affect the current labour situation? Etc.

This kind of work is done by sociologists of the emitting and receiving countries. It generally takes one to four months to conduct an appropriate survey, collect the existing data and documents, interview the various categories of personnel and draw up a synoptic report.

3.2. Situation study on the "emitter", as for instance in the technology exporting country

The theoretical know-how is always covered in manuals which may readily be translated. But what no manual contains - and this is the very essence of operating know-how - will have to be investigated on the spot and put into

---

* cf. Silvère SEURAT: "Réalités du Transfert de Technologie" Editions Masson - Paris 1976

easily readable documents. Typically: why and how does some skilled worker perform a series of manipulations, controls and checks, at his station. It frequently happens that what he does has not been learnt in some school but on the job, under the eye of an old hand, who let him into the secret of doing something in this way, or taking that precaution.

The work of the engineer-organizers during this phase will therefore consist in observing minutely the professional motions of every man in the plant, often from the manual worker right up to the manager. From this investigation a set of station cards will be prepared minutely describing every significant action performed by each person, as well as the reasons for that action.

But a study of the emitter's situation also includes the upstream systems of the plant which, humanly speaking, have enabled the solution to emerge. What schools exist dealing with what syllabuses? What is the market for technical assistance? Are there any technical assistants ready to expatriate themselves temporarily; and if so, under what conditions? Lastly, are there any curbs to the export of technology (i.e. fear of competition, wish to sell the know-how at a higher price, etc)?

It is generally considered that it is necessary to remain 1 to 5 days on the spot to study each specific station from a skilled operator to a supervisor. Other studies generally are quicker as a good many of them are already known and all that is required is to update them.

3.3. Selection, training, job specification of instructors of technological transfer

The personnel intended to become acquirers of technological know-how are generally trained by teacher/instructors. They are recruited in both the exporting and beneficiary countries, with a phasing-out calender whereby the expatriate jobs are gradually filled up by locals. The expatriates often have good acquaintance of their jobs, but they are neither teachers nor specialists in the language of the host country. They must absolutely not be allowed to leave without adequate preparation.

In contrast, instructors recruited in the receiving country know the human environment well in which they will work, but will have to do their acquiring, say, by doing traineeships in the emerging country to gain a good understanding of the industrial reality to be transferred.

In either case this training of the trainees is essential. Experience has proved that it is highly advisable, at the operational level, to use not professional instructors but present or future executives from the receiving industrial staff. Such men will in effect be the first to be interested that their future subordinates be correctly trained. It so happens too that there is no better training for posts of command for executives than this practice of prepared and controlled, active training of teachers.

3.4. Setting up teaching suited to adults

Although the training of adolescents traditionally accomodates itself to the separation of disciplines and major courses, it is not advisable to proceed in the same manner with adults.

Indeed the latter often find it more stimulating to have a dialogue type of teaching, of active participation; and above all teaching that deals not with hypothetical or theoretical situations but with real problems they are liable to meet in the course of their professional lives.

As one instance, it is far easier to let an operator handle a simulator, even a simple one, reproducing his control console, than to have him solve equations he will never meet in the course of his work.

Another merit of active teaching is to collect a very restricted group not over 8 to 10 around the instructor, consisting of persons undergoing their traineeships. Such groups are often the focus of fruitful interchange amongst those being trained. It may well be the best moment to start forming the future working teams, which will thus have the best chance of coordinating harmoniously in future.

3.5. Minute teaching programming

This teaching of the real thing could very easily turn into improvisation unless it is made the subject of minute prior programming. The preparation is all the more essential in that the "teachers" are not professional pedagogues but rather experienced technicians.(*)

It is possible to distinguish between two essential levels of preparation, as we saw under 2.6 and 2.7.

3.6. Devising a programme

In an operation of technological transfer, the syllabus emerges directly and as rigorously as possible from a series of measures procedures.

What is required is to describe with great accuracy all that has to be known about the working of each job station and the appropriate professional performance. This is greatly facilitated if the job studies mentioned earlier are themselves sufficiently detailed.

In addition, an accurate assessment is made not only of the initial level of competence which given diploma ostensibly imparts, but the actual level, by means of judiciously selected tests. The aim is not to downgrade a previous academic qualification, but to start off the operation of technological transfer on a sound and sure foundation.

The content of the syllabus then evolves naturally out of the differential between the target level and the actual level. There follows a long and meticulous work of scheduling which will give substance to the programme or programmes. A number of "common stems" will emerge, but in many cases some of the instruction will be aimed only at a small group of people.

(*) It is even pertinent to ask whether in certain cases it were not better to train teachers in a technique rather than the other way about.

If one reasons conventionally this may appear a costly procedure; but this reasoning is precisely what should be avoided. Indeed one of the known drawbacks of the conventional school training systems is to provide totally unrealistic courses which will be of benefit only in theory.

3.7. Design of courses

The programming phase is still not over. Far greater detail is needed if the training instructor is to be reassured and a reliable tool is to be given him with which he may accurately transmit the required messages.

This tool is the training course itself. Each course is the subject of creative work in order that the teaching messages it contains will be backed up by an appropriate teaching aid, which may be a simulator, a model or any other material embodiment or assembly which will act as support to the discussion of the group being trained. In such cases, active teaching merely rediscovers Socrates' celebrated "maieutics", which in essence means teaching by having the pupil discover for himself. This discovery is the finest way for the message to be memorized. The associated investment in grey matter is considerable, but is singularly profitable.

3.8. Devising and/or outfitting the job positions

Where circumstances allow it, the organizer/trainers recommend a structure for the industrial plant or complex by taking into account all of the various phases of training of a man throughout his career.

Thus, for the most sophisticated jobs, one attempts to avoid excessively lengthy training courses aiming to impart to men with no previous industrial background, the knowledge required for high-level technical responsibilities.

Experience has shown that it is far more profitable to instill in the plant or firm itself the concept that it is its own school of application. All that

is then required is to redesign the jobs in order of increasing complexity, up which the personnel can "climb" along different channels in the course of their careers.

3.9. Devising and modifying the structures

Should this sub-group spend any time analysing problems of structure?

Note straightaway that it is acknowledged nowadays that merely to recopy the structures of the emitting country is not in general a good way of transferring technology.

Rather one should tend towards "purpose-designed" solutions, as there are too many parameters involved when it comes to organizing men with their own customs, traditions and specific constraints to adapt themselves to a change which to them may be considerable, namely: industrial behaviour.

3.10. Checking results

Any system has to be checked, and this applies more than any other to a system of technological transfer.

It is unthinkable for an optimum amount of transfer to be achieved instantly, as the parameters involved are too numerous and too complex. Hence it will always be necessary to provide, at some point in the chain of operations, a check of the results obtained up to that point with, it goes without saying, a feedback on corrective action. This requires that the checking organization be at the same time a deciding body on the corrective action. This is far easier said than done.

We should never forget indeed that the essential part of the work is done on the men themselves, and that these react in a variety of ways. It is best to know in advance - as those among you who act as consultants on technological transfer well know - that one cannot guide a human system in the same way as one guides an electric system.

3.11. Transfer: the initial phase in apprenticeship of mastering change

The working habits and the style of relations arising out of the attempt to transfer technology should be kept by any firm wishing to continue facing up to the changes it is likely to encounter along the way. During this phase, organization, training and management should in principle be taken over by the beneficiaries of a successful transfer. This naturally does not prevent the employment of foreign specialists in the courses of the lifetime of the firm, as for instance at the time of some crucial change. But here the objective is clear: technological assistance should be planned systematically and be limited in time.

3.12. Strategic planning of technological transfer

Here a remark is called for. The operations briefly described above should be sequenced and followed up by a master plan, itself worked out and applied by the technological transfer architects.

Such men cannot be only engineers, economists and psycho-sociologists. It is perhaps the original feature of some European consultants to have succeeded in setting up, instructing and cultivating in this movement, multi-disciplinary teams which are especially suited to this kind of work.

During all phases of the technological transfer operation, it will be essential to bring together the custodians of the "operational know-how", the management of the facilities under construction, and the specialists in technological transfer.

Generally speaking the cost of technological transfer is evaluated as a few days of effective output of some new industrial complex: as against which, if no particular precautions are taken, the losses may amount to months or even years of production.

4. CONCLUSION

It is on this latter aspect that we shall dwell in conclusion.

The idea of creating the profession of technological transfer architect was born in Europe some fifteen years ago. At the time the idea appeared premature. Only a small minority of persons responsible for the erection of new industrial facilities over the world were prepared to admit then that technological transfer was a separate operation from engineering consultancy, or of technical training.

Today this idea is far more widespread, as a large number of buyers have been able to see for themselves - sometimes at the cost of heavy losses - that technological transfer was not a matter of improvisation.

Our trade is undergoing considerable expansion in the face of world demand for genuine technological transfer from Europe to other countries.

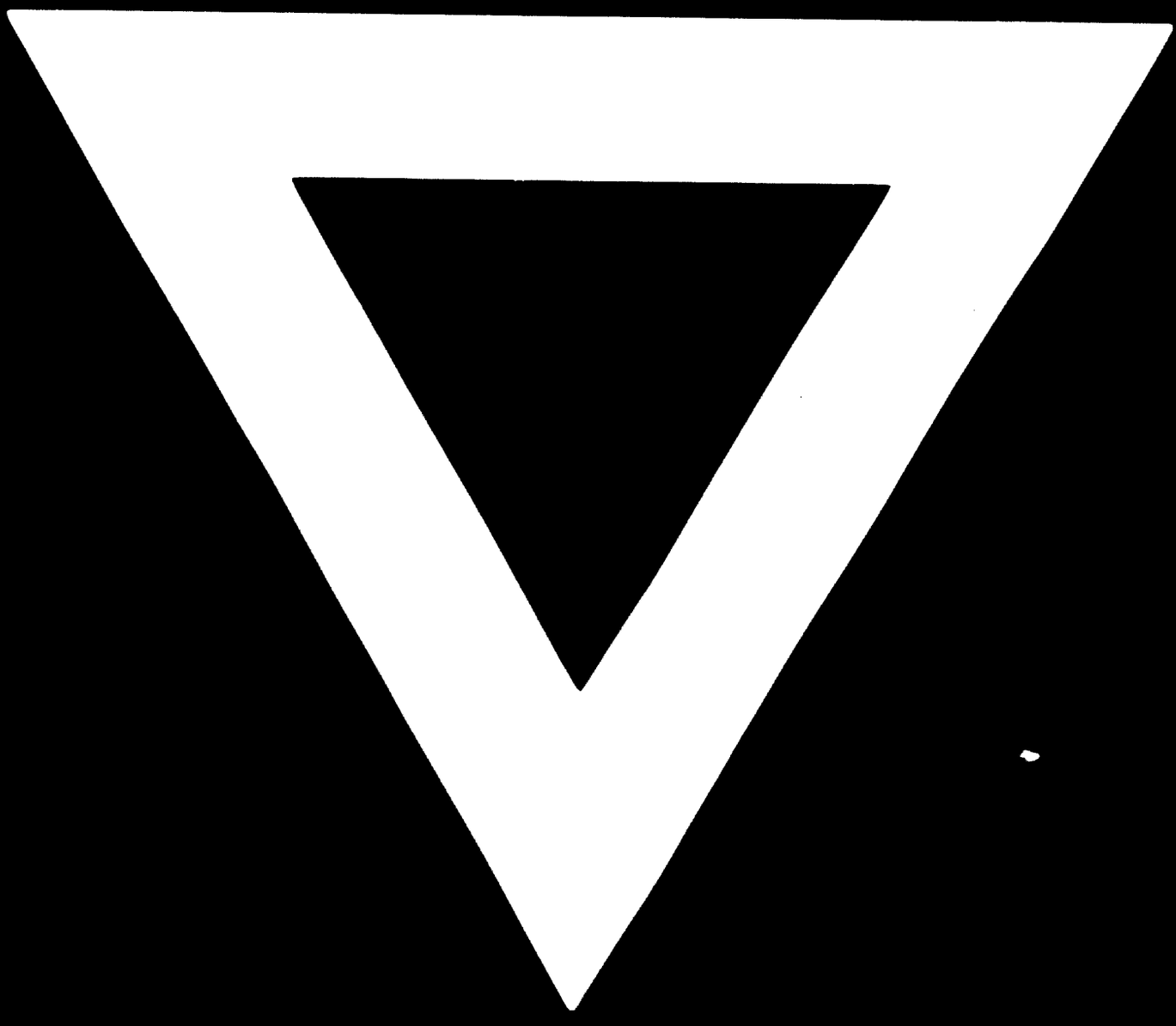
Moreover, we shall have to decide on the principle as to whether it is reasonable or not for the services of a technological transfer architect to be drowned inside those of the main industrial designer, any more than are the fees of engineering consultants drowned amongst the cost of the equipment. Shall we in this way arrive at true worth? The price for technological transfer should be a reflection of the combined effort of a team of men who are mostly unknown to the client. It will be notably higher than that for a simple team of professors giving straight courses. We know, and a great many of our clients know it too, that the capital outlay is invariably profitable.

There is another problem that requires looking into: the type of men who have the capability to cope with this type of operation. This may seem a simple matter, since the services involved are known respectively as recruiting, training, organizing etc. In fact it is a difficult problem to live with, and even a trying one, since the architects of technological transfer never have available all of the data of the problem available to them. They

therefore have to learn how to approach their solutions without ever deriving the same satisfaction as engineers do, who after months of working on a machine can at last say "It works!". This however does not prevent the technological transfer architect from having his own satisfaction when his task is accomplished.

More. Not only can he say "The machines work", but "Thanks to my efforts, they know how to make them work, maintain them and repair them; they know how to produce, keep up, store, distribute, sell and above all, themselves modify their technology". In such cases there is a valid reason to speak of genuine technological transfer.

C-267



77.06.28