INTERNATIONAL TRANSFERS OF TECHNOLOGIES: SUCCESSES AND FAILURES OF PRODUCTIVE SYSTEMS AND GENERAL GUIDELINES FOR POLICY

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Content

Summary

This chapter focuses on the success and failure of international technology transfers. It shows that technology transfers are not correctly addressed by referring only to the contracting of a technology. This is a crucial question to any vendor of technology and any buyer of technology. In fact, by limiting the chapter to what seems a specific question, we will present an account of a larger debate: how a productive system can be transferred from one location to another? Technologies are always embedded in a specific *productive system*. By looking at the productive system instead of the technology, a better understanding of the whole process may be obtained.

1. Introduction

The term "transfer of technologies" has been used to define two distinct realities. In the 1960's, it was used to describe an operation consisting of installing and rendering productive equipment operational in a country other than the one where the equipment was conceived and developed. In the 1980s, transfer of technologies was referred to as the transmission of academic knowledge to industry. Here we only want to refer to the former and older understanding of the term. Jacques Perrin gave a good definition of technology transfers as "the export of the implementation of techniques developed in the industrialized countries". More generally, technology transfer is referred to when productive knowledge comes from elsewhere. But transfers of technologies are constantly taking place and have been constantly been taking place at least since the very beginning of the industrialization, and probably also before that (See *The National*

Imperative: The State, Science, Technology, and Policy Evolution). The term is becoming redundant, being synonymous with that of "exchange of information". This explains also the difficulty in giving it a precise definition. All definitions would agree only on the idea of an international exchange.

It is perhaps useful to point out here that we are using the terms "techniques" and "technologies" in conformity with the Greek etymology, and not by reference to American usage, which tends to confuse the two notions. A technique is the knowledge of a particular relation that permits the transformation of a specific material by means of a specific energy. Every technique refers to a specific "material-energy" couple. With the word "logos", as in techno-logy, one adds a notion of discourse, that is, of a discourse that allows the reconstruction of knowledge in a more comprehensive vision.

The mastering of a particular *production system* cannot be limited to the possession of particular set of techniques. It is only possible through a discourse which structures particular elements of knowledge -a technology- in a coherent way, which explains the widespread use of the term technology in place of techniques. Moreover, one should not confuse the mastering of a production system with the possession of some technology. A technology, since it is a form of discourse, combining specific parts of knowledge, is more general than a productive system. A productive system is referred always to non-reproducible, specific and localized system, and, as we will show, is not easily transferable.

2. Technology Transfers are not limited to a Contract

Usually, technological transfer is considered as a contract between two legal entities, usually two firms. But the quality of a contract between two abstract entities may not assure the quality of exchange of knowledge between the sellers and the buyers of technology. To observe technical transfer we have to focus not on the legal contracts *but on the changes in production*. For that reason, we are using the term "*productive system*" when referring to producers, machines and production. A productive system may extend beyond the boundaries of more than one legal entity (for example a system owned by a firm in many different locations that refer to different enterprises in each location). Whatever be the legal configuration, *the quality of a technology transfer can only be assessed at the level of a whole productive system*. It follows, that the legal entities that sell and buy technologies (firms, centers, public entities) may not be exactly the same as those which transfer or receive the technologies (departments inside a firm, engineers and technicians, shop-works in a manufacturing unit).

Knowledge is not easy to define legally. It is also difficult to define conceptually, as most of useful knowledge lies in human brains or in hardware and software design. As we will see, it is hard to define precisely what is actually transferred in a technology transfer.

One cannot reduce the transfer of a productive system to the transfer of specific machines. There is a difference of nature between the material part of a machine, made of metal and plastic, and a production system, which is an articulation between machines and people. The material parts of the machines are almost completely

describable and reproducible. We say "almost" because even the material part of a machine has its own history, which includes adjustments, or minor modifications that are not always noted in any text or document. These minor changes will go unnoticed until someone tries to reproduce these parts.

People are also "non-reproducible". Each individual is unique, and each group of individuals is even more so. Any effort made to describe the human activity in a production system, however fascinating this may be, will always capture only a part of it, due to its complexity. It is not enough to read the internal rules of a firm, to note the schools attended by each of the workers, and to assemble all the existing documentation of the firm, in order to have a precise description of a productive system. And no description of an efficient production system will be enough in order to reproduce it in identical terms. A production system is not reducible to a form of merchandise, and cannot be reproduced identically.

But contracts for technology transfers are written with this “fiction” in mind. They are done "as if" a complete and adequate description of the system is possible. A seller shows its clients a productive system, which works fine for him/her, and offers to sell him/her the material objects and the procedures attached to the system. But what he/she shows is more than that: it is a production system, and the buyer will want to acquire one equivalent to what he/she held up before his/her eyes. The contract is written in precise terms, but fails to convey the "production system" to the buyer. Nevertheless, sometimes the transfer is really done adequately, sometimes not. The reasons of success or failure go far beyond what were described in the many headings of the transfer contract.

Except, when States consider certain types of equipment to be "sensitive", and prohibit their sale; the transfer of material objects constitutes no real problem. What may cause problems is the exchange of information. This is not limited to international technology transfers, but applies to all sorts of situations involving technology. Similar to a technology transfer contract, a patent does not include all the detailed body of know-how that makes most inventions usable. In order to have an effective transfer of technology, through a license or a contract, two conditions need to be met: on the one hand, the know-how has to exist and, on the other hand, the person who possesses it has to agree to transfer it. Knowledgeable authors who know these limitations attempt to describe the elements that the seller should provide, in order to make an effective transfer. For example, J. Perrin imagines that the transfer should include the provision of documents and training operations. But this is also largely insufficient to assure the success of the transfer. The difficulty might arise from the fact that the seller is not the one who possesses the expertise that he/she is claiming to sell. This knowledge is to be found in the brains of his/her employees. Very often, buyers of technologies assume that they do not benefit from the information they have paid for because of retention of information on the side of the seller. They assume that the seller possesses the detailed know-how. In reality, the problem is more complex, since the retention comes from the workers themselves, and not because of a voluntary retention of information.

But none of these difficulties are apparent at the moment discussions go by when signing a technology transfer agreement. In many cases, the difficulties begin to arise

after the experts who participate in the installation of the equipment go back home. Problems need to be solved without their help.

3. An Example of Breakdown and Repair

Since a good story sometimes permits to better understand than a long theory, we will use the comparison of two cases of purchase and installation of numerically controlled machines in Argentina. In both cases, the same robot was bought by two different firms in Argentina. Both of these robots presented problems when they were brought into service - each suffered a breakdown. But the attempts, which were made to overcome the problems, were radically different in the two cases. (The cases have been described in detail in J. Ruffier, "Qui possède les machines?", *Gérer et comprendre, Annales des Mines*, Paris, March 1989, pp. 79-86.)

The first robot belonged to a subsidiary of a European automobile group. Another subsidiary of the same group, located in Europe supplied it. The decision to buy it was taken at a very high level, as part of a strategy of homogenization of the equipment in the group's different factories. The result was that there was no direct contact between the subsidiary that produced the robot and the one that bought it. When faced with the breakdown, the Argentinean firm looked for help from the subsidiary. They did not succeed in locating anyone who could give them any advice by telephone, other than to offer to send out an expert. Given the cost of this operation, the firm decided to try and solve the problem by itself. They borrowed an identical robot from a neighboring factory, and their technicians unplugged all the suspect circuits one by one. Each time, they looked to see if this produced an anomaly similar to the one that affected their own robot. Eventually this happened; they had identified the faulty component, and ordered a replacement. The repair procedure unfortunately lasted several months, during which time the personnel who had been trained in the use of the robot were assigned to other posts. After repairing the root, the factory found itself alone in training people in the use of the robot. A year after its purchase, the robot was working at only a quarter of its capacity.

The story of the other robot gives an idea of what is concerned in mastering the technology. It concerns a firm situated in an industrial zone in Tierra del Fuego. The firm bought three robots for positioning components on printed circuits. One day, one of the robots began to refuse the instructions it was given. The engineers looked into the problem, but were forced to recognize their inability to deal with it. They decided to call on Harry, in the USA, an American technician who had participated in the installation of the robot, and in whom they had great confidence. Over the telephone, Harry got them to explain the problem at length, but he remained perplexed. He promised them a rapid reply, and rang off. He then discussed the problem with his colleagues, who found that they knew of similar breakdowns that had happened to equipment they were familiar with. The repair was quite simple, consisting simply of replacing two components on a card. The only difficulty was in indicating the components, which had caused the fault. Harry called back the factory in Tierra del Fuego and sent them a photo on their fax machine, to show them what was required. The Argentineans had taken the precaution of laying in quite a large stock of spare parts. They carried out the suggested repair operation and the robot once again began to meekly follow the instructions it was

given. Less than forty-eight hours had gone by since the time the breakdown had taken place.

What a contrast between the two examples! In one case, it took ten months to put together the information, which was probably available in the same firm, though on another continent; and, in the other case, forty-eight hours were enough to obtain the same information from a supplier who was just far away.

The reason why the firm called the constructor was because they did not know the reason for the breakdown. They did not even know whether it was something routine, or something unusual, and therefore could not know in advance if Harry would find a quick solution. So, regardless of contractual obligation that might have bound him, no one could have challenged Harry if he had claimed that long-distance diagnosis was impossible. The firm could only take him at his word. And furthermore, Harry himself could not resolve the problem. He in turn had to count on the goodwill of some of his colleagues to obtain the information necessary to carry out the repair. Harry's colleagues would have been within their rights to demand that he take a more formal approach, with the issuing of a repair form and the setting in motion of an administrative procedure. But they did not do this, which comes down to saying that, as a result of the Argentinean firm's enjoying good relations with Harry, they were able to benefit from Harry's enjoying good relations with his colleagues.

Now let us imagine what would have happened if Harry had left his job. The Argentinean firm would not have known whom to call. The reason why they called Harry was not because they supposed that he was the person most competent to resolve the problem, but because they knew him, and had confidence in him. In the absence of Harry, it would have been necessary to find the means of getting in touch with the appropriate people. Then it would have been a question of hoping that these people would prefer to do a favor for a client rather than look after the interests of their own firm. Finally, even supposing that their firm had developed an attitude of particular responsiveness to the problems of their clients, it is probable that Harry would have been difficult to replace. He was in fact the only person who knew the client’s set-up in concrete terms. He thus had a more relevant view of the situation, and one, which was more likely to lead to a diagnosis. Harry did not find the reason for the breakdown, but he was able to describe it, and its environment, in such a way that the reason for it appeared evident to the specialists. We would say that, beyond the real problems of foreign languages, Harry served as a translator. He allowed a transmission to take place, which went well beyond the elements communicated by telephone. He succeeded in communicating the worries of the Argentineans, and supplied contextual information, which they themselves didn't know how to give. Nothing of all this, neither the willingness, nor the quality of interpersonal relations, nor a pertinent appreciation of the context, can be part of a contract. Thus, the relations necessary to the satisfactory functioning of this robot could not be guaranteed by contract. While working on twenty different establishments scattered all over the territory of Argentina and Uruguay, a group of sociologists found a direct relation between the efficiency of the most complex machines and the quality of relations between the main actors in the process of their installation.

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Biographical Sketch

Jean Ruffier is a CNRS researcher, Director of Centre Franco-Chinois de Sociologie de l'Industrie et des Technologies (Lyon and Guangzhou), founder of INIDET, a network including researchers from Europe, Latin America and China. His main topics are productive efficiency, technology management, technology transfer, risk management and sustainable development. His main operative way uses mainly small international teams to study factories all over the world. He tries to explain why some factories survive, and why others no. He built a diagnosis tool in order to assert the ability of factories to face the future shocks, detect bleak points in the use of complex productive equipment, as bleak points in the ability to get strategic information where it is needed to take good decisions.