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# TECHNOLOGY TRANSFER AND MANAGEMENT SYSTEMS

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## INTRODUCTION

OVER the past several years, the developing and newly industrializing countries (NICs) have strongly demanded that the industrialized countries provide them with technology. That demand is based on an increasing awareness among these countries that they lack the technology stock to achieve industrialization and is motivated by a change in the focus of economic cooperation from funding to technology transfer.

The problems are much greater with technology transfer than with fund cooperation because the implementation of transfer is more dependent on human factors. It is for that reason that I would like to examine the theoretical basis for the human-behavior-related problems likely to occur in technology transfer.

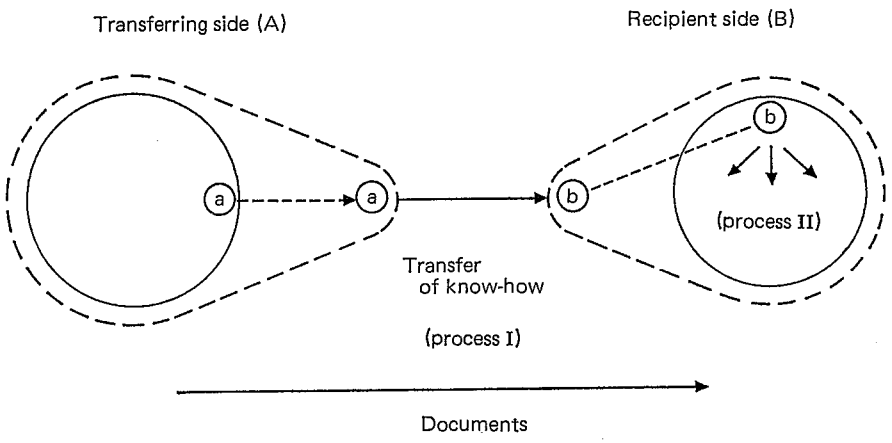
There are two types of technology transfer. One is between organizations (including private corporations), the other is within organizations. To thoroughly understand the problems of technology transfer we have to keep the two categories separate. Most research on technology transfer has focused on the first process, contracts between provider and recipient and changes in transfer methods. The problem's second aspect, in-organization transfer, has hardly been studied at all. The specific questions that must be looked into are how technology, once transferred, is distributed within the recipient organization, or how it is prevented from being distributed, and how differences in the two organizations' management style affects the transfer.

Technology transferred from a Japanese corporation is technology formed under a Japanese style of management. Since the subject of this study is technology transfer by Japanese corporations, the study also looks at a second problem: the relation between technology transfer and management system.

## I. THE TECHNOLOGY TRANSFER MECHANISM

In general, pure technology transfer (technology transfer that does not accompany capital tie-up) by Japanese corporations takes this course. The potential recipient looks for a transfer provider. Only seldom have Japanese corporations sought to sell their technology through joint ventures. If the Japanese company looks favorably on the overture, the two sides begin negotiating the conditions of transfer. Successful conclusion of negotiations will be capped by a contract, and the technology transfer then enters the implementation stage. In technology

Fig. 1. Two Processes of Technology Transfer




transfer between nations (particularly when the partner is a developing country) the recipient's government may place restrictions on the stage of contracts negotiation and conclusion, but we will not go into those problems at this time.

In addition to transferring documents in the implementation stage, the Japanese corporation sends instructors and advisers to train the recipient's employees and/or the recipient sends its people to the Japanese corporation to be trained. This gives the Japanese technology transfer form two distinct features during implementation: it is a transfer of "things written down," of documentation; and it is a transfer of "things that cannot be written down," knowledge that can be transferred only through hands-on training and experience.

In technology transfer, most Japanese corporations provide general-purpose but not detailed manuals.[1] This lack of thorough documentation is attributable to greater emphasis on direct transfer of know-how between trainer and trainee. The success of Japanese technology transfer is highly dependent on the success of non-documented technology transfer.

In simplest terms, two processes make the transfer of non-documented technical knowledge possible. Figure 1 diagrams that concept, an example of the first process. The diagrams shows that a transfer of undocumented technology from corporation A to corporation B, is a transfer of knowledge from a, the corporation A instructor, who trains b, the corporation B trainee. Some problems occur in this process but they will not be examined here.[2] After b acquires knowledge from a, b returns to corporation B. Then comes the second process in which b

[1] In field surveys on technology transfer to Korea, fifteen basic manuals were provided for study but only three were detailed. For Taiwan only one out of seventeen was provided.

[2] The language barrier for one thing. The results shows that instructors from Japanese corporations should have better ability to converse in the local language and English, and be better versed in local conditions.

imparts the knowledge he has learned to his fellow workers in corporation B. In this process, corporate management style, that is, decision-making procedures, relations between technology and skills, technician training methods and small group activities, greatly affect how fast and how far technical information will spread throughout the company.

Technology transfer progresses by repeating the two processes, the efficiency if technology transfer depends on how efficient the two processes are. If the first process has an efficiency of 100 per cent, and the second process has an efficiency of only 50 per cent, overall efficiency is only 50 per cent.

The experience of Japanese corporations as technology transfer recipients shows that even if the provider gives adequate training, the efficiency of technical acquisition cannot be 100 per cent. However, the trainee's efficiency in imparting what he learned to his fellow workers can be close to 100 per cent. If it is, the group of people who train next will have an adequate foundation for building and increasing the second process's efficiency to almost 100 per cent.

Reasons the Japanese corporation has attained an almost 100 per cent efficiency in the second process are: (1) smooth transmission of information in the organization; (2) self-help efforts to promote the absorption of technology (for example, organizing groups to study technical absorption); and (3) the relatively high availability of manuals and other documentation from Europe and the United States to aid in absorbing the technology. Points (1) and (2) are critical to the arguments of this paper, because the Japanese corporation has the kind of management system that backs them up.

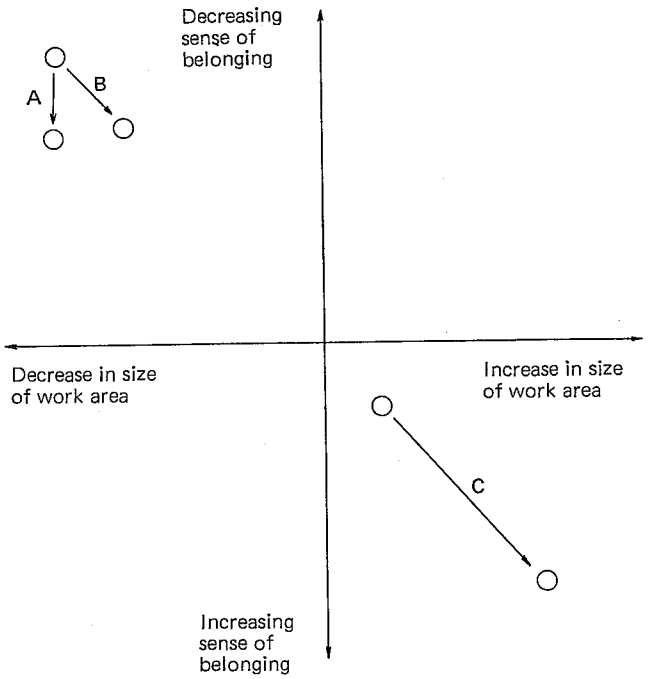
Inside the Japanese corporation, technological information is transmitted fairly and shared equally. One reason for this high level of information distribution is employee job security. The traditional lifetime employment makes the employee see his own future as intrinsically linked with the corporation's. Each employee wants to improve the company's performance because it improves and stabilizes his own life. This is why information, including that from technology transfer, is openly shared and why people know how important increasing the efficiency of technical absorption is.

Second, there are a large number of highly skilled workers and they freely interact with the engineers. With good communications between the two groups, the engineers are able to use what the skilled workers know and the skilled workers can easily get advice from the engineers.

Third, job descriptions in Japan are not as well defined as they are in Europe and the United States. Engineers and skilled workers can work in a much wider range of jobs than in other industrialized countries. The wider-ranging job area means that engineers have to have broad experience in production control and the workplace and that skilled workers have to be able to handle a much wider variety of jobs. The promotions of employees in large corporations is greatly dependent on broad experience in all areas.

Information shared by job-secure employees who have wide-ranging work experience, gives high-level support to individually acquired technical knowledge. Through information-sharing, that knowledge is converted into technical aquisition for the organization.

Fig. 2. Level of Belongingness and Breadth of Work Area




These factors have promoted technical absorption in Japan and have become the base out of which improvement is born. The existence of this base in itself gives a special Japanese flavor to technical absorption, progress, and development. The existence of this base is also one reason why the Japanese corporation does not compile detailed technical manuals and why detailed regulations do not govern every nook and cranny of Japanese work life.

To smoothly transfer technology that has been formed on this singular Japanese base, the technology provider has to have a thorough picture of the management system in the corporation or country to which the technology is going. Of the Japanese characteristics mentioned that can be used as standards of comparison, the most important are (1) employee depth on the corporate team and (2) the breadth of workplace for engineer and skilled worker. We can construct a coordinate graph as in Figure 2 in which the sense of belonging to the company is the vertical axis and workplace breadth is the horizontal axis. If we plot the changes taking place in Japan, the change vector is the diagonal line sloping down to the right. This shows that in the second and third decades after the Second World War, the feelings of belonging to the corporation grew stronger and the workplace became much wider, for it was not until well after the Second World War that the concept of long-term employment for all employees, including skilled workers, become customary. Widening the work area by transferring employees to and from different jobs in the company is not an old idea.

If we plot examples from industrial case studies on the Republic of Korea,

the plot would be like that for A. That is, the rate of voluntary employee termination in the Republic of Korea is decreasing but there is not much increase in the workplace breadth. In Taiwan, companies are appearing that have a vector like B, but they are not yet the norm. We should also keep in mind that this graph demonstrates individual corporate characteristics rather than national characteristics of the country where the corporation is.

Necessary to efficient technology transfer is a determination of where the recipient corporation is on the graph and what sort of vector it traces. If the organization is, for example, at vector A, or at starting point A, its employees have little feeling of belonging and it lacks workplace breadth. Thus, we would anticipate that the second process, the transfer of non-documented technology, would have very low efficiency of transmission. The reason that efficiency would be low is that those who acquire a high level of technical training refuse to share their knowledge with others to keep their reemployment sale value high so that when they are scouted and offered better wages by other companies, they have something unique to offer. Generally, information sharing does not increase, because even if the employee has job security, he makes no attempt to let others know what he knows. Thus, employers like these prefer that when they receive technology it be in document form. Preparation of documentation becomes indispensable. Lack of documentation greatly reduces the efficiency of such a transfer.

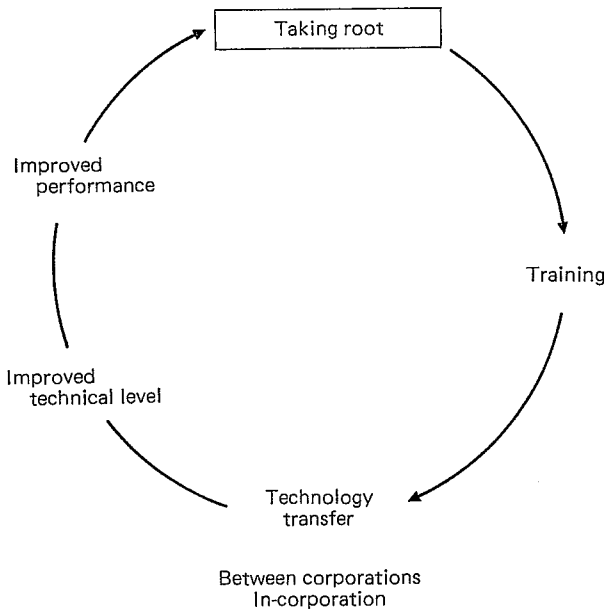
On the other hand, a vector like B indicates that non-documented technical transfer is more useful. At the same time, introducing the management system as the base on which technology in Japan was developed, is an effective means of promoting feelings of belonging among employees and expanding the work area.

## II. SPIRAL OF TECHNOLOGY TRANSFER

No matter whether the technology is documented or undocumented, the target organization definitely requests that it be the repository for technical knowledge. It is desirable that the information repository of be partly in documents and partly in a form which can be shared and used to unify skilled workers and engineers. As we have seen before, technology in Japan has grown on a base that has special characteristics and the largest relative proportion of that development has been through a unification of people. People tend to believe that a low rate of voluntary employee termination is necessary for Japanese technology to take root.

When people feel they are integral to the organization, or if there is a possibility of such feelings arising, another possibility occurs, i.e., that the spiral of technology transfer, shown in Figure 3, will start. If the rate of voluntary employee termination is decreasing it becomes possible for management to set up conditions to adequately train employees. Taking the time and money to train the employee is a sure way for the Japanese-type corporation to develop the employee's sense of belonging. This is because it takes the organization a long time to recover the cost of its investment. Conversely, if there is little possibility that employees will develop this sense of belonging, then no attempt is made to provide adequate training.

Fig. 3. Spiral of Technology Transfer




Surveys made on the die-casting and molding industry in the Republic of Korea, show almost no provision of training during the first two or three years after the employee hires on, the period of highest rate of voluntary employee termination. Since a marked drop in this rate by employees who have worked for the company two to three years would increase the rate of training efficiency, this training should be provided mainly by off-the-job training.[3]

As discussed, when technology is transferred between and in corporations, and the base for that transfer is formed by adequately training employees who have strong feelings of belonging to the company; the transfer will be smooth, and, most likely, efficient. Since the process of transfer between technological provider and recipient is, generally, constantly repeated, the transfer's efficiency or lack thereof is very meaningful.

If the efficiency of technology transfer in both between- and in-corporation aspects successfully continues, the corporation's technical level improves. That is natural because technology transfer is for improving technical levels. If the technology is not only absorbed during this period, but is improved upon, then the transfer efficiency heightens further.

If market and competitive conditions remain the same, the upgrading of technical

[3] For a detailed discussion of this point, see Shin Yoo-keun and T. Hattori, "A Pattern of Skill Formation in Korean Industries," I.D.E. Joint Research Program Series 54 (Tokyo: Institute of Developing Economies, 1986).

levels as a result of technological transfer should help the corporation improve its performance. If the fruits of that improvement in performance are distributed justly and in a way with which all employees can agree, the rate of voluntary employee termination decreases. In this stage, the sense of belonging to the company becomes a departure point for the "spiral of technical transfer," something of higher level than "generation of possibilities for a sense of belonging." When the spiral makes its second turn and managers create conditions for greater stability in which they can invest in serious employee training, they are preparing a base for smooth technical transfer.

If we look at this in its connection with Figure 2, in the stage in which the rate of voluntary employee termination for engineers and skilled workers is high, it is almost impossible to broaden the work area. The reason for this is that in order to expand the work area, the employee must be on the job for a certain period of time to be adequately trained and given responsibility in a particular area.

There are people who would argue as follows. Even if a person does not work continuously at the same corporation, if he is a skilled worker who has acquired his skills in one area of responsibility and then moves to another company and is employed in a related field, isn't the effect the same? I would answer that if an engineer or skilled worker has been trained in a particular technical area, and he moves to another company, we do not know whether he will be employed in an area related to the skills he has. More than that, though, there is a good possibility of employment in a field where he can use what he knows. In that case his work area will not expand. And even if he does work in a related area, there is no guarantee that the way in which job span is determined is the same in the new corporation. Thus, work area expansion by working in a number of corporations does not have the compatibility and is not as efficient as expansion of work area by working in a single corporation.

The contention then is that the first of two strong features of Japanese management: (1) high sense of belonging and (2) wide work area, is the more fundamental. Figure 3 shows what is most necessary for absorbing technology from Japan.

What are the major features of "Japanese" technology and skill?

One important point should first be mentioned here. Even though it may be possible to conceptually distinguish between technology and skill in the Japanese corporation, it is very difficult to do so at the job site. It is not impossible to distinguish, for example, between the engineering department and the technical department in a Japanese corporation, but it is very difficult to clearly distinguish the scope of technology and skill in production control and process control which play a very important part in bringing the two departments together. The reason is that both technology and skill are required to make production and process control function efficiently and that most sections are cooperative workplaces for both engineers and technicians.

Quite naturally, even in the Japanese corporation, the engineering department is under the control of engineers and the work site is handled by skilled workers and technicians. However, that does not mean that a person who has been trained

Fig. 4. Relations between Technology and Skills (Japan)

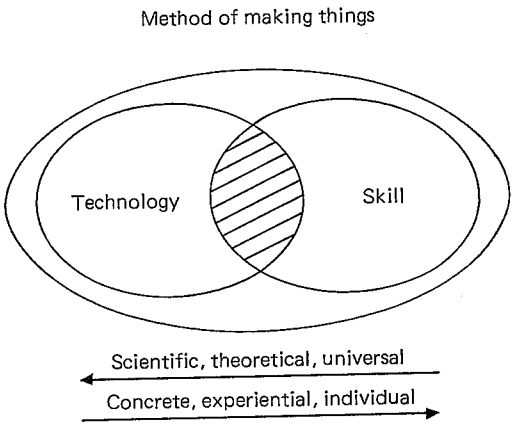
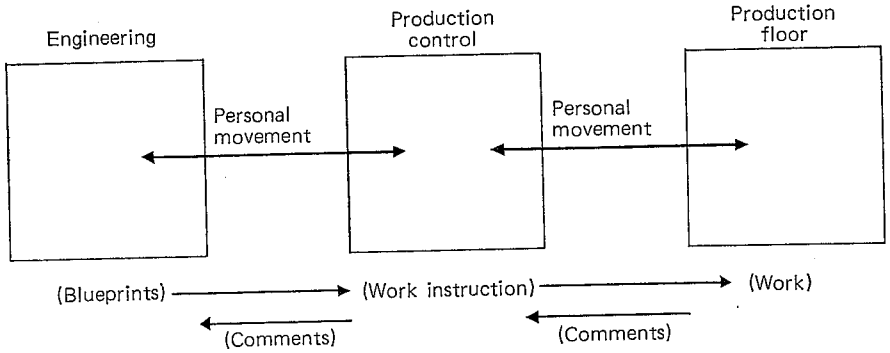



Fig. 5. Technology, Skills, and Management System (Japan)




as a technician will not transfer to the engineering department. And, as I mentioned previously there are a lot of people trained as technicians and skilled workers who have entered the production and process control departments. This is because these departments have to have the kind of knowledge that can be gained only through practical experience. However, no matter how indivisible technology and skill are in the actual workplace, we have to conceptually define and distinguish them for the sake of theoretical argument. For the purposes of this paper, I would like to define technology and skill as follows. Technology is that part of "the method of making things" which is scientific, theoretical, and universal while skill is that part which is concrete, experiential, and individual.[4]

However, since it is very difficult to distinguish a pure technology and pure skill in the corporate production process, these two overlap in a great many ways.

[4] Refer to definition in H. Tanaka, *Kaitai suru jukuren* [The collapse of training] (Tokyo: Nihon-keizai-shinbunsha, 1984).

Figure 4 shows the relationship between technology and skill in the Japanese corporation. Technology and skill can be placed as subordinate concepts under the overall concept of "the method of making things," and the two subordinates overlap. I believe this overlapping is the reason for the birth of high levels of production technology in the Japanese corporation, and that this is a part of both production and process control. The arrows at the bottom of Figure 4 indicate the trends in the character of previously defined "technology" and "skills." The farther to the left, the higher the involvement of technology, the more to the right, the greater the involvement of skill.

Areas of overlap between technology and skill differ according to the product in the particular process. The area of overlap is relatively small in semiconductor production but extremely large in die-casting and molding. That means that the relation between technology and skill changes according to what is being produced. However, as will be shown later, the relationship between technology and skill, even in producing the same product, changes according to the type of management system that backs it up.

What is the relationship between technology, skill, and management system?

Figure 5 is a model of information flow and personnel change between the engineering department, production control department, and the factory floor in one Japanese die-cast producer. The model's most important part is the production control department. The department consists of people transferred from the engineering department and the production floor. Production control's most important function is to convert designs from engineering into work instructions. Performing these duties requires design knowledge and actual factory-work experience. This is why the people in this department come from both engineering and the production floor.

During the process of conversion, designs are frequently sent back to engineering and work instructions are frequently sent back from the production site. There is a constant back-and-forth flow of information between these three departments. That strong flow is attributable to the frequency of personnel interchange between engineering and production control and between production control and the floor. Not many technicians are transferred from production to production control and then to the engineering department, but it does happen.

What makes possible this smooth flow of information and frequent change in jobs is the extremely high sense of belonging on the part of employees and the lack of difference in job conditions between engineers and skilled workers. The situation is common in many Japanese corporations.

When Japanese corporations take in technology, they rotate the spiral of technical transfer smoothly. The mechanisms discussed above and the management system work to accommodate the absorption and improvement of new technology.

## III. IMPROVING TECHNOLOGY AND MANAGEMENT SYSTEM

If the technology which Japan has adopted is absorbed and improved, and independent technology is developed through the workings of the mechanism

Fig. 6. Relations between Technology and Skills (Outside Japan)

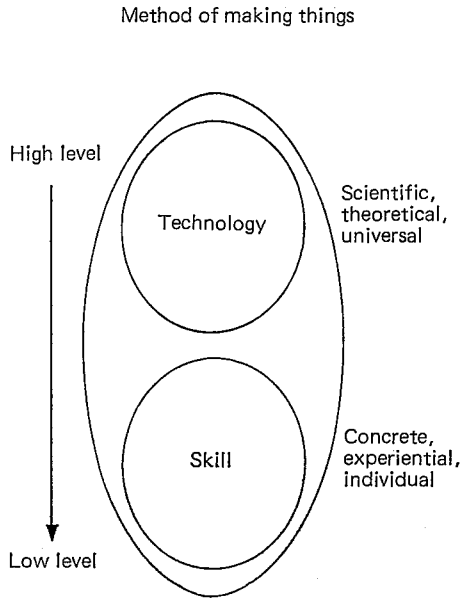
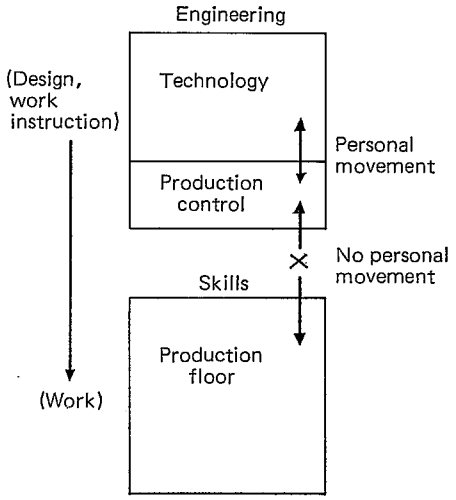



Fig. 7. Technology, Skill, and Management System (Outside Japan)




discussed, when the recipient side looks at the management system and relations of technology and skill that would be received with Japanese technology transfer, what sort of model do they have in mind?

The relation between technology and skill can be first described through the use of Figure 6. This model differs from the Japanese in that both are assumed to have a vertical relationship and there is no, or almost no, overlap in the two components. Thus, the production control department in the Japanese corporation joins the two together, is seen as part of engineering and requires control techniques, from a purely technical perspective. This means that the lack of mutual intermingling between technology and skill prevents the human interaction that occurs through the back-and-forth transfer of people between engineering and production, and very likely limits the information flow.

When we look at the management system, we find parallels in the vertical relationship between technology and skill and large differences in work conditions between the two aspects. Those differences make human interaction through job transfer very difficult between the engineering department and skilled workers on the production floor (Figure 7). This system is clearly different from the Japanese.

Despite all that, both Korea and Taiwan have absorbed a great deal of technology from Japan. The reasons for their success, from my viewpoint, can be summarized as follows. (1) Most technology Korea has brought in so far is comparatively easy to absorb because it is standardized, mature production technology. (2) Efforts in self-help (on the individual level) to absorb technology

have been made. (3) The rate of voluntary employee termination has decreased markedly during the 1980s. But, qualitatively different ways are required to deepen the hold of these work practices and to further improve the technologies introduced.

For one thing, when Korean corporations have tried to use Japanese technology, they face several blocks that prevent the spiral (Figure 3) from turning properly. Surmounting the obstacles requires changes in the relationship between technology and skills and reform in the management system that supports them. Increasing the efficiency of technical transfer within the corporation, for example, requires a management system that makes information transmission more efficient. The Japanese corporate experience requires that groups be organized to absorb and improve introduced technology, both engineers and skilled workers participate in these groups, and the groups work closely to effect exchange of information and personnel. There must be no vertical relationship between engineers and skilled workers and no great differences in rank and privileges so that employees openly give their opinions. Japanese corporations with few vertical relationships and differences in rank and privileges created groups to absorb and improve technology.

If we look at the Asian NIC and LDC corporations, we see management systems that are not developed to this extent. Differences between job conditions for engineers and skilled workers are large and no basis exists on which engineers and skilled workers can adequately exchange information.

Another important point is the lack of equitable distribution of the fruits of labor. If the benefits are not distributed in a way acceptable to the employee, they do nothing to increase the employee's motivation and sense of belonging to the company.

Rather than problems of technical transfer per se, these are problems of management system in the transfer recipient corporation. As the weight of transferred technology changes from assembly to production, i.e., from technology based on charts and manuals to know-how that cannot be placed in document form, the importance of non-documented technology increases. As this happens, the management system, the base for accepting the technology, not technology transfer, greatly affects transfer absorption and technology improvement.

## IV. CONCLUDING REMARKS

This paper has discussed the absorption by the recipient of technology transferred from Japan, the logic of that absorption and the relation between transfer efficiency and management system.

It is clear that to increase the efficiency of technical transfer, attention must first be given to the employee's feelings of belonging to the corporation, something that is fundamental if Japanese-type technology is to adequately take root in a country. This can be logically explained as follows. Not all Japanese technology is developed in Japan. But the technology transferred from a particular Japanese corporation, albeit with certain differences of degree, is technology improved by

that company. These improvements were made, as we have seen, by engineers and skilled technicians working constantly in a process of information and knowledge exchange. This is why corporations with systems for adequate exchange of information do not need detailed manuals, but corporations without these systems do. People in the former corporations are aware that technical informaiton is shared and consider the technology to have a cohesive effect on people.

It is widely believed that technology is logical, scientific, and universal, but the skills of those who use the technology reform it. That technology cannot be adequately transferred through "things that are written:" charts and manuals. This is where technology that has become coherent through the actions of people comes into play. Here lies the difference in character between science and technology. This is also the reason why management systems provide an important base for technology absorption. To fully absorb and improve technology, the recipient must change its management system to one that resembles the provider's or construct its own management system that helps to efficiently absorb technology. The provider must take as his premise the difference in management style and make preparations so that the recipient can better absorb the technology, if need be through the preparation of detailed manuals.