Chapter 3

3. Background of TT. Key issues affecting successful TT.

Mexico has traditionally been a technology importer. Technology development is a very small activity in the country. Technology transfer in Mexico has been heavily influenced by the foregoing historical factors and has been shaped by the North-South dialogue affecting hemispheric and world technical assistance programs. The modalities of such programs have been dictated almost exclusively by the industrialized nations and their powerful banking sectors.

According to INEGI statistics, there are over 3.7 million establishments in Mexico that employ 20 million people. Approximately, 96% of these establishments are considered micro-businesses, 3.3% are considered small sized businesses, 0.5% is medium sized businesses, and only 0.2% are large firms. Yet large firms present over 45% of GDP. Micro- businesses and SMEs contribute most of the rest. Large companies in Mexico are to be considered to be the most economically significant promoters of TT, they are the primary investors in new companies or expansion plans. Very few Mexican companies other than Telmex, Cemex, Bimbo, Maseca, etc. come to mind when thinking of entrepreneurial, innovative, expanding businesses.

3.1 Structural ways for TT in Mexico.

In general, there are five prominently used structural ways to transfer technology to recipient nations, such as Mexico (Madsen, 1999):

1. Multi-National Joint Venture: Host Government and International Corporation.
2. Wholly-Owned Recipient: In-Country Entity, 100% Local Control.
3. Entrepreneurship: Small Businessmen Cooperating with Foreign Company.
4. Technical Cooperation Package: Assistance from Foreign Governments or Entities.
5. Consortium: Temporary Construction Contracts in Host Country.
6. Alliance Model: On-Going Collaboration among Host & Foreign Companies.

The multinational joint venture approach is frequently used by Asian and American firms wishing to cooperate with Mexican investors. When the interests of all parties are convergent, such as during the fall of the Peso in 1995 (Kelly, 1996), then foreign interests flock to Mexico, establish joint ventures and partnerships under this JV model described by Lado (1996) and attempt to assist Mexico certainly, but also to enrich themselves in the process, which generally occurs. Joint ventures can be dissolved, as can the consortium approach, after everyone has extracted what gains they sought.

The wholly-owned recipient approach is also fairly common, according to Lado (1996), who acknowledges that countries like Mexico frequently make capital investments in foreign technology and retain full-ownership rights when doing so. The whole-ownership approach is of special applicability, in Mexico, to firms like PEMEX with considerable capital to invest in oil-related businesses, distributorships, warehousing

operations and retail outlets, among other investment channels. It is fairly rare to see smaller investors with enough capital to fully purchase new technological ventures from funds located within the recipient nation, particularly in Mexico where vast amounts of capital are controlled by an elite.

The entrepreneurial transfer approach can be fused with the wholly-owned concept, except that projects are usually much smaller and have a reasonable chance of succeeding, due to proper in-country financing. The order of magnitude of a wholly-owned industrial venture might be in the vicinity of 70 million US dollars, whereas the individual or small-group entrepreneurial investment might be on the order of less than one million US dollars (AAA Trading, 2001). These are becoming more highly visible as small stores, modestly-sized manufacturing facilities for tourist-related jewelry or handicrafts, and other small businesses are opening, in an apparently unplanned and random manner along the border (Orme, 1996).

The technical cooperation approach that is typified by the Ford-Mazda Assembly plant in Hermosillo, Sonora. By providing the most advanced technology available in the world (Japan and U.S.) to a well-constructed assembly plant complex, at reasonably high wages by Mexican standards, not only can well qualified Mexican workers be attracted, and 'fine-tuned' as required, but profits can be made on a scale that encourage further expansion of these efforts, beneficial to all parties. Apparently, although conflicting assessments have surfaced, the Hermosillo assembly plant has been only a minimal polluter and has maximized the proper corporate culture, resulting in productivity, efficiency and general contentment among workers. This technical cooperation approach has been difficult

to replicate in Mexico and, for some reason, it appears as if the Ford-Mazda plant is an exception to the rule. Although it is not a widespread transfer vehicle in Mexico, Lado (1996) goes to some pains to describe the efficacy of this approach elsewhere in the world.

The consortium approach, for example, would involve a temporary foreign presence in Mexico and the hand-over of managerial control at some point in the medium term to Mexican personnel. Ownership may remain firmly in the hands of foreign interests, but control is transferred gradually to Mexican administrators, thus dissolving the original consortium of firms and reestablishing the industrial operation under full-fledged Mexican licensure. The consortium approach is usually limited to construction of facilities and operation and maintenance for the first few years after completion of the plant. Sometimes hotel complexes, while being built, fall under this temporary consortium arrangement wherein expertise, financing and planning are provided for a brief period of time, then the participating companies dissolve and allow the local entrepreneur to manage and administer the complex. If profits fall or financial obligations are not honored, pressure is exerted to regain managerial control of the complex under another structural arrangement. Sometimes, special privileges are granted to Mexican contractors because of long-standing trust and confidence; however, the harsh realities of financial losses or the prospect of failure of a technology-transfer project ultimately resurface if stockholders or government agencies are, in turn, under pressure themselves.

The alliance approach is one that is fairly commonly used in Mexico. Entire nations collaborate with Mexico, whether the PRI or PAN parties are in power, to bring new industrial complexes into being, generally “maquilas”. Given the attractive economic

climate in Mexico, all parties in the short, medium, and long term stand to gain, in spite of the surface appearance of developed nations exploiting labor in Mexico (Wilkie, 1997; Ganster, 1998).

3.2 Models of TT.

In the literature, there are three models of TT that have been most prevalent. The "Appropriability Model" emphasizes the importance of quality of research and competitive market pressures in achieving TT. This model assumes the myth that good technologies sell themselves, but that is rarely true in the real world.

One of the most current models of TT is the "Knowledge Utilization Model", which emphasizes the importance of interpersonal communication between developers and users, organizational barriers and facilitators of transfer. This model tends to reduce a very complex process to chronologically ordered stages.

The "Dissemination Model" is a conceptual model of technology transfer proposed by Rogers (1995), and described by Walumbwa, and has three broad categories surrounding the core technology:

- Developmental stage.
- Implementation process.
- Diffusion.

TT in the dissemination model is a cyclical rather than linear process whereby the developers of the new technology collaborate with other forces of transfer, including the end users. There are some basic elements of TT which will be described later, but it is important to mention that some of them are found in more than one category of this model. This means that these elements have multiple roles in the entire process of TT.

The elements in the developmental stage are concerned with the end users of the technology. These elements are specifically important in the design stage because they enable the developer to comprehend the culture of the end users, and their economic capability. Careful assessments of these elements are a prerequisite for further steps in the TT process. The elements in the developmental stage are: needs assessment; sociocultural and environmental factors such as existing practices, experience and capacity; characteristics and types of technology, economic/financial resources and timing.

The implementation process elements are vehicles that facilitate TT. The elements in the implementation process are: sociocultural, environmental and political factors; resources such as financial, human, time and information channels; research centers and institutions and education and training.

The diffusion process is the final stage in this model. At this stage the end user decides whether or not to adopt and use the technology transferred. The elements in the diffusion process are: sociocultural, environmental factors and communication barriers; target groups such as opinion leaders and change agents; research centers and institutions; government and politics and infrastructure.

Some of the more important characteristics of the elements of TT described by Walumbwa are summarized as follows:

Needs Assessment

When conducting needs assessment it is important to ask what the social cost will be; what kind of personnel, materials, tools and knowledge are needed to build, install and operate the proposed new technology; and what risks the new or modified technology will present to other physical environments.

Sociocultural and Environmental Factors

The introduction of new technology brings profound effects on culture and people's beliefs, and some changes may even occur in the characteristics of community customs. Such changes are likely to have an influence on the transferability and/or diffusion of the technology. All human societies display certain "existence rationality". Whatever may be their information-processing capacities and effective access to resources; all human groups devise concrete strategies which enable them to survive, to protect their identity and dignity. (Goulet, 1989)

Characteristics and Types of Technology

Relative advantage, compatibility, complexity, trial ability, and observability are the characteristics of innovation that influence the nature and type of TT. Relative advantage refers to the degree to which the new technology is perceived to be much better compared to the existing one. Compatibility is the degree to which the innovation is consistent with the values, needs and experience of the recipients. Complexity is the degree to which an

innovation is perceived to be difficult. If technology is perceived to be complex and difficult by the end users, it may not be transferred easily. Trial ability is the degree an innovation can be experimented on a regular basis before final adoption and observability is based on the assumption that people are always motivated to learn new things.

Economic/ Financial Resources

TT requires high financial resources; economic capabilities of the intended end users must be analyzed at the developmental stage. A new technology may have relative advantage and compatibility with the existing situation, but if the cost of maintenance and operation exceeds what the user can afford, it becomes a burden. Financial capabilities of the technology recipient need to be given significant consideration if the TT process is to ensure continuity.

Timing

As in any competitive environment, good timing is a valuable strategy for successful TT.

Education, Training, and Human resources

Education and training are major factors in the successful facilitation and implementation of TT and they provide the best vehicle. Educated and skilled people are more apt to use new technology than uneducated people since educated individuals adopt new approaches and alternative perspectives more readily.

Communication Channels: Research Centers and Institutions

Communication is a process in which people share ideas. Communication proceeds more easily between individuals with similar backgrounds in education, social status, beliefs, and language than between people of different backgrounds. Most technology transfers involve people with different backgrounds, such as country, culture, discipline or language. Therefore, learning to overcome communication barriers is a prerequisite for successful TT.

Target Groups: Opinion Leaders and Change Agents

Change agents and opinion leaders are important elements in TT. They are individuals who are known in the social and political life of their respective societies. Many of them have been recognized by society for their past performance; that is why they are very influential. Research has indicated that people are more likely to listen and adopt ideas of those who are familiar to them than to those they meet for the fist time.

Government and Politics

Since successful TT requires a coordinated approach between the receiving governments and the developers, there is the need to recognize the role that the state plays in the dissemination of new ideas, whether it is a democratically elected government or otherwise. On the other hand, politics can be an obstacle to the transfer and diffusion of technology. This is especially true when the transfer has to go through bureaucratic processes that are likely to impede the transfer. Sometimes this is very costly, especially where administrative structures in infant stages encourage corrupt practice.

Infrastructure

Infrastructure includes such facilities as transportation, banking, housing, schools and colleges, research institutions, and telecommunication systems. Infrastructure is one of the main obstacles to the transfer of technology in developing countries.

Some experts say a transfer of technology is successful only when it becomes a profitable product or process, while others claim a transfer is successful when the technology is at least reviewed for possible use by another person or organization. There are three dimensions of TT measurement: the transfer mechanisms, the time frame in which the transfer occurs and the area of impact or result. (Cuyamaca)

Sung et al (2000) carried out a research study and factor analysis in which he concluded that the key factors in TT are:

- Communication
- Distance
- Equivocality
- Motivation.

He states that the management can take actions to develop an infrastructure that is supportive of TT. When talking about communication, some recommendations to improve its effectiveness are designed to increase the number of active mechanisms and to disseminate more broadly and effectively passive mechanisms of communications. They are: to clearly identify and give authority to persons and/or groups to monitor, receive, and appropriately disseminate the new technology; to emphasize in the importance of TT

activities and increase awareness of successful cases; to use visible and highly regarded connections to champion during the transfer; and to emphasize the use of highly interactive communication links in the transfer process. When we refer to distance, we refer to both, physical and cultural distance. The more developers and users understand the values, attitudes and ways of doing things of each other, the greater chance of successful TT. So, in order to decrease the cultural distance between researchers and users, both are encouraged: to expand the number of diversity of people interacting in the transfer process to increase mutual understanding of values, attitudes, etc.; to involve a broad range of personnel in the transfer process; to hold TT seminars to bring together researchers and users; to encourage and fund on-site visits to research and receptor organizations; and to conduct workshops to provide personnel with a better understanding of the culture and product strategy of transmitters and receptors. Equivocality refers to the concreteness of the technology to be transferred. To make knowledge and technology more understandable and less ambiguous, Sung recommends to: clarify expectations for research activities and usability criteria so that research and product development personnel have a better understanding of what each participant expects to get from the involvement with the transfer process; encourage collaborative projects in order to facilitate sharing research results; require research programs to have TT objectives; develop education/training programs on selling ideas early in research process; and to encourage on-site demonstrations to make the technology more understandable to potential users. Recommendations to increase personal motivation focus on providing incentives, rewards and recognition for those involved in transferring technology, both in researcher and user organizations.

3.3 Difficulties in the TT process.

There are many barriers to TT between countries. High inflation rates in developing countries and lack of sufficient infrastructure increase the risks for domestic and foreign investors and limit the availability of capital. Trade barriers, such as import taxes, can influence the economic assessment, and hence technology selection and implementation. National trade and investment policies may limit the inflow of foreign capital. This might be a barrier to TT. Information about assessment of technologies provided by foreign suppliers is more difficult for local investors in developing economies. Dependence on foreign suppliers may also induce risks in the case of technological support. In developing countries a lack of protection of intellectual property rights may exist, which is seen as a barrier by technology suppliers. Also, technology licensing procedures may be time consuming, leading to high transaction costs. There is a need for closer collaboration between industrialized and developing countries, especially in the areas of technological innovation, strengthening of local capacity, and increased training and information.

There are barriers due to local circumstances such as lack of capital, poorly developed banking systems, lack of appropriate financing mechanisms, lack of knowledge, technology risks, and management's unwillingness to borrow fund that reduce the availability of capital, stimulating investors to keep investment costs low, which may result in selection and purchase of inappropriate technologies. Technology assessment and selection is very important. However, often the capacity is missing, or the selected technology is determined by a donor country or by available financing. This may lead to sub-optimal technology choices. An important area for cooperation between industrialized

and developing countries therefore involves the development and strengthening of local technical and policy making capacity, for example, for an assessment of technical needs. Formal recognition of the acquired skills in knowledge transfer seems to be important to improve the status of a TT program. International partnerships of firms can be a successful tool to transfer technologies. It is stressed that development of technical capabilities is a continuous process, because it takes large resources to build up a knowledge infrastructure, and the key to success is so called “tacit-knowledge”, this means the unwritten knowledge obtained by experience, which is easily lost. The greater the existing capability, the greater the opportunities are for gaining knowledge from industrial collaboration and TT. Language can be a barrier in successful TT, especially when working with local contractors or suppliers.

Technology assessment is the study and evaluation of new technologies. It is based on the conviction that new developments within, and discoveries by, the scientific community, are relevant for the world at large rather than just for the scientific experts themselves, and that technological progress can never be free of ethical implications. Also, technology assessment recognizes the fact that scientists themselves and accordingly ought to be very careful when passing ethical judgment on their own, or their colleagues´, new findings, projects, or work in progress.

Technology assessment considers its task as interdisciplinary approach to solving already existing problems and preventing potential damage caused by the uncritical application and the commercialization of new technologies. Therefore any results of

technology assessment studies must be published, and particular consideration must be given to communication with political decision-makers (Mohr, 1999).

As in adoption of technology and practices within countries, adoption across countries depends on the motivation of management and personnel, external driving forces, economics, availability of financial and human resources, and other external driving forces.

Adaptation of technologies to local conditions is crucial. The technical operating environment is different in developing and industrialized countries. For example, different raw material qualities, lower labor costs, poorer power quality etc. Transferred technologies rarely reach designed operational efficiencies, and often deteriorate over their product life due to several reasons. Improper maintenance, inadequate availability of spare parts and incomplete transfer of "software" are some of the problems. This stresses the need for effective adaptation strategies, including transfer of technical and managerial skills. Technical training is a very important aspect of TT, and should preferably be done in the local language.

Replication and further development of practices and technologies in developing countries is needed. It is also a heavily debated issue involving intellectual property rights and dependence on foreign technology suppliers. A clear legal framework is needed to improve adaptation and replication of technology. TT projects need continued support from the technology supplier. This is beneficial to both, the technology user and supplier. The user can benefit from experience from other licensees, and licensor gets an opportunity to gain further market entrance. Experience has shown that a reasonable plant performance

will improve future business opportunities. However, technology owners may be hesitant to share all parts of a technology, including “software”, without sufficient legal protection in the user’s country. Licensors and contractor are interested in the successful transfer of proprietary technology to secure future sales. (Intergovernmental Panel on Climate Change, [4])

A very important issue in TT is the capacity building. There are many failures of TT that result from an absence of human and institutional capacity. For example, inappropriate choice of technology can result from missing capabilities for searching, selecting and negotiating. Missing implementation capabilities may result in unsuccessful employment of purchased technologies and unforeseen problems. Capacity is needed to asses, select, import, develop and adapt appropriate technologies. Much on the focus on capacity building has been on enhancing scientific and technical skills, capabilities and institutions in developing countries as a pre-condition or pre-requisite for assessing, adapting, managing and developing new technologies. Many ways of developing capabilities for the assessment, agreement, and implementation stages of the TT process are suggested by development experience: formal training of employees, technological gate keeping, by keeping informed of technical literature and forming links with other enterprises, professional and trade organizations, and research institutions; learning by doing-operational experience such as twinning arrangements with other organizations. It is also important to consider the positive interrelationship of technology and innovation to create capacity for autonomous development. Newer, broader conceptions of TT see it as a process of incremental and cumulative learning by which the results of the initial choice are internalized. The objective of TT should be to foster technological innovation in recipient

forms so that not only they master new processes, but also have the technical capability to generate improved processes and products. This will not only depend on vendors but also necessarily and largely on the active technological behavior of the recipient firms. Despite the central importance of capability for technological innovation, the capacity to innovate and then replicate is poorly developed and poorly rewarded in developing countries. For example, leaders are rarely interested in nurturing the development and capacity to innovate and even if research and development capacity exists, close involvement of industry is rare. Various kinds of high quality training are needed to embody in personnel of receiving firms the skills, knowledge and expertise applicable to particular products and processes. Such training, both generic and specific, should be an important part of the TT package and deliberately planned as a learning vehicle for the work force of the end user of the new technology. The transfer should not only be of specific know-how, but also of the related systematic knowledge of the relevant technologies so that recipients can add value. This is an important consideration for developing countries, because it implies that the work force must experience continual cumulative learning, both from experience and formal training, in order to remain competitive in a world market where intense continual incremental improvement is increasingly essential to sustained competitiveness. The focus of required action is within the developing countries suggesting: the strengthening of national and regional focal pints to cover training and human resources development; research activities; expertise on specialized aspects such as information technology; and a networking system between these components. Capacity building is required at all stages in the process of TT. It is a slow and complex process to which long-term commitments must be made for resources and to which the host country or receiver must also be committed if results are

bear to fruit. Fundamental change requires an autonomous capacity to innovate, acquire and adapt technologies. (Intergovernmental Panel on Climate Change, [4])