Chapter 2

2. The Technology Transfer Concept. Definitions and types.

Technology is the practical means people use to improve their surroundings. It is also the knowledge of using tools and machines to do tasks efficiently. We use technology to control, monitor and change the world in which we live. Technology is people using knowledge, tools, and systems to make their lives easier and better. People use technology to improve their ability to do work. Through technology, people communicate better. Technology allows them to make more and better products. Our buildings are better through the use of technology. We travel in more comfort and speed as a result of technology. Yes, technology is everywhere and can make life better. Generally speaking technology can help to: improve living standards, increase productivity, generate new industries and employment opportunities, and create more competitive products in world markets.

Technology is the systematic application of collective human rationality and scientific knowledge to the solution of problems by taking control over nature and over human processes of all kinds. Technology can be seen as the fruit of systematic research which is disciplined and cumulative, not merely accidental or serendipitous. In general, technology is knowledge applicable to practical problems (Goulet, 1989) and this knowledge may be acquired through research and development or accumulated through experience (Agmon et al, 1991).

Sharif (1986) states that technology can break up into four major components:

- Object embodied form or “Technoware”: Facilities that consists of tools, capital good, intermediary goods, products, physical equipment, machinery, physical processes, etc.
- Human embodied form or “Humanware”: Abilities of humanware consisting of understanding, capacity for systematic application of knowledge, know-how, human capability, human labor, specialized ideas, skills, problem solving capacity, etc.
- Document/Record embodied form or “Infoware”: Fact consisting of knowledge about physical relationships, scientific and/or other form of organized knowledge, principles of physical and social phenomena, technical information, standards, computer software, etc.
- Institution embodied form or “Orgaware”: Frameworks consisting of techniques, organizational work assignment, means for using and controlling factors of production, organization of products, processes, tools and devices for use by people.

The making of a technology is most often described as a linear process in various succeeding phases (Danish Centre for TT, [1]). Three main phases have been recognized. The first is the development phase of the technology, where basic research is applied to generate ideas for new products and processes. The formation phase covers the activities of design, prototype testing and engineering experimentation. And the third is the application phase, which includes the production of capital goods which are eventually used for the manufacturing of consumer goods or the provision of services.

A product technology is a technology embedded in a product (good and/or service) purchased and used by consumers. For example: televisions, appliances, clothing, food, housing, automobiles - any technology in a consumer good or service. A process technology is a technology used internally to produce a good or service, for example: robots, computers, telecommunications, bio-technology, advanced materials. Its emphasis is on the benefits of technology for the organization. In contrast, product technologies are of external focus and are technologies in the products sold to customers and to aid or benefit external constituents. Their emphasis is on the features of technology for some other organization.

One must consider that there are different technology-mentalities and each technology developer has its own values. For example, there are four basic values embedded in contemporary Western technologies. Rationality is the first one. To be “rational” means viewing every experience as a problem which can be broken down into parts, reassembled, manipulated in practical ways, and measured in its effects. Verifiability has supplanted the older traditions term truth. Eastern cultures believe the mythical level they live in is no less real than the historical level, meaning that Westerners assume that historical rationality is more real than other realms of cognition simply because its elements are more open to direct observation. The second value is efficiency. Efficiency is a general relationship, and its dynamics can be laid bare by analyzing a specific expression taken out from industry, that is productivity. Productivity looks to some proportion between what is put in and what comes out. Like efficiency, productivity is measured by comparing the products obtained with amounts of labor, capital, machinery, or time invested. On the other hand, most non-Western societies continue to make a calculus of efficiency which includes

religious, kinship, aesthetic, and recreational values in the performance of their activities. Predilection for the problem-solving stance in the face of nature and human events is the third basic value. By definition, technology is interested in getting things done; consequently, it breeds impatience with contemplation and harmony with nature. It also breeds impatience with the stance of indifference, passivity, or resignation in the presence of perceived problems. The last of these values is the “Promethean” view of the universe. Natural forces as well as human institutions are viewed by adepts of technology as objects to be used and manipulated; indeed, the value of their existence is equated with their usefulness. In contrast, most traditional societies presuppose some kind of harmonious contact with nature and its forces and seek to minimize the damage done to life. (Goulet, 1989) Trompenaars et al (1998) state that societies have developed two major orientations towards nature. They either believe that they can and should control nature by imposing their will upon it (inner-directed), or they believe that that a man is part of nature and must go along with its laws, directions and forces.

Differing views of technology see it as a commodity, as knowledge or as a socio-economic process. The classical economic view of technology as a commodity holds that technology can be reproduced without cost and transmitted from one entity to another. In this view, technology transfer is as simple as making a photocopy of design documents or obtaining a working artifact. But this view of technology has been supplanted by the view of technology as knowledge. This knowledge is brought about both through research and innovation and through a complex and often costly process involving learning from others.

2.1 Need of TT.

Nowadays, technology is central for the development process. For Goulet (1989), technology affects development on four counts: it is a major resource for creating new wealth; it is an instrument allowing its owners to exercise social control in various forms; it decisively affects modes of decision-making; and it relates directly to patterns of alienation characteristic of affluent societies. Technological activity must operate in a collective societal context and its aims are the expansion and improvement of the ability of human beings to control natural and social forces which surround them.

The 1980s and early 1990s have been years of rapid globalization. This has given firms unprecedented access to new markets and growth opportunities. From the perspective of firms already operating in those markets, it has brought unprecedented new competition. Simultaneous operation in a number of markets around the world can be a challenge even to large multinational corporations, especially in industries where the pace of new product development is rapid. Many firms find they must collaborate with other firms to share the risk and cost of competing globally. This is why technology transfer is needed. Because TT is what every organization is involved with in the process of achieving competitiveness. Each organization needs improved technology for its growth, or even for its mere survival in the global market place. The globalized feature of manufacturing has been changed, for instance, from the technology transfer to the technological cooperation.

The development of international technology transfer is a simple reality which small, medium-sized and multinational companies experience regularly. Technology,

knowledge and know-how transfers are performed every day, creating international flows of know-how and exchanges which are becoming one of the essential components of international competitiveness. The flows of technology and knowledge will develop increasingly over the coming years. New technology niches and new forms of cooperation will be created. Technological choice will become more refined. New countries will emerge as producers of technology. But until Mexico is ready to produce its own technology, it has to "import" it. Developing Countries, such as Mexico, need technology to abolish misery within their borders but lack the infrastructure to produce their own.

2.2 Definition of TT.

The concept of technology transfer (TT) is not a simple one to define; its meaning depends upon the audience considering it and the point of time (context). Transfer is the movement of technology via some channel from one individual or organization to another. The transfer of technology is a particularly difficult type of communication because it often requires collaborative activity between two or more individuals or functional units who are separated by structural, cultural, geographical and organizational boundaries. One should think on TT as an interactive process with a great deal of back-and-forth exchange among individuals over an extended period of time. (Sung et al, 2000)

TT is the process by which knowledge, technology, or information, developed in one organization or in one area or for one purpose, is applied or used in another organization or area for the same or another purpose. In its most basic form, TT includes

the transfer item itself, the developer of the technology, various channels to accomplish the transfer, and the technology recipient. (Johnson, 1997)

Most definitions of TT focus on technology as the core, but they neglect other important elements, such as the social, political, economic, and cultural environment. It is important to recognize that transfer occurs within a social system and this social system defines the boundary or limits of the technology being transferred.

There is a hypothesis proposed by Martinez and Warisawa (1997) that states that : "A given production technology may be decomposed into its two basic components: (1) The "core technology" which is present independent of the region of technology application, and (2) the "region-specific technology" which, owing to differences in culture-related facets, is unique to the region of technology application." This hypothesis, that proved to be valid, basically suggests that for technology transfer to be executed more effectively, any given production technology should be decomposed into its major components; the core technology should be transferred without alterations while the region-specific technology should be suited to the requirements of the new region of technology application. So, it can be said that the international applicability of technology may be analyzed by unveiling the "core" and the "region-specific" elements of the technology. Because region-specific elements are not readily evident as core technology elements, a technology may appear "common" or independent of the region of application at first sight.

There have been various ways to establish the globalization (Ito, 1997), for example, technology supplies and transfer to emergent industrialized and industrializing

nations, deployment of sales and manufacturing bases across the whole world, and local cooperation in manufacturing with foreign enterprises. In other words, the essential feature of globalized manufacturing has been changed, for instance, from the technology transfer to the technological cooperation. It would be more appropriate to talk about technology cooperation, rather than about technology transfer, because TT is a process in which continuous communication and retro-alimentation involving the transferor and the transferee of the technology is required. Cooperation refers to the practice people or greater entities working in common with commonly agreed-upon goals and possibly methods, instead of working separately in competition. Webster's unabridged dictionary defines cooperation as: "the association of a number of persons for their common benefit, collective action in the pursuit of common well-being, especially in some industrial and business process." In this research technology transfer and technology cooperation will be referred to as the same thing.

Hari Srinivas (2004) states that successful TT means that it is necessary to have a broad view of "Technology" to mean not only machines and equipment, but also the skills, abilities, knowledge, systems and processes necessary to make things happen. A "technology transfer" is, in reality, a structural process of learning. Successful TT requires inputs such as coordination between technology developers and users; a facilitative environment that is supportive of entrepreneurship; and networks and collaboration that provide referral links for information, finance and other pertinent resources.

In an international business context, TT is the core or heart of international business and it refers to the application of technology to a new user for economic gain. TT is

generally thought of as being product-embodied, process-embodied or person-embodied, in other words, TT occurs through the specific transfer of products, processes, information and/or people. (Agmon et al, 1991)

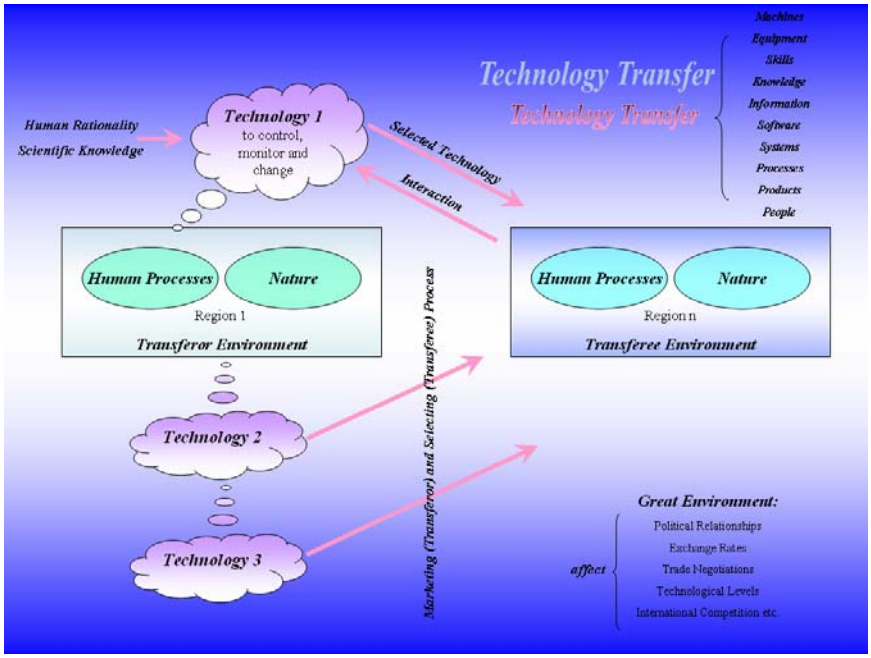

Figure 2.1 The Technology Transfer Concept

As one thinks about the business of technology transfer, or enhancing business with technology, one must realize that an understanding of business principles is required. One must understand the technology to determine its applications and to maximize its potential. In addition, one must understand the business side of the equation to make the technology package attractive to potential users. Some basic principles are necessary for a better understanding of technology transfer and the business segment. Technology transfer will not just happen; it has to be helped. Business must be viewed as a customer-satisfying process, not a goods-producing process. Good businesses make money. All business entities must have goals. Business must plan. Don't allow adversarial relationships to

develop between the partners of a technology transfer formulation and most important when in Rome; learn to conduct business as a Roman. (Cuyamaca College, [2])

In his article “Technology Transfer: An African Perspective”, Mbeki Maboyi (Notes on TT, [3]) states that TT is not about selling some hardware to a client who is left with the task of using it as he/she believes it fits. TT is the imparting of knowledge, skills, methodologies and information about a process involved in the whole production cycle. TT is a system that encompasses the social and economic fabric of a country. Where technology has been efficiently transferred, there should be a visible change –from the person to the production system as well as the compatibility with the needs, in the institutional framework, skills, training, financial capacity, promotion, and active support of endogenous capacity and appreciation of the natural environment of the recipient country. TT also has to do with the disseminating information of the technologies themselves. (Notes on TT, [3])

2.3 TT Channels.

TT has “channels”, this channels are institutions through which technology circulates, such as transnational corporations, foundations, professional associations, academies of science, universities, labor unions, voluntary agencies, individuals, and public agencies of all types, including national governments and international agencies. In manufacturing and service firms the instrumentalities or mechanisms used to transfer technology are: direct investment; exports of machinery, equipment and products; industrial

and trade fairs; licensing contracts of all types; training arrangements of various sorts, etc. (Goulet, 1989)

Technology moves across national borders in many different ways, these are the previously mentioned “channels”. The most important of these can be placed into five generic categories:

1. International technology market, which is made up of independent buyers and suppliers who buy or sell technology licenses. A license grants rights in property without transferring ownership of the property. For a license of intellectual property to be effective, the following must be satisfied: first, one must have ownership of relevant intellectual property or authority from the owner to grant a license; second, the intellectual property must be protected by law or at least eligible for protection; and third, the license must specify what rights with respect to intellectual property it purports to grant to the licensee and reserve to the licensor. Technology licenses cover patents, patentable inventions, trade secrets, "know-how," confidential information and copyrights in technical material (software, databases, instruction manuals).

2. Intrafirm transfer, whereby resort to the market is avoided and the transfer takes place either through joint venture or wholly owned subsidiary.

3. Government-directed agreements or exchanges, where the counterparts can be either public or private sectors.

4. Education, training and conferences, where the dissemination of information is made public for common consumption by either general or specialized audience.

5. Reverse-engineering, whereby access to the technology is obtained while resort to the market is avoided but at the expense of the proprietary rights of the owner of technology. (Agmon et al, 1991)

2.4 TT Types.

TT can be classified in terms of the objectives for which it is being required:

- Material transfer: consists of the transfer of materials, final products, components, equipment, and even turnkey plants. Its main objective is to supply the physical capacity to produce the desired products themselves.
- Design transfer: involves the movement of designs, blueprints and the know-how to manufacture previously designed products or equipment. Its main objective is to provide the basic information, data and guidelines needed to create a desired capability.
- Capacity transfer: provides the know-how and "software" not simply to manufacture existing products but, more important, to innovate and adapt existing technology and products and ultimately design new products. (Agmon et al, 1991)

According to Goulet (1989) TT can be categorized into two main types as follows:

- Horizontal transfer: in which a technological message; (a) spreads repetitively within a given country, or from one to another; (b) spreads form one user to another, one industry to

another, one economic sector to another within a given country, or from one country to another.

- Vertical transfer: in which the flow of knowledge and know-how takes place within the chain of “research – experimental development – technological innovation”.

TT involves a lot of legal activities, such as filling for patents, licensing, protecting intellectual property arising from research activities, trademarks and trade secrets, etc. These aspects are important and will be discussed more deeply in the next chapter.

2.5 The TT process.

There are five stages within the process of technology transfer:

- Assessment.
- Agreement.
- Implementation
- Evaluation.
- Adjustment and repetition.

Technology assessment and agreement calls for shared responsibility between technology developers and users. Success occurs when a technology is transferred across personal, functional and organizational boundaries and is accepted and understood by designated users. Implicit in these stages is the belief that successful TT is simply a matter of getting the right information to the right people at the right time. Typical mechanisms include technical consulting good-practice schemes and manuals, exchange programs and

various grants and cooperative agreements in which work is undertaken to benefit both parties. Technology assessment and selection is very important. However, often 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 arena for cooperation between the industrialized and developed countries therefore involves the development and strengthening of local technical policy for making capacity, for example, for an assessment of needs. Large companies may be able to access information or resources or hire engineering companies more easily. SMEs and local companies have generally less easy access to external resources. As in adoption of technology and practices within countries, adoption across countries depends on the motivation of management and personnel, external driving forces, e.g. legislation and standard setting, economics (i.e. profitability), availability of financial and human resources. Financing in particular may be more difficult, hindered by high inflation rates, and needing hard currencies to acquire technology. Trade barriers, such as import taxes, can influence the economic assessment, and hence technology selection and implementation. The success of technology implementation is marked by the timely and efficient employment of the technology. Users should have the knowledge and resources to implement the technology. Following evaluation and adjustment of the technology, which is the customization of the technology, repetition is directed at the fully integrated use of the technology by the user community and its further dissemination. Adaptation of technologies to local conditions is crucial. The technical operating environment in less developed countries is often different from that of industrialized countries. For example, different raw material qualities, lower labor costs, etc. Technologies that have matured and been perfected for the scale of production, market and conditions in the industrialized countries may not be the best choice for the smaller

scale of production, raw material used or different operating conditions often encountered in a developing country. Transferred technologies seldom reach the designed operational efficiencies and often deteriorate over their productive 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. (Intergovernmental Panel on Climate Change, [4])

Sharif (1986) says that any TT process involves seven major elements:

- The transferor (source).
- The transferee (receiver).
- The technology being transferred.
- The transfer mechanism.
- The transferor environment.
- The transferee environment.
- The greater environment.

The transferor is the entity which possesses the technology, while the entity seeking the technology is known as the transferee. The term technology is used in the context of the four components of technology – technoware, humanware, infoware and orgaware. A transfer mechanism is any specific form of interaction between two or more social entities during which the technology is transferred. The transfer mechanisms can be “market oriented” (purchases of plant, equipment and products, direct foreign investment, joint

ventures, etc.) and “non-market oriented” (books, academic journals, business magazines, technical information services, etc.). The transferor environment is the immediate set of conditions under which the transferor is operating – at the individual, organizational, industrial or national level. Some of the conditions that would determine the supportiveness of the transferor environment are its technological status, an inward versus outward directed orientation, its stability, and its attitude, policies and commitment towards TT activities. Even if the transferor’s commitment to transfer technology is high, unless the transferee environment is suitable, effective TT can not take place. The transferee environment is mainly determined by the absorptive capacity of the transferee. There are a series of even greater environments surrounding the transferor and transferee environments, depending on the level of the transferor and transferee. Even if the transferor and transferee environments are conductive for effective TT, such a transfer can not take place unless the greater environment permits it. For instance, TT between two nations would depend on a greater environment conditions by factors such as political relationships between countries, exchange rates, investment climates, trade negotiations, balance of trade problems, technological levels of the nations, and international competition.

2.6 Illustrative case.

In a successful case of technology transfer (Kumar et al, [17]) some main steps were followed from the point of view of the transferee. The case relates to an existing manufacturing company in the SME sector in India, which proposes to diversify into an allied product line, by acquiring technology from a company in an industrially advanced country (Japan). The first step undertaken by the receiver company was to look for a source

of technology. The criteria for selection of a product or technology are many, and each of considerable importance. Some of these criteria are: the market characteristics, ability to absorb technology, skill levels required and available, compatibility and relationship with the technology supplier, the technological strength of the transferee, the organizational flexibility and its capability to adapt quickly and match the technological growth and development of the partner in the specific area. When the firm finds a technology supplier, some pre-negotiation considerations must be made. There must be concerted efforts to collect most of the details about the technology seller and its product, its position in the world market and the state-of-the-art of technology. Then the formal negotiations must be made. The basic premise is to arrive at a common understanding of the issues involved that will lay the ground for a long-standing durable relationship between the parties. The finalized agreement must cover all aspects relating to the transfer adequately including any eventuality. It has to be clear and comprehensive. In this agreement, the product for which the technology is going to be transferred is specified. The payment terms must be spelled out clearly, both the specific amounts as well as when these are due. The treatment of tax payment and training details must be specified. It is better if a dispute mechanism is incorporated and the obligations of both the parties in case of any patent infringement claim by a third party. After the formal signing of the agreement and an initial payment is made, the technology (including technical documents such as designs, operation process parameters, materials specifications, quality control specifications; manufacturing processes and training personnel procedure) is transferred. During the analysis of this case the major issues that have been identified are:

- Technological base. The technological strength plays an important role in the entire TT process and concurrent technology absorption and assimilation “know why” exercises.

- National Research and Development base. Successful TT strategies depend not only on the efforts of individual organizations alone, but also on the strength of the National R&D infrastructure, in which they operate.
- Introduction to the market.
- Competitiveness**.** The interaction with the overseas party enabled the transferee gain confidence to approach global markets in a professional manner. They understood cultural differences and the intricacies of international marketing. Besides, it helped the Company develop a mature outlook and infused dynamism and strength in its organizational linkages, making it more open to ideas and primed for innovation.
- Need for market analysis. Many technology transactions do not fructify because of failure in undertaking these exercises effectively.
- The right information is power. The right information plays an important role in appropriate technology selection and negotiations.
- Criteria for technology selection. As mentioned above.
- Extension of product life cycle for mutual benefit. Every product has a phase during which its demand in the market is very high and the net profits grow. This growth phase cannot last indefinitely in a single market, but by using product differentiation, cost minimization and other measures it is possible to extend the growth phase and also delay or slow the decline. A beneficial technology transaction can be the most effective instrument for bringing this about, especially when the resource availability of the parties is involved.

More in deep, background and main issues affecting TT will be discussed in the next chapter.