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The Role of Technology Transfer Services in Technology Capacity Building and Enhancing the Competitiveness of SMEs*

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1. Introduction

The importance of technology transfer from a development perspective has been well established. Two decades back, Mansfield (1982) pointed out that, "One of the fundamental processes that influence the economic performance of nations and firms is technology transfer. Economists have long recognized that the transfer of technology is at the heart of the process of economic growth, and that the progress of both developed and developing countries depends on the extent and efficiency of such transfer. In recent years economists have also come to realize (or rediscover) the important effects of international technology transfer on the size and patterns of world trade."

Technology transfer (TT) is an area of interest not just to business, economists, and technologists but also to other disciplines such as anthropology and sociology (Zhao and Reisman, 1992). While anthropologists emphasize the impact of TT on changes in patterns of culture and society, sociologists are more concerned with its role as a vehicle to develop the capacity of individuals and societies to cope with modernization and related changes accompany it. For economists, as argued by Mansfield (1975), the focus is on economic growth and achievement of economic goals. However, from the perspective of business and technologists the main focus of TT is to improve the competitive advantage of firms through the enhancement of customer value. It is envisaged that, through the improvement of competitive advantage, a firm and its partners collaborating in the TT will gain financial and other strategic benefits.

From a business management perspective, the work of Hayami and Ruttan (1971), and Mansfield (1975) provide some of the earliest insights on the modes of TT, which are of relevance even today. Mansfield (1975) classified TT into vertical and horizontal TT. Vertical TT is defined as the process from new scientific knowledge through to industrial adoption to consumption, or as information flow from the basic and applied research stages, to development, to production levels. Horizontal TT is defined as the adaptation of a technology from one application to another or as the movement and use of technology used in one place, organization, or context to another place, organization, or context. Souder (1987) refers to vertical TT as internal technology transfer and horizontal TT as external technology transfer.

Hayami and Ruttan (1971) and Mansfield (1975) also refer to "material transfer, design transfer, and capacity transfer." Material transfer refers to the transfer of a new material or product while design transfer corresponds to the transfer of designs and blueprints that can facilitate the manufacturing of the material or product by the transferee. Capacity transfer involves the transfer of know-why and know-how to adapt, and modify the material or product to suit various requirements. However, these typologies can really be subsumed within vertical and horizontal TT.

The above transfer modes were further elaborated on by Amsden (1989) and Habibie (1990). Amsden (1989) argued that while in developed countries the technology/product cycle took the route,

Research ⟶ Development ⟶ Design ⟶ Production

in technologically less developed countries, it tends to take the route,

Production ⟶ Design ⟶ Development ⟶ Research

According to Amsden (1989), learners do not innovate and must compete initially on the basis of low wages, state support, high quality and productivity. The route that must thus be pursued should be based on transfer, absorption, and adaptation of existing technology. This viewpoint fits in with the material, design, and capacity transfer progression. Habibie (1990), the architect of the Indonesian aircraft industry, states that, "technology receivers must be prepared to implement manufacturing plans on a step-by-step basis, with the ultimate objective of eventually matching the added-value percentage obtained by the technology transferring firm." He refers to such an approach as "progressive manufacturing" and popularized the slogan, "begin at the end and end at the beginning"

implying that a transferee firm should start with production and move backwards to research as also pointed out by Amsden (1990).

Today, firms that own technology have many ways of exploiting their technological assets for profitability and growth. While internal exploitation of technological assets, through designing, developing, manufacturing, and selling products and processes continues to be important, interest in external exploitation, by selling the technology that a firm owns through technology transfer, has intensified in recent years. This may be attributed mainly to the globalization of business, liberalization of the economies of many developing economies, and greater emphasis on the protection of intellectual property after the formation of the World Trade Organization (WTO). Indeed, today, the transfer of manufacturing technology has become an important part of the international business strategy of firms. Similar flexibility exists in the case of buyers of technology. Ramanathan (2001) shows that in today's international business setting, depending on the attributes of the technology, its intended use, and the motivations of the transferee and transferor, a wide range of TT modalities are available. The focus need not merely be on the purchase of plant and equipment or licensing.

However, planning and managing a technology transfer project, especially an international technology transfer (ITT) project, is not easy. based on the experience gained over three decades, Godkin (1988) provided a comprehensive list of problem areas associated with technology transfer. Many of these problems still persist and with rapidly changing technological and business trends new problems have emerged. The productive entities that have been most affected by these problems are small and medium enterprises (SMEs). Large organizations can relatively easily gain access to the resources needed to overcome these problems unlike SMEs. Evidence exists to show that governments, international agencies, and non-governmental organizations (NGOs) have all attempted to alleviate these problems by introducing various supportive measures. Yet, many of these measures make the tacit assumption that TT is a relatively predictable process whereby buyers of technology (transferees) acquire, assimilate, and then improve the purchased technology, often with the assistance from government policies (Cusumano and Elenkov, 1994). This approach tends to oversimplify the magnitude of the problem faced by SMEs in planning and implementing TT projects.

The main objective of this paper and presentation is to draw attention to the range of problems faced by SMEs and argue that its time that technology transfer agencies adopt a holistic approach to assist SMEs to be successful in bringing the technologies they need, through TT projects, so that they can compete effectively and grow in today's global business setting. The rest of this paper is divided into five parts. The next part shows how the technology transfer capability of a firm contributes towards customer value creation and enhanced competitiveness. The third part of this paper then shows how the operations at a firm level are influenced by the national innovation system (NIS). This is followed by a detailed discussion of the TT problems faced by a firm due to various factors, including those that arise due to weaknesses in the NIS. The fifth and sixth parts of this paper then delineate the services that can be provided by technology transfer agencies, such as the Asian and Pacific Centre for Transfer of Technology of the United Nations – Economic and Social Commission for the Asia and Pacific (UNESCAP–APCTT) to help SMEs overcome these problems.

2. Enhancing Competitiveness through Technological Capability

All enterprises whether they are large firms or SMEs can compete effectively only on the basis of "customer value creation." Customer value may be defined as a function of quality, delivery, flexibility, convenience, and cost (Ramanathan, 2001). Quality represents how well the good or service meets customer expectations. Speed describes the time needed to design, produce, and deliver the good or service as characterized by determinants such as cycle time and speed to market. Flexibility reflects how easily and quickly the firm can modify goods or services to meet customer needs in terms of aspects such as options and extent of customization possible. Creating convenience for the customer implies not only speed of service, but also self-service, process visibility, and easy to use, streamlined, consistent, and reliable customer service. Lastly, cost refers to all objective and subjective costs that the customer incurs to acquire, use, and dispose of the good or service and

includes dimensions such as discounts, rebates, and incentives. Customer value is enhanced as quality, speed, flexibility, and convenience increases while cost decreases. These five determinants of customer value creation may be referred to as core value determinants (CVDs) (*ibid.*). To ensure sustainable competitive advantage a firm must offer its customers a CVD profile that sets it apart from its competitors. The implementation of a CVD-driven competitive strategy requires a firm to manage technology in a manner that creates value for the customer and continually enhances it vis-à-vis its competitors.

The framework, as depicted in Figure 1, implies that a firm acquires and deploys technology, to create customer value, through the fulfilment of productive activities. The effectiveness of these activities would be determined by the firm's core technological and supportive capabilities. The generic core technological capabilities include design engineering, research and development (R&D), production, and selling and CRM capabilities. The elements of these capabilities are listed below (Panda and Ramanathan, 1997, 1998; Ramanathan, 1998, 2001).

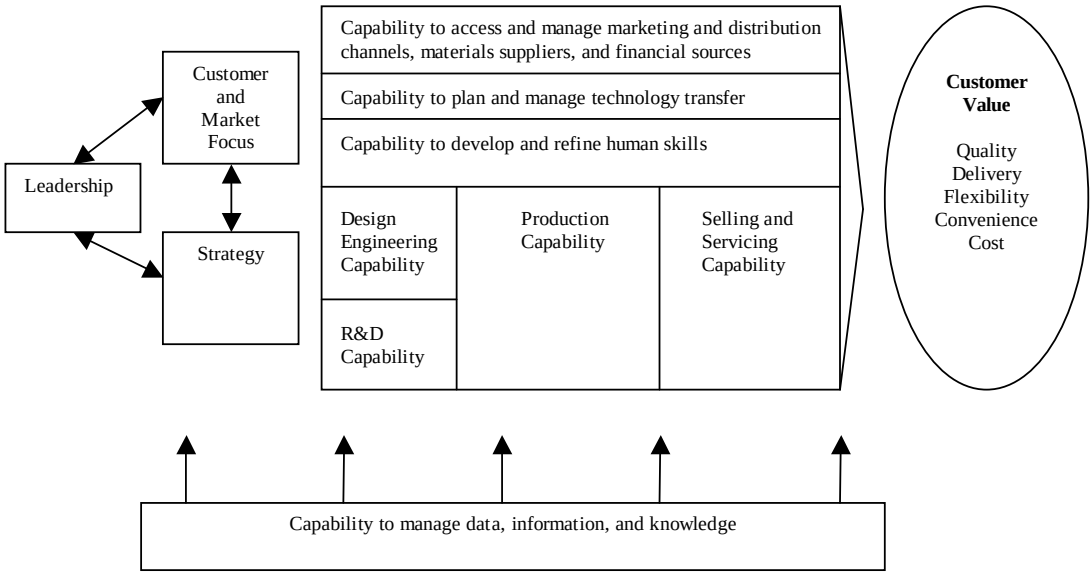

Figure 1: Customer Value Creation through Technological Capability

Design engineering capability

- Capability to carry out routine design and detail engineering of a product/process
- Capability for adapting purchased technology
- Capability for duplicating purchased technology

R&D capability

- Capability to improve existing products and processes
- Capability to generate radical technologies
- Capability to develop expeditionary and future-oriented market intelligence for the development of new products and processes

Production capability

- Capability to effectively plan and control production operations and deliver quality
- Capability to carry out troubleshooting and total productive maintenance
- Capability to customize production

Selling and servicing capability

- Capability to reach customers and identify customer needs
- Capability to provide product information to customers
- Capability for managing customer relationships

These core technological capabilities have to be supported by generic supportive capabilities. These supportive capabilities include the following:

- Capability to plan and manage technology transfer (specify, identify, assess, negotiate, and finalize the purchase or sale of product, process, and peripheral technologies from global technology suppliers)
- Capability to continuously develop and refine human skills (human resources development – HRD)
- Capability to access and work effectively with marketing and distribution channels
- Capability to effectively access necessary material inputs for production through effective partnering with global supply networks
- Capability to identify funding sources and obtain funds at competitive rates from global sources for expansion and growth

The need for sustained and well targeted human resources development (HRD) at the organizational level requires no justification in an era of accelerating technological change. The capability of a firm to plan and implement effective programs for skill upgrading, by anticipating and responding to technological change, will have a distinct bearing on how well the organization is able to cope up with competitive pressures. It is also imperative that HRD is not regarded merely as training but as a means of creating company-wide learning ability. The development of the capability to continuously develop and refine human skills has long-term implications for the competitive posture of a firm.

These core technological and supportive capabilities are built up over time and, as emphasized by Leonard-Barton (1995), their direction and rate of development will depend on how the firm creates, nurtures, and grows the experience and accumulated knowledge into renewable assets and competitive advantage. It would also be interesting to view the unique “fusion” of the core and supportive capabilities as a means of developing inimitable and relatively immobile “core competencies” that could lead to the enhancement of a firm’s competitive advantage. The term fusion is used here to emphasize that, from a competitiveness perspective, fusion implements an arithmetic in which one plus one makes three (Kodama, 1995). Teece (2000) points out that, “the ownership of difficult to replicate complementary assets can represent a second line of defence against imitators and an important source of competitive advantage.”

To promote fusion of the core technological and supportive capabilities to create customer value, and hence business results, it will be necessary for a firm to initiate the fusion process effectively. This is initiated by the “leadership triad,” a term borrowed from the Malcolm Baldrige National Quality Award. In Figure 1, the triad consists of leadership for technology-based entrepreneurship, strategy, and a customer and market focus. This triad spots “opportunities” in the market place and through the deployment of the core and supportive capabilities creates customer value along desired determinants.

The importance of a strong customer and market focus, which is one of the elements of the triad, is well recognized. Today, firms are obliged to satisfy customer needs much faster in a setting where customer expectations have evolved from commodity based product requirements to those that

are more complex and customized with higher quality and service expectations. Unless a firm has a sophisticated understanding of its market and customers, it cannot configure its core technological and supportive capabilities to deliver a unique customer value proposition.

Another element of the triad, strategy, emphasizes the need for the firm to have a clear vision regarding its strategic intent, and a capacity for system thinking. Senge (1995) defined system thinking as the ability of the firm and senior management to see connections between events, issues, data points, and to think of the whole rather than the parts. This system thinking should manifest itself through the corporate strategic plan that elucidates organizational aspirations, vision, objectives, and strategies that configure the core technological and supportive capabilities, through well-linked functional strategies.

Thirdly, the crucial issue of leadership, at all levels of the organization, needs to be addressed. The need for leadership that fosters "technology-based" entrepreneurship, competition, and growth has been talked about extensively and this aspect has been elaborated in some detail in Sharif (2004). Evidence exists to show that effective leaders are highly knowledge and self-learning oriented. However, the specific attributes of such leadership are still not clear. Should the leadership needed views corporate behaviour with "technology glasses" on (Drejer, 1997)? Does commitment for technology-based competition automatically imply readiness for action? What type of leadership approach is best suited to guide strategy when a firm finds itself in "no mans land" between two technological S-curves (Drejer, 1997)? How should leadership configure and transform organization structure to cope with challenges posed by today's dynamic business environment? In spite of a clear consensus on best practices for strategic leadership it is nevertheless clear that the attributes and style of leadership will clearly influence the extent to which "technology is brought into management."

The leadership triad and the fusion of core and supportive capabilities are supported by the firm's infrastructure for managing data, information, and knowledge as shown in Figure 1. Following Davenport and Prusak (1998), data is defined as a set of discrete objective facts about events and becomes information when it is endowed with relevance and purpose. Data can be converted to information through contextualization, categorization, calculation, correction, and condensation (*ibid.*). Also, information is turned into knowledge through acts of transformation such as (*ibid.*):

- Comparison (temporally and vis-à-vis other situations)
- Consequence analysis (implications for decisions and actions)
- Connection examination (the relationship of specific information to others)
- Conversation (feedback from informed sources about the relevance and value of information generated)

Knowledge may be regarded as a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. (*ibid.*). Knowledge is embedded in organizations not only in documents but also in organizational routines, processes, practices, and norms. From a technology management perspective the infrastructure for managing data, information, and knowledge is crucial considering the unprecedented rate of technological change. The infrastructure will consist of the current and dynamic state of technological knowledge as embodied in publications, training, practices, and analytical tools and techniques. It should also consist of knowledge related to the reception, perception, and utilization experiences with respect to the firm's products, processes, systems, and related factors that customers use to evaluate the "performance gap" between expected and actual performance and with that of competitor offerings.

The leadership triad, the capability elements, and the knowledge and information infrastructure collectively contribute towards the creation of customer value. This is true whether an organization is large or an SME. This approach emphasizes the importance of using a process view for managing technology to generate customer value and enhance competitiveness. It may be said that the framework essentially consists of three major components:

- The leadership triad
- The fusion of core and supportive capabilities
- Knowledge and information infrastructure

The leadership triad creates the vision, conditions the climate for managing technology, and sets the stage for developing a strategy for the effective fusion of the core and supportive capabilities. The vision is realized and the strategy is translated into action by implementing the fusion process. The knowledge infrastructure provides the necessary "intelligence" to the triad as well as for the fusion process.

The framework also emphasizes the key idea that TT is but one element of the customer value creation process. Even if a TT project is well implemented it will not result in enhanced competitiveness if, for instance, production capability is weak. Furthermore, an ineffective leadership triad could well result in a poor formulation of a TT project. The next section shows how this customer value creation system is embedded within a national innovation system.

3. The Influence of the National Innovation System on the Firm

The productive entities of a nation, namely customer-value creating firms, are embedded within a national innovation system (NIS) of a country. If the NIS supports and fosters "technology-based" development, then the firms are better able to compete by enhancing customer-value through technology-based interventions. Based on the work of Sharif and Ramanathan (1995), the NIS of a country may be, for the sake of convenience, be considered as consisting of the following interacting elements:

- Firms
- Physical infrastructure
- Facilitating infrastructure
- Collaborating infrastructure
- Market rivalry
- Clusters
- National policy setting

The "physical infrastructure" refers to the supply of electricity, water and related utilities, transportation facilities, and communication facilities. Clearly, if this is poorly developed or ineffective then firm level activities will suffer. In fact this is a critical issue in many developing nations. Even in developed nations there are instances of the physical infrastructure being stretched to its limits due to increased demand and inadequate upgrading investment to meet such demand.

The "facilitating infrastructure" refers to national/sectoral institutions, which play a catalytic role in guiding technology-based economic activities. These include institutions such as investment promotion boards, venture capital institutions, science and technology information centres, technology forecasting and technology foresight services, and technology transfer advisory services. These institutions can promote the commercialisation of indigenous innovations and promote the transfer of the right technologies.

The "collaborating infrastructure" comprises the academic institutions engaged in science and technology education and research; the range of research development (R&D) related organisations; and design engineering and production units. Strong linkages between these this "triad" institutions can enhance technological activities. In fact, considerable work being done on the "triple helix" model of NIS focuses on the collaborating infrastructure. The absence or subcritical strength of these linkages will lead to each of these categories of institutions operating in isolation without mutually reinforcing and strengthening the activities of other two.

The fifth element of the NIS, namely, "market rivalry" that exists in a country also fashions the technological trajectory of a firm. According to Porter (1990) extremely intense market rivalry may lead to a shakeout and only a few firms may eventually survive. The right level of rivalry in an industry improves industry attractiveness. It could also facilitate innovative behaviour at the firm level whereby each firm tries to retain and possibly enlarge its market share by trying to meet customer demands better. Vigorous local rivalry not only sharpens advantages at home but also encourages domestic firms to export in order to grow. Domestic rivalry also forces firms to seek higher-order and more sustainable sources of competitive advantage such as: proprietary technologies; economies-of scale; and superior marketing because other local rivals will also have the same lower-order sources of competitive advantage such as low labour cost or cheap raw materials (*ibid)*. This sharpening of competitive skills at home can help good local firms to succeed in export markets.

The sixth element of the NIS, namely, "clusters" of related firms and industries comprising subcontractors, component dealers and manufacturers, and upstream and downstream industries can facilitate co-operation and enhance local content and economic value added in manufactured output. Having a good cluster of industries enables a firm to: have close working relationships with its suppliers upstream and clients downstream: carry out joint problem solving with suppliers and clients; and share and exchange experiences for mutual benefit (Porter, 1990). Lack of such clusters leads to low value-addition even in export-oriented activities. If many firms within an industry cluster are competitive then considerable synergy is possible within the cluster.

The various elements of the NIS described this far, are embedded within a national development policy climate. A national policy that supports "technology-based development" is liable to remain a mere piece of rhetoric if it is not substantiated by a means of implementing it (APCTT, 1988). These means are referred to as policy instruments. Policy instruments are the links between the expressed purpose and the results that are sought in practice. There are both direct and indirect policy instruments. The three major types of instruments for fostering "technology-based development" are legal instruments, financial instruments, and fiscal instruments. Examples of legal instruments which are technology specific are laws, acts, decrees, and regulations for the promotion of science, technology, and research and development activities, legal cover for various types of enterprises involving technology transfer, technology contract law, environment protection laws, and intellectual property laws. Examples of technology specific financial instruments are special credit for technological activities and risk financing. Similarly, a good example of a fiscal instrument to promote technology is the tax incentive given for research and development (R&D). Some policies deal explicitly with technology while others do not.

In addition to legal, financial, and fiscal policies, the behaviour of the other six elements of the NIS is influenced by economic policies (such as interest rates, exchange rates, exchange control, tariff and non-tariff barriers, wages and labour compensation policies, foreign investment policies, economic development policies, specific industrial policies, and specific agricultural policies), human resources development policies (such as policies related to the educational system, higher education policies with respect to universities, training institutes, management training, post-doctoral training, and continuing education, international fellowship policies, industrial training and retraining policies, policies for the recognition of skilled human resources, and remuneration policies for professionals and skilled workers), policies related to cultural renewal (such as mechanisms to modify the general value structure, attitudes, norms, etc., including the position of women, and policies for the popularisation of science and technology), and policies related to the environment (such as policies for the exploitation and preservation of natural resources, and policies toward environmental control and pollution).

It may be said that, based on the conceptualization of an NIS as comprising of seven interacting elements, the planning and implementing of TT at the firm-level will be influenced not only by internal factors but also by external factors arising out of the elements of an NIS. The next section examines various TT problems that are commonly faced by firms that are caused by both internal and external factors.

4. Technology Transfer Problems Commonly Faced by SMEs

Technology transfer has always been, and continuous to be, an area where considerable potential exists for conflict between the buyer and seller of technology. Since the 1960s, considerable anecdotal evidence has been gathered to highlight critical issues and a wealth of literature dealing with common problems faced in technology transfer is available. With changes in the global business setting some of these problems have diminished while new ones have emerged. Recently, Jagoda (2007) has compiled a valuable list of common technology transfer problems. Adapting the work of Jagoda (2007), this section presents a summary of common problems associated with ITT. The problems are classified into technology transfer process issues; corporate capability issues; and operating environment and NIS issues.

(a) Technology Transfer Process Issues

Problems during the technology justification and selection stage

- Wrong selection of technology based on misjudgements when preparing a business case for a TT project (Roberts & Frohman, 1978; Jolly 1980; Godkin 1988; Tihanyi & Roath 2002)
- The cost of buying, installing, operating, and maintaining the technology is too high (Voll 1980; Godkin 1988)
- The technology selected is too complex for easy understanding and assimilation of the transferee (Lin & Berg 2001; Saad *et al*. 2002)
- The technology needs considerable adaptation to suit local conditions (Saad 2002)
- Obsolescence of technology while the transfer is in progress (Saad *et al*. 2002).

Problems during the planning stage

- Transferor (seller) underestimates the problems in transferring the technology to a developing country setting (Bradbury *et al*. 1978 Godkin 1988)
- Transferor does not fully understand transferee needs (Lingwood 1975; Godkin 1988)
- Transferee managers are not involved in the planning which is carried out only by the transferor (Saad *et al*. 2002)
- Too much attention is paid to the hardware to be purchased and not enough attention is paid to skills and information acquisition (Saad *et al*. 2002)
- Overestimation of the technological capabilities of the transferee by the transferor thereby leading to unrealistic expectations on how well the transferee can meet target dates (Mann 1989)
- Poor market demand forecasting by the transferee of the outputs to be produced by using the transferred technology (Mann 1989)
- The objectives of the transferor and transferee are not compatible (Baranson 1971; Tidd & Izumimoto 2002)
- Mechanisms chosen for implementing the transfer are not appropriate (Voll 1980; Godkin 1988).

Problems during negotiations

- Differences in negotiation approaches and strategies (Mann 1989)
- Lack of trust between the transferor and transferee (Jassawalla & Sasthittal 1998)
- Goal incompatibility during negotiations (Bradbury *et al*. 1978)

- Inability to reach agreements on pricing, product, and marketing strategies (Tidd & Izumimoto 2002)
- Both parties try to achieve results in an unrealistically short period of time (Tidd & Izumimoto 2002)

Problems during technology transfer implementation

- Shortage of experienced technology transfer managers (Gaither & Naiman 1978)
- Lack of trust in transferor developed systems by the transferee (Chung 1984)
- Inability to achieve quality targets (Baranson 1967)
- Delay in obtaining supplementary materials, needed for quick implementation, from the local environment (Chaudhuri 1980)
- High cost and poor quality of locally available materials needed to implement the technology transferred (Chaudhuri 1980; Saad *et al*. 2002)
- Inadequate tracking of the technology during implementation (Bell and Hill, 1978; Saad *et al*. 2002)
- Cost overrun due to poor implementation (Mann 1989)

(b) Corporate Capability Issues

Problems due to inadequate skills

- Inability of the transferee to attract the required skills due to financial and industrial restrictions (Chaudhuri 1980)
- Lack of experience of the transferee's workforce and absence of required skills at the industry level (Baranson, 1967; Baranson 1971;Roberts & Frohman 1978; Tihanyi & Roath 2002; Saad *et al*. 2002)
- Lack of training of transferee personnel (Knox, 1973)
- Absence of incentive systems at the transferee firm for learning and assimilating new technologies (Essoglou 1985; Godkin 1988)
- Language barriers that inhibit effective communication between transferor and transferee personnel and restrict effective transmission and assimilation of relevant information (Baranson 1967; Brown 1985).

Problems due to ineffective management

- Lack of visible and committed top management support for the project (Godkin 1988)
- Lack of top management guidance to decide the type of the technology to be acquired, remuneration, incentives associated with the transfer, and the control of the flow of information (Nyenhuis & Welborn 1976; Godkin 1988).
- Differences in working methods and practices between the transferor and transferee managers (Baranson 1967; Baranson 1971; Mann 1989)
- Individual or organisational competition for the ownership of the technologies and the presence of the "not-invented-here" syndrome (Pearson & Richards 1974; Monrone & Irvins 1982; Essoglou 1985; Godkin 1988)
- Failure of top management to identify transferee and transferor personnel who would work closely form project initiation through to full implementation (Battenbur 1980; Godkin 1988).

(c) NIS issues

- Shrinking of local markets due to adverse changes in the economic levels of the country (Tihanyi & Roath 2002).
- Poor physical infrastructure (Sharif & Ramanathan 1995)
- Inadequate supportive institutional infrastructure to provide support in terms of finance, information, skill development, and technology brokering (Sharif & Ramanathan 1995; Day *et al*. 1995)
- Inadequate mechanisms for intellectual property protection (Tihanyi & Roath 2002)
- Lack of local suppliers who can deliver quality supplies and lack of policies to develop such suppliers (Baranson 1967, Mann 1989)
- High dependency on foreign suppliers and imports (Saad *et al*. 2002).Lack of good education and training institutions to upgrade skills (Saad *et al*. 2002)
- Ineffective legislation and incentives such as tax holidays, tariff adjustments, and industry parks to promote technology transfer (McDermott 1985)
- Bureaucratic delays at various levels of government in obtaining approvals and clearances for finalizing technology transfer agreements (Goldscheider 1982)
- Ineffective and sometimes excessive government intervention and regulation (Abernathy & Chakravarthy 1979; Tihanyi & Roath, 2002)
- Foreign exchange restrictions (Chaudhuri 1980)
- Inability of new ventures to compete with former monopolies, often owned by government (Tihanyi & Roath 2002)
- Uncertain tax environments (Tihanyi & Roath 2002).

Agencies such as the Asian and Pacific Centre for Technology Transfer (APCTT) of the United Nations - Economic and Social Commission for Asia and the Pacific (UNESCAP), thus have a major role to play in helping SMEs to overcome these problems by providing services that can address their immediate needs while strengthening their capacity over the long-term to independently find solutions to these problems. The next section deals with possible approaches that technology transfer agencies may take in helping SMEs to plan and effectively manage TT projects.

5. Possible Role of Technology Transfer Services in Technology Capacity Building and Enhancing the Competitiveness of SMEs

Essentially, the role of technology transfer services should be to help overcome problems/barriers arising in the three categories mentioned above. Thus possible services to help alleviate these, with respect to the three categories, are described briefly below.

<u>Services needed to overcome problems with respect to technology transfer process issues</u>

- Develop training programs to teach SMEs how to prepare a business case based on market assessments, develop realistic forecast demands of the final product based on the TT project, and estimate reasonably accurate operating costs.

- Work with Government Agencies, Chambers of Commerce, and Industry Associations to develop technology roadmaps in priority areas that could delineate future trends and help SMEs to avoid buying outdated, inappropriate technology, and ensure non-obsolescence of technology while the transfer is in progress.

- Develop training programs to teach SMEs how to estimate the resources and technological capabilities needed to plan and implement new technology so that these requirements can be transmitted to the transferor to avoid the overestimation of the technological capabilities of the transferee.

- Develop training programs to teach SMEs how to develop a clear set of specifications of the technology to be transferred so that the transferor knows exactly what is needed.

- Develop training programs to teach SMEs how to develop a preferred supplier/transferor profile so that a proactive search for projects and partners can be initiated and the right type of supplier can be identified.

- Develop a list of supplier firms in different areas of technology and helping SMEs to access different supplier databases so that they can minimize problems of pricing in an imperfect market of technology suppliers and also locate alternative sources if a supplier is reluctant to sell due to the fear of creating a future competitor.

- Provide information to SMEs on assistance available from government and technology intermediaries to plan and implement TT projects and also make them aware of government regulations (such as foreign exchange regulations, tax regulations, environment, and intellectual property laws) that they need to be aware with respect to TT projects.

- Develop training programs to teach SMEs the important issues related to intellectual property protection (IPR) and how to value technology and intellectual property so that they can use these skills during the negotiation stages.

- Develop training programs to teach SMEs how to negotiate in today's global business setting. Skills that need to be imparted would include:
  - ü How to reach agreement on each party's contribution towards the technology transfer project
  - ü How to reach agreement on the extent of adaptation needed to ensure that the technology suits local conditions
  - ü How to reach agreement on selecting the most suitable mechanism(s) to transfer the technology
  - ü How to reach agreement on the extent of training needed for transferee personnel.
  - ü How to reach agreements on the transfer of both codified and uncodified knowledge
  - ü How to make arrangements to ensure effective channels of communications between the transferor and the transferee personnel are put in place.
  - ü How to reach agreement on payments for technology
  - ü How to develop critical milestones to monitor project progress

- Develop training programs to teach SMEs how to prepare a detailed technology transfer agreement.

- Develop training programs to teach SMEs how to develop a detailed technology transfer implementation plan based on the decisions reached during the negotiations.

- Develop training programs to teach SMEs how to continually assess the actual outcome of a TT project with planned outcomes so that corrective action can be taken and the knowledge gained can be effectively utilized in new TT projects.

- Develop training programs to teach SMEs how to assess the impact of a TT project from market, financial, technological, and organisational perspectives (i.e. use a Balanced Scorecard approach)

<u>Services needed to overcome problems with respect to corporate capability issues</u>

- Develop training programs to teach SMEs how to make changes to the organizational structure, work design, and remuneration system, and how to recruit new skills, currently not available within the organization, to ensure that the new technology brought in is used effectively.

- Develop training programs to teach SMEs how to build a good knowledge management system so that the intangible assets of technology gained through the transfer will not be lost.

- Developing training programs to teach SMEs how to plan and implement skill upgrading programs on a continuing basis to improve skills and experience of their personnel.

- Develop training programs to teach SMEs how to manage local and global supply chains and formulate arrangements in advance with suppliers for parts, materials, and services so that the technology that has been transferred can be effectively utilized.

- Developing training programs to teach SMEs how to be proactive in identifying new or complementary technologies that can help to get more out of the transferred technology.

Services needed to overcome problems with respect to the NIS

To overcome barriers to effective technology transfer, due to weaknesses in the NIS, it would be necessary for agencies providing technology transfer services to work with governments to ensure that barriers caused by physical infrastructure, facilitating infrastructure, collaborating infrastructure, market rivalry, clusters, and national policy setting. It would be very difficult for individual agencies to handle these issues independently and what is needed is a cooperative effort by the various stakeholders who shape the NIS.

Benchmarking best practices of the NIS and creatively using lessons learnt by different countries in implementing measures to overcome barrier to technology transfer would be one way of speeding up the process of making changes to the NIS of a country. In this context many United Nations agencies are involved in such efforts. The Mongolia National Workshop on “Subnational Innovation Systems and Technology Capacity Building Polices to Enhance the Competitiveness of SMEs” is a good example of this cooperative effort.

6. Concluding Remarks: Activities of UNESCAP-APCTT as a Technology Transfer Service Provider.

The Asian and Pacific Centre for Transfer of Technology (APCTT) of the United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP) was set up in 1977 with the objective facilitating technology transfer in the Asia-Pacific region. While considerable work has been done in this regard over the past three decades, only some of the recent work that has been carried out as a technology transfer service provider will be highlighted.

- APCTT has developed a web-based technology transfer service package that is available at www.technology4sme.net. The website enables the online transfer of technology offers and requests with a view to establish it as a regional “technology transfer market service” for Asia and the Pacific. The website has several features including technology market service, technology transfer partner links, basic and practical knowledge on technology transfer.

- To supplement this website, APCTT has also designed a business-asia website, www.business-asia.net as a one-stop business support and information website for SMEs in member countries. This website will enable users to find information on business start-ups, joint ventures and foreign direct investment (FDI) across borders in the Asian and Pacific region as well as to provide information on new technologies and market opportunities. It is envisaged that this website will help entrepreneurs get information for business start-up and operation in countries of the region, seek business partners and facilitate technical cooperation among various key players, researchers, business people and academics in the Asian and Pacific region.

- APCTT has also established a Biotechnology Information Network for Asia (BINASIA) in collaboration with the Korea Research Institute of Bioscience and Biotechnology (KRIBB) with support from the Ministry of Science and Technology of the Republic of Korea. This network is aimed at facilitating inter-agency information exchange on biotechnology, including national R&D programmes, industry R&D partnerships, technology transfer and nurturing of biotechnology-related industries in the Asia-Pacific region. Thirteen countries of the region are members of this network.

- Another initiative of APCTT is the Asia-Pacific Regional Network for Traditional Medicine and Herbal Technology (APTMNET) that the Centre has established in close cooperation with the Hubei Provincial Science and Technology Department in Wuhan, China. This network will eventually link fourteen countries of the region and will become an information exchange centre for traditional medical and herbal medicinal technology and development of herbal medicines in the Asia-Pacific region. The network architecture, website design, database structure and APTMNET management aspects had been finalized in consultation with the member countries.

- To supplement these web-based initiatives, APCTT provides several technical periodicals and publications that are aimed at playing an essential role in the dissemination and promotion of technology information and utilization. These publications are the Asia Pacific Tech Monitor and the Value Added Technology Information Services (VATIS) in the areas of Ozone Layer Protection, Waste Technology, Biotechnology, Food Processing and Non-Conventional Energy which are currently distributed in 60 countries.

Based on the above information it appears that currently APCTT is focusing mainly on two of the “services needed to overcome problems with respect to technology transfer process issues.” These are:

- Providing a list of supplier firms in different areas of technology and helping SMEs to access different supplier databases so that they can minimize problems of pricing in an imperfect market of technology suppliers and also locate alternative sources if a supplier is reluctant to sell due to the fear of creating a future competitor.

- Provide information to SMEs on assistance available from government and technology intermediaries to plan and implement TT projects and also make them aware of government regulations (such as foreign exchange regulations, tax regulations, environment, and intellectual property laws) that they need to be aware with respect to TT projects.

In addition, APCTT has completed Phase 1 of a project on National Innovation Systems whereby, in consultation with senior policy makers of member countries, issues related to technological capacity building have been discussed. Issues related to technology transfer were an important component of this project. This work will be carried further through a second phase. Thus, as a technology transfer service provider APCTT has, by working with member countries, helped create awareness on how governments may shape their NIS to mitigate barriers to technology transfer as a result of weaknesses in the NIS.

However, as a technology transfer service provider APCTT also needs to be actively involved in developing SME skills by providing other services (listed above in section 5) under the two categories, namely:

- Services needed to overcome problems with respect to technology transfer process issues
- Services needed to overcome problems with respect to corporate capability issues

In this context, the Technical Committee and Governing Council of APCTT, at its deliberations in December 2006, mandated APCTT to undertake a project that will enable it to provide services that

will address the skill development needs of SMEs so that they can develop the capacity to overcome problems with respect to technology transfer process issues and corporate capability issues. More specifically the Technical Committee and the Governing Council made the following recommendations.

- The facilitation of technology transfer activities should be viewed holistically to include technology transfer planning right through to implementation and assimilation. In this regard, it is important to develop skills in SMEs and MSMEs ranging from business case preparation, technology sourcing, technology assessment, technology selection, technology pricing, negotiation, contract finalization, implementation, and impact assessment.

- To enable a critical mass of such skills to be developed in member countries, APCTT should help develop a programme of capacity building, including training of trainers, in R&D and support institutions who could then become trainers. This programme would include the preparation of training materials that could also be used for online training and education. These trainers would then train SMEs in their own countries through business and industry associations and relevant government organizations.

APCTT is currently at the preparatory stage of a project that will enable it to fulfil this mandate given by its Technical Committee and Governing Council to assist member countries to develop indigenous capacity to provide the additional technology transfer services that are not currently available. With the implementation of this project it is envisaged that APCTT, as a technology transfer service provider, will be able to effectively provide a complete suite of services to help foster technology capacity building in SMEs of the Asia-Pacific region thereby enhancing their competitiveness in today's highly competitive global business setting.

REFERENCES

ABERNATHY, W.J. AND CHAKRAVARTHY, B.S. 1979. Government intervention and innovation in industry: A policy framework. *Sloan Management Review*, Spring, 3-18.

AMSDEN, A.H., 1989. *Asia's next giant: South Korea and late industrialisation*. New York: Oxford University Press.

APCTT, 1988. Technology policy formulation and planning: a reference manual. Bangalore: APCTT-UNESCAP.

BARANSON, J., 1967. *Manufacturing problems in India, the Cummins diesel experience*. New York: Syracuse University Press.

BARANSON, J., 1971. *International transfer of automotive technology to developing countries*. UNITAR research reports No. 8, UNITAR.

BATTENBUR, J. 1980. Forging links between industry and the academic world. *Journal of the Society of Research Administrators*, 12, 5-11.

BROWN, W.S. 1985. A proposed mechanism for commercializing university technology. *Technovation*, 3(1), 19-25.

CHAUDHURI, S. 1980. *Acquisition and assimilation of technology in the tractor industry in India: The strategic perspective*. Doctoral thesis. Indian Institute of Management. India.

CHUNG, Y.S. 1984. *Healthcare financing policies of South Korea: The interaction of national characteristics and influences from more developed nations*. Doctoral thesis, University of Illinois, Urbana-Champaign.

CUSUMANO, M.A. AND ELENKOV, D. 1994. Linking international technology transfer with strategy and management: A literature commentary. *Research Policy*, 23, 195-215

DAVENPORT, T.H. AND PRUSAK, L. 1998. *Working Knowledge: How Organizations Manage What They Know*, Boston, MA: Harvard Business School Press.

DAY, D., DOSS, M., JORGENESEN, C., 1995. The transfer of research information within and by multicultural teams. *Information Processing & Management*, 31(1), 89-100.

DREJER, A. 1997. The discipline of management of technology, based on considerations related to technology. *Technovation*, 17, 253 – 265.

ESSOGLOU, M.E. 1985. Technology transfer for enhanced research development test and evaluation effectiveness. In: J.W. CREIGHTON, J.A. JOLLY AND S. LANCER, eds. *Technology transfer: A think tank approach to managing innovation in the public sector*. Monterey, California: Naval Postgraduate School, 1-16.

GAITHER, J. AND NAIMAN, C.S., 1978. Making technology transfer happen. *Research Management*, 21(3), 34-38.

GODKIN, L., 1988. Problems and practicalities of technology transfer. *International Journal of Technology management*, 3(5), 587-603.

GOLDSCHEIDER, R. 1982. *Technology management handbook.* New York: Clark Books.

HABIBIE, B.J., 1990. Sophisticated technologies: Taking root in developing countries. *International Journal of Technology Management*, 10(1), 489-497.

HAYAMI, Y. AND RUTTAN, V.W. 1971. *Agricultural Development: an International Perspective*, Revised 1985 Edition, Baltimore and London: The Johns Hopkins University Press.

JAGODA, K. I., 2007. A stage-gate model for planning and implementing international technology transfer. Doctoral thesis. University of Western Sydney. Australia.

JASSAWALLA, A.R. AND SASHITTAL, H.C., 1998. Accelerating technology transfer: Thinking about organisational paranoia. *Journal of Engineering and Technology Management*, 15, 153-177.

JOLLY, J.A., 1980. Technology Transfer –capacity building. *In*: J.W. CREIGHTON AND J.A. JOLLY, eds. *Technology transfer: Research utilisation and user stimulation*. Monterey, California: Naval Postgraduate School.

KODAMA, F. 1995. *Emerging Patterns of Innovation: Sources of Japan's Technological Edge*, Boston, MA: Harvard Business School Press

KNOX, W.T., 1973. Systems for technological information transfer. *Science*, August, 415-419.

LEONARD-BARTON, D.1995. Wellsprings of Knowledge: Building and Sustaining the Sources of Innovation. Boston, MA: Harvard Business School Press.

LIN, B. AND BERG D., 2001. Effects of cultural differences on technology transfer projects: en empirical study of Taiwanese manufacturing companies. *International Journal of Project Management*, 19, 287-293.

MANN, J., 1989. *Beijing Jeep, the short unhappy romance of American business in China*. New York: Simon and Schuster.

MANSFIELD, E., 1975. East-West technological transfer issues and problems, international technology transfer: Forms, resource requirements, and policies. *American Economic Review*, 65(2), 372-376.

MCDERMOTT, K. 1985. Government R&D: A wealth of new product ideas. *Dunn & Bradstreet Reports*, 33(6), 40-42.

NYENHUIS, K.E. AND WELBORN, J.H. 1976. *Analysis of the perceived reward to the receiver and its impact on the predictive model of technology transfer*. Monterey, California: Naval Postgraduate School.

PANDA, H. AND RAMANATHAN, K.1997. Technological capability assessment as an input for strategic planning: Case studies at Electricite de France and Electricity Generating Authority of Thailand. *Technovation.* 17 (3), 359-390.

PANDA, H. and RAMANATHAN, K.1998. Technological capability assessment of an engineering consultancy company. *Technology Management: Strategies and Application*. 4(2), 255-298.

PEARSON, A.W. AND RICHARDS, T., 1974. Current problems in transferring science to technology. *In*: H.F. DAVIDSON, M.J. CETRON AND J.D. GOLDHAR, eds. *Technology transfer*. The Netherlands: Noordhof Leiden.

PORTER, M.E., 2000. Location, competition, and economic development: Local clusters in a global economy. *Economic Development Quarterly*, 14(1), 15-34.

RAMANATHAN, K. 1998. An eclectic classification of technological capability. In Technology Management and Education Training for Developing Countries. Bangalore: UNESCAP-APCTT.

RAMANATHAN, K., 2001. E-strategies for technological capability development, *Proceedings of the Portland International Conference on Management and Technology*, Portland, Oregon, July 29-August 2

ROBERTS, E.B. AND FROHMAN, A.L. 1978. Strategies for improving research utilisation. *Technology Review*, March-April, 33-39.

SAAD, M., CICMIL, S. AND GREENWOOD, M., 2002. Technology transfer projects in developing countries-furthering the project management perspectives. *International Journal of Project Management*, 20, 617-625.

SENGE, P.M.,1990. *The Fifth Discipline: The Art and Practice of the Learning Organization*, New York: Doubleday.

SOUDER, W.E. 1987 *Managing New Product Innovation*, New York: D.C. Heath.

TEECE, D.J. 2000. *Managing Intellectual Capital*, Oxford: Oxford University Press, 2000.

TIDD, J. AND IZUMIMOTO, Y., 2002. Knowledge exchange and learning through international joint ventures: An Anglo-Japanese experience. *Technovation*, 22, 137-145.

TIHANYI, L. AND ROATH, A.S., 2002. Technology transfer and institutional development in Central and Eastern Europe. *Journal of World Business*, 37, 188-198.

VOLL, S.P. 1980. *A plough in field arable: western agribusiness in third world agriculture*. New Hampshire: University Press of New England.

ZHAO, L.M. AND REISMAN, A., 1992. Toward meta research on technology transfer. IEEE *Transactions on Engineering Management*, 39(1), 13-21.