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Why Technology Transfers?

How We Can Do It?

1.Introduction

Knowledge and technology accumulation, transfer, application, and diffusion are key to sustainable economic prosperity in the emerging global economy of the 21st century. Rapid advances in Information Technologies (IT) and declining costs of producing, processing and diffusing knowledge and technologies are transforming social and economic activities worldwide. The knowledge and technology revolution is critically different from the past industrial revolution in that it is based upon a shift of wealth creating assets from physical things to intangible resources based on knowledge and technologies. Thus, effective management and transfer of knowledge and technologies are believed to be the most critical capability of individuals, organizations, and nations in the globalized 21st knowledge society.

Knowledge and technology transfer is a complex, difficult process even when it occurs across different functions within a single product division of a single company (Zaltman et al., 1973; Kidder, 1981; Smith and Alexander, 1988). Moving innovative ideas from the research lab through production, marketing, and sales to the customer in a timely profitable manner has proven to be a difficult challenge even for the best managed U.S.firms (Peters and Waterman, 1982; Leonard -Barton, 1988; Badaway, 1991). The challenges of technology transfer are magnified when crossing organization boundaries (Williams and Gibson, 1990). Most current literature on knowledge and technology transfer describe the process of transfer in details, but has limitation in terms of their application in contemporary high-tech industries since most studies have not provided plausible explanation on levels and factors affecting transfer of knowledge and/or technology.

Thus, the purposes of this paper were: (1) to define technology, (2) to define knowledge and technology transfer and categorizes the levels of transfer, and (3) to identify mechanisms of technology transfer.

2.Technology

The enhancement of economic prosperity for countries, industries, and businesses depends upon the effective management of technology. Technology creates wealth. The proper exploitation of technology strongly influences business competitiveness, which is no longer, a matter of choice but a matter of survival in the marketplace. The development of technology provides an innovator with a leading edge. Clearly, the application of technology, not just its development, is a key to success in the competitive global economy. Technology can be defined as all the knowledge products, processes, tools, methods, and systems employed in the creation of goods or providing services. In simple terms, technology is the way we do things. It is the means by which we accomplish objectives. Technology is the practical implementation of knowledge, a means of aiding human endeavor.

3.Knowledge and Technology Transfer

Theoreticians and practitioners define the concepts of knowledge and technology transfer in many different ways. There is usually agreement, however, that (1) knowledge and technology is not just "thing," and (2) that transfer requires a profoundly human endeavor (Gibson and Smilor, 1991). Transfer is the movement of knowledge and technology via some channel from one individual or organization to another. The transfer of knowledge and technology is a particularly difficult type of communication if that it often requires collaborative activity between two or more individuals or functional units who are separated by structural, cultural, and organizational boundaries. Appreciation for the human component in knowledge and technology transfer directs us away from thinking of simply moving knowledge and technology from point "A" to point “B”. Instead, think of knowledge and technology transfer as an interactive process with a great

deal of back-and-forth exchange among individuals over an extended period of time (Gibson and Smilor, 1991).

Three models of technology transfer have been most prevalent (Devine et al., 1987). The "Appropriability Model" emphasizes the importance of the quality of research and competitive market pressures in achieving technology transfer. This model assumes the myth that good technologies sell themselves, but seldom true in real world. The "Dissemination Model" concentrates on the diffusion of innovation (Rogers and Kincaid, 1982). The objective is to disseminate innovations to individual users. But one-way communication from expert to user does not characterize the process. Most current one is "Knowledge Utilization Model", which emphasizes the importance of (1) interpersonal communication between researchers and users, and (2) organizational barriers and facilitators of transfer. But this model tends to reduce a very complex process to chronologically ordered stages.

To overcome the limitations of above mentioned three models, the following four levels of knowledge and technology transfer are suggested based on Gibson and Smilor's (1991) technology transfer model (refer to Figure 1).

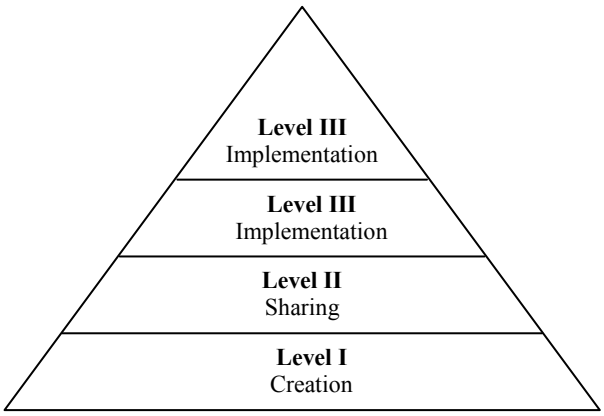

Figure 1: Four Levels of Knowledge and Technology Transfer
Note: In some papers there are nine level for technology transfer

At Level I, knowledge and technology creation, individuals conduct state-of-the-art research or develop the best practices into knowledge, and announce these results by such varied means as research publications, videotapes, teleconferences, news, and anecdotes. Knowledge and Technology transfer at this level is a largely passive process that requires little collaborative behavior among the transceivers, although the researchers may work in teams or across organizational or even national boundaries. Level II knowledge and technology transfer, sharing, calls for the beginnings of shared responsibility between knowledge and technology developers and users. Success occurs when knowledge and technology is transferred across personal, functional, or organizational boundaries, and it is accepted and understood by designated users.

In Level III transfer, success is marked by the timely and efficient implementation of knowledge and technology. For Level III success to occur, knowledge and technology users must the resources needed to implement. Knowledge and technology implementation can occur within the user organization in terms of manufacturing or other processes, or it can occur in terms of services or best practices. Level IV transfer, knowledge and technology utilization, centers on commercialization. Level IV builds cumulatively on the successes achieved in attaining the objectives of the three previous stages but market strength is required. Success is measured in terms of return of investment (ROI) or market share.

Research on technology transfer has traditionally concentrated on effective linkage and information movement usually to the exclusion of management theory (Levenson and Moran, 1987). An exception of this tradition is Creighton et al. (1985), who isolated nine elements that were repeatedly stated or implied in descriptions of technology transfer models. They are: organization, project, documentation of information, distribution of information, linking, capacity to transport or receive and to act, credibility of organizations in the transaction, willingness to transmit, receive or implement ideas, and reward. Smilor et al. (1990) emphasize the importance of difference between consortia and their member companies in terms of academic and business values, networking and information sharing, long versus and short-term perspectives, universal versus particular research objectives, and performance evaluation. Other variables such as risk, cost, and timing of the transfer process are also cited as being important to successful transfer (Inman, 1987; Pinkston, 1989; Gibson and Rogers, 1991). From comprehensive literature review, the following 16 research variables are identified as affecting the process and results of knowledge and technology transfer (Creighton et al, 1985; Gibson and Rogers, 1991; Inman, 1987; Levinson and Moran, 1987; Pinkston, 1989; Smilor et al .,

1990). They are: person-to-person contacts, knowing whom to contact, variety of communication channels, set up transfer office or committee, a sense of common purpose, understanding of nature of business, attitude and values, increase awareness of transfer, concreteness of knowledge/technology, establish a collaborative research program, clear definition of transfer, programs (Training, Demo, Tutorials), provide incentives for transfer, share success stories, push and pull for technology, and product champion.

4.Knowledge and Technology Transfer (TT or T^2) mechanisms

There are some types of mechanism that allow the flow of knowledge and technology. In the following pages, each transfer mechanism is reviewed and identified as either applicable or not applicable for any receiver or resource.

4.1Alliances

An alliance is an informal (TT) tool that allows resources laboratory to enter into Memorandum of Understanding (MOU) or Memorandum of Agreement (MOA) with a group of companies, laboratories, and /or educational institutions to pursue common technology interests. Accomplishment of specific T^2 efforts result through more specific transfer mechanisms.

Resources and industry after work together within consortia or alliances constrain draw collectively on the expertise of laboratories, universities, and industry to focus an broad technologies that can be pursued cooperatively until specific market opportunities arise.

Education partnerships

Educational partnerships are a formal agreement between a resource and an educational institution to encourage and enhance study in scientific disciplines at all levels of education. This may include the donation or loan of equipment, use of laboratory personnel to teach or assist in developing courses, and involvement of faculty and students in research.

4.2Collegial Interchange, Conference, Publication

The informal and free exchange of information among colleagues that includes: Presentation at professional and technical conferences, Presentation at professional and technical conferences, Publication in professional magazines

Caution should be taken to avoid premature disclosure of information that may be the subject of a patent application or proprietary data

4.3Consulting to the Laboratory

A party outside the laboratory provides advice and/or information; formal written contract, generally short term and specific, consultant certifies that no intellectual property conflicts exist

4.4Consulting by Laboratory Personnel

Consultation provided to a private sector party by laboratory personnel to further technology transfer; Laboratory must approve of the laboratory personnel consulting arrangement, conflict of interest must be avoided Intellectual property aspects require care

4.5 Contracts

A contract is an acquisition instrument entered into between the resourse and a contractor for the contractor to provide supplies or services to the resources; Can be used to fund R&D that may eventually be transferred to the private sector, Allocation of patent rights determined by the type of contractor performing the work, Large businesses may frequently obtain waiver of inventions, Nonprofit organizations/small businesses may obtain title to inventions

The resource and a contractor enter into a *contract* (an acquisition instrument) in which the contractor is required to provide supplies and services to the resource. The resource 's purpose is to acquire goods, services, or research for the primary benefit of the resource. Contracts may be used to fund research and development that may eventually be transferred to the private sector.

4.6Commercialization

The unique feature of *commercialization* is that the first step in this process is to identify a laboratory technology with commercial potential. Then a company search is conducted to find a company who can develop and use the technology in a commercial product or process.

4.7Cooperative Agreement

A *Cooperative Agreement* allows a federal agency to provide money and/or property to a business to support or stimulate research. The effort typically requires a cost-sharing arrangement, with government funding up to 50percent of the total collaborative effort .

4.8 Cooperative Research and Development Agreement (CRADA)

A *CRADA* is a written agreement between one or more laboratories and one or more parties under which the Government, through its laboratories, provides personnel, facilities, equipment or other resources to conduct specific research or development efforts that are consistent with the agency's mission. Although the collaboration involves the expenditure of federal funds and the use of federal personnel, services, equipment, intellectual property or other resources, no funds may flow to the CRADA partner.

In CRADA, requirement that no funds leave the laboratory; not subject to 31USC 6303- 6305terms for procurement contracts, grants, or cooperative agreements, rights to inventions and other intellectual property are negotiated as part of the agreement, and certain data generated by the federal laboratory may be protected up to five years.

4.9Cost -Shared Contract

A contract is entered into between the government and a contractor in which costs associated with the work are shared as specified in the contract. This contract includes in-cash and in-kind arrangements, must be of mutual benefit to industry and government, Commercially valuable data may be protected for a limited period of time, Advance waivers frequently not granted unless the contractor shares at least 20% of the total contract cost

4.10Personnel exchange

Personnel exchanges allow the scientific or technical staff members from the private sector or academia to work at government scientific or technical staff members to work in industry or academia.

4.11 Grants

The government awards research grants to educational institutions, nonprofit organizations, state and local governments only. Grants are used extensively to stimulate and support research. No cost sharing is required.

4.12 Grant and Cooperative Agreement

Grants and Cooperative Agreements are entered into solely by the government with a recipient whereby money or property is transferred to the recipient to support or stimulate research; Government can enter into these agreements, Less involvement between the government and recipients than acquisition instruments

4.13 Licensing

A *patent license* is an agreement by the patent owner permitting a licensee (i.e., a third party) to practice (i.e., make, use or sell) the patent invention in return for some valuable consideration (e.g., royalty). A license may be granted on an issued patent or pending patent application.

4.14 Partnership Intermediaries

A *partnership intermediary* serves as a T^2 intermediary between federal laboratories and industry. Partnership intermediaries are established through contracts or Memoranda of Understanding between the federal laboratory and state/local agencies.

4.15 Patents

A *patent* is a grant issued by the Government giving an inventor the right to exclude all others from making, using, or selling an invention within country, its territories and possessions. A patent granted to a federal agency may be licensed to a company for commercialization.

4.16 Technical Assistance

A Company can request *technical assistance* from a federal laboratory to solve a technical problem. Technical assistance is accomplished in an informal and timely manner. Transfer of federal laboratory expertise or technology through this mechanism is accomplished without the legal protection of a CRADA or license.

4.17 Use of Facilities/Loaned Equipment

In addition to technical expertise and technologies, federal agencies designate scientific equipment and facilities for use by industry and universities.

Theses facilities are unique, complex, experimental scientific facilities including equipment and expertise at a government laboratory designated by the government for use by the technical community, universities, industry, other laboratories, and other government entities

Use may be for proprietary or non-proprietary research. For proprietary R&D, full cost recovery is required. Patent rights generally go to inventor and proprietary data of the user can be protected. For nonproprietary R&D, title to inventions goes to the user but data generated are freely available If funded under another government contractor or international agreement, users are subject to those intellectual property clauses

4.18 Work for Others

Contract between an Agency and a partner for contract R&D to be performed by a laboratory or facility

4.19 Special type of technology transfer

There are some special types of technology transfer mechanisms in much country that government supports them. These programs mechanism help industry to develop there ability. Some TT mechanisms that USA federal supports them are:

4.19.1 Dual Use Science and Technology (DUST)

The Department of Defense (DOD) *DUST* program provides industry an opportunity to partner with the military services in the development of new dual uses technologies. DUST technologies must have military relevance and benefit in terms of Defense system cost, performance, or sustainability. There must also be sufficient commercial applications to sustain the industrial base. DUST is a 50 cost share program - industry must fund at least 50 percent of the project cost.

4.19.2 Independent Research and Development (IR&D)

IR&D is a Department of Defense (DOD) program that encourages contractors to pursue independent research and development (IR&D) projects that are of potential interest to DOD, thus encouraging a strong national technology base. Contractors are allowed to recover some of their IR&D costs.

4.19.4 Mentor-Protégé Program (MPP)

The Department of Defense and Department of Energy (DOD/DOE) *MPP* provides incentives to major contractors to assist small disadvantaged businesses (SDBs) as subcontractors. MPP is used as an outreach tool between major contractors and SDBs. SDB protégés receive technical assistance at no cost from the prime contractor mentor.

4.19.5 Small Business Innovation Research (SBIR)

SBIR is a program offered by ten federal agencies including the Department of Defense. SBIR contract awards stimulate technology research by small businesses while providing the government with cost-effective technical and scientific solutions to challenging problems. SBIR also encourages small businesses to market SBIR technology in the private sector.

4.19.6 Small Business Technology Transfer Program (STTR)

Similar to the SBIR program, STTR awards stimulate research and development conducted jointly by small businesses and research institutions (e.g., universities). STTR seeks innovative concepts for solving defense-related scientific and engineering problems, especially those concepts that have a high potential for commercialization in the private sector.

5.Summary and Conclusions

The purposes of this paper were: (1) to define technology, (2) to define knowledge and technology transfer and categorizes the levels of transfer, and (3) to identify mechanisms of technology transfer.

Most current literature on knowledge and technology transfer (
Model, and Knowledge Utilization Model), describe the process of transfer in details, but has limitation in terms of their application in contemporary high-tech industries since most studies have not provided plausible explanation on levels and factors affecting transfer of knowledge and/or technology. To overcome these limitations, the four levels of knowledge and technology transfer are suggested: Knowledge and Technology Creation (
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knowledge and technology transfer