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Abstract: The intention of this paper is to show the importance of the human conveyer in the world of Technology Transfer. A general overview of the some forms of technology transfer will be examined, but more specifically it will focus on the importance of the human interaction portion. Two different organizations will be examined for their use of technology transfer and for what reasons.

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Abstract

The intention of this paper is to show the importance of the human conveyer in the world of Technology Transfer. "The best way to transfer technical information is to move a human carrier" stated by Thomas J. Allen in his book, Managing the Flow of Technology. In an interview for a paper by Sigvald J. Harryson, Dr. Kikuchi of Sony actually stated that "the transfer of researchers is like breathing: both necessary and natural. A general overview of some forms of technology transfer will be examined, but more specifically it will focus on the importance of the human interaction portion. Two different organizations will be examined for their use of technology transfer and for what reasons.

Introduction

Technology Transfer is a complex process, which is not easily described. It can happen between private industry and universities, government and private industry, government and universities and within private industries. It has been stated that technology transfer is an old phrase describing an interaction between people and between businesses. Below are a few definitions from various organizations about technology transfer.

Definitions:

Technology Transfer is:

"The transfer of technology, expertise, or facilities from one person or organization to another for the purpose of commercialization or product/process improvement." (Washington Area Chapter of the Technology Transfer Society)

"A strategy for achieving organizational goals, as "a process leading to actual transfer." and as " a discipline involving a multiplicity of skills." (The Technology Transfer Society's brochure)

"The process by which existing knowledge, facilities or capabilities developed under federal R&D funding are utilized to fulfill public and private needs." (The Federal Laboratory Consortium.).

The concept of technology transfer is broad and to define it in simple terms is difficult. From the few examples above it can be seen that each organization defines technology transfer by the specifics of the situation.

Technology Transfer Mechanisms

There are different transfer mechanisms for different types of technologies. Four basic mechanisms are explained briefly below. They are: 1) documentation, which consists of specifications, drawings operation manuals and schematics; 2) instruction programs consisting of formal education or on the job training, 3) seminars and conferences among technicians and experts. 4) visits or exchanges of technical personnel.

Documentation consists of manuals, specifications designs, schematics, process instruction, troubleshooting and other forms of written material to support the technology which these items are part of. The documents can be very detailed to the proprietary level or general, which leaves the recipient of the documents with general information providing only basic guidance. For the more detailed documentation, one of the most significant lessons to be learned is that, however specific the instructions may be, they are not generally adequate enough to permit the recipient to produce precisely what was achieved in the headquarters plants. (Transfer of Manufacturing Technology Within Multinational Enterprises; Behrman, Wallender.) This is due to the fact that documentation does not completely reflect what is done on the manufacturing floor. People on the floor develop methods or settings to produce the product smoothly, which are not documented and are location specific.

The results of the gaps between documentation and shop practice can be quite striking. As documented in the book, Transfer of Manufacturing Technology Within Multinational Enterprises, a company received a request from a Japanese firm to repair one of its machines. The engineers arrived in Japan to see what was wrong. They worked on what they thought was their machine for several days but were unable to find the problem. The machine had the proper company trademark and serial numbers. After much frustrating work, and communication back to the parent company to find out the history of the particular machine, it was discovered that the Japanese had purchased one machine, and had duplicated it. They had even copied the serial numbers and trademark stamps onto the machine. However they had not been able to make it work. The Japanese had missed something in the process or procedures which made the difference between making a copy and making a functioning product.

There are two types of mechanisms used in transfer technology through instruction. They are formal education and on the job training. The company sees the employee who has a formal education as a benefit for the company. They offer tuition reimbursement, money for books, and time off of work to attend classes to help employees obtain a formal education.

The other is On the Job training (OJT). OJT is training that can be done while performing necessary job related work. It is gaining knowledge through actual time spent working. For example, a production line is made flexible enough to allow for mistakes and errors while a person builds the necessary skills to be proficient, while at the same time being efficient enough to produce a sellable product.

Conferences and seminars also support the flow of Technology Transfer by showcasing and holding lectures on products and ideas. The flow of technology between different competitors however is hampered by the fact that most firms protect their positions in the highly competitive market place by classifying information, "Proprietary". This label stifles the open discussion of technological ideas between engineers. So while general ideas are presented and discussed, more sensitive information is guarded. As

Allen discusses in his book, "It is always amusing to observe engineers from different companies interacting in hallways and cocktail lounges at conventions of professional engineering societies. Each one is attempting to gain as much information from his competitor without giving up any information or as little as possible (Pp 41)."
The conferences and seminars within an organization and between its partners have more freedom to discuss technology. As in the case of Sony, it schedules biannual open house meetings to discuss present and future research projects. Included in these open houses are, mangers, group leaders, sales personnel, manufacturing personnel, along with many other employees with intimate knowledge of various products and ideas. These types of gatherings open up unlimited solutions to problems and potentials for new technologies because each person involved brings different experiences, observations and knowledge.

Employee exchanges and intercompany visits are still another aspect of Technology Transfer. Formal training for a fixed amount of time would be necessary if a new product was being manufactured in a location different from where it was developed. If the people who were directly involved with the development of the product are not on site, the manufacturing manger needs to be trained so that the product can be produced correctly. This is not only a one way exchange of information. As the developer trains the manager, the manager is able to give his educated opinions as feedback on the product.

Casual visits can also produce results. Face to face interaction always produces opportunities for discussion and a more intimate working relationship between people which makes all communication more effective. For example, just the simple idea of suggesting a new technique that had not been thought of at the host's facility might aid production.

Visits or transferring of people is the key element of information exchange. Because as mentioned above it opens communication pathways and it encourages discussions. While extensive documentation, seminars and conferences are necessary for general information transfer, they aren't specific enough to capture the complete process of transferring information to ensure understanding by all parties.

Case studies

The following case studies support the previous statement that visits and transferring of personnel is key to Technology Transfer.

Ford; <u>Transfers of Manufacturing Technology within Multinational Enterprises</u>; Behrman and Wallender.

Since 1920, Ford has established plants in England, Europe, Scandinavia and South America. It operates in many diverse nations and sells vehicles in over 200 countries. To help its affiliates in developing countries understand and use the flow of information Ford uses extensive technical assistance and training programs. The impacts of technology transfer between Ford's headquarters and one of its affiliates will be discussed to support the human aspect of technology transfer. Ford's principal resources that are available to an affiliate are derived through its headquarters in Dearborn and it's regional management centers.

If Ford South Africa (SA) has a problem with some part of their operation, they contact the technical services staff at the World Headquarters. This staff selects the right person or persons from anywhere within their global operation and requests their services to be sent to Ford SA. Since 1964, two years after introducing expanded manufacturing, Ford-Dearborn had sent 53 different experts to South Africa with a wide variety of expertise. (Behrman, Wallender) This illustrates that even in the 1960's, companies realized the benefit of moving the people with the knowledge to the necessary location.

Another example of human transfer within the Ford Corporation is the plant in Neave, South Africa. It has received continuos assistance from many different sources within the Ford Company as a whole. Two control specialists were sent from Dearborn, one for twelve months and the other for ten months. Another specialist was sent to solve problems regarding body build, metal finishing and paint. In addition, an engineer from U.S. manufacturing a was sent to South Africa within 48 hours to investigate a problem with blistering underneath the paint.

From the knowledge that SA had gained it has sent engineers to help similar operations in other counties such as Rhodesia, the Philippines, New Zealand, Taiwan, and Thailand. These transfers provide opportunities for finding and solving problems in different ways than they would back home. It also allows engineers to see why a particular procedure is followed or not; "the answer obtained on the shop floor is often different from that given by the engineers" (Behrman, Wallender,p 56). "They find that to transfer of technology appropriately there is no substitute for face to face discussion of a particular problem as it has arisen" (Behrman, Wallender pg 56).

A joint decision between the South African group, the Latin American Group and the Dearborn officials to build an engine manufacturing facility led to another stimulus for technology transfer to develop. The manufacturing staff in Dearborn, out of its worldwide experience, developed the entire plant construction, layout and process. An engineer was sent to oversee the entire construction of the facility. This reduced cost and increased efficiency due to the expertise on hand. Additional 40 personnel were selected from various worldwide locations for their experience in specialized areas and were transferred to the engine plant for 12 to 30 months at a time for technical assistance. Dearborn also selected certain equipment and processes from Britain that would be best suited for the South Africa engine plant. The scope of technology transfer for the engine plant included building construction, plant layout, processes, equipment and model selection prior to start. After a couple of years, South Africans took over all positions in the plant (Behrman, Wallender).

Sony and Cannon; <u>How Cannon and Sony Drive Product Innovation Through Networking and Application-Focused R&D</u>; Sigvald J. Harryson

Sony and Cannon both transfer technology from external networks and within their organizations through internal networks. Cannon and Sony both transfer people from R&D to manufacturing and to marketing. This allows for easier manufacturing and marketing of a new technology. Cannon and Sony promote cooperation and open sharing of both R&D competencies and results to increase their innovative impact across labs and business units.

Cannon asked Dr. Kanbe to identify their future technology for displays. He discovered the new technology of Ferroelectric Liquid Crystal (FLC) technology through an Applied Physics Letter that reported on the new technology in 1980. Dr. Kanbe established a three-man task force to work on this new display technology with the help of the two inventing scientists. After a lot of trial and error a small FLC prototype was presented to top management. With some pressure of being out maneuvered by their competition Seiko, Cannon decided to pursue the FLC display and immediately sent people to the two universities where the invention was created for support in physics.

During the same period, Cannon had another task force working on a competing technology called Thin Film Transistor. After a period of time and through demonstrations of both prototypes it was decided to continue with the FLC display technology. This prompted Cannon to pursue an additional agreement with the scientists who invented the FLC technology. This allowed Cannon to keep the necessary knowledge in material design and other related research activities at Cannon. After a few years, the FLC display project became known as the Display Business Center. There they focused on three projects: Materials Analysis, Production Technologies and Interface.

Once the trial production line produced non-defective prototypes, a Planning & Marketing group of five engineers was formed from the R&D team and sent to the Planning & Marketing Headquarters in Shinjuku, downtown Tokyo, where they were joined by marketing experts. This shows how Cannon used employee knowledge of the total project to ensure consistent and productive R& D, production and marketing. A manager from the Display Business Operations Center stated:

> "Knowledge from external divisions is brought in whenever necessary, by moving in members from these divisions. As a result, a project team is not in a rigid form but rather transitory and flexible through the continuous moving in and out of members (How Cannon and Sony Drive Product Innovation Through Networking and Application-Focused R&D; Sigvald J. Harryson)."

A senior researcher joined the material analysis division at the Cannon Research center to work on FLC materials. He was sent to Tokyo University to learn new skills required for the evaluation of advanced materials. He returned to Cannon, assigned to the new generation FLC project. In this position he was communicating between the research center, production plant and occasionally the University.

A portion of Cannon's software interface was developed in their lab in ShinKawaski, but the majority was done at the Cannon Information Systems Research Lab in Sydney, Australia. Dr. Kanbe stated:

> "Some of our engineers go to Australia five-six times a year. This lab strongly supports our development of software simulation programs and interface electronics. Our R&D labs in the US and in the UK also give us some support in these fields."

Throughout the above examples, researchers were employed for successful transfer of knowledge from external sources to the Display Business Operations Center. "The Japanese Engineers were acting as human know how shuttles between Japan and the different overseas R&D labs", Sigvald J. Harryson pp. 291.

Cannon and Sony's research for Design and Manufacturing goes through three gates or samples as they refer to them. They are the technical, engineering and[3] commercial samples. Each gate has to be passed successfully before moving on to the next gate. Through this process technology finds a market, if there is no market, it gets killed early on before too much time and money are spent.

Once a technology passes through the three gates, the entire team who developed the technology moves or transfers to the manufacturing facility for the establishment of a prototype production line. This transfer of knowledge, meaning personnel, greatly increases the success of a timely established production line. If the production line had to be established through documentation and occasional visits, the probability that a functioning prototype production line would not be operating in short order would be extremely higher than if the technical expertise that developed the technology was directly involved in the manufacturing process.

To support this idea of moving the human carrier, Sony moves about fifty percent of their researchers out of the labs after three years and 80% after ten years. Harryson states, "This quasi-institutionalized transfer of engineers from development to production is particularly useful for new technologies. If the technology of a product is new, none of the existing engineers in production are likely to have prior experience in the field." In addition, this transfer of researchers becomes necessary, because, as in the example of the Cannon FLC display project , the team grew from three men, to the current operation of 200 people. 90% of the current team are working at the production facility.

Conclusion

From the examples above it is apparent that face to face communication is necessary and productive in the world of technology. This can be seen in the Japanese work cycle, the way they move from research to production to market. The Japanese researchers realize that even with the best technological innovations, if product knowledge is not well understood by manufacturing and marketing, the company will not be able to produce it and therefore the development of the product will not be beneficial to the company.

Ford even realized the importance of the human carrier in the early 60's by the statement, "They find that to transfer of technology appropriately there is no substitute for face to face discussion of a particular problem as it has arisen" (Behrman, Wallender).

Even with sophisticated information systems such as email, CAD systems, and other communication tools. Nothing can replace the efficiency of the physical human to human transfers of solutions.

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