

Elements of managing transfer of technology from laboratory to industry: Technology Transfer Management (TTM)

C U Saraf

CSIR- National Chemical Laboratory, Pune 411008 (India)

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This research paper throws light on problems faced by small, medium and large scale chemical industries in managing the transfer of technology from laboratory to industry. There are several reasons that may increase cost and time overruns and thus causes inordinate delay in completing transfer of technology in both private and public sector projects. This paper also suggests solutions to eliminate the problems and underlines the importance of involving local and national R & D institutes in effectively “Managing Transfer of Chemical Technology” into commercial practice. This communication presents “a13 steps model” developed by the researcher for efficient, smooth and effective transfer of technology. The findings have been duly supported by data interpretations, with appropriate examples of technology transfer and literature published. The primary data collection technique used is structured questionnaire as well as in-depth interviews of entrepreneurs, heads of R and D units and staff involved in technology transfer in chemical industries in and around Pune. The facts are also supported by the secondary analysis of literature published in related area. The basic objective of this communication is to communicate Technology Transfer Process Model (TTP) for effective commercialization of technology.

Keywords: Technology Transfer, Technology Management, Technology Transfer Process Model (TTP), Industrial Technology Commercialization, Technology Transfer Offices (TTO), Multi Disciplinary Man Power Team (MDMPT).

Introduction

In the present technological era interest in the profitable exploitation of a firm's technological assets, through technology transfer, has intensified. The factors favorable for the technology transfer are globalisation, liberalisation, and the impetus given to the protection of intellectual property etc. These factors have collectively resulted in commercial transfer of technology becoming an important element of the international as well as national development¹. Experience over the decades has shown that the technology transfer process may be problematic and transferees often lack the skills to manage it effectively². The importance of international technology transfer (ITT) for economic development is an important issue and needs detailed analysis of the factors involved in technology transfer, both for acquisition and technology diffusion. A study of the ‘Elements of Management of Transfer of Technology from Laboratory to Industry’ is necessary to avoid time and cost overruns in commercialization of

technology. The delay can be due to several reasons, right from the conception of the project idea to implementation of process know-how into commercial practice^{3&4}. This present study has made an attempt to understand the basic concept of transfer of technology from laboratory to industry and the observations of the study are specific to chemical industry. The paper analyses the problems faced by small, medium and large chemical industries and offers solutions which could minimize losses due to time and cost overruns in effecting Transfer of Technology with the help of 13 steps model developed by the author called Technology Transfer Process (TTP) model. Technology transfer process as a whole is a series of activities and actions right from conceptualization of business idea in to commercial practice. Different studies have been conducted by the scholars in defining the process of technology transfer and it is classified into the following three phases, each phase consists of a number of different activities as described below⁵:

Phase-I: Pre-investment phase:

- (i) In this phase activities are related to generation of information and data that are necessary for taking

*Author for correspondence
E-mail: priya.saraf@ymail.com

investment decision. The major activities in this phase are: Scouting for project ideas, market and demand analysis for the products, market surveys, demand forecasting, and international market situation.

- (ii) Scouting for technologies, the level at which the technology is offered, actual terms of transfer of technology.
- (iii) Pre-feasibility study, preparation of project feasibility report for investment decision.
- (iv) The final action in phase-I is “negotiating and deciding contractual terms and conditions of transfer of technology from supplier and responsibilities of supplier and buyer (user) of the technology.

Phase-II: Investment phase

This phase consists of the following activities which are major in the process of technology transfer –

- (i) the execution of contractual / license agreement between the parties concerned
- (ii) acquisition of technology, scheduling of technology transfer
- (iii) erection and installation of the plant equipment and machinery as per precise engineering designs and specifications of the plant of desired production capacity
- (iv) commissioning of the plant

Phase III: Post-Investment Phase

This phase consists of the following activities which are very important to maintain competitive advantage:

- (i) to improve operating efficiency of the plant
- (ii) capacity expansion
- (iii) technology up- gradation

Technology Transfer: Some Major Management Factors

A further analysis of the above statements shows that one should take into account the following managerial factors carefully in studying the process of technology transfer in the present context of time –

- 1 Selection of the product/project, manufacturing process, based on complexity of the technology involved, and on project feasibility study. Viz-a-vis the entrepreneur's/ company's financial & technological capacity and capability.
- 2 Identification of the users of the product and consumer acceptance
- 3 Size of the market, imports, competition in the business – knowledge about the leading players in the market

- 4 Social and political atmosphere in the country
- 5 Knowledge about the statutory requirements, Government Rules and Regulations to be followed
- 6 Availability of land, finance and infrastructural facilities (eg. Transport, supply of power, water and labour)
- 7 Selection of project site for setting up the factory and/or business activity
- 8 Person's/Organization's background, educational qualifications, family background, his/her experience in manufacturing and marketing activity, trading business
- 9 Availability of a commercially viable process know-how/manufacturing technology⁶, specifications/quality of the finished product
- 10 Availability and prices of the raw materials and finished product, its imports/exports data
- 11 Understanding the levels of transfer of technology from supplier/s to user (transition of the technical knowhow from laboratory / supplier to industry), scale and level of transfer of technology and guarantees of performance⁶
- 12 Knowledge about Intellectual Property Rights (IPR), terms and conditions agreed for commercial utilization of the IPR
- 13 Creation of marketing and other infrastructural facilities e.g. marketing outlets
- 14 Application of management tools / techniques
- 15 Appropriate & timely use of various tools & techniques of information technology.

The success of the project by the entrepreneur depends upon his ability to identify these factors, anticipate possible problems that are likely to come up and plan the project activities for its implementation accordingly. Take periodic reviews of the project implementation and if necessary, modify the plan, activities at the right time, search appropriate solutions and implement them to overcome the difficulties keeping in mind the time, cost and business opportunity. In view of the above, the study on transfer of technology from laboratory to industry was undertaken by the author. The following paragraphs give a detailed summary of findings of the research and its practical implication. The study was conducted in chemical and related chemical industrial sectors in and around Pune (Maharashtra) India during 2007-2011. The results of the study are applicable and useful to transfer of technology irrespective of its level of transfer.

Technology Sources

For industrialization, in addition to man, material and money, what is required is an appropriate technology. Unless an appropriate technology is available, nothing can be done. Therefore, we must know Technology Sources; some of them are mentioned below:

- R&D Organizations of Council of Scientific and Industrial Research, New Delhi such as NCL, Pune, IICT Hyderabad, CSMCRI Anand, CECRI Karaikudi, CFTRI, Mysore.
- Chemical Project Engineering Firms (Indian and Foreign)
- Project Consulting Firms / institutes (Indian and Foreign including NCL, and MITCON, etc dealing with chemical projects).
- Foreign and Indian Multinational Companies engaged in production of chemicals and related products.
- NRDC (National Research Development Corporation, New Delhi)
- NRIs
- Universities and Indian Institutes of technology doing R&D in chemicals.
- MCCI&A, Maratha Chamber of Commerce Industries & Agriculture, Pune, Maharashtra Centre for Entrepreneurship Development (MCED) Pune and in Other states all over India.
- International and National Industrial Exhibitions, Expo, IITF, etc.
- In-house Chemical R&D centers

The entrepreneurs must gather data of the respective technology suppliers, evaluate their track record, check market credibility and their current market status and then select the technology supplier. Also, in a transfer of technology the scale of technology development and level at which it is offered and the contents of the technology package are very important. This aspect is further discussed under item 3 of the model developed by the researcher for smooth transfer of technology.

Involvement of Local, National R&D Units in Technology Transfer

In this context, therefore, the research & development work carried out by the national laboratories / R&D institutes such as the National Chemical Laboratory (NCL) Pune, IICT Hyderabad, must be taken into account as also the R & D work carried out by Appropriate Rural Technology Institute, Pune (ARTI) in a developing country such as India. Because of their R&D achievements, their

technological capability and the experience they got in commercialization of indigenous and foreign technologies during the past 25-30 years, they have certainly built in them the very expertise and professionalism required to provide necessary advice and guidance to technology receiving parties^{7&8}. The chemical technology as developed by the laboratory is usually offered at different levels depending on the complexity of technology. The chemical processes developed by NCL, Pune were formerly offered at different levels. As per the present trend, the processes are developed on bench scale as per the requirement of industry.

Importance of Technology Transfer Offices in Effecting Transfer of Technology Smoothly and with Minimum Possible Time and Cost Overruns.

In this context, it may be noted that all institutions, including universities, especially in USA and UK, have dedicated Technology Transfer Offices (TTO). According to one estimate (some years ago), over Rs 2000 millions are spent annually on R&D in chemistry and chemical technology alone in India, and many times that amount is devoted to the transfer of R&D results to the market or into the production process. The above statement underlines the very importance of successful transfer of chemical technology from lab into commercial practice. However, in India, except CSIR, very few institutions have such offices. Because of this, technology transfer has become the responsibility of the individual faculty and not an institutional responsibility. This is a pathetic situation in a developing country like India. In order to transfer the laboratory research and development work into commercial production with minimum time and cost overruns, it is essential that the Indian companies having R&D centers and business houses (including small & medium enterprises) must have dedicated TTOs to minimize losses caused due to time and cost overruns in effecting transfer of technology.

Field work carried out by the researcher and its implication for practice and development of 13 steps model developed for smooth transfer of technology into commercial practice.

The questionnaire was addressed to 175 units. The break-up is as follows: Chemical units (nos.42), Non-chemical units (nos.133). Due to the attitude of the companies not to disclose the information, the total no. of units responded were 81 (46%). The break-up

of which is: Chemical units 28 nos. and the Non-chemical units 53 Nos. However, the present paper and the observations are specific to Chemical industry,

For this research study, the convenient and purposive sampling method was adopted. The sample units were selected from two categories viz. chemical and non-chemical industrial units in and around Pune.

Robust Technology Transfer: some key factors

Based on the data collected, results of research and experts' opinion it can be said that the successful transfer of technology will depend on the following key factors:

A well drafted Transfer of Technology agreement^{9&15} must clearly specify the financial, technological and contractual transactions that are mutually agreed to by and between the parties to the agreement. It should have a preamble explaining the purpose of the agreement, names and occupational details of the parties concerned. It should have the following clauses.

- Whether the technology will be licensed on exclusive, non-exclusive or limited exclusive basis.
- The payment schedule
- The performance guarantee
- Secrecy and confidentiality clauses
- Strong IP protection
- Exchange of Technical information, technology transfer/ demonstration schedule.
- The general clauses including force majeure, default, patent infringement, un licensed

infringement, assignment, governing law, arbitration, letter of training agreement giving schedule and training contents, insurance clauses and terms and termination of the agreement.

Benchmarking

Use of new technology has not always been a success. In fact experience shows that many heavy capital investments have not provided the expected increase in productivity, and the announced profitability has not always been reached. Osterman¹⁰ showed that more advanced technology did not mean an increase in productivity; however human resource management was considered to be very important. The technology in all industrial sectors the world over is developing very rapidly and therefore the objective of the technology transfer agreement (particularly for imported technology) should clearly define Globally Benchmarked Process and engineering documents envisaged to be transferred, clearly benchmarking the status of the investment process of new technology.

Practical Implications

For the research study 175 industrial units from chemical and nonchemical sectors were selected in and around Pune. The researcher interviewed 81 industrial unit holders concerned with technology transfer. The outcome of the data analysis and interpretations of responses is a basis for the development of "a 13 steps model" proposed for transfer of technology from laboratory to industry by the author. The steps involved in this model are depicted in the figure given on the last page.

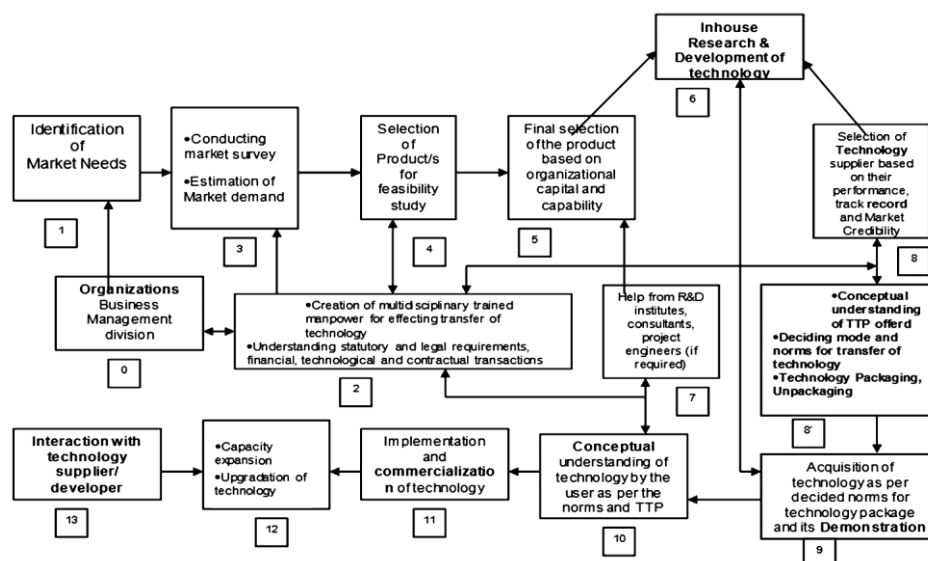


Fig. 1—TTP Model

Explanation of the steps discussed in the 13 step model:

1. Steps 1: For any business, identification of the product is the first step. For this, conducting a market survey to estimate the present and the future requirements of the market must be done. The market survey can be carried out by the firm or through a consulting organization depending on the capacity, capability and expertise available at the firm.
2. Step 2: For taking meaningful decisions in real and right time on the steps described above and for carrying out the technology transfer activities thereafter it is essential to formulate a multidisciplinary manpower team (MDMPT) to interact with the concerned departments / officials – both internally and externally. The composition of the experts in the above multidisciplinary team preferably should be as follows: the team should comprise of experts from finance department, business field having MBA or MBS degree, engineers i.e. chemical, mechanical and also civil as well as experts who are aware of business laws, industrial rules and regulations, export, imports procedures, Industrial Acts, experts who are aware of pollution control and chartered accountants, IT experts and Marketing Managers - preferably having some industrial operation and marketing experience. The composition of MDMPT as above is essential so as to eliminate the likely time and cost overruns due to non understanding or misunderstanding of the basic concepts and applications relating to various transactions. (Financial, technological and contractual) in effecting transfer of technology from Lab to industry. Team leader of MDMPT should monitor and control progress of the work and eliminate deviation of the activities, if any.
3. Steps 3 and 4 : Based on the data collected in steps 1 and 2 above, two or three product names should be short listed to conduct project feasibility study. The project feasibility study will give marketing insight relating to the technical and commercial feasibility of the project.
4. Step 5: This is a critical decision step since it leads to the final selection of the product for doing the business i.e. taking investment decision. While taking the decision of final product selection, it is imperative to take into account the organization's capacity and capability to judge whether the firm is capable of generating the required funds i.e. preferably soft loans, handle the complex technologies at different levels and whether the firm has adequate well-trained manpower (both at technical and managerial level) and a dedicated, enthusiastic sales force people.
5. Step 6: In-house R & D: After product selection is done the leader of multidisciplinary manpower team must checkup whether the company's R&D center is capable to develop the required technology/process know-how at the desired level from where it could be transformed into commercial production.
6. Steps 7 and 8: The organizations/entrepreneurs that are small or medium size may not have any R&D centre. In such cases, the multidisciplinary team leader should do the scouting for appropriate technology with the help of team members and find out the right laboratory for supply of the technology. The technology supplier/laboratory must be selected on basis of its talent, its recent past performance track record and present market credibility.
7. Assuming that the lab / technology supplier is selected, the next critical stage is deciding the terms and conditions and most importantly working out the details of transfer of technology viz., technology packaging. The terms and conditions of transfer of technology must be incorporated in the Technology Transfer Agreement (TTA) required to be signed by and between the technology supplier and technology receiver. In other words the TTA must spell out details of a) Financial b) Technological and c) contractual transactions that are envisaged vide the TTA. The responsibility here is that of the MDMPT team leader to crystallize the terms and conditions and put them in black and white.
8. Step 9: Here the responsibility is that of the workshop and production department people along with the members of the MDMPT. They have to ensure that the experimental details scientific / technical details of the technology, the process know-how in the form of a written document, plus relevant design data; specifications of the plant equipment, their sizes and capacity and material of construction etc are received from the technology supplier. The process know-how must also provide analytical and testing procedures for finished product as also for the raw materials, intermediate products as per the specifications.
9. Step 10: The concerned people must also ensure that the technology has been demonstrated on the

scale of its development with the guarantees of performance as per the terms and conditions incorporated in the TTA. In this regard and especially for the small, medium enterprises (SMES), it is preferable that in the activities numbered 8, 8', 9 and 10, involvement of local R&D or National Chemical Laboratory (for chemical technologies) & other Govt. R&D institutes is essential for understanding scientific details that are to be received. Experimental details regarding effluent disposal treatment should also be available. For this the manager of the MDMPT has to act as the catalyst to facilitate the transfer of technology as per TTA.

10. Step 11: At this stage it is the joint responsibility of MDMPT and the workshop, Production dept. and the finance dept/unit of the organization to see that a Time plan is made, installation of the plant equipment, utilities (supply of water, steam and electricity) are done and other infrastructural facilities are made available. (Including the necessary technical and non technical manpower) and commercial trial runs are taken as per the conditions incorporated in the TTA. Subsequently the commercial production can be started.
11. Steps 12 and 13: Once the production is established and marketed successfully at planned capacity, and then the company can think of expansion and later do technology up gradation in consultation with the laboratory / technology supplier and or the local R&D or NCL.

The model developed is based on the inferences drawn from responses obtained by the researcher from 81 industries, marketing officials and plus some experts in the field of transfer technology.

The outcome of research findings:

The analyses of study indicated that 73% of the respondents concurred with the following facts identified by the researcher which can cause inordinate delays in effecting transfer of technology from lab to industry.

- (a) The cost and time overruns are caused due to
 - (i) Lack of management
 - (ii) Misconception about Technology Transfer Process (TTP)
 - (iii) Human factors and
 - (iv) The procedure for issuing various permissions, clearance, certificates particularly by the govt. agencies /dept

Examples strongly supporting the TTP Model developed.

Example (A):

Technologies for production of pesticides developed and licensed by a R & D organization, could not go into commercial production as scheduled because the necessary permission was not granted by the Central Insecticides Board for want of adequate registration data as required by Insecticides Act 1967 and Insecticides rules 1972. This lapse¹¹ was entirely due to lack of management which failed to realize essentiality of fulfilling the statutory requirement by both the technology supplier and the licensees of the technology which include medium size and multinational companies. As a result, the companies suffered production and financial loss for about one and half year! The example emphasizes the importance of the items 7, 8', 9, 10 in the above TTP model.

Example (B):

A complex technology for production of β - ionone from lemongrass oil could not be commercialized by the firm because the firm did not have the necessary technological capacity and capability and therefore the technology remained unutilized¹². This happened purely due to lack of techno managerial judgment and absence of right type of manpower at the user firm as referred to in the steps 4, 5 and 7 in the above TTP model. As against this, the same technology which was released to a multinational company having necessary expertise, testing and pilot plant facilities was able to successfully commercialize it in a reasonable time and use it for several years for its business. Here appropriate techno-managerial judgment and availability and use of the right type of man power are the key factors.

Example (C):

A young science graduate, who started commercial production of collapsible tubes, had to finally windup his business as there were no buyers in Thane-Belapur industrial belt for such products. The young man undertook commercial production without conducting marketing research and feasibility study. The example clearly brings about the management aspects mentioned under the steps 1, 3, 5 and 7 of the model. Several other examples related to time and cost overruns and project failures have been reported in different literature as mentioned by earlier research

workers Tripathy (1982), Kapoor (1983), Kharbanda (1983) and IDBI¹³ and other authors like M Sakthivel Murguan and N.P. Srinivasan, University of Madras¹⁴ on their study on project management related to Transfer of Technology. These examples also support TTP model developed and presented for management of transfer of technology from lab to industry.

Recommendations:

- 1 There is a need for undertaking systematic study of the process of transfer of technology especially by the small scale industrial units, which are spread in and around Pune and also for those who are aspiring to become entrepreneurs.
- 2 The Entrepreneurship Development Programs (EDP) conducted by The Maharashtra Centre for Entrepreneurship Development in Pune Agricultural College Compound should also include a special training unit in their EDP for Technology Transfer Process.
- 3 The University of Pune Management Courses has a subject on Entrepreneurship Development. Technology Transfer as an important chapter and it is felt that there is a scope for inclusion of a chapter on "Transfer of Technology" from the supplier to industry in these courses. This will certainly help in avoiding time and cost overruns which are normally experienced by both small and medium scale sector units in industries during commercialization of technology.

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