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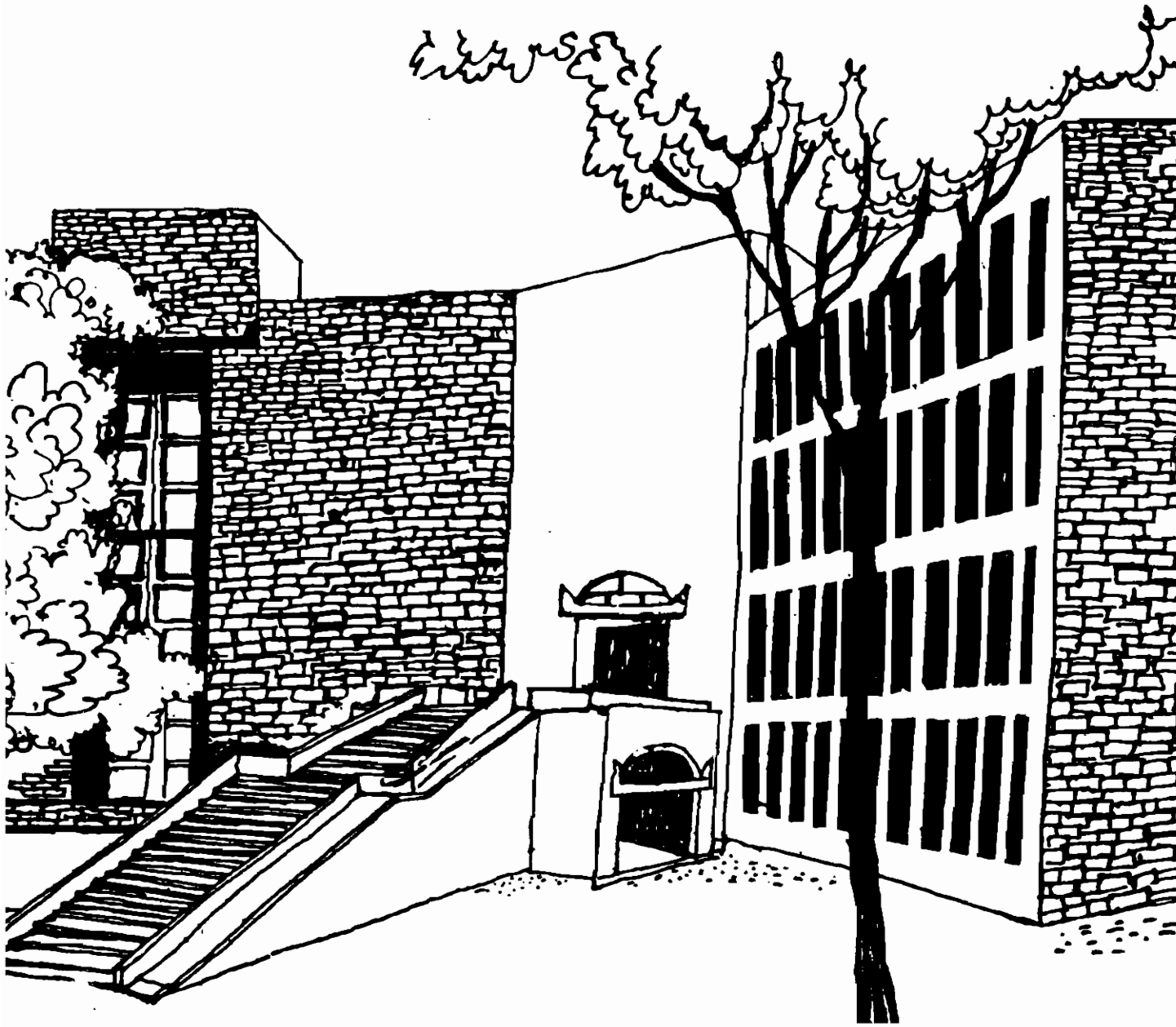

CONCEPTUALIZING STRATEGIES FOR TECHNOLOGY DEVELOPMENT: A CASE STUDY OF AN INDIAN LICENSEE

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Abstract

The ensuing economic liberalization in the country has seen a rapid increase in licensing and joint venture arrangements involving Indian firms. For long term growth, the domestic firms will have to develop mechanisms and strategies to learn from these tie-ups. Available literature suggests that, in the past, Indian firms have not been able to build on the knowledge acquired through such linkages. Often licensing contracts do not provide adequate knowledge about the licensed product which would enable the licensee to modify and develop it further. Such a strategy requires, first, to identify those elements of technology that are essential for building on licensed technology and have not been transferred by the licensor, and second, to generate capabilities in order to acquire and/or develop these elements. This paper presents a framework for analyzing technology strategies at the firm level and illustrates its usefulness in the context of an Indian licensee.

Introduction

In the current liberalized environment in the country, firms have diversified their technology acquisition package both in terms of sources and modes of technology transfer. While the opportunities to obtain better quality technology have improved, it is not sure that Indian firms are able to acquire the state-of-the-art technologies and whether these technologies are being employed to enhance and develop the technological capabilities of these firms. Studies have shown that unless countries develop competitive technological capabilities their gains from international technological trade, in the long run, will remain inadequate. Besides, development of domestic technological capabilities is found to be essential for assimilation and absorption of newer technologies [Evenson and Westphal , 1994; Kokko, 1992]. The inflows of technology, in recent years, have been significant while our investments in technology development have not grown commensurately. According to some estimates, the number of foreign collaborations approved during the period August 1991 to March 1994 was 3989, while the number of approvals was around 3050 during April 1987 and March1990. However, the percent of R&D expenditure to sales turnover in the private sector rose from about 0.77 in 1980-81 to 0.90 in 1988-89 and then declined to about 0.64 in 1992-93 [CMIE, 1994]. The challenge, therefore, is to ensure that future technological developments in the country is not entirely dependent on imported know-how, i.e., adequate investments are made at the firm level to absorb, assimilate and build on such know-how.

For long term growth, the domestic firms will have to develop mechanisms and strategies to learn from technology inflows and build on the knowledge acquired through such linkages. Often licensing contracts do not provide adequate knowledge about the licensed product which would enable the licensee to modify and develop it further. Such a strategy requires, first, to identify those elements of technology that are essential for building on licensed technology and have not been transferred by the licensor, and second, to generate capabilities in order to acquire and/or develop these elements. The technology response of Indian firms to recent macro-economic changes will have to be assessed in the above context to ascertain if they are likely to be dynamic in the future. In this paper we first present a framework for analyzing technology

strategies/responses at the firm level. This is followed by a case study of an air conditioner manufacturer, where we use this framework to analyze the technological strategies of this firm and their implications.

Managing Technology in the Liberalized Environment: Opportunities and Challenges in 1990s

In the pre-liberalization phase, the availability of technology was limited due to severe restrictions on foreign equity participation, technology licensing, import of capital goods, components and raw materials, restrictions on capacity expansion and raising of funds. Since 1991, firms have experienced relaxation of these constraints. Moreover, India is being seen as a strong emerging market. This has induced competition among international technology suppliers which works in favour of the domestic firms. The exposure of domestic manufacturing enterprises to newer technologies has significantly improved, creating opportunities amongst firms for Schumpeterian competition. In principle, if utilized appropriately, these opportunities could result in better quality products and processes.

Immediate challenges in managing these technology flows range from procuring the latest vintage of the imported technologies at the right price to ensuring that the acquired technology is absorbed quickly and successfully. The question that remains unanswered is whether firms are strategically thinking of unbundling technology into components that can be developed and improved in-house and those that will need to be acquired due to lack of capabilities or high costs of development. While the former will require strong engineering R&D and a desire to become technological innovators, the latter will require skills for scanning and negotiating technology acquisition. Needless to mention, both will require strong capabilities to manage technology implementation . In other words, the challenge is to develop technology strategy as an integral and strong component of the business strategy of the firm in order to enhance its capabilities in the long run.

Analysing Technology Strategy: A Heuristic Framework

It is not very clear if the current spate of technology flows through collaborations, licensing, equity participation etc. form a part of a well defined, long term strategy for enhancing the technological capabilities of these firms. The technological response of Indian firms to liberalization can be categorized as follows:

(a) passive assembly,

(b) blue-print manufacturing,

(c) advanced blue-print manufacturing, and

(d) imitation and developement.

Passive assemblers (e.g., computer manufacturers, some consumer durables like BPL, Videocon, HP-HCL etc.) procure components & sub-assemblies within and outside the country for domestic/foreign markets. Their investments in the development of technology is practically nil. The blue-print manufacturers typically acquire designs through arms-length arrangements and use their production capabilities to manufacture the products. Examples in this category include some pharmaceutical firms like Torrent or IPCA that produce formulations patented elsewhere. The advanced blue-print manufacturers often enter into joint ventures with technology supplying firms and use the latters' know-how and resources to implement the design. Large textile machinery manufacturers like Lakshmi fall in this category. The imitators and developers develop their own variant of existing or new designs based on their internal R&D capabilities. They exploit the spillover potential of existing as well as emerging technologies and recognize technology development as core component of their business strategy. Firms like Ranbaxy, Dr. Reddy's, Cipla, C-DAC and BHEL would belong to this group. While in practice firms' responses could cut across the above categories, we will need to focus on their dominant responses. The categorization of firms in terms of their dominant response to liberalization will help us evaluate their technology strategy. A somewhat large database on such responses can be useful in designing policy instruments for enhancing the long term technological dynamisim of the economy.

In order to analyze the technological strategy of a firm, one would need to understand: (a) its inter-linkages with the business strategy, and (b) the nature of activities undertaken by the firm to build technological capabilities. Several researchers [e.g., Porter, 1980; Schoemaker, 1992] have defined the dimensions of business strategy which includes where, how, and with whom does a firm compete. Whether technology is central to this strategy would define where the firm would fall in the above categorization. In this context, our framework seeks information on how a firm responds to the chosen business strategy in terms of technology choices. For example, an international technological collaboration can constitute a key component of a firms entry startegy in a new product market. Alternatively, the firm can invest its own resources to develop new products to serve this market. Similarly, technology choices could support the unique selling position and product characteristic visualized in the business strategy. Clarke (1989) cites the example of how Mazda chose a unique process technology mix (comprising highly automated and flexible welding processes, sophisticated short cycle stamping and mixed-model assembly procedures) to increase product variety - the key element of the firm's business strategy.

The focus of the second dimension of our framework is on the activities that the firm undertakes in order to build technological capabilities. These activities play a key role in the movement from "passive assembler" to a "technology developer". Teece (1986, 1992) has argued that developing "complementary assets" (e.g., manufacturing, distribution, complementary technologies and services) is crucial for appropriating maximum benefits from technological innovations. Pisano and Wheelwright (1995) studied 11 American pharmacetical firms over a period of 14 years and found that despite significant innovative activity at the firm level, companies found "themselves squeezed by shorter product life cycles, less pricing flexibility and higher cost" due to weak manufacturing and process engineering efforts. Strong manufacturing capabilities allow firms to rapidly ramp-up production and reduce the time required to introduce a product in the market. Apart from manufacturing, technological capabilities include an ability to effectively implement acquired technologies on the shop floor, conformance to world-class standards, creating a learning environment, and developing networks with other entities to complement in-house capabilities. Therefore, technology strategies must consciously incorporate processes that build capabilities within the firm for it to deliver competitive advantage.

In the next section we present a case study of an air-conditioner manufacturer with a view to analyse its technology strategy using the above framwork.

Case Study: Amtrex Co. Ltd.

Amtrex is a relatively new and a small entrant in the international airconditioner (AC) market. It produces different types of ACs - Window AC (WAC), Split AC (SAC) and Package AC (PAC) - in different sizes (1, 1.5, and 2 Tons for WAC; 1, 1.5, and 2 Tons for SAC; and 3, 3.75, 5, and 7.5 Tons for PACs. For SACs there exist several models at each sizes, e.g., floor, wall or ceiling. Its turnover has grown from a Rs. 9 crore in 1990-1991 to a Rs 52 crore in 1994-1995 and it hopes to doube its turnover by the year 1996-1997. Exports account for 7-10% of Amtrex's output. Located in the suburbs of Ahmedabad, it desires to become the "3M" of the Heating, Ventilation and Air Conditioning (HVAC) industry - to grow on the basis of new and innovative product introductions. It has had an interesting path towards developing competencies that are necessary for competitive product and process innovation.

Being new to this industry, Amtrex took the licensing route for the procurement of technology. Since 1990, it has entered into a technical agreement with Hitachi where both, drawings and some manufacturing tools, have been bought on a license from them. Table 1 lists the products developed or bought on license from Hitachi. While Amtrex licensed earlier products (e.g., WAC & Split AC), it started to purchase CKDs from Hitachi of their most recent products (e.g., big flow SAC and Cassette SAC). Amtrex has used this relationship to develop capabilities, experience and visibility in the domestic and international markets.

During 1991-93 Amtrex introduced modified/adapted versions of WACs and the basic SAC model. This development was facilitated by networking with various domestic vendors (see below). By the end of 1993, the firm had benchmarked and copied packaged ACs. It could design and develop on its own packaged ACs of up to 3T capacity. It continued to purchase toolings fron Hitachi and elsewhere. It may be noted, that in this period Amtrex had only arms

length links with Hitachi whereby only codified knowledge about the AC technology and its manufacturing were available.

While Amtrex's goal has been to learn about the science and art of AC design from Hitachi, the collaborator has been forthcoming mostly with codified knowledge on technology - querries on tacit knowledge, e.g., issues like why components were designed in the way they were, have been ignored by the external collaborator. As a result, Amtrex has had to learn for itself the rationale behind AC design - the usage of different components, materials, design of fixtures within the AC box, the shape of the fins and brazing of tubes etc. This movement from "know-how" to "know-why" has not been easy and has forced Amtrex to understand, for itself, the basics of product design in this industry. The results have been very encouraging - eight patents have been or are in the process of being filed in India, new insights into what could become their competitive strength (e.g., "tropicalization experts") vis-a-vis firms from the west and the east, and a confidence that, in India, they could design, manufacture and deliver an international product. While the challenge remains to be overcome, the promise is quite heartening !

Amtrex has chosen to make "product design" an important element of its technology strategy. The above situation has helped the firm to develop competencies on "this route" towards growth. The elements of this technology strategy for developing competitiveness can be described as follows:

(a) Interlinkages between business and technology strategies

In the case of Amtrex, the links between business policy and technology strategy can be seen through entry strategies and product positioning (i.e., the market niche it identified for itself).

(i) *Entry through International Collaboration:* Amtrex entered into an association with Hitachi of Japan to get a foothold in the AC sector and when tacit knowledge was not shared by the licensor, they developed a formal relationship with Fedders of USA. Manufacturing for Fedders gave Amtrex not only an additional source of design input but also an entry into the Middle

Eastern AC market. Molds and some toolings have also been procured from Hitachi. Some components have been globally sourced, e.g., copper coils. Hence, diversification of sources of technology, even through the "marketing" route has benefited the company in a variety of ways. More on this later.

(ii) *Development of a Unique Selling Position*: The firm has decided to position itself as the producer of "silent" airconditioners for "tropical" areas. It has identified various product design attributes that contribute towards these two characteristics and is trying to modify their product designs accordingly (e.g., these efforts range from making the drain pan more aerodynamic for noise reduction to using filters for dust protection for heat exchangers to enhance life in tropical areas). The firm believes that it is better equipped to serve the large and growing markets in tropical countries, compared to firms in the west or the east, as its domestic base is in such a country. This enables the firm to understand the requirements of such a market far better than its competitors.

(b) Building Technological Capabilities

Technological capabilities can be built in a large variety of ways. Many studies (e.g., Lall, 1987) have shown that such capabilities range from skills in investment, search and bargaining to actual implementation on the shop floor. In the case of Amtrex, four processes involving the building up of such capacities seem important:

(i) *Manufacturing Capabilities & Technology Implementation:* The firm is in the process of implementing several programs for enhancing its capabilities, e.g., developing various training programs, various "kaizen" efforts to upgrade the quality of the product by improving its design, implementing a finished goods quality program (goods that are not "100% OK" are not shipped out of the plant), development of an accurate psychometry room, simplification of products, planning for an ISO certification etc. However, first and second pass yields on the shop floor remain high requiring a lot of rework in order to conform to the 100% OK philosophy, material movement and Work In Process are high, batch sizes in fabrication unit are large, and assembly

is done by casual workers who do not have adequate training.

(ii) *International Conformance:* An important element of Amtrex's technology development strategy has been seeking international affirmation of the quality of its products. Other than just the association of the Hitachi name, the firm has also benefitted from Fedders' requirement of having the product tested and approved by the Underwriter's Laboratory - an international product testing organization. The firm has sought the ISI and UL-484 approvals for its products. While meeting these requirements has been most challenging, it has also been very useful in improving its product quality.

(iii) *Technological Learning*: Learning from collaborators have come through formal transfer of blueprints on the product and manufacturing processes, visits to the collaborator's facilities and technical documents on the product. But an important source of innovation has been technological learning through its own R&D activities, e.g., incorporation of CAD into its design activities, modifying top throw models for an inclined throw of air based on market requirements, it developed a capillary extension (separate from the evaporator) and then used that knowledge to design a new spring system for the capillary etc. The firm has also embarked on a training program for its factory and design engineers. It has built up a small but an active R&D team. The team now consists of a designer, ten engineers in various disciplines, and ten draftsmen. In 1995, it spent 2.8% of its turnover (Rs. 1.2 crores) on R&D and related activity.

(iv) *Innovation Networks:* The firm has actively pursued short/long term collaborations with firms that have core competencies different from those of Amtrex. These networks of firms have helped Amtrex innovate on product improvement as well as new product development. In keeping with its mission to compete on innovative designs, the firm developed a close interaction with the industrial machine designers at the National Institute of Design in Ahmedabad to gradually develop a 100% indigenous design of the WAC . Its network of innovation partners include Arvind Mechanicals, Bombay (for fan & blower prototypes), a small Ahmedabad fabrication unit (for drain pan design & fabrication), KK Nagar Co., Pune (for thermacol sections for packing & support), Madras Precision Electronics, Madras (for remote control/electronics

devices), Kirloskar Copeland, Pune (for compressor supply), and Centre for Mechanical Engineering Research Institute, Durgapur (for testing and design of small capacity AC). They are exploring linkages with a Taiwanese firms for electronics control. While most of these linkages are project oriented, several small scale industries are assisting Amtrex in building prototypes and experiment with improvements in their products.

It needs to be noted that networking of the kind described above is a direct outcome of the unbundling of technology attempted by Amtrex. In this sense, appreciation of the usefulness of unbundling of AC technology has facilitated the company to identify areas which fall within the purview of its competence and those for which it will require external inputs if it wishes to develop a world class product.

Conclusions

Amtrex has developed a coherent technology strategy that is based on improvements in product design and cost competitiveness. In these early years of incorporation, the firm has exhibited how Indian firms could use international collaboration to develop domestic capabilities. This requires investment in R&D and clear goals of patent seeking and commercialization of R&D outputs. It is also a recognition of the fact that, in future, the market for knowledge will become far more competitive as well as profitable. It is too early to tell whether the firm will succeed in meeting its global objectives. But one thing is sure, competition in this segment will intensify in the coming years. It is easy to make money in the short run, in this product market, but very difficult to sustain it in the long run unless the firm has innovative product designs, a responsive manufacturing environment, and tight distribution channels.

This brings us to the challenges that face Amtrex if it has to make its product development based technology strategy successful:

* improve its weak manufacturing capabilities - innovative manufacturing practices will be

needed to deliver an innovative product in the market at low cost, quickly and in one piece;

* improve its design base - technical and industrial design training has to be complemented with research and training in micro-airconditioning, electronics and new materials; and

* investment in R&D will have to increase sharply and on a sustained basis.

It is interesting to note that Amtrex started off being a "blue-print manufacturer" but managed to move on to become an "imitator and developer" with a reasonably well defined technology strategy. However, its recent attempts to assemble the state-of-the-art Hitachi models reflect a move towards "passive assembly" on these products. One wonders if it is a strategic move to unbundle the technology through the "assembling-cum-R&D" route or a move to cope with the rapid product introductions by the competititors given its own technological capabilities or a reflection of the foreign partners new strategy for India ? Are other firms in India faced with the same prediliction and are they following similar "strategies " ? Researchers will need to look at many other case studies before proposing a assesment of the technological responses of majority of the Indian firms.

Table 1: Product Development History at Amtrex	
Year	**Product Development Milestones**
1990	Arms length technical collaboration with Hitachi on 1.5T Window Air Conditioner (WAC)
1991	Arms length technical collaboration with Hitachi on Split Air Conditioner (SAC)
1992	Development of Heater SAC through arms length technical collaboration with Hitachi
1993	Development of Remote Control for AC through arms length technical collaboration with Hitachi
1994-95	Introduction of 0.75T WAC through arms length technical collaboration with Hitachi
1996 (planned)	Introduction of small Big Flow SAC through assembly of Hitachi CKDs
1996 (planned)	Introduction of Cassette type SAC (SAC of higher capacity) through assembly of Hitachi CKDs

References

Clarke, K.B. (1989) "What Strategy can do for Technology," Harvard Business Review, November-December, 94-98.

Centre for Monitoring Indian Economy, CMIE (1994) Basic Statistics Relating to the Indian Economy, Tables 24.3, 24.4 & 20.3, Bombay.

Evenson, R.E. and L.E. Westphal (1994) "Technological Change and Technology Strategy," UNU/INTECH Working Paper # 12, The United Nations University Institute of New Technology, Maastricht, The Netherlands.

Kokko, A. (1992) Foreign Direct Investment, Host Country Characteristics, and Spillovers, The Economic Research Institute, Stockholm School of Economics, Sweden.

Lall, S.(1987) Learning to Industrialise, Macmillan Press, London.

Pisano, G.P. and S.C. Wheelwright (1995) "The New Logic of High-Tech R&D," Harvard Business Review, September-October, 93-105.

Porter, M. E. (1980) Competitive Strategy: Techniques for Analysing Industries and Competitors, Free Press, New York, U.S.A.

Schoemaker, P.H.J (1992) "How to Link Strategic Vision to Core Capabilities," Sloan Management Review, Fall, 67-81.

Teece, D.J (1986) "Profiting from Technological Innovation: Implications for Integration, Collaboration, Licensing and Public Policy," Research Policy, 15, 285-305.

Teece, D.J. (1992) "Strategies for Capturing the Financial Benefits from Technological Innovation," in N. Rosenberg, R. Landau and D.C. Mowery (eds.) Technology and the Wealth of Nations, Stanford University Press, Stanford, CA , U.S.A.