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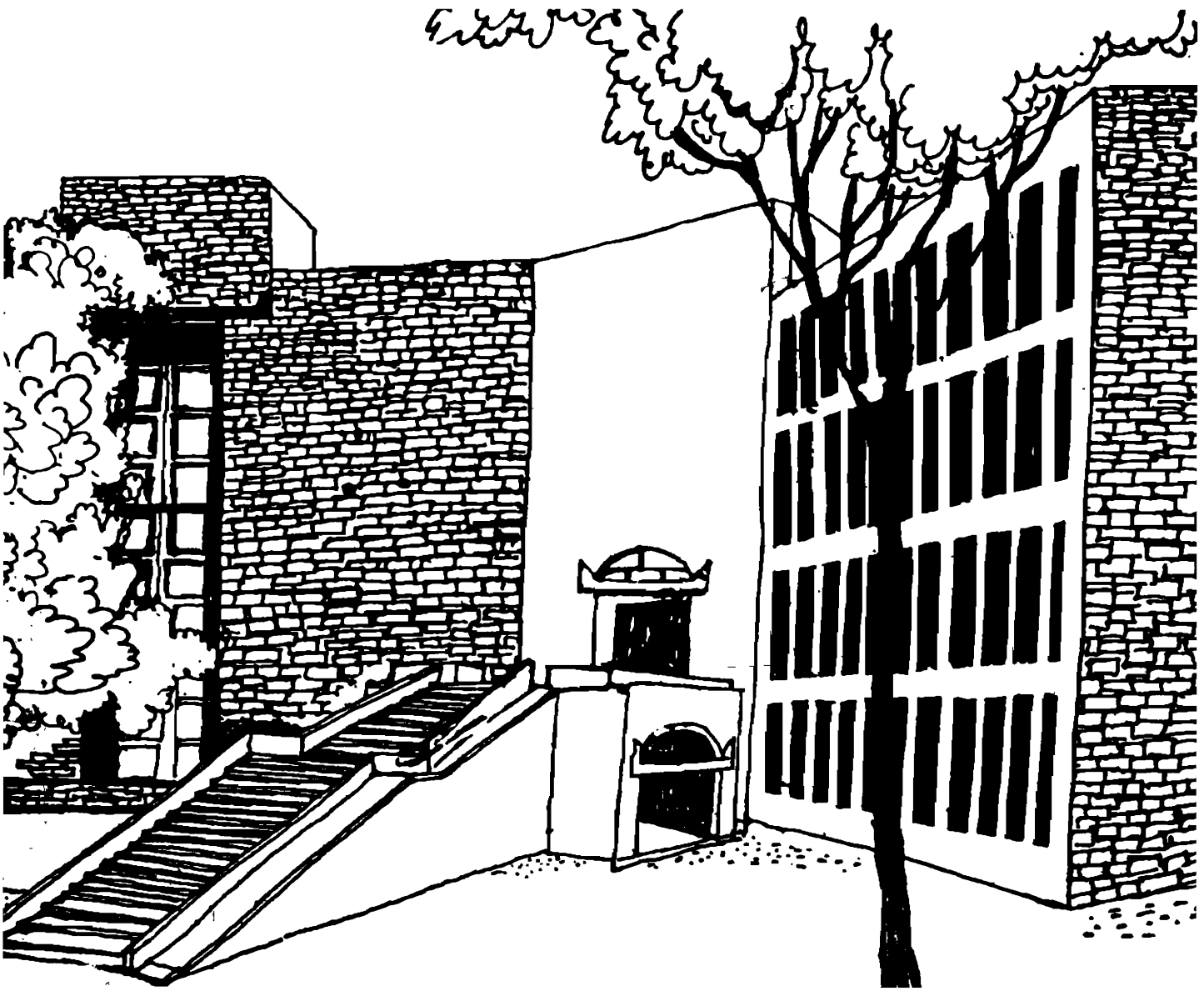

Strategies of Technology Intensive Firms

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Introduction

Technology has always been one of the critical factors of development especially in this century when technological changes have taken place quite rapidly leading to major structural changes in the economies of various countries. Over a period of time technology has also become complex in all sectors of the economy. Small and medium enterprises which are found to play a key role in the economies of most countries also account for large number of high-technology firms (Ookey 1991). Earlier studies on small and medium high-technology firms have largely focussed on areas such as product development (Rothwell and Zegveld 1982), marketing (Walters 1989), and overall performance (Ookey and Rothwell 1986). Several authors have written on the role of high-tech firms in economic development (Reekie 1982), Bollinger, Hope and Utterback 1983), Kenney 1986), Tassey 1991). Some authors (Manimala 1988), Ramachandran and Ramnarayan 1993) have focussed their attention on the role of social networking to raise resources by high-tech firms. Still, no serious attempt seems to have been made to understand the broad management strategies followed by these firms especially in the context of a developing country such as India which is undergoing major structural changes. It is in this background that this study was undertaken of the firms which have consciously chosen new or complex technologies as a strategic variable to enhance their competitiveness.

There is no universally accepted definition for high technology except that the higher the technology the more complex it is to master. Reviewing various definitions of high technology, Moriarty and Kosnick (1989) concluded that uncertainties in both technology and market were characteristic of high technology firms. There are also risks and uncertainties involved in the process of development and commercialisation of such complex technologies from the laboratory level upward. It takes time to understand and absorb these technologies. Management of firms which consciously adopt this route to commercial growth is therefore extremely challenging. The strategies they follow are indicative of the potential of such high quality innovative entrepreneurs.

Methodology

Since decision rules otherwise called heuristics reflect policy orientation of individuals (Khandwalla 1986, Manimala 1988), it was decided to identify the heuristics followed by successful high-tech entrepreneurs while taking strategic decisions. To start with case studies based on high-tech enterprises which were published in the Business India journal during 1990-94 were analysed which brought out 97 general management heuristics. The criteria applied to identify hi-tech firms were: they should either have used complex technology or they are in new industries where technology is yet to be stabilised. We used our judgement to select or reject any particular case based on careful examination. Some of the heuristics which conveyed similar meaning were clubbed. Finally we obtained 60 heuristics. A questionnaire for primary survey was subsequently developed to rate these heuristics on a 4-point scale (1 for 'not at all like me' to 4 for 'most like me'). Respondents were asked to read each of the heuristics (e.g. enter attractive niches and dominate) and indicate the extent to which they reflected their decisions or beliefs.

The next challenge was to identify high-tech firms in the small-medium sector which can be approached for the purpose of data. Since venture capital companies traditionally financed high-tech firms, it was decided to generate a mailing list from such companies. The Technology Development Information Company of India Limited is the oldest and largest venture capital company in India. We could generate a list of 200 firms from them which fulfilled the criteria of high-technology specified earlier. The questionnaire was mailed to 190 of them; the initial letter was followed by a reminder after a month and we received 36 completed forms back. In order to get a deeper understanding, we interviewed another ten entrepreneurs extensively and prepared caselets on them besides collecting response to the questionnaire. Thus, altogether we have 46 responses from high-tech entrepreneurs.

The sample characteristics are given below.

While 3 of the 46 firms had an annual turnover of less than Rs. 10 million, 10 firms had turnover in the range of Rs. 10-30 million in 1993-94. Interestingly there are 11 firms in the Rs. 30-70 million range, and 12 in the over Rs. 70 million range. This indicates that most of the firms studied here are not very small firms. Even in terms of employees, while 26 firms have employed less than 100 people, there are 14 with employees ranging from 100 to 300, and 6 employing over 300 people. Most of the firms were set up in the eighties. While there are 3 firms which were started before 1980s, 9 were started during 1980-85, another 10 during 1985-90 and 4 afterwards. In terms of age, 4 firms were set up before 1980, 14 during 1980-85, 17 during 1986-90 and the remaining 11 after 1990. In other words, a majority of them are less than a decade old.

Findings

It is natural for most high-tech entrepreneurs to have strong technological background. This assumption cannot be automatically extended to their qualifications in management. Therefore it will be interesting to find out the principles these entrepreneurs follow in managing their business for survival and growth. The analysis that follows will also attempt to see whether there is any pattern of management which will be characteristic of technology intensive firms. The following discussion summarises the findings from the analysis of 46 responses.

1. **Technology-Product-Market Choice:** It is natural to expect hi-tech entrepreneurs to choose their technology carefully especially when their start up resources are primarily knowledge and contacts in their specialised area of operation (Cooper 1986) and not finance. Most of them chose their product and technology in the same area in which they had got exposure by way of training or earlier working. They can be categorised as traditionalists. Some others were more radical who used their background and exposure to explore new avenues in emerging areas especially in the context of Indian market. There were yet others who started in their known territory but quickly switched over to products new to the Indian market. For instance, one firm which started with process control equipments soon switched over to computer Visual Display Units and key boards which were not being manufactured in India in a ny significant way. In depth interviews with ten entrepreneur indicated that the technology absorption process was also smooth for most of them whether they were traditionalists or radicals.

The questionnaire survey of 46 firms indicated that high-tech entrepreneurs believed in the use of state of the art technology to ensure quality and reliability of their products. On a 4-point scale, this orientation had a mean score of 3.54 with a standard deviation of 0.74 (see Exhibit 1). Their response to heuristics on some other technology related aspects also indicated that they used technology to achieve their long term commercial objectives. For instance, a silk fabric manufacturing firm invested in CAD/CAM to make superior quality and design products for advanced countries. Its turnover went up from Rs. 69 million in 1985 to Rs. 311 million in 1994. As shown in Exhibit 1, the mean was high with low standard deviation and negative skewness for all the technology related heuristics. They believed in investing in technology through own R&D and/or by keeping abreast with the latest technological developments as it can be used to leverage growth in the organisation. For instance, an analytical laboratory started with a small base has grown to be rated as one of the best in the world having sophisticated equipments. They believed in the use of technology to differentiate products so as to add value to customer. In other words, technology was the natural lever which they used to build market and develop their overall growth strategy.

2. **People Orientation:** Independent of the size and nature of technology used it was found that most entrepreneurs did not have hierarchical organizations. In fact, one computer software firm which employed nearly 800 people have given tremendous flexibility to their staff even in terms of working hours. An analysis of the heuristics in Exhibit 2 shows this clearly. They believed in team work, and delegated authority and responsibility to their colleagues substantially. They invested in people through training and welfare schemes, and some of them offered share ownership to facilitate recruitment and retention of good quality people. One entrepreneur said, "we believe in human dignity". In short, these

Exhibit 1 **Technology Orientation**			
Heuristics	Mean	S.D.	Skewness
Invest in technology for growth	3.47	0.83	-1.55
Technology for product differentiation	3.37	1.00	-2.10
Latest technology for quality/reliability	3.54	0.74	-1.58
R&D to develop new ideas	3.28	0.93	-1.47

entrepreneurs have realised the importance of both technology and people of high quality in the success of their business. Since their cutting edge is technology they invested in it and also in the people who helped them sustain it, it is imperative that they believed in the contribution of people and treated them as assets to achieve growth. Also, for employees who love technology, there are considerations other than money in their choice of organizations to work for.

Exhibit 2 **People Orientation**			
Heuristics	Mean	S.D.	Skewness
Build strength through team work	3.72	0.67	-2.56
Delegate, decentralize	3.58	0.76	-1.74
Innovatively solve labour problems	2.63	1.18	-0.76
Invest in people	3.37	0.87	-1.88
Recruit professionals	3.44	0.91	-1.95
Innovative schemes to retain people	3.21	1.06	-1.52

It may be noted that the heuristic on labour problem is rated surprisingly low. Looking at the case histories of the companies studied here except in one case, we could not find any serious instance of industrial relations problem in them. As a result, there might have been no question about innovations in it. The high rating of the other heuristics in the same exhibit discounts possibilities of labour problems in these companies. It may also be a reflection of their appreciation of the value of a human being. One of the entrepreneurs said, "people respect each other, appreciate each other and criticise each other openly". Our hunch is that their technology orientation may be even discounting their money orientation (make money somehow) because of which they tend to treat people better. Although we do not know whether they had family business background, we tend to hypothesise that they tend to avoid industrial relations problems greatly because of their experiences from working for others. Also, the heuristics may be reflecting their inclination to solve labour problems innovatively if required (note that the standard deviation is unusually high).

3. **Market Orientation** : Most entrepreneurs surveyed seem to believe that customer is the king and they have to satisfy customer requirements exactly. In fact, the motto of one of the companies is to "offer service beyond the call of specifications". The results supported findings of Bruno, Mcquarrie and Torgrimson (1992) that honouring the customers and their needs was critical for the success of new technology ventures. Our entrepreneurs believed that a good product/technology may not become a commercial success by itself unless the customer is ready and is willing to pay for the products/

services. Since customer requirements vary and that it is almost impossible for a SME to offer products services to satisfy every customer need, they identified market niches to meet specific customer needs for success. For instance, one firm entered computer peripherals at a time when there were few competitors in India and made it a success by specialising in it. Similarly, another firm's success in computer networking can be attributed essentially to its sharply focussed niche marketing. This enabled it to draw substantial scale economics over the years.

Still, few entrepreneurs who did not have a balanced view of technology and market paid heavily for their lapses. This was amply demonstrated in the case of one computer graphics firm which despite being one of the most advanced software firms in the country has not been able to break even the operations even after 13 years of operations primarily because the product they had offered was ahead of its time in India. There is ample evidence in the literature to suggest that timing of entry into the market is critical for the success of a technology intensive firm (Hofer and Sandberg 1987; Bruno, Mcquarrie and Torgrimson 1992). In short, even a technologically superior product or service will fail if the customer is not ready to accept it for whatever reasons.

Interestingly some of the other components of the marketing mix such as packaging, promotion and distribution had not caught the attention of many in any significant way, contrary to the findings of Bruno, Mcquarrie and Torgrimson (1992). They did not think of innovations in these areas. There could be two explanations for this. One, since their products/services were unique and highly market focussed, there was sufficient customer pull which ruled out the need for innovations in marketing. Two, because of their bias towards technology, they did not even realise that there could be possible innovations in marketing. Our ten case studies indicated that in most cases a combination of these two explanations would be valid. For instance, a company manufacturing DNA research chemicals and enzymes was a run away success from the very beginning without any market developmental efforts.

Exhibit 3
Market Orientation

Heuristics	Mean	S.D.	Skewness
Enter attractive niches & dominate	3.28	0.93	-1.47
Create market by concept selling	3.07	1.14	-1.20
Serve customer innovatively	3.16	0.97	-1.27
Innovate new use for existing product	2.93	1.26	-1.17
Customer is the king	3.26	0.98	-1.30
Innovate promotional strategies	2.79	1.15	-0.93
Differentiate through quality	3.26	1.00	-1.53
Innovate distribution channels	2.63	1.18	-0.85
Package innovatively	2.28	1.18	-0.47
Go global	2.74	1.26	-0.82

Looking at the relatively high standard deviation for the marketing heuristics (except for 'customer is the king') compared to people and technology related heuristics discussed earlier, we feel that there is less unanimity in view in the case of marketing heuristics. Taking into consideration the reasonably high negative skewness also, we tend to believe that most entrepreneurs identify themselves with these heuristics to a large extent. Still, the differences in perception may be due to the differences in the nature and market competitiveness of products and services. It appears that for several products the latent demand may be already matured. While discussing the sources of innovation Ramachandran (1995) argued that marketing efforts would be low where the latent demand for a product is matured.

4. **Finance Orientation:** As shown in exhibit 4, high-tech entrepreneurs seem to believe in ploughing back of funds for growth investments. This is natural for at least two reasons. There is enough evidence to indicate that many hi-tech entrepreneurs start very small, often in a garage or a rented place for want of start up capital. They reinvest most of their returns to build up the business. Besides, driven by their passion for technology, they try to refine and further develop the technology. Our in depth study of ten firms supports these arguments. The other two heuristics on availability of cheap funds and low working capital do not give any clear picture. However, they seem to indicate that despite having matured latent demand for their products, many of them were not able to translate into zero or low own working capital. This could be a reflection of their poor background in financial management especially at the early stages. Non-availability of cheap capital is an indication of the absence of any such financing policy on the part of public financial institutions. In other words, their entrepreneurial urge does not seem to be highly money oriented but one to establish themselves as successful technology oriented entrepreneurs.

Exhibit 4
Finance Orientation

Heuristics	Mean	S.D.	Skewness
Start small, reinvest returns	3.35	0.75	-0.66
Cheap funds during tech absorption	2.88	0.98	-0.84
Build bargain power for low w/c	2.54	1.16	-0.78

5. **Core Competence:** It appears that the relatively stronger base and bias of the high-tech entrepreneurs towards technology have led them to look at growth opportunities more from a technology angle than a marketing angle. This premise is supported by the presence of a market pull strategy followed by most firms as discussed above. Their growth strategy seems to be based on the choice of a good technology which could help them enter a clear market niche where there is hardly any competition, at least when they entered. For instance, an entrepreneur chose to start the business of undertaking geographical surveys for oil companies using highly sophisticated mobile equipments as there was hardly any competition for it in India. Also, since most of the respondents are not in consumer products, the need to be innovative on various components of the marketing mix also may be low.

It is pertinent to note here that 17 of the 23 firms for whom we have complete data on the turnover figures for the year of origin and 1993-94 have achieved a compound annual growth rate of over 30 percent during this period. There are 2 firms having growth rates of 20-30 percent, 3 with 10-20 percent and 1 with less than 10 percent. Our hunch based on understanding of the other companies is that most of the firms have registered very high rates of growth over the years.

Exhibit 5
Growth Strategies

Heuristics	Mean	S.D.	Skewness
Unrelated diversification	2.30	1.23	0.03
Expand through acquisition	1.70	1.01	0.49
Stick to the knitting	3.12	1.10	-1.33
Related diversification	3.12	0.91	-1.20
Backward integrate to grow	2.74	1.22	-0.86

In Exhibit 5, two heuristics, 'Stick to the Knitting' and 'related diversification' are rated high. Also, their inclination to grow via 'unrelated diversification' is low (mean 2.23 and standard deviation 1.23).

This seems to imply that hi-tech entrepreneurs search for growth opportunities in their familiar areas of activity. This may be because of their love and commitment to technology more than anything else, and also because growth prospects therein and related areas may be bright. Besides, since they operate in the frontier areas of technology especially in niche markets, they may not have faced problems of matured markets which sometimes prompt managers to look for unrelated areas. Roberts and Berry (1985) found that successful firms stuck to their initial technology area and introduced new products only in related areas. It appears that market unrelated diversification may be too risky for them as their core strengths are in technologies.

High-tech entrepreneurs studied here are generally growth oriented. This not only enabled them to position themselves better in the growth scenario but because of their technological capabilities they were able to make entry much more smoothly. In some cases such as software, entrepreneurs were not only able to make global quality products but also make them cheaper than many overseas competitors.

Realising the need to build their core competence to maintain competitive advantage, more than 60 percent of all the firms studied have invested in upgradation of technology and product features. Exhibit 1 corroborates this conclusion. The history of successful High-Tech firms shows that they did not wait for the development of a perfect product (which anyway is never achieved as there is no limit to perfection) before its initial market launch. Instead, they continuously improved and perfected the product and thus maintained market leadership.

We observed high level of mission clarity for all the fast growth firms. For instance, the DNA chemicals and enzyme manufacturer wanted to attain national level leadership in molecular biology. Three key words in its mission statement were innovation, quality and customer satisfaction. They were able to tune their core competence to accomplish it. This is in line with the arguments of Cooper (1979), Abell (1980) and Feeser and Willard (1990)that firms need clarity of purpose of the business at the entry stage itself for long term success.

Discussion

The finding that high-tech entrepreneurs choose their product/technology based on their familiarity enables them to enter from a point of strength. Since the technology is often unique or pioneer, they get a head start. The cutting edge of technology gives them enough confidence to explore further in the same or related areas of growth. Subsequent success of the firms depends naturally on maintaining this leadership. They seem to realise this as is indicated by their high technology orientation and further investment in the development of technology. This high level of technology orientation has provided them with the basic inputs required to develop technology based core competence which are essential for long term firm survival and growth. Again, their inclination to grow in technologically related areas supports this argument.

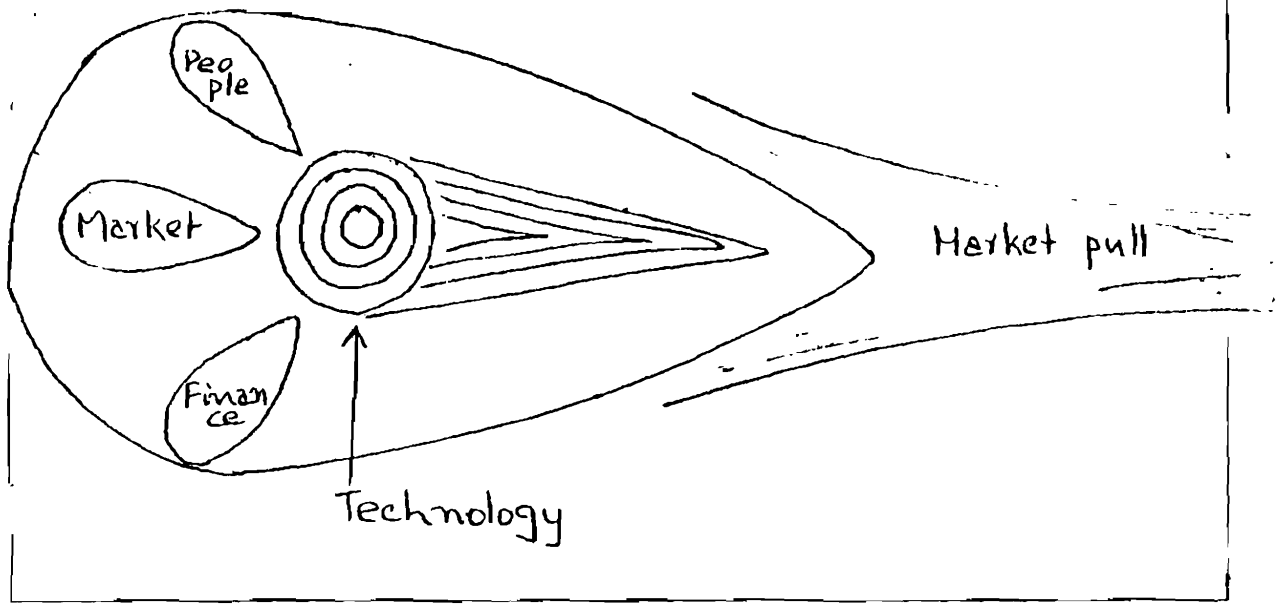
The way in which they build competence in the technology gives us the impression that they weave around their existing areas of strength. They seem to be moving from a core to outer rings of related technologies (see Exhibit 6) as they grow.

As shown in Exhibit 6, entrepreneurs seem to look around for opportunities where they can use their core competence. This gradual spread from inner circle to outer circles enable them to manage risk better. Also, this growth path, in a way organic, is especially useful for small and medium firms which are largely resource starved, and grow through ploughing back of profits.

This pattern of behaviour could be for various reasons. One, they are trying to sustain over the years the head start in terms of technology and product that they had in the beginning. Since the markets they entered were generally virgin or with low competition, their major challenge was in reaching the customer and meeting their specific needs. It was more of building the necessary contacts than

Exhibit 6

Core Competence - Growth Model



developing new demand. Further, we are talking about products which are already available, at least in advanced countries and not new industry or non-existent products per se.

Two, following from the above, most of the entrepreneurs seemed to have chosen lines of activity where the latent demand was mature. They entered the market and filled a felt need. If there is a perfect match between the offer of the entrepreneur and the customer needs there will be customer pull which can be met through conventional (direct sale or distribution route) channels. Then the need for innovations in pricing, packaging and distribution are minimised.

Three, since most of the firms studied here are successful in their operations, the pressure to innovate totally new products may not have existed. It seems that the axiom 'necessity is the mother of invention' holds good here. This may also be a feature of the level of development of the economy. In developing countries such as India, there are plenty of opportunities for products which are already available in advanced countries. On the contrary, in advanced countries the pressure will be to innovate entirely new things. This means that the effective level of risk to be managed in a developing country is likely to be low as one can relate projected business possibilities to experiences elsewhere. Moriarty and Kosnick (1989) may be right that high-tech firms in general face uncertainties about technology and market may be true more for advanced than for developing countries.

Shanklin and Ryans (1984) underlined the importance of a match between technology, R&D and market for high-tech firms. We however do not find evidence to support their view that one may have to do more of advertising, pricing and distribution. This seems to suggest that wherever the match between technology and market is easily established, especially where the latent demand is mature, the need for investing in advertising and distribution of an innovative nature may be low. In short, where the market uncertainties are not very large, the inherent risk is limited and these firms may find it feasible to develop a match between technology and market without much difficulty.

Our analysis of the case studies shows that entrepreneurs tend to network and build alliances in areas where they are weak. For instance, some entrepreneurs followed this route and entered into marketing tie up especially when the risks associated with the technology were greater.

Our findings also indicate that in these firms technology plays the central role. As shown in Exhibit 6, the other functional inputs play a relatively lower profile but actively supporting role. With the technology at the centre and with synergistic orientation in finance, marketing and personnel areas the high-tech firms are in a unique position of strength. The clear positioning of their products creates a pull effect from the market which discounts the role of other components of the marketing mix such as innovations in advertising, distribution and pricing.

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