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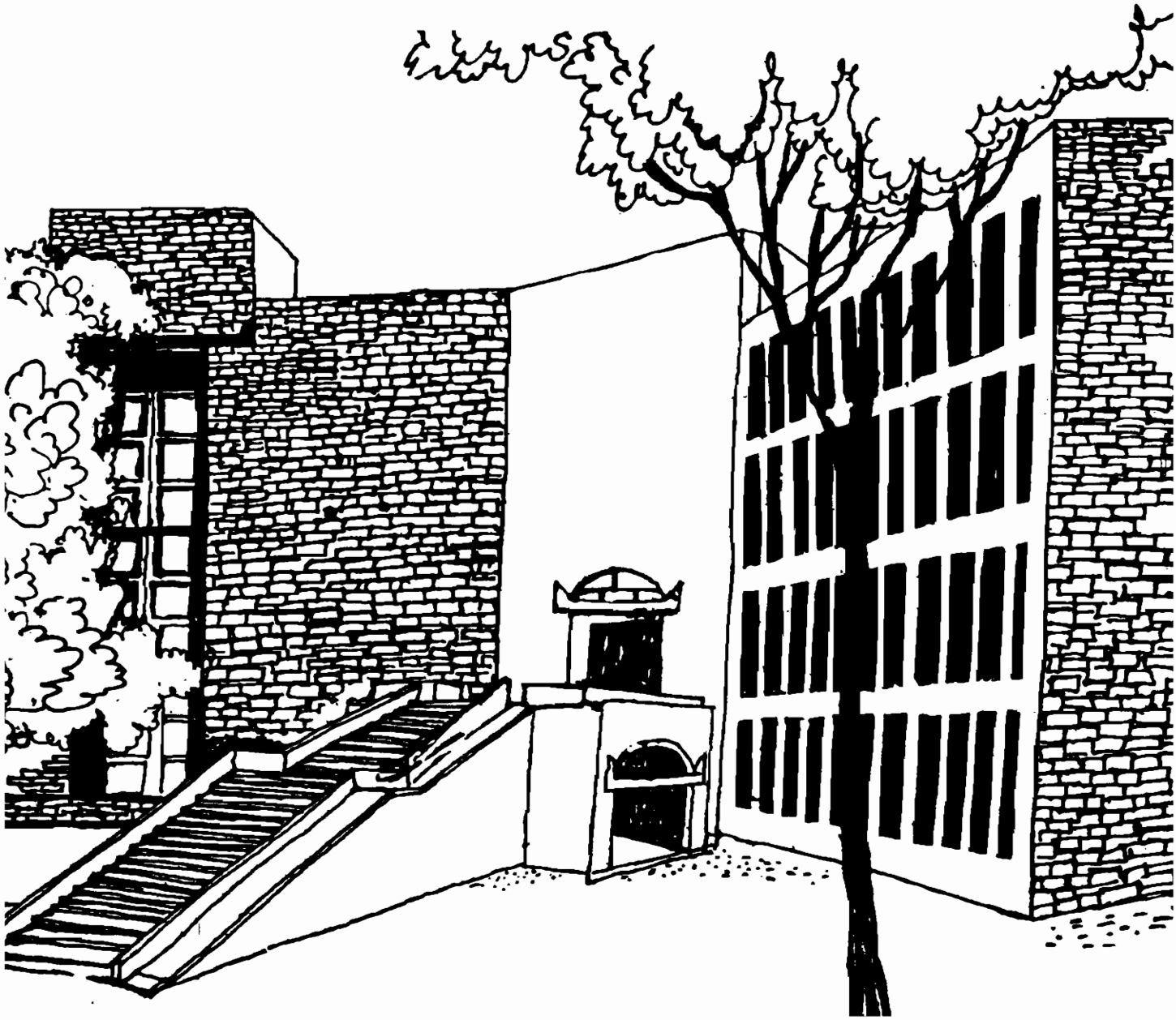

How Firms Make Technological Improvements: Observations From a Field Study

by

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Abstract

The paper presents observational data and impressionistic accounts emerging from a study aimed at understanding the determinants of technological dynamism, and the role that publicly funded technology institutions play in facilitating product or process innovations in industrial firms. The study covered 23 foundries, 13 polymer units, and 3 technology institutions.

Firms were found to obtain new technologies largely through foreign collaborations. They focused their technology efforts on assimilation of technology and adaptation for local conditions or local volumes. Several factors were found to be inhibiting technology development efforts : short term planning horizons of the management; perceived absence of connection between technological sophistication and commercial success; inadequate attention to development of markets to utilize the benefits flowing from technology development; high costs of modernization; and absence of reliable quality inputs and infrastructure which keeps managers mired in routine, survival concerns.

The study identifies some factors which contributed to technological fervour : inclusion of technology concerns on the management agenda and conscious attention to technological aspects; processes and mechanisms for encouraging technological innovation; attention to linkage and integration processes to institutionalize technological changes; upgradation of technological capability through careful HRD efforts; new and exciting corporate strategies that can serve as frameworks for technology plans; and active networking with technology institutions, suppliers, customers, industry associations etc.

The paper examines the implications of the findings for roles of senior managers. To meet the technological challenges, two sets of roles become very important : entrepreneurial role that is aimed at discovering new possibilities and displaying high level of initiative to implement innovations, and leadership role that is oriented to meeting the needs of change by mobilizing and energizing members toward a common vision.

How Firms Make Technological Improvements: Observations From a Field Study

S.Ramnarayan

How do firms make product or process innovations? What role do the publicly funded technology institutions play in facilitating such changes? What are the determinants of technological dynamism of organizations? To answer these questions, a field study was conducted covering 107 firms and 13 technology institutions (organizations involved in education, consultancy, research and development work etc. in specific technology areas) in seven major industrial sectors: auto parts, foundry, machine tools, pharmaceuticals, polymers, software, and textiles. The sample organizations were selected from different parts of the country. In this paper the author presents observational data and impressionistic accounts emerging from a study of 23 foundries, 13 polymer units, and 3 technology institutions.

The study included large, medium, and small firms, firms which are technologically dynamic, firms which run stable operations, firms which are stagnant or declining, firms which have strong linkages with collaborators and technology institutions, and firms which have hardly any such linkages. Approximately, a day and a half was spent in each firm for collecting data. The following questions were explored with the managers:

* How technologically active is the firm? What are the information sources for the firm in the areas of existing best technological practice in the industry, or successful new technologies from other parts of the world? Have the environmental changes (liberalization, increasing market pressures, etc.) changed the technological behaviour of the firm in any way?
* To what extent does the firm have a long term perspective on technology (a strong technology culture, formal technology strategies, significant and systematic technology development, high R & D intensity, substantial new product or process development programmes etc.) as opposed to a conservative short-term approach (dependent on imported technology, evolutionary technological change, little formal organization of technological development, low status and morale of technology staff, etc.)?

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What is the nature of the firm's link with technology institutions (intermittent short-term problem solving, information provision, testing, technological assistance, product/process specifications etc.)?

A factory visit was invariably included to get a visual feel of the organization and the technology. As one took rounds of factories and held discussions with managers and technologists on how they made choices relating to their firms' technology development, certain images of technologically more dynamic and less dynamic firms and the determinants of technological dynamism developed. These images were explored further with the respondents to see how far they captured the complexity at ground level. These impressions were also tested against the subsequent observations of other units.

Forces for Traditionalism

In a number of firms, one could see the coexistence of a range of technologies from the very primitive to the most advanced. For example, in the foundry sector, there were a few foundries where raw materials were being brought in bullock carts; large scrap pieces were being broken manually with heavy hammers before being carried on the head by individuals to the top of the cupola for charging; melting, moulding and fettling operations were done manually with primitive tools; and there were practically no safety or protective equipment for the workers. Not far from such a primitive unit was a sophisticated foundry. In between the two extremes were several units on the continuum of technological sophistication. The presence of such a wide range of companies makes it virtually impossible to make general propositions that cut across all contexts. But one could see age-old methods still being widely used, lack of proper control, no instrumentation, and no efforts in energy conservation, leading to low levels of productivity and quality.

Two major external factors were identified by respondents as creating disincentives for technological orientation : perceived absence of connection between technological sophistication and commercial success, and high costs of modernization. In one foundry, the owner manager was trying to obtain certification from an 'expert', that molten metal was not a saleable commodity for excise purposes. He felt agitated that he was required to waste time on such meaningless activities. Control-oriented and excessively bureaucratic procedures of the past had created a set of 'success factors' (such as cornering certain permits and licenses) that did not create strong incentives for technological orientation. Of course, the recent wave of liberalization is changing the rules of the game for several units.

There was also a strong feeling, particularly among the foundry managers, that higher quality did not always translate into higher prices. Where government was the major buyer, the 'lowest

quotation' principle tended to equate technologically sophisticated manufacturers with technologically unsophisticated manufacturers of low-quality products. The respondents felt that they had, therefore, little incentive to invest in upgrading and modernizing their facilities and adding to their costs. Even non-government customers were perceived to be interested more in lower prices than higher quality. When there was not much competition, pressure for upgrading technology did not exist. Another disincentive was high cost of capital and high level of import duties. Thus, technological upgradation was perceived to be a risky proposition providing doubtful returns.

When firms did not see clear connection between investments in technology and commercial success, they did not see any necessity for becoming more technologically oriented. Interestingly, proactive managers with high internal standards of excellence alone put technological concerns on their agenda for the future.

Foreign Collaborations as Source of Technology

No firm in the sample was found making very high investments in research and development to be a world leader in technology. This strategy would require firms to have large, global operations and pursue frontier areas of research actively. Indian firms are generally smaller in size than their counterparts in advanced countries, have not pursued globalization strategy, and have limited ability to commit resources for technology development. Firms mostly obtained new technologies through foreign collaborations, and pursued assimilation of technology and adaptation for local conditions or local volumes, as part of their technology development efforts.

A number of respondents mentioned that they could not effectively utilize technologically advanced equipments from developed countries, because these had been primarily designed for a much larger scale of operations. For example, a foundry manager mentioned that his firm (which would be considered large by Indian standards) had reviewed a list of secondhand equipments that would help it upgrade its technology. Invariably however, the capacities were much higher than the firm's requirements. The manager, therefore, felt that it would be a great help if Indian technology institutions could work on downscaling such equipments, so that those technologies could be adopted by Indian firms.

Two firms had brought in equipments from abroad with very high capacities. But they did not develop effective marketing units, which could ensure that the firms had enough orders to operate at breakeven level. Consequently, both firms were running in losses in spite of their ability to produce high quality products.

Thus, investments in technology development have to be complemented by investments in market development. If firms try to go full gear on the route of obtaining advanced equipment and machinery without simultaneously building their marketing muscle, their survival could be in jeopardy.

There were several small firms in the sample which had a static view of the market. They, therefore, felt that the market would not be able to support any major technology investment. They expressed interest only in small, incremental improvements. They found themselves entrenched in their strategy of running a low technology, low cost (and often low margin) operation that catered to a narrow market.

But a few firms were found to have consciously chosen to pursue significant technological changes and create new markets. For example, a foundry group set up a new unit to manufacture high quality investment castings. The new unit made all the necessary investments to run a high quality operation, and recruited qualified professionals to staff the various positions. Initially, the unit had great problems in selling its products as customers were unwilling to pay a higher price. It made losses for seven years, before it succeeded in educating customers about the value that its higher quality product could add. The unit is now highly profitable. At the time of the field study, it was planning to move into frontier areas of technology.

Variability of Quality of Inputs

Absence of reliable quality inputs and infrastructure forces many managers to remain mired in routine, survival concerns and prevents them from undertaking technological improvement and innovation. For example, a foundry manager found it difficult to get scrap of assured quality. Similarly, the quality of sand, fluxes, alloying elements, etc. may not be as per specifications. Testing all the inputs was not always feasible. Assured timely supplies of inputs was not a luxury the foundry manager enjoyed.

A foundry manager mentioned regarding his visit to a foundry in the United Kingdom. When he met the works manager of that foundry, he asked him what his specifications were for a specific raw material, whose quality was a constant source of problems in India. The works manager replied that his only specification was the name of the firm supplying that material. He added that he did not ever face the need of drawing up specifications or testing the incoming material. In rare cases when the raw material quality was not up to the mark, he could simply call up the supplier on phone, and the material would be promptly replaced.

The higher the technological sophistication of the process, the smaller the permitted variance in inputs. When input variance remains very high, firms are forced to settle for a less sophisticated process that can accommodate the vagaries of input variability. Consequently, there is lower efficiency.

Technological Fervour

What motivates some managers to make consistent efforts to draw on new technology developments, adapt these to local conditions, initiate process innovations and improvements to adapt technologies to local volumes, and develop markets so that technical decisions lead to commercial success? How is it that, while some managers invest time, energy, and effort in such technical areas, other managers operating in the same environment shun risk-taking and persist with the status quo? As we examined technological behaviour of dynamic and stagnant firms to explore these questions, certain interesting patterns emerged which have been discussed below.

Management Attention to Technological Aspects: We noticed that a number of key managers were unable to respond to questions relating to organizational plans for the future with respect to technology. When asked as to what support they would need from technology institutions, they could not identify what services would be the most useful for their firms. It appeared that they had not done sufficient thinking on these aspects.

Some of these firms did not have to work hard for their success, and technology was supplied to them 'on a platter'. They were able to absorb the technology, produce acceptable goods, and make good profits. Many of these firms had got stuck in this approach and had, therefore, no technology strategy of any kind.

On the other hand, there were also organizations in the sample that were concerned about moving beyond absorption (developing ability to operate as per specified conditions and get the desired product) and adaptation (understanding process parameters even beyond the narrow range as provided for operation/control by collaborator) to assimilating the technology (understanding the intricacies of the technology through applied research and engineering, and developing the ability to make substantial improvements independently). Towards this end, a firm had set up several facilities: a research and development department with scientists in important areas; good laboratories and facilities; pilot plants for scale-up and evaluation; process engineering and technology development groups staffed by qualified professionals; product applications centre to develop new applications for new technologies, and to develop new markets;and formal and informal collaborations with academic institutions, technology institutions, and detail engineering contractors. Obviously, this firm had a well laid out technology strategy, and had clearly articulated technology plans for the future.

An ancient Chinese proverb goes: "People do, not what the boss expects, but what the boss inspects." Management attention is a scarce resource in any organization, and if technology does not appear on the management agenda there is a strong likelihood that technology development efforts would receive little or no support. A company had technical collaboration for five years with a world leader in technology. But during these five years, hardly any improvements resulted in the working of the unit because the company was going through difficult industrial relations problems, and all improvements and innovations were put on hold. Now the company does not have the collaboration, but is making substantial improvements on the basis of the insights gained earlier. The industrial relations climate of the unit has improved substantially, and management is attending to technical improvements with renewed commitment to retrieve lost ground.

Processes and Mechanisms for Technological Innovation: Management attention to technology development also translates into organizational systems, mechanisms, and processes which are oriented to technology development and diffusion. For example, an organization had instituted a system of developing short term, medium term, and long term plans for technological improvement ..ad defined short term plan to include changes and improvements that would take less than six months for implementation; medium term plan included those which would take 6 to 18 months for implementation; and long term plans would take over 18 months. Towards the end of every year, the chief executive sent a note to all technical personnel in the organization to send their suggestions in a specified format. These were consolidated by the research and development department and discussed to finalize the technology agenda for the company. This company had made substantial progress over the years in upgrading and modernizing its works.

Another company had constituted an advisory committee consisting of well known experts in related technologies. The committee not only provided broad directions, but also supervised the review and monitoring of R&D plans.

We found that innovative firms had several such fora and processes to channelize attention to technological concerns. They encouraged their employees to visit other companies and lea their innovative practices. They considered it important to attend trade fairs and exhibitic followed it up with meetings to see what new ideas could be implemented. These organizations had mechanisms to facilitate interaction among different functions so that good ideas did not become victims of the 'management-by-objections' system.

Lack of Institution Building: Certain limitations or shortcomings were noticed even in a few technologically dynamic firms. In a firm that has the Department of Science and Technology

approved R & D facilities we found that there was just one individual who was highly creative. The firm had a good library, and the scientist had a laboratory to test different formulations. The company had come up with a number of product innovations, but all the successes centred around this individual. There had been no effort to institutionalize the innovation process.

Another organization had been set up by individuals who were deeply committed to self-reliance and indigenous technology development. The firm had certain outstanding successes in the 60s and the 70s, but technology development continues to be monopolized by the founders. For the past 8 to 10 years, the company was stagnant.

Capability Upgradation: Vast differences were found among firms in terms of their efforts to keep upgrading the capability of their employees. Capability upgradation does not merely refer to employee training, but includes several important facets of people management: assignment of growthful roles to technical people, induction and socialization programmes, performance planning and appraisal, transfers, compensation, career planning etc. Even relatively junior personnel in innovative firms had significant responsibilities and freedom to act, while even senior managers felt powerless in mechanistic non-innovative organizations.

On a visit to an industry association which conducts regular training programmes, we noticed that participants were largely from progressive companies. Paradoxically, the firms which were low on technological sophistication and which needed the training programmes the most were the ones which were least likely to attend.

New and Exciting Strategies for the Organization: Another interesting observation was that firms which had developed difficult and exciting goals and objectives were the ones which were concerned about technology development. Organizations with short term orientation were interested primarily in catering to a local market and therefore had no technological orientation.

Among the progressive firms that we visited, several had plans to obtain ISO 9000 certification. Some of these firms had outside experts evaluate their strengths and weaknesses in technological capabilities. They had studied the export market, and were aware of the technology and quality gaps that needed to be overcome. They had plans to tie up with foreign collaborators to bring in new technologies. They had plans for growth and diversification. These were the firms which felt excited about economic liberalization and had concrete technology plans.

Top Management Orientation and Philosophy: Several respondents were asked to list the factors that made firms technologically oriented. Many concluded that top management orientation and philosophy was probably at the heart of the technological innovation process. A dynamic top management was more likely to have well defined corporate plan, which could serve as a framework for technology plan. An enlightened top management was more likely to institute systems, processes, and mechanisms to channelize attention to technological issues. It was more likely to concern itself with capability building, not only through appropriate human resource management interventions, but also through a strategy of networking with collaborators, technology institutions, and progressive firms in industry. They were more likely to institutionalize a culture where technologists and managers go beyond day-to-day survival issues and concern themselves with innovation and improvement issues.

A company whose top management was strongly committed to technology had instituted a system for attending to complaints received from customers. When a complaint was received, it sent its engineers to study the problem. The engineers felt that the problem had arisen owing to the processing operation at the customer's end. To test this hypothesis, it asked the customer for certain records. Since the company had a good reputation for its responsiveness and its technological capabilities, the customer made available all the records of the further processing carried out on the company's product. This made it possible for the engineers to identify the problem and advise the customer how the processing work should be done. Once those steps were instituted, the problem did not surface again.

In the above example, a free and frank exchange of views had occurred only because the company had approached the situation with an orientation of solving a technological problem rather than with a defensive posture of avoiding any penalties associated with product failure. The engineers were aware of their company's long term commitment to technological leadership and did not hesitate to make the investments required for problem solving. In the end , the company also gained in terms of experience and customer loyalty.

In another case, a licensor had transferred identical technology to two units in the country. In one case, the technology had been a great commercial success, while in the second the operations were still not profitable. In the first unit, there was careful selection, training, assignment of tasks, and career planning which created a strong feeling of ownership among the managers and technologists who were responsible for project planning and implementation. In the second case, there was no seriousness in the execution of the project. For example, individuals had been sent for training abroad solely on the basis of seniority and their subsequent placements were not linked to their training. There had also been frequent transfers of managers in charge of the project.

To sum up, several organizational characteristics contribute to technological dynamism:

a) Well defined technological goals and investment in time, energy, and efforts to pursue these goals.

b) Good systems for selection and training of people; creating a work organization in which members find challenging roles; providing members exposure to good technological practices through visits, collaborations, etc.

c) Challenging organizational missions and objectives.

d) Instituting systems, processes, and mechanisms for scanning the environment for new ideas and concepts, willingness to experiment, taking risks, and institutionalizing changes.

e) Networking with technology institutions, suppliers, customers, industry associations, etc.

Functioning of Technology Institutions (TIs)

At the time of the study, the senior officials/scientists from the TIs were concerned about a number of important challenges:

a) developing greater market orientation and learning to generate own resources to become self-sufficient and at the same time pursue the institution's own long term technological agenda to retain the competitive edge in terms of technological knowledge and skills;

b) designing programmes and processes to strengthen linkages with industrial firms, clarify mutual expectations, and develop meaningful collaborative working relationship;

c) changing culture within TI to create delivery orientation, not just problem orientation. Developing awareness among the scientists that working with the industrial firm is more than just solving a scientific problem; ensuring greater flexibility and speed of action and overcoming self-imposed constraints by modifying work methods/practices in personnel, administration, accounting, finance, and purchases;

d) defining the organization's niche carefully, identifying areas where the chances of success are high, where the technology is very strategic, or where the organization possesses high level of skills.

These concerns are new for TIs, as they are now required to generate their own resources to meet part of their budget. A number of TIs were seen to be going in for some form of review of their organization, either with the help of external consultants or internal committees/task forces.

We found only a few examples of significant collaboration between industrial firm and technology institution which resulted in important product or process innovations. In most cases, management of the TI-firm interface was rather poor. For example, in an industrial town, a TI had been originally created to support the industry in that town. But scientists at the TI were found to

have an outlook that was national or international, and not local. They had projects on topics funded by international agencies. They were involved in collaborative projects with a national level institute. The scientists had no inclination to work with the local industry. The companies, on the other hand, were small and were run by owner managers who had little formal qualifications. They were involved in the manufacture of standard, low cost products. They felt that their work methods needed substantial improvement, but were hesitant to approach TI. They were not even sure if the TI personnel could help them, and were more interested in having access to TI's testing facilities. Thus, there was practically no interaction between the TI and firms in this town.

One of the factors that inhibited collaborative work relations was the excessively formal or bureaucratic work methods of the TI. For example, TIs tended to have a standard contract, which did not give any exclusive right to the firm to develop an innovation. The firm was, therefore, hesitant to offer its facilities and resources for joint exploration. Few TIs had professionals in the areas of costing, finance, project management, or marketing management. Individuals with accounting and management qualifications were not even considered 'professionals' in some TIs, and so they had fewer career opportunities. This made it difficult for these TIs to attract competent professionals in these areas. The personnel also felt that salaries were low, and there was little accountability. As a result, TIs were sometimes not perceived by firms as credible sources of help for upgrading technology.

Movement of personnel from industry to academia/TI or vice versa was not very common. In a small number of cases where such movements did take place, we found that transfer of technology had been highly successful. Technology is often embodied in people and, when there is movement of people, it helps in diffusion of knowledge and skills.

The respondents felt that it was necessary to start the process of interaction between TIs and firms to clarify mutual expectations. Collaborative links are often built from a background of relationships, and it is important to initiate these links. Some TIs found that educational programmes for firms provided a useful forum for building bridges. In a few cases, senior scientists from TIs were on the boards or advisory committees of firms and this was again found to provide a useful linkage. One of the TIs was involved in a programme of consciously reaching out to firms and building collaborative work arrangements.

To sum up, TIs felt that they should manage the tension between two forces: develop and pursue technological agenda that would give them an edge in the future and at the same time generate own resources and become financially self-sufficient by meeting the needs of the customer. They

should deliberately design programmes to manage the interface with industrial firms. They should define their technology strategies and 'niches' carefully, balancing training, problem solving applied research, and blue sky research. For achieving this agenda, they must upgrade their organization, by building new skills needed for change, generating a willingness to undertake the process of reorientation, and investing time, energy, and effort to successfully manage the transition.

Concluding Observations

The field observations suggest that different firms find different levels of technology appropriate for their needs. When a firm is catering to a narrow market requiring simple and standard products at low prices, a low technology operation may be quite appropriate. But firms which are serious about developing a competitive edge in the global markets have to pay attention to technological development. With economic liberalization and greater competition at the doorsteps of several Indian firms, companies have to pay greater attention to technological issues even to hold on to their existing markets. Companies are increasingly finding that it would be futile to build one's strategic game plan solely on the basis of the so-called advantage of low-cost manpower in India.

A major block for technological development was found to be the short term planning horizons of industrial firms. In the words of Professor Sampat Singh, several Indian entrepreneurs have come from 'shop' and not 'workshop'. Given their 'trade' background, they have traditionally sought commercial success through the selling and accounting route, and have not bothered much about technological issues.

It was obvious from the field that some of the new generation entrepreneurs were markedly different in their orientation, given their exposure and background: they had much greater appreciation for technology. Their firms were willing to give primacy to manufacturing excellence. They had longer term planning horizon and were willing to make investments to build a sophisticated organization that was capable of making high quality products. Such entrepreneurs are more likely to succeed in the emerging environment.

What do these observations suggest for medium and large firms, especially in terms of HRD implications? To answer this question, we focus on how senior managers should shape their roles in the emerging environment. The notion of role shaping, developed by Professor Udai Pareek, is first briefly discussed. Then we present aspects of senior management roles that need to be strengthened.

Implications for Roles of Senior Managers: In a dynamic environment, we cannot think of roles at senior levels in static terms. Words like change, innovation, and learning carry more meaning for

today's senior manager than the more control-oriented language used earlier. If we define roles as sets of behaviours that individuals perform to accomplish tasks, it is clear that managerial roles cannot remain fixed in a changing environment.

Senior executives have to do self-reflection occasionally by considering questions such as whether they are allocating their attention appropriately between their current activities and future responsibilities, whether they are doing work that ought to have been delegated, whether they are organizing their work according to changing priorities, and whether they are developing their own capability and the capability of the organization to meet newer challenges. It is important to understand how effective managers actively shape and redefine their roles to improve managerial and organizational effectiveness.

There are two popular models of role behaviour: role making and role taking. When individuals respond solely to the expectations that are communicated by members in interdependent positions, they are said to have assumed or *taken the role* as defined by others. Thus, executives themselves have little or no latitude to modify them. They are merely expected to perform according to their job descriptions or job definitions created for them by the organization.

If individuals respond only to their own set of expectations, values, and priorities without taking into consideration the expectations of others, they would demonstrate the extreme case of *role making*. Executive positions are never completely defined. There are always facets of the role which have to be influenced by the individuals who occupy these positions.

A concept that is responsive to transience and change in organizations is *role shaping*. The model assumes that positions in organizations have loosely defined rights and obligations, allowing members sufficient latitude to negotiate expectations on an ongoing basis to be able to respond to changing environmental demands. According to this model, the definition of a role is never complete but is always evolving. The managers hold a concept of the role in their mind, perceive the expectations of others in interdependent positions, mediate these with their own expectations, and enact a role. If the concept of the role or the perceptions are changed over time, it is expected that performance of the role would also change.

To meet the technological challenges enumerated in this paper, two sets of roles become very important entrepreneurial role and leadership role. While *managerial role* ensures efficiency and order and enables organizations to act in accordance with system requirements which are highly rational and predictable,the *entrepreneurial role* is aimed at discovering new possibilities and displaying high level

of initiative to implement innovations, and the *leadership role* is oriented to meeting the needs of change by mobilizing and energizing organizational members toward a common vision.

Entrepreneurial Role: A senior manager performing an entrepreneurial role is primarily concerned with risk taking and creation. The person is characterized by high level of initiative, not just initiative of thought (for example, conception of new ideas), but an initiative of action. The entrepreneurial role mainly responds to contexts which are new and cannot be dealt with by means of experience or routine.

In the present context, it is important for senior managers to perform the entrepreneurial role, given the challenges of developing new technologies and new markets. This involves calculated risk taking. We have noted above that the context conspires to keep the senior manager mired in routine activities. Day to day pressures do not leave any space for thinking, experimenting, and creative behaviour. So the manager should really have a strong internal drive to innovate. As the saying goes, like turtles, we make a forward move only when we stick our neck out. The senior manager must set clear technological goals, which are balanced by appropriate goals for market development, and then break down the goal to specific objectives, and establish ownership for different parts by assigning clear responsibilities.

Leadership Role: The leader creates a sense of excitement to implement changes. It is argued that employee dissatisfaction is a negative emotional state; satisfaction is only a neutral state; and it is the sense of excitement which is the positive emotional state that inspires and empowers members actualize the vision by taking up technological improvements and innovations. The leadership role involves a number of important functions : creating internal constituency for change and innovation; ensuring participation; following up strategies for individual and organizational learning by developing networks with different stakeholders and constituents; measuring and monitoring key parameters against standards of excellence, etc. Thus the leadership role is concerned with creating technological temper in the organization. A leader builds an institution that values technological excellence.

As is obvious from the field study, there can be a wide variety of technological behaviour existing within the same context. While macro policies are certainly important to create climate for fostering technological excellence, this paper has focused on the micro initiatives of individual firms and the roles of senior managers. By focusing the organizational energies on challenging goals and paying attention to linkage, integration, and mobilization, effective managers create technologically dynamic firms.