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## INVENTIONS AND INNOVATIONS: ENTERPRISES – KEY ACTORS IN THE COMMERCIALIZATION OF INVENTIONS AND INNOVATIONS "ARROW IN THE BLUE OR TECHNOLOGY DEVELOPMENT AS (UN)GUIDED MISSILE"

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Introduction

1. The relationship between science and technology and economic development is too obvious to require any elaboration. The literature on the subject is considerable, covering historical perspectives, theoretical aspects and policy related issues. It is therefore proposed to take it as axiomatic that a science and technology policy is a necessary condition for accelerated economic development. The Scientific Policy Resolution adopted by the Government of India in 1958 states: "The key to national prosperity, apart from the spirit of the people, lies, in the modern age, in the effective combination of three factors - technology, raw materials, and capital, of which the first is perhaps the most important, since the creation and adoption of the new scientific techniques can, in fact, make up for deficiency in natural resources, and reduce the demand on capital."

2. In this paper an enterprise level experience is presented to highlight some of the problems connected with technology development and their impact on competitiveness of enterprises in India. The need for major shifts in the way technology is viewed is sought to be brought out. Finally, the need for a paradigm shift in the approach to technology will be indicated. The discussion will be confined to business and industry, and will not cover very important technology development efforts in areas like aerospace and defense-related industries.

3. In the first section a narration of events connected with the technology development efforts in bio medial devices by Department of Science and Technology will be presented. The serendipitous nature of the trajectory of technology development in the absence of a clear strategy is sought to be brought out in this section. In the second section, the reasons for indigenous technology not developing fully or rapidly enough will be examined. In the third section a thesis is proposed regarding technology development in the changed post-WTO context. Based on this thesis, elements of a strategy are listed out for developing countries to follow.

Chronology of events

4. A consultant from the National Blood Transfusion Service (UK) was invited by the Government of India to recommend ways of improving blood transfusion services in the country. A proposal to set up a National Blood Transfusion Service on the lines of the National Blood Transfusion Service in the UK was drawn up. The same consultant observed that blood banking in India at the time (1982) relied almost exclusively on glass bottles for the collection and storage of blood. One of the recommendations was that the proposed NBTS should switch over completely to disposable plastic blood bag systems in view of the greatly enhanced safety of the processes using the latter. The consultant also noted that blood bags would have to be imported in large numbers. During his study of the situation in India, the consultant came across an Institute under the Department of Science and Technology that appeared to have the capability of developing an indigenous blood bag system. This was based on the observation by the consultant that the Sree Chitra Tirunal Institute, (SCTI) had already made some progress in developing an indigenous blood oxygenatorand cardiotomy reservoir for coronary artery bypass graft procedures. Since materials employed in these devices would have to meet similar performance and bio compatibility criteria as blood bag systems, the consultant felt that SCTI were in a position to quickly develop a blood bag. In such a serendipitous fashion was the Indian blood bag project born. The Ministry of Health was charged with the responsibility for setting up the NBTS. The Department of Science and Technology was given the task of developing the indigenous blood bag.

5. In a remarkably short time, given the various complex technical issues that had to be overcome, a blood bag system was developed which passed through all invitro trials. After clearance by the Institute Ethics Committee, trials were conducted at selected hospitals in the country. After the results were scrutinized and found satisfactory, the Ethics Committee decided to release the technology for commercial use. In 1984, the know-how transfer agreement was signed with the National Research Development Corporation (NRDC). It took more than 10 months to prepare the Techno Economic Feasibility Report since there were many gaps in the information provided by the SCTI. Since neither the SCTI or the NRDC would provide process guarantees it was difficult to convince financial institutions about the workability of the technology especially since no pilot plant trails had been conducted. Finally, due to a combination of hard sell, persistence, and plain luck, a consortium of state financial institutions agreed to extend term loans for the project. Project work started towards the end of 1985 and was completed in the beginning of 1987. The plant was commissioned in March 1987.

Post commercial production problems

6. The company faced major problems regarding batch to batch variation in quality in the materials used. Import of these materials was not a viable option owing to the very high import duties then prevailing.

7. Many of the problems encountered on the shop floor or experienced by users were faced for the first time. SCTI were not in a position to help since by then the project team had been disbanded and were engaged in other projects.

8. Each process therefore had to be painstakingly improved. Since blood bag technology is closely held by a few companies, there was little in the literature or in terms of consultancy know-how that was available to the company.

9. Blood Banks in India predominantly used glass bottles and there was considerable resistance to switch over to unfamiliar plastic blood bag systems. This problem was compounded by the fact that blood bag systems were perceived to be more expensive.

10. At this time imports of blood bags were exempted from import duties as they were classified as life saving items. Using this facility overseas suppliers started dumping products at artificially low prices.

11. Due to a combination of all the above, the company incurred heavy losses and within three years was very near to bankruptcy.

The long difficult road to recovery

12. After much lobbying against heavy odds, the Government was persuaded to impose a token import duty of 40 per cent on imported blood bags. This must be seen in the context when the average incidence of import duties on raw materials and intermediates was over 100 per cent. But this step did have some effect.

13. By maintaining close contacts with customers, we were able to react quickly to quality complaints and did not hesitate to take back entire batches and replace them with fresh supplies. This helped build our credibility among customers.

14. A culture of experimentation and willingness to try new ideas very soon developed not only in the company's small R&D department but also on the shop floor. Ideas were exchanged freely and the company was willing to spend money on any idea that was likely to succeed.

15. The willingness of the promoters to fund heavy losses in order to stay in the market obviously had an impact on imports, which gradually dwindled.

16. The gradual improvement of quality and reliability backed by a responsive customer support system led to a turn around in the company's fortunes and the first half of the 1990s saw the company wiping out past losses and gaining a dominant market share.

17. During this period the first tentative steps were taken into the export market. Although little encouragement was received from export finance institutions owing to the losses shown on the balance sheet, an agency supported by the Dutch government assisted the company in its first venture into the overseas market. This assistance which included training and consultancy regarding aspects such as packaging, technical literature, and standards proved invaluable.

Competition

18. Barely had the company wiped out past losses when several new companies entered the market. Some of them were licensees of the same technology by NRDC and others acquired technology from other sources.

19. The bulk of healthcare purchases in India is in the public sector and purchases are generally by public tender procedure. Since this is driven by the "lowest tender" approach the downward pressure on prices intensified driving the prices to uneconomical levels. The company subsequently had to withdraw from several tenders owing to uneconomical prices, which naturally affected capacity utilization.

20. The earlier export promotion efforts came in handy at this time in the form of increased exports. These efforts did not fully compensate for the loss of important local markets. The situation by the middle of 1997 was that the company starting incurring losses again although its products were acknowledged the best among the local brands and the company was regarded as a reliable supplier.

21. The need to enter into a strategic tie up, which would open up export markets, began to be felt. Since the manufacturing plant was already nearly 10 years old the need to modernize was also acutely felt, since all competitors had relatively new plants. An overseas company looking for a manufacturing base in India invested in the company which is today known as TERUMO PENPOL Ltd (TPL). Already plans are being drawn up for further expansion of capacity.

Building technological capability in bio medical devices manufacture

22. The intention behind the blood bag project as well as other initiatives by SCTI was presumably to build indigenous capability in these areas to make available high quality products at low cost to the Indian healthcare system. As part of this, technologies to make products such as blood bags, blood oxygenator, cardiotomy reservoir, hydrocephalus shunt, tilting disk heart valve, etc., were developed and transferred to various companies. This happened towards the second half of the 1980's. This should have led to a blossoming out of several manufacturers making these products to good quality and this know how having a spin off effect into related products of mass use such as IV Sets, BT Sets, IV Fluids in plastic pouches, etc., etc. But things did not turn out that way. What we see today is not very different from the situation that existed before the launch of the blood bag project. While some overseas companies have entered the market, there are few local players who have evolved to high levels of quality and capacity.

23. There is a broad spectrum of quality ranging from the barely adequate to the unspeakable. The scene is still dominated by a large number of players making products of poor quality. The reasons for these are the following:

- No quality standards for commonly used hospital products;
- Very little demand for quality from the medical community;
- Purchase procedures driven by "lowest price";
- Low level of awareness of quality among the public.

24. The foregoing is a recipe for disaster. Like Gresham's Law where bad coins drive out good ones, poor quality cheap products tend to drive out better quality but higher cost products. Given the state of healthcare delivery systems and documentation in the country then and today, there was no easy way to understand the costs of this neglect to the healthcare system.

Underlying causes for retardation of technology development efforts

25. While these are some of the more obvious factors, there was several other less obvious but more fundamental reasons that prevented indigenous technological capabilities from taking deep roots during this period:

a) Technology has been improperly understood by policy makers. Instead of understanding it to represent a capability to find solutions through the application of science and technology, technology has tended to be understood as the know how to make a particular product. In other words, Indian policy makers did not perceive what the British consultant saw in SCTI, i.e. a capability represented by multi disciplinary skills and facilities to develop a range of bio medical devices and products for healthcare delivery. As a consequence, after completion of the blood bag project and a couple of other related projects, the project team was disbanded and reassigned to other projects. Thus was lost the invaluable capability in development of biocompatible materials and products made therefrom.

b) Commercial policies of the Government should have been aligned towards promoting the objective mentioned earlier i.e. to develop indigenous capability in bio-medical device manufacture. This could have been done by allowing imports of advanced materials and components by local manufacturers at confessional or zero import duty, while imposing

protectionist duties on finished products from other countries. Instead, the situation that prevailed in 1990 was that while a blood bag could be imported by paying 40% import duty, important components and materials like needles, polymeric materials, etc attracted import duties in excess of 150 per cent! This was in fact pointed out by the Asian Wall Street Journal which brought out a feature on this company and its efforts to make modern bio medical devices. The writer observed that the same import duties that were felt necessary to protect the company during its early faltering years were found to be the obstacle preventing the company from improving the quality of its products to match international standards.

c) One the most serious factors that has prevented the emergence of a strong bio-medical industry in India is the fact that companies such as TPL were not able to enjoy economies of scale. There was reservation for SSI units for many of the products used in the healthcare sector. The absence of product standards prevented standardization of healthcare delivery procedures, which would normally have led to expansion of market size. As a result markets got fragmented and were catered by local manufacturing units offering poor quality products at low cost. With their low overheads and reasonably secure markets, there were no incentives for these units to improve their processes or products. The resulting fragmentation of the market prevented other companies from entering the market or quality conscious companies like TPL from expanding capacity.

d) The trajectory of the bio-medical technology development effort resembles that of a missile launched into the blue without any guidance system. Where it hits is largely a matter of chance, and affected by serendipitous factors. The blood bag project is a case study that brings out this aspect clearly. There were too many points at which the effort could have failed.

e) The analogy to a missile is relevant for another reason too. Science and technology have hitherto been 'big' in the sense of requiring considerable resources. Many organizations and large numbers of scientific personnel were necessary to carry out projects. This is analogous to a missile development program. The need for clear focus and strategy are even more important in such a context, and both were lacking in the case studied.

The post WTO context

26. Manufacturing in the globalized economy that exists today is more a matter of plugging into a global network bound together by a complex web of patents, contracts, covenants, etc. Materials are procured from where they are available cheap, manufactured where it can be done at the lowest cost, and sold where it is most profitable. In the global market, it is no longer a question of making a product and then going around to find a buyer. One needs to log in to the network. In this way only is the pedigree of a product or company established. Quality certifications such as ISO 9000 are to be seen as part of this network.

27. Given the resource constraints of developing countries, the effort on their part is to attract international capital to their countries. This means the effort is to project how the investor will be assured of a good return within the context of the global network alluded to in the previous paragraph.

28. However this does not mean that there is no space for technological development within a country. In fact, the capability to absorb advanced technology and continuously improve quality of products and reduce costs is much valued in this network.

The need for a new technology paradigm

29. In the context of this globalized network and in fact despite its existence, there is an urgent need for a change in the way we view technology. The following hypothesis is presented as the basis for changing the way we look at technology:

> All the expertiseneeded to transform healthcare delivery, education, communications, transportation, agriculture and food production etc., can be developed locally through local initiative. The constant exercise of such application of science and technology to the solving of simple problems will foster a spirit of creativity and enterprise among the ordinary people that will form a solid foundation on which to build scientific endeavor.

30. This hypothesis is based on the following premises:

- All the knowledge needed to develop such expertise and capability is available in the public domain today;
- What is needed is to have the strong will to put this knowledge to work for public purpose and development;
- The capabilities exist in a country like India but are today fragmented. They are to be found in research laboratories, universities, industry R&D departments, etc. but in watertight compartments;
- These capabilities are further fragmented because they are focussed on projects. This project orientation deflectsattention from the capabilities underlying the projects;
- What is needed are mission-oriented efforts which can focus these capabilities into teams that are capable of developing low-cost solutions;
- This was best exemplified by the technology missions initiated by a former Prime Minister, the late Rajiv Gandhi where the technology mission for the development of rural automatic telephone exchanges transformed the communications system in the country at a cost that was a fraction of the cost that would otherwise have had to be incurred;
- There is a need to align public policy to achieving Mission objectives. Today technology development is just seen as one more activity and the comprehensive systems needed to make these effective are not put into place.

31. The amazing developments in telecommunications and information technology hold out great potential to leap-frog over several stages of technology evolution. These technologies are also people friendly as they enable small numbers of people at various locations to come together in a broad-based effort to take science and technology to the farm, the household, the school, the hospital, the workshop, etc.

The way forward

32. It is important to learn from past mistakes. But it is also tru that one needs to look out for different ways to do things that are made possible by the expanding frontiers of

science and technology. The way forward should therefore consider the opportunities thrown up by the enormous developments in telecommunications and information technology.

33. In India, knowledge and capabilities reside in various locations, e.g. laboratories, universities, industry R&D, etc. It is important to network these locations so that they are easy to access. This is now possible through the technologies referred to earlier.

34. The need is to enable the rapid application of this knowledge to the solution of problems. If a farmer has a problem requiring information on the chemical analysis of the soil and water, the knowledge required for the task is available in the chemistry department of the local college. But he does not know that, and neither is the chemistry professor aware of this need. Putting the two together is what is needed. Similarly, a small town may need a structural design of a check dam for water conservation to be evaluated. The expertise required will be available in the structural engineering department of the nearby engineering college. But the network is not there for this to happen. If a district hospital has a problem with the sterility of instruments, the services of the nearest manufacturer of medical disposables can be availed of to validate the sterilization equipment and process. A thousand other examples of the everyday need to apply science and technology to problems of the real world can be given.

35. The regular application of such knowledge will develop the confidence that problems can be solved locally. This will serve as the surest way to catalyze creativity and innovation. To coin a slogan employed by Mao, in a completely different context, we can, in this way, "let a thousand flowers bloom". To achieve great things, a necessary condition is the belief that one can do it. Science and technology have to be rid of the perception that they are a western phenomenon, and have to be restored to the people of India and every developing country as the heritage and inheritance of all of us. While recalling past ancient capabilities will help such a process, this is by no means a necessary condition. Even a people who have little or no tradition of past scientific achievement, will be able to develop the scientific and technological capabilities to enable them to partake of the fruits of development and progress in equal measure as the others.

36. Science and technology will also be liberated from the 'big science' image that often serves as a deterrent. Planners tend to feel that substantial resources are needed for any initiative in this area. Starting simple, ordinary people will, by networking their humble skills, find themselves solving many problems through the application of thought and analysis. Gradually, with experience, they will become more demanding in terms of the solutions they seek. This will lead to the search for more information and skills. Much of this is available in the public domain and is accessible through the Internet and other means.

37. The quest for technologies will become more purposeful, with people knowing better what they really want instead of having to be entirely guided by consultants. This will lead to better decisions and better use of resources.

38. The most significant feature of this new paradigm is that the role of the state is not a crucial factor. If the state is supportive, that will definitely help take the process further and more rapidly. But, it will be largely a movement of the people.

Enterprises as key actors in this paradigm - a case study

- TPL is a manufacturer of blood bag systems and special purpose equipment used in blood banks**.** TPL possesses a range of capabilities in plastics processing, clean room operations, sterilization, electronics assembly, testing, etc. TPL have applied this range of capabilities to innovative use.

- The R&D facilities - A Metabolic Disorders Research Center - was set up to conduct screening of infants as such a facility did not exist in the state. This uses the facilities available as well as the expertise of the scientists.

- Hospital consultancy - on a wide-range of matters including sterilization, audit of clean rooms, validation of equipment and processes.

- Turnkey blood bank projects.

- Development of new products, urology products, paediatric transfusion systems, several process patents.

- Reports on healthcare improvement projects.

- Hospital-waste management.

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