

# TECHNOLOGY MANAGEMENT AND COMPETITIVENESS

## THE CHALLENGE OF INDIA

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### ABSTRACT

*The author summarizes the need for and importance of technology management in a developing country such as India. He analyses the current situation with respect to technology in industry and innovation capabilities in higher education institutions. He suggests that technology management should be given high priority by government, industry and higher education sector so that the country can respond more forcefully and resourcefully to global competition.*

### INTRODUCTION :

Today success in the global market place means creating and applying new knowledge - which is to say new technology - faster than one's competitors. That is the fundamental law in this competitive world.<sup>1</sup>

In the present era of globalization and liberalization, technology has assumed great importance. It has become the 'push' factor in industrial and economic progress. Thus the management of technology is a key determinant in national competitiveness. Solow<sup>2</sup> noted that the GNP of the USA doubled between 1909 and 1949, and that 85% of the growth was attributable to technology change.

Those nations, organizations and

individuals exploiting the latest technology are likely to win - others may work hard, may have essential resources to draw on, but will lag behind without technological capability and adaptability.

### EXTERNAL PRESSURES :

The Indian industrial environment, is currently disrupted due to globalization, and is in a critical phase. Multinational companies have brought more productive technologies and better management practices. These companies have vast financial resources and sell their goods and services in the world market. They represent severe competition for Indian companies, many of which consequently find themselves in

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difficulty - some are in crisis, some have gone down, and some have merged and or have been acquired by foreign companies. Representatives of Indian industry such as the Confederation of Indian Industry and the Chambers of Commerce - have urged the Government to give protection to indigenous companies, Rahul Bajaj,<sup>3</sup> however, has argued that competition is the best teacher for product improvement, cost reduction, and higher quality. If Indian industry is to become truly competitive internationally, he suggests, liberalization is essential. What industry needs now is not protection but freedom - freedom to take decisions in the boardroom and not in the corridors of Government.

#### **FROM SUNSET TO SUNRISE TECHNOLOGY :**

The National Council of Applied Economic Research, New Delhi,<sup>4</sup> has published the results of a survey which found that of the 657 Indian companies in the study sample that started up in 1997, 56% were manually operated, and 38.7% were semi-automated. In the same period, according to the study, 80% of the start-up companies in Japan were fully automated and 20% were semi-automated.

It seems then that substantial investment in India is being made in companies which are based on outdated technologies and which are therefore handicapped from the start. Such companies cannot hope to be competitive on a global scale. In the USA, 26% of capital investment is in new-technology based firms (NTBFs) - in India NTBFs are non-existent. The likely future well-being of

companies can be judged from the level of technology business, and this demands the scientific management of technology.<sup>5</sup>

According to another study,<sup>6</sup> the annual output of an Indian industrial worker is US\$1277. The comparative figure for Japan is \$57,246. This does not mean, of course, that Japanese employees work twenty times harder than Indian employees - the difference relates to the use of technology. The economic future of a nation now depends on how much it uses technology power rather than muscle power.

However, the shift from a low-technology industrial base is not easy to achieve. It presents many critical sociological, political, economic, and technical problems, as well as resistance from trade unions. People must 'unlearn' old methods and skills and adapt to new techniques and knowledge. Colleges, universities and learning centres must re-orient themselves, prepare to offer courses and to interest people in learning and in becoming more competent. It has been said that 'to cherish traditions, old buildings, cultures and graceful lifestyles is a worthy thing, But in the world of technology to cling to old outmoded methods of manufacturing, old product lines, old marketing, old attitudes among management and workers is a prescription for backwardness.'<sup>7</sup>

#### **JOY OF LEARNING STRATEGY FOR CHANGE :**

In the past, technology change was slow. A production line, once established, could be expected to last for twenty or thirty years, and products

could remain in the market for a long time. The trade or skill which someone learned would be enough for his or her lifetime. Now, product life has shortened dramatically, production lines have to be altered frequently, and people have to learn continuously.

Adaptation of new technology cannot happen without strategic social change. Fears of technology lead to hesitation and union resistance - if you change slowly you lose to your competitors. Resistance to change is reduced by the development of a culture of lifelong learning.

OECD statistics for 1990 revealed that Europe, USA and Japan together represented about 80% of global industrial output. The contributory factors to this dominance include the continuing engineering education policies of the industrialized nations. Continuing engineering education (CEE) facilitates better management of technology adds significantly to economic success.<sup>8</sup>

#### **ADAPTATION TO THE ENVIRONMENT :**

The animal species which have the best chance of survival are those which are most adaptable to change - not those which are the strongest or the most intelligent. This is also true of organizations.

In an era which is characterized by rapid technological change and innovation, Indian industrial development, as in the past, continues to depend on imported technology. Technology transfer is often costly and ineffective. The buyers often lack of the professional skills and technological competence to select technology that is appropriate to their needs.

It tends to be expensive because of aggressive marketing by foreign companies, especially through tied loan and aid programmes of international financial agencies. Given the poor exchange rate of the rupee, the cost of imported technology is inevitably high. In addition, it is usually not the latest technology which is sold to Indian companies - and this too harms their competitiveness in the international marketplace.

Past experience in developing countries in general tells us that the borrowers have no bargaining power, because they are technologically weak.<sup>9</sup> Desai,<sup>10</sup> writing about the absorption of technology by Indian industry, argues that there has been little transfer of technology - rather, it has mainly been a question of importing machines. Technology absorption and improvement hardly happened at all because the importing companies lacked the technological capabilities and knowledge to achieve those ends. Now that an increasing variety of technologies are on offer, selection has become still more complex. There is a need for the establishment of technology databases at national and state levels.

#### **R & D AS THE DRIVING FORCE :**

Thus, given that Indian industry now faces global competition, strategic changes are needed in Government, industry and education. Mind-sets must be changed. The various sectors must work together to achieve national competitiveness, Innovation must be the driving force behind development.

Technology development through 'Swadeshi' is one option. 'Swadeshi' is an Indian word, meaning 'manufactured in-

digenously' (Videshi' means 'imported'). Past experience in India has been that imports have far exceeded exports. As a result, the balance of payments has consistently adverse. To bridge the gap, a drive for self-reliance has been initiated both by Government and by non-governmental organizations, such as 'Swadeshi Munch'. Recognizing the importance of science and technology, the Indian Government set up in 1996 a statutory body, known as the Technology Development Board. The Board includes representatives from industry, government, and science. It gives financial grants to researchers to develop new technology. This is in addition to the established R & D schemes of the Department of Science and Technology. The recommendations of the Board constitute an intervention in the federal budget and commit the Government to provide funds and act according to its directives.

The Government also introduced, in 1986, the Venture Capital Fund (VCF), which is managed by the Industrial Development Bank of India.<sup>11</sup> Under this scheme, financial organizations, both public and private, provide venture capital with equity to new start-ups using innovative technology. The VCF scheme is gaining increasing acceptability from the scientific community working in the Indian Institutes of Technology, research laboratories and universities. It represents another attempt to change the mind-set in Indian firms and research institutions which has led to a neglect of technology development.

#### **PATENTS AND IPR :**

In many backward regions of India

there is no Council for Scientific and Industrial Research (CSIR) laboratory. Companies in such regions, furthermore, have almost no R & D. Strategic initiatives are needed for these areas - such as the establishment of technology parks, incubator centres, and innovation centres. Such initiatives would need to be financed - this would have to be done partly from Government sources and partly through private sources, such as bonds and VCF.

R & D support is essential for the sustainable development of industry. In a previous publication,<sup>12</sup> I have highlighted the importance of matching innovation and R & D with the current horizontal expansion of industry in India. There is massive investment in industry, but no corresponding investment in technical education and research. However, awareness of this problem is increasing and more investment is now being put into R & D.

The key to industrial development lies in the use of frontline technologies. However, knowledgeable individuals may be, it is institutions that ultimately affect social destiny. Balanced investment in R & D is necessary to cope with the ambitious plans for industrial development. In 1950, Professor Terman of Stanford University in the USA observed that industry needed access to first-class research in order to remain competitive.<sup>13</sup> He also observed that academics and researchers need to commercialize the results of their research. These observations are now very pertinent to the situation in India, where scientists must have access to information on patenting and intellectual property

rights and must be encouraged to exploit their innovations.

#### **INVESTING IN R & D :**

The trend to establish 'research companies' in the USA, Germany and Japan reflects the realization that it is profitable for one organization to do research, obtain a patent, and market the technology. Innovation is a wealth-creating activity. In India, the government too should increase its funding of R & D, especially in engineering colleges with technology transfer and patent departments.

The Government encourages private industry to invest more in R & D, offering tax concessions. R & D can be a provider of 'energy' and profit regardless of whether it is done in the public or private sector. The results of research carried out in the public sector - for example, in CSIR labs or higher education institutes - can be made generally available. This is generally not the case with private - sector research, which remains secret within the company which carried it out and is exploited solely by the company for its own advantage, sometimes ignoring potential wider social benefits. More investment in the public sector is needed in India, especially in universities and colleges which tend to be more productive than CSIR laboratories. Education, research and extension are intertwined and the combination is a powerful one.

#### **AUTONOMY FOR COLLEGES :**

There are about 300 universities in India. Each one of these has around 200 affiliated colleges. They are comprehen-

sive universities, with a wide range of faculties, covering both science and the arts. Universities have academic schools on campus which offer Ph.D. and other postgraduate courses. The syllabuses and examination in all these colleges are centralized : students know that their teachers have little say in the setting or assessment of examinations. They find their educational material in reference books etc. and attendance at formal classes is very low. The link between students and teachers is thus a very weak one. What is taught in universities and colleges is not wanted and what is wanted is not taught.

The universities tend to remain detached from the changing industrial environment. Consequently, many educated people cannot find jobs, and yet many employers cannot find people with the skills and knowledge they are looking for. There is a serious mismatch between demand and supply . Rather than motivating and preparing their students for the world of work, the universities have become 'hamstrung' organizations which tend to thwart the potential of their students. The National Education Policy of 1986 gave autonomy to colleges to enable them to respond to the needs of industry in terms of research, training, and technology transfer. However, progress has been slow.

#### **CAN INDIAN ACADEMICS PROPEL INDUSTRIAL DEVELOPMENT ?**

The traditional affiliating system of universities and colleges has become a problem rather than a solution. It has stifled the innovation potential of academics and the public is unhappy about

higher education. Attempts at improvement are being made. The lack of mobility of Indian academic staff and research staff to world-class centres is seen as a major problem. Why is India unable to upgrade its education system? The cost of its mediocrity higher than the cost of upgrading. Why do Indian institutes not transfer technology to industry through the use of patents and intellectual property rights?

Indian industry, whose development has been driven to date by foreign collaborators, is seeking help from Indian academics. The Confederation of Indian Industry (CII) has appointed committees of business leaders to examine the interface between HEIs and industry. They are increasing the pressure on government to improve the higher education system. They are establishing world class management schools at Hyderabad, the Indian Institute of Technology at Kharagpur (IIT Kharagpur), and IIT Mumbai and are creating chairs in various universities. It remains to be seen whether Indian HEIs can produce leaders in technology and industry.

#### **EXPERIENCE OF IITS :**

The Indian Institutes of Technology, which were set up around 1960, differ from the universities, they are autonomous. They are single institutions, with one campus and a strong research base. They are held in high repute and attract the best students in the country. (The IITs were initially set up in collaboration with the UK, the USA, Germany and the USSR, among other countries.)

The IITs are successful in providing high-quality education and generating

new technologies for industry. But there are only six of them - too few for a country size of India. After graduation, many students from the IITs leave for the UK or the USA, a cause of national concern. The infrastructure needed to retain such graduates is lacking. Lately, however, the IITs have realized the importance of such facilities as technology parks and innovation centres and have been introducing them as a matter of urgency. For example, IIT Delhi has set up a foundation for innovation and technology transfer, and IIT Kharagpur has established a science and technology park for entrepreneurs.

However, although the IITs have begun to pay more attention to the transfer of technology to industry, much remains to be done to if the aspirations of both students and the business sector are to be fulfilled. There is a need to develop far greater interaction between the IITs and the universities and colleges. In this way, the activities of IITs can inform the establishment in other HEIs of effective mechanism for technology transfer and the needs education system can be more closely linked to the needs of industry. The indigenous expertise which is available within the IITs needs to be used more widely. My own college has followed this path, and the experience has been good : we regularly get professors from IITs to teach and to advice staff in the management of R & D projects.

#### **RAPID APPLICATION :**

I have underlined elsewhere<sup>14</sup> the importance for India of universities with a technical focus, and I have advocated

the establishment of separate technical universities which would integrate engineering education research and technology transfer. Without such a move, industrial progress will be hindered. The agricultural universities in India have shown the way through their success in alleviating the food problem. Their technical counterparts are urgently needed to make the country more competitive industrially. Discussion and debate on this issue are currently underway in India. Some state governments, such as Karnataka in 1998, have already gone ahead and established a technical university. Other states have the matter under active consideration and may well follow suit.

In *The Competitive Advantage of Nations*,<sup>15</sup> a study of ten developed countries, Michael Porter addresses the question of why some countries are more industrially developed than others. He concludes that the technical university is a more efficient model, consumes less budget and produces more output relevant to industrial needs than the broader-base university. The nations with more technical universities are also the more advanced industrially. This model provides a means of involving young people in technology development and diffusion which leads to rapid application.

#### **INNOVATE OR FALL BEHIND :**

Although at the national level in India there is the Council for Scientific and Industrial Research, there are no equivalents at state level. Because they tend to generate employment opportunities, innovation and R & D have an

extremely important role to play in the alleviation of poverty in the state and increasing the standard of living.

The country must be able to cope with the pace of technology advances : if it fails to do so, India may find itself permanently left behind and so destined to be one of the poorest nations in the twenty-first century. The task of raising the scientific and technological capabilities of people is crucial and must be directly addressed by key players in each state. The issue cannot be left to lower levels, it is only through proper science and technology management that companies can achieve high levels of success.<sup>16</sup> They must invest more in R & D and learn to harness intellectual capital.

#### **A BRAVE NEW INDIA ?**

In association with the Department of Science and Industrial Research of the Government of India, the Shri Guru Gobind Singhji College of Engineering and Technology at Nanded held a seminar on technology management on 16 June 1998. About 100 industrial and academic leaders participated. The seminar helped to develop an awareness in participants from both sectors that technology management is crucial for economic success and also that they need to work more closely together on a continuing basis. Similar seminars have been and continue to be organized by IIT's and by the Indian Institutes of Management, located in various parts of the country. The response to the meetings has been promising. In addition, technology management courses are now being taught at various institutes, including the Shri Guru Gobind Singhji

College of Engineering and Technology.

Difficulties in implementation and management are bound to arise, and these will need to be analysed and solved so that the benefits of new technologies can be realized. There will be need to continuous monitoring to check that Indian industry is using new technology. Wealth continues to flow from developing to developed countries, driven by superior technology management, policy and practices, If India is to be a technology-oriented nation, it will have to develop a culture of science and technology development and adopt world-class technology policies. If it does not do this, the current poor performance of industry and the economy will simply worsen and more and more indigenous businesses will go under.

In Japan, the Japan Research Development Corporation provides finance to various agencies for innovation. The grants are to be refunded only when innovation is successful. Similar measures should be considered for India. The creation and development of new high-technology firms will be a major factor in the emergence of a 'brave new India'.

#### CONCLUSION :

Experience throughout the world tells us that the use of superior technology is the most important ingredient of economic success. It is principally new technology which provides industrial management with the means to compete. Government, industry and higher education therefore need to interact closely with each other in this respect and evolve a strategy of technology

management.

The Indian economy can flourish only if there is a culture within the country which is favourable to innovation and technology transfer. At present, political and bureaucratic obstacles stand in the way of such an environment. The priority given to science and technology in the national budget, although increasing, is still far from adequate. The prospects for science and technology workers in India, and the respect which they are afforded, are comparatively very limited - consequently there is a brain drain to countries where respect and prospects are greater. Research, industry and training are isolated from each other - regulations constrain closer links and prevent creative talents from developing their potential; innovators are seen as a nuisance. Venture capital for innovation is not readily available and there is a fear of failing.

India must learn from the experience of other countries in setting up technology diffusion centres, technology parks, and technology incubators. Bridges must be built between researchers and industrialists. Universities must make it part of their mission to provide technology managers and industrial leaders.

The management of technology should not be left as a 'peripheral' task - it should become a central element in the operations of government, industry and higher education institutions. India's academic and research institutes need to move away from their culture of stability and security and encourage creativity and risk-taking. Innovation-

based industrial growth is sustainable and thus must be the goal. If the country fails to make up lost ground, jobs will continue to be lost and the value of the rupee will continue to decline.

The tasks of managing finance, materials and personnel are all important, but are not in themselves enough. The management of technology is now the key task for India. Global visions and strategies need to be adopted. In practical terms a project to encourage the formation of new-technology based firms, especially by researchers and engineers in education, would be an important national development.

Technology development within India is important, but even more important is the rapid application of new technology, regardless of whether it is *swadeshi* or *videshi* (indigenous or imported). *Swadeshi* is of course preferred : it is cheaper, more appropriate and user-friendly. But it may be necessary to bring certain new technologies from abroad to ensure rapid application in industry, rather than depending entirely on indigenous technology development.

The Prime Minister of India recently called for '*Jai Vigyan*' ('Science and Technology - a Winning Strategy')<sup>18</sup> and underlined the need to launch a nationwide 'Innovation Movement'. It remains to be seen how soon and how well the Prime Minister's vision will be translated into action.

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