

# **Entrepreneurial India: Reengineering West or Rediscovering Self <sup>1</sup>**

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## **ABSTRACT**

This paper discusses policies and practices related to entrepreneurship in India. Evidence on two alternative paradigms - reengineering West theory, vs. rediscovering self theory is examined. The discussion is organized chronologically - pre-British era, British colonial era, early independence mixed economy era, and reforms era. The real-world facts assembled, and insights gained are pregnant with meaning for socio-economic science practitioners and researchers alike.

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<sup>1</sup> Entrepreneurship is broadly defined to include all innovative endeavors. The term “West” is defined to include all industrialized nations. Technology is broadly defined to include all intellectual property (Reisman, 2004).

## INTRODUCTION

This paper investigates entrepreneurial strategy during the national development process, using the case of India. India is an ancient land. She enjoys several diverse and well-established cultures. India was a British colony from the 18<sup>th</sup> century. In 1947 she gained her independence. As a legacy of the British administration, widespread, poverty, disease, and illiteracy prevailed. During several Soviet-type five-year plans India acquired technology for some heavy industry both from the industrialized nations. However, the acquisition and absorption of foreign technology involved considerable costs, including an over-reliance on the public sector. As a result, India was pushed to reflect and experiment with an alternative paradigm of Self-discovery. The alternative paradigm was initially applied in selected domains where the government policy of acquiring and absorbing Western technology was not paying off. Thereafter, India sought to promote the two paradigms together, along with an emphasis on promoting technological exchange between the local and the foreign firms. This policy led to the Indian firms taking over in few niche technologies growing to become worldwide suppliers. India became a dominant destination for IT software outsourcing by all multinationals in the business. Over the recent years, policy has shown increasing concern with protecting and leveraging the indigenous knowledge of those disadvantaged by the policies to acquire and absorb Western technology. The real-world facts assembled in this paper, and insights gained from results of fairly simple statistical analysis of hard data, are pregnant with meaning for socio-economic science practitioners and researchers alike.

### **The role of “Reengineering West” in the entrepreneurship of developing markets**

Many scholars have considered the process of technological growth, and thus entrepreneurial strategy, in developing markets (e.g. Westphal, Kim & Dahlman, 1985; Lall, 1987; Enos and Park, 1988; Bell and Pavitt, 1993). These studies suggest that developing markets should rely on imported inputs and on export-oriented growth, and should do so rather heavily during the early phases of technology accumulation. For rapid growth, they need to exploit and build upon the local capacity to assimilate, absorb, and improve upon the acquired foreign technologies. *We refer to this paradigm of research as “Reengineering West” theory.*

“Reengineering West” theory has specific implications for entrepreneurial strategy. Specifically, the entrepreneurs should be focused on trading technology from the industrialized markets to the developing markets. And, if the market for trading technology is imperfect, as is the case in the international markets, then the entrepreneurs may be successful only by finding substitutes of trading for transferring technology. Some of the substitutes of trading include imitation, poaching, and reverse engineering. If moral or legal restraints preclude these substitutes, then another direction for entrepreneurship is to try developing the market for trading technology, such as by investing in the industrialized markets or inviting firms from the industrialized nations to invest locally. Such investments for trading technology, however, add to the cost of reengineering foreign technology, and erode the cost advantage of the developing market entrepreneurship.

As a paradigm of research, “Reengineering West” theory has gone largely unchallenged. The costs of trading expensive technology from the industrialized markets has been implicitly assumed to be worth bearing. While the issues of market imperfections and legal failure are sometimes discussed, morality cost is rarely considered as a factor guiding entrepreneurial initiatives. Similarly, the options of investing overseas, or of inviting investments from the international partners, are often on the table as potent vehicles for technological learning in the developing markets. However, the cost analysis of these options has been incomplete. Most investment models focus on the informal knowledge spillovers (Cantwell, 1990), a jargon that means flow of technology from the industrialized firms/ the industrialized geography to the emerging market firm/ developing market geography. What is ignored is the fact that if this flow involves trading, then the developing market firm has to bear the cost of technology as well as the cost of investment that enabled trading of that technology.

What is this cost of technology that an entrepreneur has to bear? We have already alluded to two costs: compensating for the financial cost of industrialized technology, and the morality costs of transferring technology without due compensation. In addition, the cost of technology also includes the cost of social polarization within a nation, and of political polarization between nations.

First, industrialized technology is prone to generate “social polarization” within the developing markets. Industrialized technologies tend to be capital and scale intensive, and require large markets and sophisticated infrastructures. Industrialized technologies tend to be

more appropriate for large, professionally managed and male dominated firms, for activities that can be systematized and routinized (Nelson & Winter, 1982). They are less appropriate for the smaller businesses, family owned businesses, women owned businesses, rural communities, and for the groups that operate smaller scales and have limited capital. Dependence on the industrialized technologies may therefore result in significant inequalities and polarize a diverse society based on the capital various groups have, the scale at which they wish to operate such as because of their work life balance priorities or because of their debt vs. equity priorities, and the moral costs they are willing to accept.

Second, industrialized technology is also prone to generate political polarization between nations. The recognition and exploitation of industrialized technologies require substantial prior knowledge and research experience (Cohen & Levinthal, 1991). Effective improvement of technology is feasible only when a nation has a substantive prior base in related technologies, and in the disciplines associated with them (Cantwell, 1990). Considerable costs are required for even trying to transfer technology to partners that do not have a similar level of technological base (Teece, 1977). Further, the original developers of international technologies tend to enjoy well-established markets, and well-endowed resources and capabilities, for rapid, continuous innovation (Porter, 1990). And, they have limited incentives to transfer their entire package of technology and techniques. The local entrepreneurs in the developing markets are rarely able to develop capabilities for fundamental innovation and engineering based on a single generation of know-how transfer. Rather, technological capabilities are accumulated over a period of time by working on multiple successive generations of inter-related know-how (Cantwell, 1990). In addition, the industrialized technologies are fundamentally targeted to meet the needs of the customers in the industrialized markets (Porter, 1990). Therefore, the entrepreneurs in the developing markets become politically dependent on the industrialized markets for both inputs as well as outputs (Teece, 1977).

In order to mitigate the financial, morality, social, and political costs that the entrepreneurs must bear to successfully Reengineer Western technology, a popular solution is to bear the costs of institutional biases. Typically, the government and government supported institutions seek to play a major role in financing imports of foreign technology. Their role is often at the cost of the independent initiatives of the private sector (Chandra, 2002). Moreover,

the the government-supported institutions tend to suffer from bureaucratic and policy mandates that make their transfer of technology to the private sector costly.

In summary, we have identified five costs of the Reengineering West entrepreneurial strategy: (1) financial cost of technology, (2) morality cost of acquiring technology without due compensation, (3) social cost of within polarlization as a function of adoption contingent on the specific nature of technology, (4) political cost of polarization as a function of the dependence of the developing nation on the industrialized nation, and (5) cost of institutional biases, arising from the substitution of private inititaives with the public initiatives. One must account for these costs in the overall benefit cost analysis of the Reengineering West model. In many contexts, these costs may outweigh benefits. In such contexts, entrepreneurial strategy requires self-discovery of an alternative to the Reengineering West theory.

### **Is “Self-discovery” a Viable Alternative for Entrpreneurship in the Developing Markets**

Self-discovery is an empowering way of learning. Peer interactions in regional markets can be a source of powerful innovations. These innovations typically rely on the regional resources, regional know-how, and regional markets, and address fundamental needs in of the regional community. The value of peer interactions are recognized in the industrialized markets (Porter, 1990). It is less recognized for the developing markets, and for the groups disadvantaged by the industrialized technology – such as family owned businesses, women owned businesses, small and micro enterprises, and rural communities. The reason is perhaps the assumption that the peers ought to have some knowledge in order for the dialogue to be fruitful. After all, dialogue among fools can result in only pandemonium!

This begs the following question: are the developing markets, and the groups disadvantaged by the industrialized technology, really devoid of useful knoweldge? Based on the insights from the various disciplines as noted below, we do not believe so.

Descriptive history research suggests that the pre-industrialized nations had rich endowments of knowledge. The the ancient Chinese, Indians, Greeks, and Egyptians had advanced knowledge of mathematics, astronomy, biology, chemistry, metallurgy, and other arts and sciences. They were able to apply this knowledge to create and exploit various technologies.

Similarly, descriptive anthropological research shows that, in contemporary societies, all tribal groups – even when isolated from the modern education - are repositories of deep

knowledge about the flora, fauna, resources, and geography of their region, and are able to apply that knowledge for variety of ends for survival, healing, and enjoyment. Since the flora, fauna, resources, and geography of different regions vary, the knowledge base of these groups also tend to vary. The development policy studies show that even the illiterate women in rural communities use knowledge that lies outside the modern industry, and that have been passed on within their communities for successive generations. For instance, the environmentally friendly use of cow dung for moderating the temperature inside the hut made out of straw, and also as a source of renewable and non polluting energy.

Descriptive data are also available showing that the cultural practices and values differ across nations and regions. GLOBE program investigated if the cultural practices and values of the nations may be clustered based on their history, geography and other factors that influence knowledge base (Gupta and Hanges, 2004). The answer was in the affirmative, and ten regional clusters of nations were identified that had rather homogenous orientation of cultural practices and values. These ten clusters were then grouped into two meta-clusters: Western world, and Eastern world. Varying cultural practices and values imply that the nations not only have different knowledge bases, but they also approach their knowledge differently. The knowledge base may, for instance, be used for supporting gender balancing roles (e.g. enabling men to take up more household roles, and lightening the demand for muscle power in the field), or for gender biased roles (e.g. pushing women out of the fieldwork, and making household chores more time consuming for women), as a function of the degree of gender egalitarianism in a nation's culture.

Therefore, the developing markets, and the disadvantaged groups, may have deep geographical knowledge, and may have diverse technologies as a function of their cultures. Peer interactions may enable collective awareness of the resources and know-how available within a community. Peer interactions, however, are not without their pitfalls. Group Psychology research suggests Teamwork is prevalent in organizations, yet it has pitfalls such as groupthink. During groupthink, members avoid and discourage ideas outside the comfort zone of consensus thinking (Janis, 1972). Groupthink is magnified by the conditions of social identification, salient norms, and low self-efficacy. It results in suppression of diversity, polarization of power in authoritative leaders, poor decision process, and poor decisions (Baron, 2005).

Learning effectiveness in groups is compromised by groupthink and other factors, including social loafing, overdependence on a dominant leader, over-commitment to goals, and diffusion of responsibility (Adams, Keyes, and Kolb, 2005). An effective antidote is reflective observations. As Adams et al (2005: 3) note, a “team can develop a composite image of itself by developing the capacity to reflect on its experience through conversations that examine and integrate differences in members’ experiences on the team.” According to Kolb’s four-stage learning cycle (1984), immediate or concrete experiences are the basis for observations and reflections. These reflections are assimilated and distilled into abstract concepts, from which new implications for action can be drawn. These implications can be actively tested and serve as guides in creating new experiences.

Thus, self-discovery may be a powerful technique for entrepreneurial strategy even in the developing markets. While that may be news for the Reengineering West paradigm, from our perspective what is even more significant is its implications for the Reengineering West paradigm. Conceptually, self-discovery becomes an even more potent technique when combined with the opportunities for trading international technology. The knowledge generated through self-discovery can be offered in exchange for the knowledge traded from the international markets. The investments made to offset the imperfections in the market for trading technology could be used for exchanging self-discovered knowledge also. The absorptive capacity created by the self-discovered knowledge would also allow for cost-effective and complete grasping of knowledge as well as transforming of knowledge.

### **Entrepreneurial India – Reengineering West or Self Discovery?**

India is a unique case to examine the effectiveness of Reengineering West and Self Discovery theories of entrepreneurial strategy. During the pre-British era, India had a rich base of diverse indigenous knowledge and technologies, many of which were apparently self-discovered. During the British era, the focus shifted on promoting Reengineering West paradigm. During the early independence era, the emphasis was to create a parallel economy, with public sector charged with Reengineering West, and private sector empowered to self-discover. Finally, during the reforms era, the public sector was found to be inefficient, and private sector was entrusted with the additional responsibility of Reengineering West. At the same time, the motivation of the foreign firms investing in India shifted from transfer of

technology to exploit lower labor costs to the use of Indian talent, resources, and know-how for driving innovations. Thus, in India, the evolving entrepreneurial strategy comprises of Self-discovery, Reengineering West, as well as technological exchange – i.e. exchange of self-discovered knowledge with the West. This strategy allows for reciprocal, comprehensive, and sustained exchange of techniques and technologies with foreign firms, and enables broader participation of private firms and individual entrepreneurs in the development process.

Below we assemble the real-world facts, and derive insights that are pregnant with meaning for socio-economic science practitioners and researchers alike.

### **Technological base of the Pre British India**

India has been a center for technology exchanges from times immemorial. Both written and archeological artifacts document trade with the Middle East (Mesopotamia) as far back as 2600 BC (Parpola, Parpola, & Brunswig, 1977). Indian merchants traded weapons and tools of copper and bronze, cotton textiles, and luxury goods (such as beads and shell inlays), in exchange for silver, tin, woolen textiles and other materials.

Bundled merchandise from India was sealed with clay impressions – perhaps the world’s earliest evidence of branding. An adaptation of Indian motifs and scripts subsequently emerged on Mesopotamian seals – one of the earliest documented instances of intellectual property piracy (Brunswig et al, 1983). Hunter (1932: 469), looking at the seals, observed, “the square seals are in the Indian language, and were probably imported in the course of trade; while the circular seals, although in the Indus script, are in a different language, and were probably manufactured in Mesopotamia for a Sumerian- or Semitic-speaking person of Indian descent.” As shown in Figure 1, besides carrying signs in Indus language, the square seals of India carried a distinctive one horn animal.

**Figure 1: Square Seals of Ancient India**



Source: Phoebe A. Hearst Museum of Anthropology, University of California, Berkeley

Urbanization in India went hand-in-hand with trade prosperity. Artisan communities sprung up in the cities. Raw cotton was brought in bales to the cities to be spun, woven, and dyed—a development of rural-urban linkages (Wheeler, 1968). Knowledge was transferred via a “gurukul” system of education. In the gurukul system, the learner lived in a hostel with a proficient teacher for several years. Training was provided in all aspects of life, including self-discipline (Gupta, Surie, Javidan, & Chhokar, 2002).

On the eve of British colonialism, Western scholars were in awe of India’s technological base. Macintosh (1782) noted, “India was anciently so renowned for knowledge and wisdom that the philosophers of Greece did not disdain to travel thither for their improvement.” Pierre Sonnerat (1745-1814) added, “We know that all peoples came there to draw the elements of their knowledge.... India, in her splendor, gave religions and laws to all the other peoples; Egypt and Greece owed to her both their fables and their wisdom.” (quoted in Danino & Nahar, 1996: 18)

### **Reengineering West Paradigm of the British India**

During India’s early colonial years, the British denied education to the locals, on the grounds, “we had just lost America from our folly in having allowed the establishment of schools and

colleges, and that it would not do for us to repeat the same act of folly in regard to India.” (East India Company, 1792; quoted in Kochhar, 1993: 54) After colonializing, British introduced a new educational policy focused on the superiority of British techniques, language, and values. Farquhar (1914/1967: 21) noted, “The new educational policy of the Government created during these years the modern educated class of India. These are men who think and speak in English habitually, who are proud of their citizenship in the British Empire, who are devoted to English literature, and whose intellectual life has been almost entirely formed by the thought of the West, large numbers of them enter government services, while the rest practice law, medicine or teaching, or take to journalism or business.”

In addition, British sought to transfer several technologies to facilitate colonial administration and commercialization. Postal, telecommunication and railroad systems were notably introduced in the 1850s as engines of social improvement (Bear, 1994). New towns were formed along the railroad lines for the purpose of exporting Indian raw materials to England, and importing British ready-made textiles and other goods. English machine made goods, made from Indian raw materials, squeezed out skilled Indian village artisans, and forced them into subsistence living as unskilled workers in British factories in India. Similarly Indian farmers were led to cultivate cash crops, which were more capital intensive and prone to make farmers debt-ridden and eventually landless and bonded laborers (Bear, 1994).

### **Mixed Paradigm of the Early Independent India**

At independence time, India’s agriculture was growing at a mere 0.3 %, and its manufacturing sector was miniscule (INSA, 2001). To correct the situation, Prime Minister, Jawahar Lal Nehru, advocated adoption of the Soviet type Five Year Planning system (Nehru, 1936/1972). Nehru’s scientific resolution identified technology’s critical role in overcoming a lack of resources. He observed, "The future belongs to those who make friends with science" (Nehru (1937). Furthermore, "It is the inherent obligation of a developing country like India, with its tradition of scholarship and original thinking and its great cultural heritage to participate fully in the march of science, which is probably mankind's greatest enterprise today" (Government of India, 1958). The scientific resolution was a blue print for creating universities, policy institutions and publicly funded R&D laboratories. As a founding member of Non-

Aligned Movement (NAM), Nehru led India's role to maintain open relations with both the Soviet and the NATO block, and to seek technological inputs from both.

Basic amenities and basic infrastructure was the focus of the First Five-Year Plan (1951-56). Depleted wartime rail-net and rolling stock was repaired, fresh irrigation water augmented, and idle industrial capacity was brought into use for rapid growth in national income. The 1948 and 1956 industrial policy resolutions entrusted heavy industry projects, such as steel, cement and hydro-power, to the public sector. The Second Five-Year Plan (1956-61) aimed to triple outputs of iron ore, double that for coal, and for electric power. It laid down the framework for the separation of roles between the private and public sectors, and introduced a "license raj" to regulate private sector companies. Investment funds were offered to the large public and private sector borrowers only if the relevant production was pre-approved; and in such cases, funds were offered at rates substantially lower than the market rates. Most foods, steel, coal, and other basic commodities were subject to price controls, pegging prices well below world prices (Chandra, 2002). Additionally, the government 'reserved' a large number of industrial products for the small sector, thereby fragmenting the market, and forcing the concentration ratio in many industries below the Western levels by the 1980s (Chandra, 2002).

India's Third Plan (1961-66) sought to mobilize foreign aid and technical collaboration for developing basic industries. Through various collaborations, India became the seventh largest steel-producing nation in the world. Similarly, in the tractor industry, several firms were set up: Eicher (German collaboration), Escorts (tie up with Ursus of Poland), Hindustan (tie up with Zetor of Czechoslovakia), TAFE (tie up with Massey Ferguson of Yugoslavia), and International (tie up with International Harvester, UK) – (Mohan, 2003).

However, the pitfalls of the Reengineering West philosophy were becoming rapidly apparent, as India fell into deep economic crisis. The Aid India Consortium forced a 57.5 percent devaluation of rupee in June 1966, by making it a pre-condition for the resumption of aid. The cost of foreign loans outstanding rose sharply in rupee terms. Droughts, famines, and inflation compounded the crisis, and generated a shift in voter behavior towards one based on the swadeshi factor (indigenous self-reliance, based on import substitution).

In this scenario, Nehru's daughter, Indira Gandhi propagated the slogan of "Garibi Hatao" (eradication of poverty) to obtain the support of the poor and the leftists (Esho, 2004).

After becoming Prime Minister in January 1966, she ushered the nation into an opposite paradigm of internally driven technological growth.

### **Significant Experiences with the Shift from Reengineering West**

Below, we discuss some of the most significant experiences with the Reengineering West attempts. These include (a) Role of Soviet Union in industry, (b) Role of the United States in agriculture, (c) Role of government in electronics, and (d) Role of Japan in the auto revolution. In all these areas, Reengineering West path was earlier deemed to be of high priority. However, dismal results encouraged the policy makers to increasingly focus on Self-Discovery – often led by the public sector enterprises who were expected to take the nation to the commanding heights. By the end 1970s, India had become self-reliant in food, but suffered from massive unemployment as the engines of Reengineering West – the public sector enterprises – proved to be inefficient.

#### ***Role of Soviet Union in Industry***

At the time of independence, India lacked technical methods, machinery, manpower, and materials, as well as adequate monetary resources and domestic savings, for establishing a modern industrial complex. The Western nations, pre-occupied with their Post-war reconstruction projects, refused required assistance for establishing basic industries. However, as the Soviet bloc nations expanded their assistance to diverse sectors including steel, oil, machinery, power generation equipment, and tractors, India was able to procure both technology and finance from several Western nations for a large number of state owned factories in heavy and capital goods industries. The US and other Western nations also encouraged their private multinational sector corporations to set up new plants in India, as a policy to counter-balance the possible rise of communist influence in India. These initiatives exposed India to diverse techniques and technologies, and cultivated a scientific interest in developing local versions rooted in local capabilities and suitable to local climatic conditions. Consequently, India became largely self-sufficient in capital goods by the late 1970s, importing only 10% of its annual requirements (Chandra, 2002). India's industrial base became highly diversified.

For instance, starting in 1955, the USSR provided help in constructing a public sector steel plant in Bhilai. The Soviet assistance led the UK and West Germany to also help construct one steel plant each at Rorkela and Durgapur respectively. These too were state owned. All these plants were highly inefficient. Only in the 1980s, when the private sector set up steel plant did India become self-reliant in steel (Chandra, 2002).

Similarly, the Soviets offered India crude oil at a substantial discount in early 1960s. When the Western oil companies refused to process the Soviet crude, Indian Oil Corporation gradually built its own refineries, with only limited imports. After offshore oil was discovered in India, the Soviets helped the Oil and Natural Gas Commission (ONGC) to explore new oilfields, and productionize them. By early 1970s, India was able to become almost self-sufficient in oil technology from exploration to refining (Vedavalli, 1976), and its public sector firms had joined the ranks of Fortune 500. After the late 1970s, India confined its imports from Soviet Union mainly to raw materials, minerals, and fuels, and bought very little machinery (Chandra, 2002).

Development of the tractor industry offers insights on how trading technology from diverse foreign partners was married with the self-discovery approach. In 1965, India was assembling 13,000 tractors annually, using mainly imported components. India wanted to up it to 20,000, but no foreign partner was interested in transferring the technology needed. Hence the Central Mechanical Engineering Research Institute (CMERI), Durgapur, proposed that an indigenous technology be developed. All foreign players had already provided detailed workshop manuals for their tractors, as part of the National Certification Center's required documentation. CMERI benchmarked these to incorporate the best design concepts of competing models, such as sealed disc brakes, better seating posture, and positioning of controls, as well as aesthetic sheet-metal with zero tooling costs. It studied international patents to avoid infringement. Thus India developed its own designs and patented them. It pioneered the concept of a 'unified series', similar to the 'common platform' concept used in passenger cars today. Common sub-assemblies, such as hydraulics and gear boxes, were used across tractor models. Though additional manufacturing cost in a unified series between different tractors was marginal, the difference in selling price was huge (Mohan, 2003).

### ***Role of the US in Agriculture***

In the 1950s, India signed an agreement with the US to improve agricultural education and research, and to launch an extension service aimed at providing advice to farmers on new agricultural technologies and state of the art practices (Planning Commission, 2001). India secured US assistance in several domains, including procurement of fertilizers, financing construction of fertilizer plants, developing rural electricity infrastructure, and establishing modern irrigation systems for reducing dependence on rain-fed irrigation (Mulford, 2004).

In addition, five state agricultural universities were established with help of the United States Agency for International Development (USAID), the U.S. Department of Agriculture, and the Ford and Rockefeller Foundations. The US universities sent several educators and agricultural advisors for collaborative work with scientists and students in India, and invited many Indian agricultural specialists for learning about farm technologies employed by the US (Mulford, 2004).

With the help of the US, India adopted high yielding breeds, new pesticides, new agricultural implements, and the collaborative scientist-farmer extension model. The result was a rapid growth in agriculture productivity, referred to as Green Revolution. Initially the Green Revolution outside of wheat proved to have a more limited impact in India than elsewhere because of country specific conditions. However, India made innovations in areas where the American approaches were not in tune with her climates. New varieties were developed for crops grown by poor farmers in less favorable agro-ecological zones. Among these were sorghum, millet, barley, cassava and pulses. Public institutions researched and developed plants with durable resistance to a wide spectrum of insects and diseases, plants that are better able to tolerate a variety of physical stresses, crops that require significantly lower number of days of cultivation, and cereal grain with enhanced taste and nutritional qualities (Evenson and Gollin, 2003). Given Indian's diverse climatic zones, a majority of state governments R&D funding even in mid-1990s was devoted to agriculture. In 1996-1997 it was 93.3 percent of total (Ministry of Science and Technology, 1997).

India was thus able to attain food self-sufficiency and resilience, while effectively withstanding a severe drought in 1979. By the 1980s, India's agricultural growth had risen to three percent, for the first time since independence outpacing population growth, and facilitating a dramatic fall in rural poverty from 60% in the late 1960s to 40% in late 1980s. Indian farmers were able to diversify their operations with new crops and livestock products, particularly dairy and poultry, and were able to hire more paid labor, as food grain production rose from 70 million tons in 1954 to 200 million tons by early 2000s (Mulford, 2004).

### ***Role of the Government in Electronics***

In 1966, the Bhabha committee – comprising scientists-technocrats mostly trained in the US – created a vision for developing an indigenous informatics sector, in the wake of US electronics

equipment cutoff during the 1965 Indo-Pakistan war (INSA, 2001). At the time, informatics was based entirely on imports, with limited local manufacturing by the wholly owned foreign multinationals. For instance, IBM and UK's ICL were supplying only old and refurbished equipment at a substantial markup. Though the Indian government requested IBM to share ownership locally in 1966, IBM threatened to shut down its operations, leading the government to back down until 1978 when it would decide to assert itself and induce IBM to close its Indian operations. India's only local capability was in Bangalore-based Bharat Electronics Ltd. (BEL), a state-owned producer for the military, set up in the 1950s. In the early 1970s, BEL took on the full cycle of semiconductor wafer fabrication, and served as the training ground for thousands of engineers. However, its products remained commercial failures.

In 1967, the Electronic Corporation of India Ltd. (ECIL) was formed, under the aegis of the Bhabha Atomic Research Center. Its brief was to tie up with international companies for local manufacture of computers, sufficiently different from those available from abroad, and to increase the local value-added to the point of self-reliance. The government regulated the import of computers depending on ECIL's production capacity, taking at least 6 months to clear import requests, if at all. ECIL minicomputers were built around DEC architecture, incorporating components from Intersil and Motorola, hardware from BASF, Memorex, and Dataproducts. ECIL took up to 18-24 months to deliver systems, offering limited applications for its proprietary operating system, yet charging more than the more powerful foreign systems (Mulhearn, 2000).

In the 1970s, over 80% of India's R&D was government financed. Much of it was in the strategic sectors of atomic energy, space research, and defense. The nation developed a range of techniques and technologies for prospecting raw materials, and the design, construction and operation of large power reactors. A network of forty laboratories was formed under the Council of Scientific & Industrial Research for work of relevance to industry; though the transfer of knowledge to the industry remained limited because of various restrictions on the private sector. These restrictions included limits on expansion, diversification, importation of capital goods and of technology, and of course the high cost of local inputs. On the other hand, the small scale sector was offered priority if not exclusivity. Fiscal benefits such as lower excise duties, encouraged the firms to develop imitative products through reverse-engineering and improvisation, though without any incentive to grow to exploit economies of scale or scope (Tyabji, 2000).

### ***Role of Japan in the Auto Revolution***

The focus of the auto initiative – at the behest of Indira Gandhi – was on developing a mass transportation vehicle, accessible to India’s middle class. Since independence, the auto market in India was divided mainly between Hindustan Motors and Premier Automobiles. The market was supply driven, and few people had access to cars. In 1981, the government decided to form a joint venture, called Maruti Udyog Ltd., with 26% equity by Suzuki Motors of Japan for developing a small mass-market car. Suzuki’s business model involved the use of top local suppliers to help acclimatize its own technology to local conditions. Suzuki also introduced various Japanese techniques, such as quality circles, vendor collaborations, and continuous improvement for fully exploiting the technical talent of the local workforce. Consequently, localization of parts, subassemblies, and product design was rapidly achieved, thereby enabling an unusual mobilization of the self-discovered indigenous knowledge (Gupta, 1998).

The first car – Maruti 800 – launched in 1983 was a runaway success; and was later followed by an up-scale model, the Zen, and two utility vehicles; each of which became leaders in their respective segments because of competitive pricing and appropriateness to Indian climatic and road conditions. In the late 1980s, the government diluted its stake to allow Suzuki to increase its share first to 40% and then to 50% in 1992. By 1999-2000, the automotive sector had a turnover of \$11.9 billion (up from \$3.6 billion in 1993-94). It employed 0.45 million people directly, and 10 million people indirectly. The auto industry contributed about 17% to indirect tax revenue of the nation, and 4% of the GDP, starting from a negligible share in the early 1980s. In the 2000s, attracted by the strong auto base in India, nearly two dozen foreign firms established manufacturing operations in India. Many local players such as Mahindra & Mahindra (originally a tractor firm) also decided to enter the market. India was creating a distinct space for itself in the world, with several innovations, including the world’s most affordable car Nano launched by the Tata Group for \$2500.

### **First Generation Reforms – Entrusting Reengineering West to the Private Sector**

In 1984, new Prime Minister Rajiv Gandhi laid a vision for a central role for the electronics industry. Rajiv invited the UK-based India-origin scientist, Satyen (Sam) Pitroda, to start the Center for the Development of Telematics (C-DOT) with the goal of replacing the foreign switches on which Indian phone system was based by designing an indigenous digital telecom

switch for licensing to and large scale manufacture by private firms. C-DOT licensed switching technologies from various foreign firms for developing its own version. It produced an affordable and adaptable smaller rural exchange switch (that included solar panels), suitable to Indian conditions of high heat, humidity and dust, and then built a bigger capacity switch and transmission equipment ([www.cdote.com](http://www.cdote.com), 2005). In 1985, Rajiv opened the telecom equipment manufacturing sector to the private firms.

The government policy to computerize its departments and enterprises generated large and complex assignments for the local firms, and became a key catalyst for development of software industry. The most notable was the automation of state-owned railways reservation. In 1983, Indian railways was running the world's second largest railway system, carrying about 100 million passengers a year, involving "7 different categories of trains, 72 types of coaches, 7 classes of reservations, 32 types of quotas, and 85 kinds of concessional tickets." (Mulhearn, 2000) Passengers often had to wait in line overnight for reservations. The contract was given to CMC. CMC, set up in 1976 as a substitute for IBM maintenance to initially service IBMs, had grown to service about 40 foreign platforms and a few local platforms as well (Dataquest, 2002). CMC used state-of-the-art hardware and write indigenous software in DEC's proprietary operating system (taking 35 engineer years for automating the first location – Delhi – alone), to produce a system that was both efficient and far cheaper than what had been quoted by the foreign companies. The average waiting time for the passengers was reduced to less than 20 minutes (Mulhearn, 2000). This contract helped CMC grow into India's second largest informatics company in the 1980s, with more than three fourths of revenue coming from design of large infrastructure delivery related turnkey projects. Similarly, in 1985, the Rangarajan Committee decided to computerize all public sector banks, using Unix systems. And immediately, private companies raced to introduce Unix systems, ahead of the companies in other nations (Dataquest, 2002).

Ironically, the most competitive Indian products were design-intensive based on the indigenous design and engineering talent, as opposed to being commodities (Mulhearn, 2000). Given the evolving industrial policy climate, it was difficult for the firms to forge the requisite network of foreign suppliers to reliably deliver high-quality low-cost parts and components, and because no firm succeeded in commodity production, a base of local suppliers could also not be formed in the nation. The firms, such as CMC, ECIL, and HCL, that faltered in hardware, still flourished by moving into software. And the firms that could not enter the hardware market, either

because of limited funds (for upstarts) or late focus (for established business houses), also found design intensive and software domains as an easier entry strategy. For instance, Tata Consulting Services, formed in 1968 by Tata group, emerged as the biggest private player in local software market and the largest software exporter by 1989. Without the economies of scale of high volumes, the Indian firms found themselves uncompetitive in an increasingly capital intensive hardware development and manufacturing industry. By the 1990s, most of the India's IT hardware companies were transformed into direct or indirect dealerships for foreign brand computers and related products (Jhungjhunwala, 1999).

The exports of software from India had started in 1974, reaching \$4 million in 1980, \$28 million in 1985, and rising to \$481 million by 1995. However, given the weak telecommunication infrastructure, the Indian firms found it more difficult to do large volume body shopping work from India (Mulhearn, 2000). Under this scenario, three factors enabled an increasing offshore software project work in India: (1) build up of experiences and client relationships of Indian firms having overseas offices, (2) improved telecom infrastructure in India, and (3) offshore software development joint ventures of the foreign hardware firms.

First, many Indian firms set up US offices that served the client's maintenance, basic programming and testing needs onsite, and later moved up the trust curve of the client to gain higher value-added contracts to be performed offshore. Creation of the US offices was facilitated by the growing network of educated Indian diaspora overseas, as well as improved Indo-US government relations that allowed Indian firms to send low-cost Indian programmers to work on the client projects onsite in the US on H1-B visas. Indian firms charged, on average, 70% of Western contract rates for onsite work and 40% for offshore work (Mulhearn, 2000). Through interactions with the Western clients, best practice benchmarking, and self-discovery, Indian firms rapidly built a base of in-house training programs, quality processes, and productivity tools. By 1999, 137 Indian firms obtained either ISO 9000 or SEI-CMM Level 2 certification, and more Indian firms were certified at the highest Level 5 than the US firms.

Second, as the telecom infrastructure improved by the early 1990s, firms took up more body shopping work offshore. In mid-1990s, two thirds of the work on software exports was done onsite (at client's site overseas), and one third offshore (in India). Further, two-thirds of the projects were body-shopping (low skill programming, requiring only coding and testing services,

often without any strong ties with the client) and one-thirds were higher value-added (systems analysis and design skills, often with client alliances) (Mulhearn, 2000).

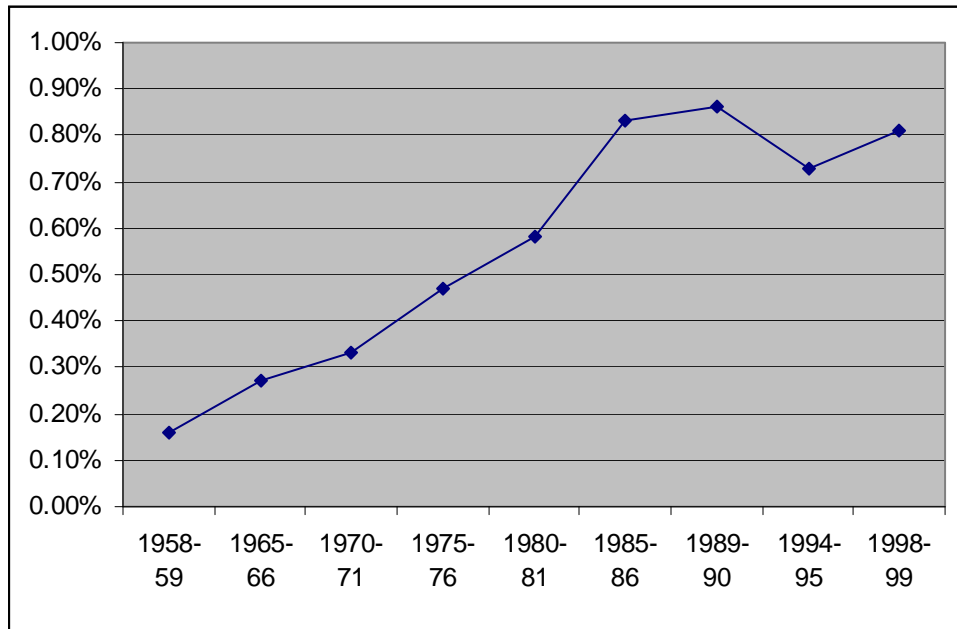
Third, Rajiv Gandhi invited foreign multinationals to set up software development joint ventures in India. Because of stronger ties with the MNCs, these joint ventures were able to take far more offshore, turnkey work, than the local Indian firms. By 1992, nearly all major Indian firms had formed a joint venture with a major MNC: HCL with HP, PSI with Bull, Modi with Olivetti, DCM-DP with Control Data Corp, IBM with Tatas, and Wipro with Acer. Though by 2000, most joint ventures had been dissolved, both the MNCs and the local firms were able to operate independently with their distinct capabilities (Dataquest, 2002).

By 2000, a majority of the Fortune 500 companies outsourced IT services to India. The successful outreach by DOE in making the results of advanced R&D available, both through licensing of know-how, as well as embodiment of know-how into equipment and technologies, to a large number of smaller and other private enterprises ushered India into a new era (Krishnan, 2003). National Chemical Laboratory (NCL) became the largest Indian holder of US patents. NCL not only licensed its technologies, but also undertook contract research for multinational corporations. NCL created separate business planning and scientific information system divisions, and offered medals and awards for technology development and support functions (Krishnan, 2003). The government introduced several programs to support the absorption of imported technologies, as well as to develop, demonstrate, and commercialize indigenous technologies, and to encourage technology-based entrepreneurs. The share of private sector in national R&D expenditures, consequently, rose to 20-25% during the late 1990s, as opposed to 15-20% during the early 1990s (Department of Science and Technology, 2002).

The Ministry of Information Technology, set up in 1999, launched the National Venture Fund for Software and IT industry (NFSIT), and helped several States, such as Andhra Pradesh, Karnataka, Delhi, Kerala, Gujarat, and Tamil Nadu, to set up their own venture funds. The amount of venture capital funding for IT sector surged from \$80 million in 1997-98 to \$500 million by 1999-2000 (Singh, 2002). The Ministry also sponsored hundreds of R&D projects at scores of enterprises, labs, and institutes, including the use of Indian languages for computers and a stronger extension of IT to rural India. Consequently, the total estimated size of the IT economy in India surged from 1.7 percent of GDP in 1997-98 to 3.7 percent in 2000-01 (Raipuria, 2002). The software industry's revenues grew from \$835 million in 1994-95 to \$8,300 million in 2000-01

(Raipuria, 2002). Its exports grew at 229% annually (from \$485 million to \$6,200 million), and domestic revenues rose by 35% annually (from \$350 million to \$2100 million).

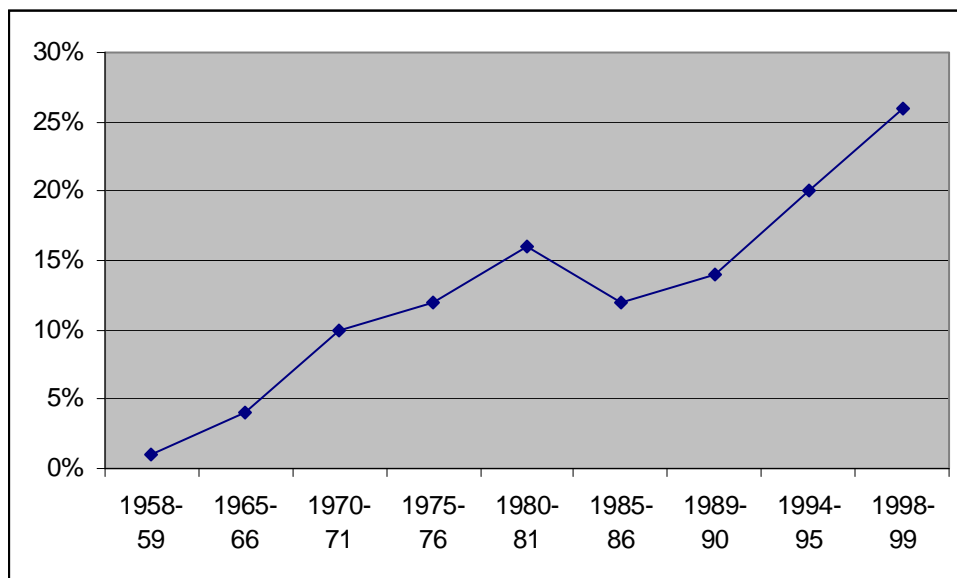
As shown in Figure 2, India created a track record of building on its successes. Since gaining independence she plowed back an ever higher percentage of her GNP into her domestic R&D.



**Figure 2. India's science and technology expenditures as a % of GNP**

Source: Department of Science and Technology (2002).

Moreover, as the private technology sector grew her share of R&D plowback increased at a most impressive rate as is shown in *Figure 3*.



### **Figure 3. India's private sector science and technology expenditures as a % of total science and technology expenditures**

Source: From Department of Science and Technology (2002).

Thus, one may conclude that the institutional support did eventually facilitate the private sector growth. However, this support also resulted in significant social polarization. Most households in the lower socioeconomic brackets enjoyed relatively limited or no benefits of the IT revolution. There was a setback of about 15 percent of India's progress in poverty reduction as a result of trade liberalization (Topalova, 2004). The total factor productivity growth in Indian manufacturing industry, which had been positive during 1981-95, stagnated and perhaps started declining during the late 1990s (Thirwell, 2004). Significantly, the Vajapayee government – that oversaw the revolution over the late 1990s and early 2000s-- was thrown out of power in the 2004 national elections. In rural India people voted in greater numbers, while the urban areas that benefited most from the market oriented policies had low voter turnout. The elections were a signal that the nation must mobilize the indigenous knowledge of the disadvantaged and empower and engage them also in the development process.

### **Second Generation Reforms: Mobilizing the Indigenous Knowledge**

In February 2005, the new Manmohan Singh government launched a major plan, through the Union budget for 2005-06, to rebuild village infrastructure in irrigation, roads, housing, water supply, electrification, and telecom connectivity (Government of India, 2005). Termed Bharat Nirman (Constructing India), the plan sought to unleash rural India's potential as a growth engine by 2009. The budget also introduced special, higher income tax exemption brackets for women and senior citizens, and allocated Rs. 144 billion for women's development, while introducing the concept of gender budgeting for all government departments. It sought to strengthen the manufacturing sector with a focus on SMEs, with an income tax relief to firms having annual turnover of Rs. 40 million (Government of India, 2005). Government also decided to pursue reforms in the cooperative banking sector, to promote microfinance and credit linking, and to use non-government organizations and self-help groups as micro-insurance agents (Government of India, 2005).

Also, worth taking stock were the several widely publicized cases of international biopiracy, and the evolving government response to it. Patents had been issued in the US and

European union, for instance, on wound healing properties of turmeric, hypoglycemic properties of bitter melon, and fungicidal properties of neem, all of which have been part of the knowledge of the disadvantaged. The National policy on biodiversity had sought to “Ensure benefits to India as country of origin of biological resources and to local communities and people as conservers of biodiversity, creators and holders of indigenous knowledge systems, innovations and practices.” (Government of India, 1999) A Traditional Knowledge Digital Library (TKDL) covering 35,000 Ayurvedic formulations involving medicinal plants had been sent to international patent offices to help check biopiracy (Srivastava, 2002).

Honey Bee - GIAN (Grassroot Innovators Augmentation Network), set up in state of Gujarat in 1993 collected over 10,000 examples of contemporary innovations and outstanding examples of the use of traditional local knowledge in the sustainable management of natural and other resources. This knowledge was shared with communities in 75 nations through the Honey Bee newsletter. The Honey Bee network requires the formal sector to use the traditional knowledge only after acknowledgment, citation, and prior informal consent of the knowledge holder. This created new models of empowered collaboration between the formal and informal sectors cutting across geographical boundaries. It helped convert several rudimentary innovations into product prototypes. These include the tilling bullock cart, motor cycle mounted sprayer, hand operated sprayer, 12.5 HP tractor, first cotton stripping machines, poly-bag filter and an innovative pulley.

Consider the experience with Kani – a tribal community in the Kerala State. In 1987, a team of scientists from the Tropical Botanic Garden and Research Institute (TBGRI) noticed that the Kani tribals frequently ate certain fruits which kept them energetic and agile. After probing, the team discovered interesting ethnomedical information on a wild plant locally called “Arogyapacha.” The team identified the plant as *Trichopus zeylanicus*, and detailed chemical and pharmacological investigations confirmed the anti-stress, anti-hepatotoxic, and anti-fatigue properties of compounds contained in its leaves (Gupta, 2000). A polyherbal formulation named “Jeevni” was formulated, and the manufacturing license was transferred to the Aryavaidya Pharmacy Coimbatore Ltd. for a license fee of Rs. 1 million (approximately 21,000 US \$) for a period of 7 years. Half of the license fee and royalty was shared with the tribal community, for welfare and development activities and promoting biodiversity (Gupta, 2000).

The government introduced a program called 'Ecodevelopment' for sustainably conserving biodiversity involving local communities, through integration of ecological and economic parameters. The program takes care of the economic needs of local communities through provision of alternative sources of income and a steady availability of forest and related produce. At the village level, People's Biodiversity Registers have been set up to document local people's knowledge – acquired a part of their daily subsistence activities such as grazing, fishing, and basket weaving – on the status, properties, uses, and management of a variety of biological resources. The knowledge includes, for instance, draught resistance of certain varieties, methods of preservation of foods, or use of certain plants in treating human or livestock diseases. Most of this knowledge until now has been almost exclusively orally transmitted .

A National Innovation Foundation was established in October 2000. Its mission is to provide institutional support in scouting, spanning, sustaining and scaling up of grassroots innovations, and to enhance technical competence and self-reliance of grassroots innovators. The Foundation focuses on technological grassroots innovations by individuals who are engaged in small and cottage industries, farming, craft, fishing and animal husbandry, herbal medicines, and household and workplace technologies used by women, as well as innovations by slum dwellers and by local communities in managing natural resources, construction of low cost environmentally benign houses or small machines, products or any other technological aspects of survival in urban and rural areas.

## **DISCUSSION**

In this paper, we examined the role of Reengineering West and of Self-Discovery paths to development of India. India was notable for her the depth and breadth of her indiginous knowledge during the ancient times. The British strived to push alternative technology and learning systems intended to strengthen their supremacy and control of India. Since independence, the policy efforts have focused on reenabling the Self-Discovery process – initially with a greater emphasis on Reengineering West, but increasingly prioritized on Self-discovery and technological exchange.

The Reengineering West paradigm dominated during the British era and the early post independence era. India relied heavily on foreign technology. She reserved all basic and heavy industries to the public sector. Expansion of large-sized private companies in other industries by

way of licensing and other industrial controls were closely restricted. As foreign nations withheld key components and services required to productively exploit imported technologies, India became dependent for even the basic foods.

The Self-Discovery paradigm evolved during the 1960s and 1970s. India withdrew into a protective shell of a closed economy, focused on self-reliance and indigenous capability building. Higher education and training institutions in science, technology, and related domains played an important enabling role. Specialized research institutions were created and supported by the government, and were asked to import international technologies and practices, and to develop indigenous versions for applications, particularly in agriculture and defense. While the public sector developed significant technical strengths during this period, the costs of using these technologies and techniques were higher than international levels. The limited spillovers to the economy resulted in high levels of poverty, unemployment, growing disparities in income distribution, and a general decline in the standard of living, except in selected states where local conditions were more suitable to adopting foreign technologies and techniques.

A combination of the two paradigms, along with technological exchange, began shaping up during the 1980s and 1990s. India gradually opened the economy, and invited private sector firms to exploit the infrastructure and capabilities created in the public sector. Private firms were able to discover innovative and creative linkages for productively exploiting the public infrastructure in domains where the Self-discovery path superimposed on the Reengineering West path had been failing. This enabled them to rapidly move on the learning curve of servicing a diverse base of costly foreign technology; to confidently expand overseas with onsite maintenance, testing, and other software and information technology services.

In late 1980s and early 1990s, the multinational firms, such as Texas Instruments and Hewlett-Packard, began to catalyze the developmental process, by setting up first offshore software development units in India during the mid-1980s. These became certificates endorsing India's capability for reliable 'offshore' development. In the software sector, more Indian firms got certified at the highest level of process capability maturity than all the non-Indian firms put together in the world. Additionally in most other sectors, domestic firms became able – possibly by virtue of their matured process capability – to retain a dominant share of the market, except where they consented to be acquired by multinationals (as in soft drinks), or where the multinationals were operating in India for a long period in so much they are deemed to be

virtually domestic (for instance, Unilever in detergents and cosmetics). The multinational firms also began encouraging their Indian subsidiaries to be first to introduce new products. This contrasted with the past when the foreign firms offered only old and antiquated products with high mark-ups and high maintenance fees.

Over the 1990s, the strategy of large private sector firms relying on imported technologies, services, and capital goods lost momentum. Many technology collaborations with foreign firms fell apart. Some large private sector firms, such as Reliance, started emphasizing internal R&D, rather than continuing to depend on imported know-how. They began pioneering new frontiers of technology at the global level that they then leverage to offer niche services to the foreign firms. The public sector firms also shifted priorities. They made available their own internal R&D results to private firms, locally and globally. The government shifted its role from being the nation's primary financier of knowledge and technology, to a secondary supporter of innovations by well managed private sector enterprises, and then to a tertiary governance and organization of the distributed knowledge in diverse communities.

## **CONCLUSIONS**

In this paper, we sought to examine the entrepreneurial strategy based on the Reengineering West paradigm, and explored the alternative of Self-Discovery paradigm.

Like many developing nations using the socialist model India's public sector was created to help the nation reach the 'commanding heights' of the economy, and to conduct activities that would not be performed in the private sector, because of high risks, high investment requirements, or unwillingness to assume the developmental obligations. In this model, the public sector assumed a development and supportive role so the risk and investment requirements reaped beneficial results that were spread over a large number of private sector enterprises who were able to and willing to respond to the developmental climate, education and training, infrastructure, know-how, and technology offered by the public sector. However, this model proved to be dysfunctional, in terms of high costs, high corruption, and high polarization and dependence on the foreign nations, and had to be eventually abandoned in favor of independent initiatives by the private sector firms as well as by the disadvantaged groups.

Early on, India sought to bring radical breakthroughs to the nation through foreign alliances. A context of denial of critical technology, parts and components encouraged a policy

that promoted incremental innovations through business process manipulations. Subsequently, the thrust shifted to nurturing innovative organizations in the private sector. There was a growing awareness about grassroots or micro innovations, which involve artisans, farmers, women in households, slum dwellers, tribals, and other unsung heroes who never obtained credit for their creativity. The emphasis was on engaging and empowering all sections of the society in the technological process, so that the nation does not experience any backlashes from the isolated groups and remains resilient in the face of any unexpected contingencies.

India, with over 100 spoken languages but with English as its *lingua franca*, has transformed itself from a third world country to a significant destination for technology. Beatty (2004, pg. 168) suggested two scenarios for classifying a developing country's adoption and diffusion of foreign technology<sup>2</sup>. One where technology imports yield technological dependence, and second where they promote domestic technological capability. Based on these two scenarios, the case of India falls squarely on this "technology imports helped to promote domestic technological capacity." India did so in her unique way of fusing imported foreign technology; fundamentally improving it using indigenous knowledge, adopting it to diverse local conditions, and producing for import substitution and for export by state owned enterprises and a small group of established oligarchs, ultimately leading to SMEs taking over in few niche technologies and growing to become worldwide suppliers.

However, on deeper reflection, the totality of facts shows that the case of India points to a third scenario: domestic technological capability helped to promote technology imports, and when these imports became cost-escalating, they helped the policy to reorient towards promoting technology exports. India's constructed this new scenario by fusing its indigenous knowledge, fundamentally improve it using technology imports, adopting it to diverse global conditions, and producing for technological exchange by a broadening group of emerging entrepreneurs, established family and other private businesses, and public sector firms, ultimately leading to local firms becoming global contenders in diverse core technologies and growing to become independent but strategic partners for the corporations worldwide.

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<sup>2</sup> Based on much documentation he classified 19<sup>th</sup> century Mexico as falling in the "foreign technology yielded technological dependence" scenario. By inference he suggested that 19<sup>th</sup> century Japan fell in his "technology imports helped to promote domestic technological capacity" scenario.

## REFERENCES:

- Adams A.B., Keyes D.C., and Kolb D.A. (2005). Experiential Learning in Teams. *Simulation & Gaming*, 36(10), 1-25.
- Baron, R. S. (2005). So Right It's Wrong: Groupthink and the Ubiquitous Nature of Polarized Group Decision Making. In Zanna, Mark P (Ed.) *Advances in experimental social psychology*, Vol. 37. (219-253). San Diego. Elsevier Academic Press.
- Beatty. E. (2003). Approaches to Technology Transfer in History and the Case of Nineteenth Century Mexico, *Comparative Technology Transfer and Society*, 1(2): 167-197.
- Gupta, V., & Hanges, P. J. (2004). Regional and climate clustering of societal cultures. In R. J. House, P. J. Hanges, M. Javidan, P. W. Dorfman, & V. Gupta (eds.), *Culture, Organization, and Leadership: The GLOBE Study of 62 Societies*, CA: Sage Publications.
- Janis, I L. (1972). *Victims of Groupthink*. Boston. Houghton Mifflin Company.
- Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, NJ: Prentice Hall.
- Bear L G. (1994). Miscegenations of Modernity: constructing European respectability and race in the Indian railway colony, 1857-1931, *Women's History Review*, 3(4), 531-548.
- Bell, M. and Pavitt, K., (1995). 'The Development of Technological Capabilities,' in Haque, I. (ed.), *Trade, Technology and International Competitiveness*, Washington D.C.: The World Bank.
- Brunswig, R.H. Jr. et al, (1983). New Indus Type and Related Seals from the Near East, 101-115 in: Daniel T. Potts (ed.), *Dilmun: New Studies in the Archaeology and Early History of Bahrain*, Berlin, Dietrich Reimer Verlag.
- Cantwell, J. (1989): *Technological innovation and multinational corporations*. Oxford: Basil Blackwell
- Chandra, N. K. (2002). Soviet Impact on Economic Development in Non-Socialist Countries 1947-1991, *Russian History*, 29(2-4), 459-480. Chemicals.nic.in (2005) Accessed April 2.
- Cohen, WM and Levinthal, DA (1990). Absorptive capacity: A new perspective on learning and innovation, *Administrative Science Quarterly*, 35:128—152.
- Danino, M and S. Nahar (1996) *The Invasion that Never was*. Delhi: Voice of India
- Dataquest (2002). *HARDWARE: All About Frontiers, Reached and Crossed*. December 23.
- Department of Science and Technology (2002). *R&D Statistics 2000-01*. New Delhi: Government of India.
- Enos, J. and Park, W., (1988). *The Adoption and Diffusion of Imported Technology: The Case of Korea*, London: Croom Helm.
- Esho, H. (2004); *Indian Development Strategy and Economic Performance Mirrored in the Eyes of a Japanese*; Paper presented at Fifth Annual Global Development Conference, New Delhi
- Evenson, RE, and D. Gollin. (2003). "Assessing the Impact of the Green Revolution, 1960 to 2000." *Science* 300 (2 May): 758-762
- Farquhar, J.N. (1914/1967); "Modern Religious Movements in India" Delhi: Munshiram Manoharlal.
- Government of India (1958) *Scientific Policy Resolution*.
- Government of India (2005). *The Union Budget 2005-06*.
- Gupta, V. (1998). *A Dynamic Model of Technological Growth*. Unpublished Ph.D. dissertation. The Wharton School of the University of Pennsylvania.

- Gupta, V., Surie, G., Javidan, M., & Chhokar, J. (2002). Southern Asia cluster: Where the old meets the new? *Journal of World Business*, 37, 16-27.
- Gupta, A. (2000). unep/cbd/cop/5/inf/26. United Nations, May 10.  
<http://pib.nic.in/archieve/factsheet/fs2000/telecom.html>. Accessed January 13, 2005
- Hunter, G.R. (1932). "Mohenjodaro--Indus Epigraphy", *Journal of the Royal Asiatic Society of Great Britain and Ireland*, 64, 466-503
- INSA (2001); Pursuit and Promotion of Science: The Indian Experience. New Delhi: Indian National Science Academy.
- Jhunjhunwala, A. (1999) "Can Information Technology Help Transform India?" Department of Electrical Engineering, Indian Institute of Technology, Madras  
<http://www.tenet.res.in/Papers/IT-Trans/ittrans.html>
- Krishnan, R T. (2003). "The Evolution of a Developing Country Innovation System During Economic Liberalization: The Case of India." Paper presented at the First Globelics Conference Innovation Systems & Development Strategies for the Third Millennium, Rio de Janeiro, Brazil, November 3-6.
- Lall, S., (1987). Learning to Industrialise: The Acquisition of Technological Capability by India, London: Macmillan Press.
- Macintosh, W. (1782) Travels in Europe, Asia, and Africa: describing characters, customs, manners, laws, and productions of nature and art: containing various remarks on the political and commercial interests of Great Britain 3rd ed. 2 vols. Dublin: Charles Lodge.
- Ministry of Science and Technology (1997). R&D in Industry 1996-97, Government of India.
- Mohan, C. (2003). "How India's fields got `Swaraj'" Interview by H. Damodaran. Aug 8, The Hindu Business Line
- Mulford, D C (2004); U.S.-India Partnership: Creating Economic Opportunities in Agriculture;; Talk delivered at The Confederation of Indian Industry, Chandigarh, India, April 16.
- Mulhearn, J. (2000); Birth, Evolution, and Globalization of the Indian Information Technology Industry: Protected Insular State Enterprises to Private Global Software Exporters,  
<http://www.contrib.andrew.cmu.edu/~mulhearn/india.html>, Accessed January 13, 2005.
- Nehru, J.L. (1936/1972). Introduction to M. R. Masani: Soviet Sidelights, rpt. in Selected Works of Jawaharlal Nehru (New Delhi, 1972), 7: 128-29.
- Nehru, J.L. (1937). Indian Science Congress Association. 26th December.
- Nelson, R. R. and Winter, SG, 1982, An Evolutionary Theory of Economic Change, Cambridge MA: The Belknap Press of Harvard University Press.
- Parpola, S., Parpola, A., and Brunswig, R.H. Jr. (1977). The Meluhha village: evidence of acculturation of Harappan traders in late third millennium Mesopotamia? *Journal of the Economic and Social History of the Orient* 20 (2): 129-165.
- Planning Commission (2001); Report Of The Working Group On Agricultural Research And Education For The Tenth Five Year Plan, Government Of India, TFYP Working Group Sr. No. 41/2001
- Porter M (1990) The Competitive Advantage of Nations, London, Macmillan.
- Raipuria, K (2002), What Size the 'New' Economy? A Conduit Approach, *Economic and Political Weekly*, 37: 1062-1067.
- Reisman, A. (2004). Illegal Transfer of Technologies: A Taxonomic View. *Journal of Engineering and Technology Management*. Forthcoming.
- Singh, N (2002). Information Technology and India's Economic Development, Unpublished paper, Department of Economics, University of California, Santa Cruz.

- Srivastava, S. (2002). Biopirates Beware! TerraGreen, Issue 8, March 15, TERI.
- Teece, D J, 1977. "Technology Transfer by Multinational Firms: The Resource Cost of Transferring Technological Know-how," *Economic Journal*, 87(3): 242-261.
- Thirwell, M P. (2004). *India: The next economic giant*. New South Wales, Australia: Lowy Institute for International Policy.
- Topalova, P. (2004). Factor Immobility and Regional Effects of Trade Liberalization: Evidence on Poverty and Inequality from Indian Districts. Paper presented at LSE/World Bank Economics Of Industrial Development Conference, December 3 & 4, London, UK.
- Tyabji, N., (2000), *Industrialization and Innovation; The Indian Experience*, Sage Publications, New Delhi.
- Vedavalli R. (1976), *Private Foreign Investment and Economic Development: A Case Study of Petroleum in India*, Cambridge University Press
- Westphal, L., Kim. L., and Dahlman, C., (1985). 'Reflections on the Republic of Korea's Acquisition of Technological Capability,' in N. Rosenberge and C. Frischtak (eds.), *International Technology Transfer: Concepts, Measures, and Comparisons*, New York: Praeger.
- Wheeler, Sir M. 1968. *The Indus Civilization*, Cambridge University Press, Cambridge  
[www.cdott.com](http://www.cdott.com). Accessed January 13, 2005.