Indian Manufacturing Industry

Technology Status and Prospects

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Executive Summary

In 1990, India and China had almost the same GDP per capita. Since then, driven by its manufacturing sector, China's economy has grown much faster than has India's and its GDP per capita on a PPP basis is 90% higher than India's GDP per capita. To achieve faster rates of economic growth India urgently needs to strengthen its own manufacturing sector.

The growth in manufacturing sector is dependent on the investment climate. The structural reforms since 1990s have made some progress. Despite recent setbacks, it is universally acknowledged that the reforms process in India cannot be reversed and sooner or later these reforms will be implemented. However, the long term competitive ability of Indian firms would depend on production efficiency. Production efficiency, in turn, is dependent on ability to develop, import and adapt new technologies among other factors.

India has made significant progress in various spheres of science and technology over the years and can now take pride in having a strong network of S&T institutions, trained manpower and an innovative knowledge base. Given the rapid pace of globalisation, fast-depleting material resources, increasing competition among nations and the growing need to protect intellectual property, strengthening the knowledge base is an important issue. While India's technical talent is recognized world over, there have been serious institutional gaps in promoting industry-research institutions interaction.

This report takes a critical look at the Indian manufacturing sector with respect to the technology and scientific resource availability. Critical high growth manufacturing sectors like food processing, auto components, pharmaceuticals, light engineering etc have been profiled. The current technology status, technology development initiatives and future imperatives have been identified to propel Indian manufacturing industry achieve high growth rates.

Section 1
Indian Manufacturing Industry

Indian Manufacturing Industry Profile

GDP: US$ 650B (July 2005)

Agriculture: 22%
Manufacturing: 22%
Services: 56%

The Indian economy is firmly on the path of steady growth. Even during the last decade when other countries were in the grip of a massive slowdown, India continued to enjoy a comfortable economic position. This recent spurt in growth is propelled by radical reforms such as the removal of restrictions on foreign investment and industrial de-licensing. Tailoring the EXIM policy to promote exports and aligning the import duties to meet WTO commitments further contributed to this development. This trend is expected to continue over the next five years, driven by a favourable business policy environment in terms of tax cuts, broadening tax base, and reduced interest rates.

The liberalization of the economy has opened new windows of opportunity for manufacturing sector. Increasingly the success of manufacturing industries is dependent on innovations, research and development. It is critical not only to remain competitive but also, significant advantages can be gained by developing and commercializing new technologies

With a size of US $ 22 billion, the engineering sector exports stood at US $ 6.6 billion in 2001-02 and imports at US $ 4.9 billion the same year. Indian engineering manufacturing sector employs over 4 million skilled and semi-skilled workers. The engineering manufacturing sector comprises of heavy engineering (70%) and light engineering (30%).

India's growing integration with the global economy and the government's recognition that infrastructure needs to be overhauled are likely to ensure that the trend rate of growth increases in the next decade.

Importance of manufacturing sector in India's economic growth

Growth of manufacturing sector is critical

Allows equitable wealth distribution
Largest number of jobs created

The structural transformation of the Indian economy over the last three decades has been spectacular growth of the services sector, which now accounts for about 50 per cent of the GDP. However, the rapid growth of the services sector much before the manufacturing industry attaining maturity is not a healthy sign. A knowledge-based economy cannot be sustained in the long run unless it is adequately supported by a growing manufacturing economy. Moreover, a service economy cannot continue to thrive on a long-term basis in a country where over 80 per cent of the population is education below the middle-school level.

Some sectors, such as IT, ITES and pharmaceuticals, will compete globally, employing perhaps 2% of the population and bringing wealth to many parts of India. At the same time, around 60% of the population will remain dependent on the agricultural sector, sharing less than one-quarter of India's GDP. Without reform, the agriculture will continue to suffer from endemic underemployment, low wages and monsoon dependency. This will result in continued urban migration, but without the development of an industrial sector this will lead to rising unemployment in the cities. Recognition that this pattern is unsustainable is growing.

It is estimated that India needs to create 7-8 million new jobs each year outside agriculture to stay at its current unemployment level of 7 percent. Manufacturing jobs are ideal for workers transitioning out of agriculture as service jobs require high level of education and professionalism. The revival of manufacturing sector can create close to 2.5 Million new jobs every year.

With the removal of all quantitative restrictions on imports and the falling import tariffs under the WTO regime, it is all the more important for the Indian industry to improve its competitive edge. The sheer volume of international trade with over 70 per cent of the seven trillion dollar market being in processed manufacturing, strongly indicates the necessity of developing global competitiveness in this sector.

Thus the above 8% growth of manufacturing industry in India is critical to ensure healthy balance of income parity, employment generation and sustenance of growth.

Industrial growth

Manufacturing sector driving GDP growth

Growth Rate: 8.9%
Manufacturing contribution to GDP has increased from 17% to 22% in 5 years

The manufacturing sector grew by 8.9% in 2004-05, comfortably outperforming the sector's long-term average growth rate of 7%. The sector has remained one of the engines of economic growth since the start of 2005-06.

Industrial growth averaged 7.1% per annum in the 1980s. It accelerated slightly to 7.6% per year in the first five years following the beginning of the economic policy reform process in 1991. In the second half of the 1990s industrial growth trended lower at around 5% per annum. However, since 2002-03 industrial growth has accelerated markedly on the back of recent strong GDP growth. Rising disposable incomes, easy access to finance and the changing attitudes of India's rapidly rising middle class (with a traditional focus on savings) have resulted in a consumer lending boom. Industrial growth rose above 8% in 2004-05, with consumer durables and non-durables showing exceptionally strong growth. Capital-goods production has been growing at double-digit rates since 2002-03, suggesting increased investment in the industrial sector and the economy as a whole.

SECTORAL REAL GROWTH RATES IN GDP (AT FACTOR COST)

Percentage change over the previous year

Item	1998-99	1999-00	2000-01	2001-02	2002-03 (P)	2003-04 (Q)	2004-05 (A)
I. Agriculture & allied	**6.2**	**0.3**	**-0.1**	**6.3**	**-7.0**	**9.6**	**1.1**
II. Industry	**3.7**	**4.8**	**6.5**	**3.6**	**6.6**	**6.6**	**7.8**
Mining & quarrying	2.8	3.3	2.4	2.5	9.0	6.4	5.3
Manufacturing	2.7	4.0	7.4	3.6	6.5	6.9	8.9
Electricity, gas & water supply	7.0	5.2	4.3	3.7	3.1	3.7	6.3
Construction	6.2	8.0	6.7	4.0	7.3	7.0	5.7
III. Services	**8.4**	**10.1**	**5.5**	**6.8**	**7.9**	**9.1**	**8.9**
Trade, transport &communication	7.7	8.5	6.8	9.0	9.8	11.8	11.3
Financial services	7.4	10.6	3.5	4.5	8.7	7.1	7.1
Community, social & personal services	10.4	12.2	5.2	5.1	3.9	5.8	6.0
IV. Total GDP at factor cost	**6.5**	**6.1**	**4.4**	**5.8**	**4.0**	**8.5**	**6.9**

P: Provisional **Q: Quick estimates;** **A: Advance estimates;**

Source: Central Statistical Organisation.

Critical Issues for growth

Macro-level Bottlenecks for growth

Historical focus on small scale unorganized manufacturing units
Poor infrastructure
High cost of power

The primary reason for Indian manufacturing not being competitive enough is the significant presence of small-scale unregistered manufacturing units across the entire spectrum, even in classically scale and capital-intensive segments. Such unregistered manufacturing accounts for 23 per cent of the total capital employed and 84 per cent of the workforce. Even the registered manufacturing sector is highly skewed towards low scale. Eighty five per cent of factories in India have less than USD 200,000 invested in plant and machinery. While this is not to belittle the value of small and medium enterprises, in India, a large number of such enterprises have been created because of artificial market distortions. The deliberate fragmentation of units has been detrimental to competitiveness.

The other important reasons for the Indian manufacturing being not competitive enough include:

- Poor quality of transport infrastructure across all sectors including port facilities (where productivity is among the lowest in the world), surface roads, railways, airports and waterways.
- High cost of power. Industrial power continues to be among the most expensive in the world. It is about 50 per cent more expensive than in China.
- High cost of capital: It continues to be 10-12 % against international average of 6-8 %.

The Government has to play a crucial role in providing the industry with a favourable investment climate in terms of better infrastructure support, institutional finance at affordable rates of interest, and designing fiscal policies aimed at promoting accelerated growth of the manufacturing sector. In particular, special efforts are needed to upgrade infrastructure facilities.

Firm-level technology Bottlenecks for growth

Emphasis on reverse engineering
Minimalistic technology enhancements on imported technologies
Low R&D investment

At the same time, the manufacturing firms should concentrate on internal changes aimed at improving efficiency and reducing costs. For E.g. a CII-Mckinsey study identifies the difference in labour productivity across multiple sectors between India and China from 10% in TV assembly to 360% in footwear.

Following imperatives are required at firm level:

- Upgrading manufacturing technology levels
- Redesigning organisation structures to enhance accountability and responsiveness
- Enhanced emphasis on attracting and retaining talent
- Eevolving product-mix strategies, explicitly factoring in the opportunities in export markets
- Re-engineering core processes to dramatically improve efficiency and drive business value
- Enhancing quality focus and customer orientation.

Industry Structure

Industry Structure

Heavy Engg still dominated by Public Sector Enterprises
Capital goods and consumer durables are the fastest growing segments

Although reforms have reduced licensing and regulation, heavy industry is still dominated by public-sector enterprises. State-owned companies have accounted for the bulk of activity in steel, non-ferrous metals (virtually 100% for copper, lead and zinc, and about 50% for aluminium), shipbuilding, engineering, chemicals and paper. The government had pledged to reduce its holdings in non-strategic public-sector undertakings to a maximum of 26%, and to close down non-viable enterprises.

Economic sectors: Manufacturing

Industrial production					
(fiscal years Apr-Mar; 1993/94=100; % change year on year)					
	2000/01	2001/02	2002/03	2003/04	2004/05a
Basic goods	3.9	2.6	4.9	5.4	5.5
Capital goods	1.8	-3.4	10.5	13.6	13.3
Intermediate goods	4.7	1.5	3.9	6.4	5.9
Consumer durables	14.5	11.5	-6.3	11.6	14.5
Consumer non-durables	5.8	4.1	12.0	5.8	10.6
All (index of industrial production)	5.0	2.7	5.9	7.0	8.2
a Preliminary.					
Source: Central Statistical Organisation (CSO)					

Profile of Key manufacturing sub-sectors

Automotive

The automotive industry's turnover stood at US$19.1bn in 2003-04 and has been one of the fastest-growing sectors in recent years. Rising income levels, continuing poor public transport systems, wider availability of car finance and the increase in the young population are the main drivers of growth. Total production of vehicles rose from 4.2 m units in 1998-99 to 7.3 m units in 2003-04. In volume terms, vehicle production is dominated by two-wheelers, which accounted for 5.6 m units of total production in 2003-04.

The production of passenger cars stood at 842,000 units in 2003-04, followed by three-wheelers (340,000), commercial vehicles (275,000) and multi-purpose vehicles (146,000). Most local production is sold domestically, but rising quality has contributed to a surge in vehicle exports, which registered growth rates of over 50% in 2002-03 and 2003-04.

Steel

India produced 31.8m tonnes of crude steel in 2004-05, making it one of the ten largest steel producers in the world. A variety of grades are produced and the quality is at par with producers such as South Korea and the US. Increased demand from China as well as strong domestic demand, particularly by consumer-durables and automotive manufacturers and the construction sector are the key drivers of production growth. Around 40% of output is produced in integrated steel plants; the remaining comes from mini-plants, of which over 180 exist, almost all in the private sector.

Light Engineering

The size of Indian Light Engineering industry is estimated at US $ 7 billion. In India, the light engineering industry has a diverse industrial base with significant unorganized market. It is estimated that light engineering sector contributes to 8-10% of total exports of the country and its exports were US $3 billion in 2002-03. The exports from the light engineering industry in India mainly consists of structured steel products; motorcycles, cycles and auto components; electrical, electronics, telecommunication and automation equipments; hand and machine tools; fans, filters and pumps; and metal machine tool parts.

The Light Engineering Industry is a diverse industry with a number of distinctive sectors and sub sectors. This sector includes low-tech items like castings, forgings and fasteners to the highly sophisticated micro-processor based process control equipment and diagnostic medical instruments. This group also includes industries like bearings, steel pipes and tubes etc. The products covered under the engineering industry are largely used as input to the capital goods industry.

Pharmaceuticals

The Indian Pharmaceutical Industry today is in the front rank of India's science-based industries with wide ranging capabilities in the complex field of drug manufacture and technology. A highly organized sector, the Indian Pharma Industry is estimated to be worth $ 4.5 billion, growing at about 8 to 9 percent annually.

The Indian Pharmaceutical sector is highly fragmented with more than 20,000 registered units. It has expanded drastically in the last two decades. The leading 250 pharmaceutical companies control 70% of the market with market leader holding nearly 7% of the market share.

Machine Tools

An industry, which has undergone a radical shift in its paradigm thinking, the Indian machine tool industry is now recognized as a provider of low-cost high quality lean manufacturing solutions. The industry resiliently supports all its users to enhance productivity as well as improve competitiveness, for the betterment of the end user. The Indian machine tool industry is approximately a US$ 500 million industry. There are 138 major companies manufacturing metal cutting, metal forming, conventional and automated machine tools.

The sector grew by 10 percent in 2002-03. Approximately 6 per cent of the production is exported. Exports include CNC lathes, vertical machining centres, grinding machines, etc. Major export destinations include USA, Germany, China, Italy, Mexico, Canada, UK and Brazil. Most manufacturers have their own in-house R&D and there exists tremendous scope for institutional collaboration for development of new technology.

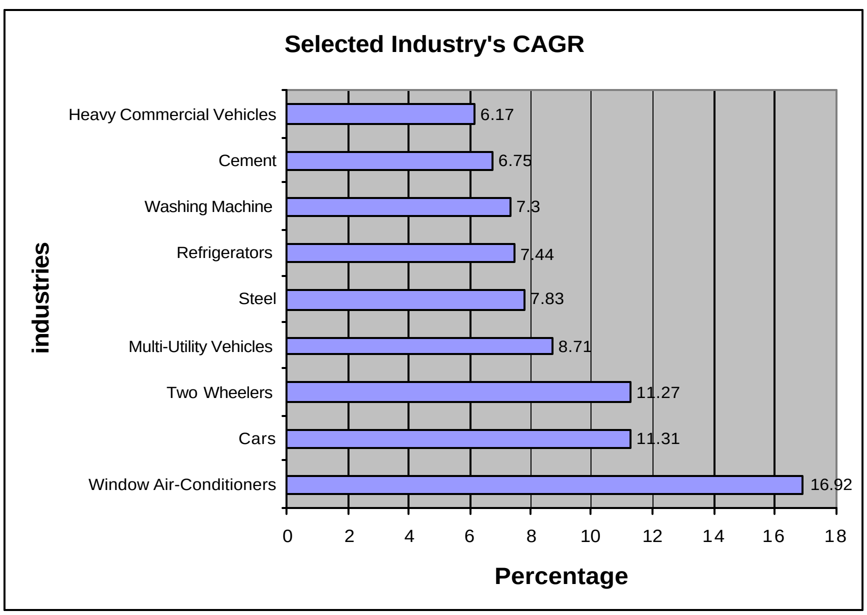
Textiles

Textiles account for around one-fifth of total export earnings. Because the government discriminated for decades against integrated textile mills, with the aim of helping cottage handlooms, most mills closed down. Mills currently produce only 4% of textiles output. Despite government assistance, the share of handlooms in total output is only 18%; the remaining is produced by power looms located in sheds outside the mills, which allow them to escape the restrictions.

Production in the textile industry is based on a decentralised system with continuing small-scale reservation for many items. The phasing out of the Agreement on Textiles and Clothing (ACT) at the beginning of 2005 is likely to benefit the Indian textile industry. The industry has a natural competitive advantage in terms of a strong and large multi-fibre base, abundant cheap skilled labour and presence across the entire value chain of the industry ranging from spinning and weaving to the final manufacture of garments.

Computer hardware

The rapid growth of software exports has attracted thousands of people into the industry and has stimulated the demand for computers. Sales of personal computers rose by 20% in 2004-05, to 3.6m. Import liberalisation and the entry of foreign manufacturers has transformed this industry, which, until five years ago, was tiny and dominated by a few Indian manufacturers. The ease of importing components has nurtured hundreds of unbranded assemblers, which command 62% of the market.



Section 2
Manufacturing Technology Status

Manufacturing Technology Status

Technology development is critical to a country's efforts in improving productivity, efficiency and competitiveness of its industrial sector. Factor cost advantages are being replaced by technology-related factors such as zero-defect product quality and international certification of firms' quality assurance systems (e.g., ISO 9000) in determining international competitiveness. Central to maintaining competitiveness is the ability of producers to respond quickly and effectively to the changing demands of the international market.

Sectoral Technology capabilities

Basic Level: Food Processing, Metal forming and forging, machine tools, chemicals
Intermediate: Steel, Pharmaceuticals,, Automotive, Petrochemicals
Advanced: Auto components, Telecommunications

Technological capabilities can be best described in terms of three levels: the basic level involves the ability to operate and maintain a new production plant based on imported technology, the intermediate level consists of the ability to duplicate and adapt the design for an imported plant and technique elsewhere in the country or abroad, while an advanced level involves a capability to undertake new designs and to develop new production systems and components.

Indian firms present a full spectrum of technological capabilities - while there are few firms close to the international frontier in terms of product design capability and process technology, technological capabilities of most players are extremely limited due to growing technological obsolescence, inferior quality, limited range and high costs. This adversely affects the ability of the organizations to respond to the challenges, not only of increasing international competition from other low-wage countries like China, but also from trade liberalization within the context of WTO.

Most Indian manufacturing firms appear to be stuck at the basic or intermediate level of technological capabilities. Though Indian manufacturing industry has mastered standard techniques it has remained dependent for highly expensive and complicated technologies.

Sector	*Technology Capability Level*
Food Processing	Basic
Metal forming and forging	Basic
Steel	Intermediate
Machine Tools	Basic
Pharmaceuticals	Intermediate
Chemicals	Basic
Electrical and Electronics	Basic
Automotive	Intermediate
Auto Components	Advanced
IT	Advanced
Telecommunication	Advanced
Petrochemicals	Intermediate
Light Engineering	Basic

Factors in Technological Competitiveness

The technology competitiveness of a country is determined by a combination of policy factors and industry specific factors. This section outlines the factors and their status In Indian context.

Policy Factors

Import Substitution

Positive Factors

High quality manpower
Good science and technology infrastructure
Superior technical educaton

The import strategy of the Indian government, which fostered the development of a wide range of industries, also facilitated the unpackaging of technology imports, and hence helped absorption and accumulation of technological learning. Though India achieved self-reliance in technologies for local production and consumption owing to the policy of import-substitution and self-reliance, it could not build capacity to create internationally competitive technologies to produce for international markets. As a result, export competitiveness capabilities could not be acquired.

Human Resource Development and Technology Infrastructure

The expansion of infrastructure for technical and higher education under the Scientific Policy Resolution, 1958 has ensured an adequate supply of qualified technical personnel and high degree of self-reliance – facilitating quick replacement of foreign personnel and absorption of imported technology. Although Indian organizations are served by a network of national laboratories and institutional infrastructure, these institutions generally fall short of quality when compared to those in industrialized countries – putting India at a comparative disadvantage. The role of national laboratories in designing and innovations varies from industry to industry. The main determinants of success of national R&D institutes appear to be the nature and extent of laboratory-industry interaction, the extent of market orientation of products and accessibility. Since most of the R&D effort is limited to specialized institutes, rather than in-house, market orientation is a weak link.

Some key R&D institutes and testing facilities directly related to manufacturing industry are:

- Central Manufacturing Technology Institute (CMTI)
- Council of Scientific & Industrial Research (CSIR)
- Central Mechanical Engineering Research Institute (CMERI)
- Central Power Research Institute (CPRI)
- Indian Institute of Petroleum (IIP)
- National Institute of Foundry & Forge Technology (NIFFT)
- Bureau of Indian Standards (BIS)
- In-house R&D units of large enterprises

The range of activities of these institutes includes education/training (both academic and practical), research and development (academic, practical, product, process and input material related), provision of information services, and provision of services like testing & inspection etc. Although the range of activities undertaken by these institutes is quite wide, resource constraints with respect to budget, staffing and equipment limit their effectiveness in both quantitative and qualitative terms. Some of them are located in areas away from the industrialized zones like Mumbai, Delhi etc.

Apart from R&D institutes, a number of engineering colleges - Regional Engineering Colleges (RECs) and Indian Institute of Technology (IITs) – provide a steady stream of engineering graduates, while the Bureau of Indian Standards (BIS) is responsible for activities related to the development, promulgation and maintenance of industrial and other standards.

The culture of collaborative research involving different institutes has not been promoted in past and the limited resources are not pooled through networking to develop core technologies in sectors where Indian industry has potential. Another vital link missing is the isolation of universities from

R&D. While universities are the major research centres in almost all developed countries, especially Germany, Taiwan and Korea, in India they are isolated from scientific research and advancements. This is largely because government funding of the research institutes does not goad them to seek funding from industry and industry associations through fees and royalties charged for work performed. This results in low commercial orientation. This has also affected the quality of higher scientific education, which is becoming increasingly irrelevant over the years.

Direct intervention

Public sector enterprises - i.e. HMT, EIL, BHEL etc. – initially emerged to be the nuclei for technological development. Public sector industrial enterprises, because of the relatively large scale of their operations, were able to finance and coordinate the requisite level of technological activity – thereby overcoming high entry barriers for innovation.

Standardization of unit sizes

Negative Factors

Poor industry-academia linkages
Amongst the lowest R&D investment in the world as per cent of GDP
Small scale of organizations
Brain Drain
Industry's preference for tried and tested technologies – focussing on import

For process industries, the choice of unit size has an important bearing on the development of local technological capability. Standardization of unit sizes by the government in the case of power equipment, petroleum refining, and fertilizers has helped rapid absorption and mastery of technologies because it has made possible the frequent replication of similar plants.

Structural and Industry-specific factors

Technological maturity and pace of technological change

Technological self-reliance is achieved more easily in industries with relatively mature and stable technologies, such as the process industries, than in those undergoing rapid technological change.

Availability of Scientists & Engineers

High quality human resources, and rich stock pool of engineers and scientists is necessary for innovation. The availability of engineers and scientists determines the ability of a nation to develop competitiveness through differentiation. In terms of availability and quality of scientists and engineers, India scores very highly as seen in the table below.

WEF Rankings for Human Resources

Country	*Rank*
India	4
Germany	32
Japan	9
USA	8
China	59
Korea	35
Taiwan	15

Source: World Economic Forum Global Competitiveness Report 2001

However it is necessary to continuously upgrade the manpower skills in technical and techno-managerial dimensions. In a labour-surplus economy, new and efficient technologies tend to be discouraged unless sufficient redeployment opportunities are created. This results in a vicious cycle where new technologies are not introduced, the engineers and technicians continue to work inefficiently, and the technical manpower quality deteriorates with respect to the world.

Thus the advantage accruing from the rich pool of engineers has been frittered away by not continuously upgrading the talent pool. This has, in turn, resulted in the brain drain phenomenon leading to flight of talent to advanced countries where the opportunities to upgrade exist. India has been ranked low on the ability to retain its qualified manpower when compared with the reference group of countries. Therefore, Indian scientific and engineering talent pool is at the disposal of countries that create conditions conducive to the nurturing and advancement of this talent pool.

Technology Acquisition

Technology acquisition has traditionally been viewed as a source of techniques necessary for initiating production and hence was considered as substituting domestic R&D. In the absence of the inflows of new and advanced technologies, however, there has been little incentive, direction and capability to update the existing technologies. Technology continues to be sourced from other nations, but the firm-level technology absorption is low. This is in sharp contrast to firms in Taiwan and Korea, which absorb sourced technology and improve upon it.

WEF Rankings for Technology Resources

Country	*R&D Spending as % of GDP - Rank*	*Company spending on R&D*
India	31	42
Germany	7	4
Japan	3	2
USA	5	3
China	37	34
Korea	2	18
Taiwan	14	20

Source: World Economic Forum Global Competitiveness Report 2001

Expenditure on Research & Development by Capital Goods firms in the public and private sectors

	R&D units	R&D Expenditure(Rs million)			R&D Expenditure as % of Sales Turnover		
		1996-97	1997-98	1998-99	1996-97	1997-98	1998-99
Public sector	34	849.10	535.91	542.53	0.21	0.12	0.10
Private sector	223	2076.37	2602.59	2637.74	0.40	0.51	0.53

Source: Department of Science and Technology

The table shows that Capital Goods firms invest less than 1 percent of their sales turnover in research and development. Also the private sector firms invest marginally more than the public sector firms, which makes it look further worse, considering that the major machine tools firms are in the public sector. This could be due to lack of confidence in domestic technology. In the absence of the internationally competitive quality and standards in technology development, industry has created demand for foreign technologies that are tested abroad and are easily available.

Nature of international technologies markets

The nature of international markets, in respect of the seller concentration and the degree of vertical integration in an industry, affects national attempts to achieve technological self-reliance. The choice of the mode of technology import has been found to influence local technological capability building.

Product Technology

World Bank study (1990) on the Indian Capital Goods sector notes that the share of human resources devoted to design and engineering activity in Indian Capital Goods enterprises is low compared to other industrialized countries - roughly 20 to 50 per cent of what might be expected in comparable enterprises in those countries.

Sound product design and engineering work could have greater impact on ultimate product cost, value and quality than comparable efforts undertaken further down the manufacturing chain. In the firms that were sampled during the World Bank survey, there was evidence that greater engineering resources are devoted to downstream manufacturing activities than upstream conceptual design activities.

Process Technology

India has the technical ability to achieve a high level of precision, yet Indian firms are unable to produce quality products due to lack of supporting technologies, such as precision measuring, material engineering and process control. The defect rates of final products are many times 5-10 time than that of Japan and those of USA. In addition, about 20 per cent of the firms have equipment, which is more than 20 years old, and therefore obsolete. Most Indian firms are vertically integrated and rely far less on subcontracting arrangements, although such trend is beginning to emerge.

Summary

The competing imports of products, increasingly allowed on quality and cost considerations, have led to a greater consciousness of quality and costs on the part of domestic manufacturers. The more liberalized technology import policy is also helping to bridge the technology gap. All these factors are putting pressures on the organizations to develop best-practice technology, either by importing or by generating their own.

Few solitary achievements notwithstanding, there is clear evidence that technological dynamism has not taken firm root in the Indian industry. In sum, the disjointed policies in India with lack of focus have resulted in a weak innovation system and under-utilisation of research capabilities created during the first phase of growth. Thus, the overall problem relates to the lack of appropriate linkages between different actors of the national innovation system.

India needs to address constraints on technology development as an important part of its overall strategy for improving manufacturing sector competitiveness. The role of government in enhancing technological competitiveness is critical to make this happen.

India: Global R&D Hub

Global R&D Hub

Utilizing low cost high quality technical manpower

Over 100 MNCs have set up their research centers

The Indian government has put in significant effort in last 50 years to develop the scientific and technical infrastructure of the country. With more than 250 universities, 1,500 research institutions and 10,428 higher-education institutes, India churns out 200,000 engineering graduates and another 300,000 technically trained graduates every year. Besides, another 2 million other graduates qualify out in India annually. The combination of state-of-the-art infrastructure and highly qualified manpower ensures that India is poised to be the next Global R&D hub.

This is increasingly being observed in Industry as large MNCs including GE, Microsoft, Bell Labs etc have opened there R&D Centers in India – a first outside US for most of these companies. The cost arbitrage provides immediate incentives for corporations to source high quality research output from India. It must be noted that this research is not just restricted to IT industry. Some examples:

- Jack Welch Research Center in Bangalore is conducting research for GE Medical Systems. It is the company's largest research outfit outside the United States. The center also devotes 20 percent of its resources on five-to-10-year fundamental research in areas such as nanotechnology, hydrogen energy, photonics, and advanced propulsion
- National Chemical Laboratory Pune has transformed itself into a contract research agency where more than 50% of its revenues come from conducting contract research for International clients
- P&G comes to India scouting for innovations
- 20 percent of the world's largest passive component manufacturer Tyco Corp's high-precision tooling is done by its Strategic Tool Shop in India
- Eli Lilly's research facility in Delhi is its largest in Asia, and the third-largest in the world

More than 100 multinational companies (MNCs), including Delphi, Eli Lilly, Hewlett-Packard, Heinz, Honeywell and Daimler Chrysler, have set up (R&D) facilities in India in the past five years. For some, such as the US$12.6 billion Akzo Nobel's car-refinishes business, the center came even before the company began selling its products in India.

This makes India second only to USA and ahead of other more established hubs, such as Japan, Israel and Western Europe, and, for that matter, China. India may be behind China in manufacturing, but it has taken an early lead in attracting R&D investments. According to a survey by Tokyo's National Science Foundation, only 33 of the BusinessWeek 1,000 companies have their R&D centers in China. Although India is not yet near the big league in the United States, it is certainly emerging as a serious contender as a base for new offshore R&D centers.

IICT, Toyota Arm Team Up For Nanotech R&D

Aisin Cosmos, a subsidiary of Japanese auto major Toyota Automobiles , has entered into a joint venture with the Indian Institute of Chemical Technology (IICT) to undertake joint research in the area of nanomaterials for the automotive sector. It includes manufacture of auto spare parts using nanomaterials which reduce pollution besides increasing the quality and the life of automobiles.

A Centre for Nanoscience and Technology will be set up at IICT premises. The project will receive funding of $200,000 from Toyota Automobiles and will initially be for a period of two years. This long-term project on nanomaterials is the first of its kind in the country. It is primarily aimed at collaborating research activities in the areas of nanomaterials for the automotive sector. The research efforts will provide novel industrial standards for the auto segment thereby assisting in reduced recycle effort and sustainable fabrication processes.

Using of nanomaterials in the automotive sector will pave way for development of eco-friendly machines, light stiff chassis, windows, easy-to-clean materials both interior and exterior, among other automobile accessories.

Global Comparison

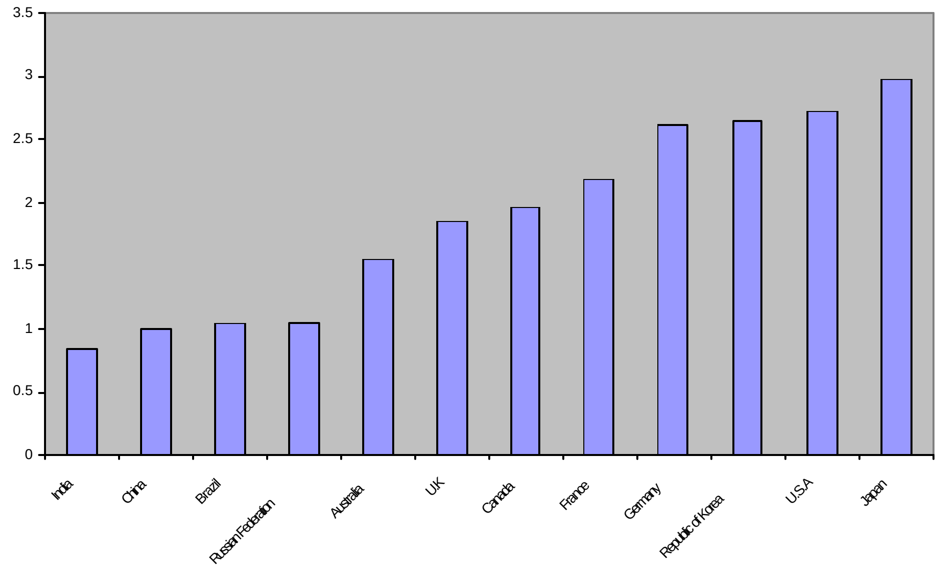
Global comparison

Total spend on R&D is 0.8% of GNP well below 2-3% spend of developed countries

Lowest among the key competing nations like China and Brazil

Private sector spending on R&D less that 1% of sales turnover

India has been spending 0.8% of its GDP in R&D which is much less than 2-3% range amongmost of the developed countries. Even China and Brazil spend more than India on R&D. This is reflected in the relatively poor rankings on innovation in the global competitive index



Technology Ranking	*Availability of scientists*	*R&D Spending as % of GDP - Rank*	*Company spending on R&D*
63	4	31	42

Section 3
Technology Development Initiatives

Technology Development Initiatives

R&D Set Up

250 Public Research Institutions
264 Universities
1500 private sector R&D establishments

Research Agencies

India has a network of scientific and academic institutions engaged in wide spectrum of research. Scientific research is carried out in about 250 research laboratories and institutions. A large part of these belong to scientific ministries. A few research organizations under non-scientific ministries and their public sector industries essentially carry out research programs of relevance to the respective ministries. There are more than 1,500 private industries with R&D establishments and a similar number of state-owned research centers.

In addition, there are 264 universities, deemed universities and institutes of technology, where basic scientific research is conducted in new and emerging areas through external and internal support. Most of the research in the academic sector receives funding support from various scientific agencies of the government, namely, Department of Space, Department of Atomic Energy, Department of Science & Technology, Department of Biotechnology, University Grants Commission, and others. In recent years, several non-scientific ministries have also come forward to fund R&D in the project mode with the participation of public and private industry as well as of academic institutions. This has given a new synergy in the promotion of technology in areas of concern.

Funding for R&D

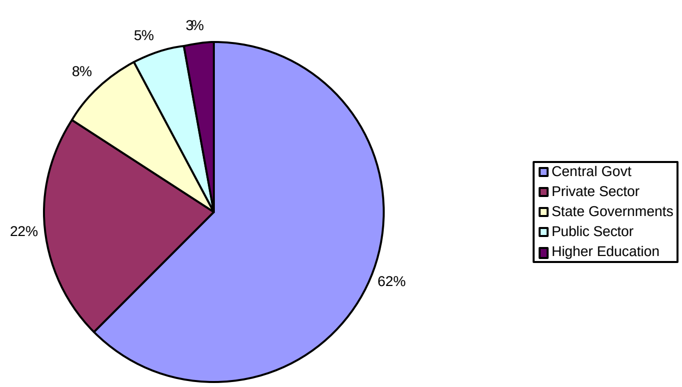
R&D Expense: USD 2.8 Billion

Government: 70%
Private Sector: 22%

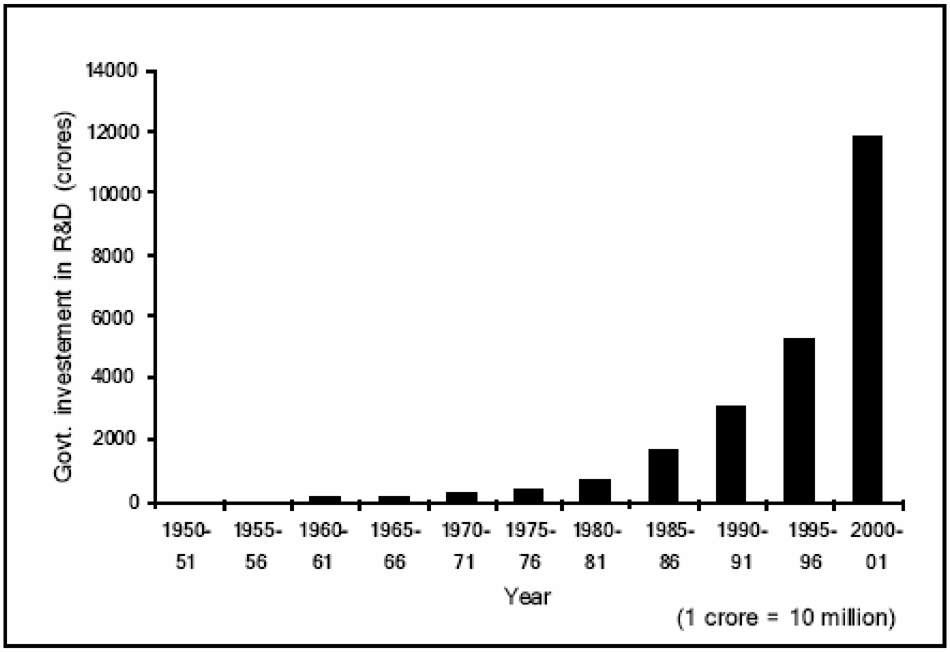
The Government of India allocates a budget for scientific and technological (S&T) activity under an R&D fund. The allocation has increased from USD 18 Million in 1950-51 to USD 2800 Million in 2000-01. In comparison, the share of industry in R&D has become of the order of $547 million, about 20 per cent of the government's contribution. The percentage share of major scientific agencies in total S&T expenditure is approximately 70 per cent.

In the total S&T expenditure by the government, the share of non-scientific ministries has been approximately 30 per cent combined for all sectors, including agriculture, rural development, energy, industry and minerals, transport, communication and others. The total expenditure on R&D, including from industry, is about 0.8 per cent of GNP for the past several years. Compared to most advanced countries, which spent between 4 and 6 per cent on R&D, this proportion is quite low

National Expenditure on Research and Development-1998-99



Fugure 1: The increasing fund allocation for R&D by the government



Policies and targets

The Government has facilitated S&T infrastructural development in the country through a policy framework. A Science Policy Resolution (SPR) was adopted on 4 March 1958.The resolution aimed to secure benefits from the acquisition of scientific knowledge and its application. It emphasized training of scientific and technical personal to fulfill needs in the fields of science and education, agriculture, industry and defense as well as to ensure an adequate supply of scientists and to recognize their work. In January 1983, the government announced the Technology Policy Statement (TPS), with the objective of attaining technological competence and self-reliance, providing gainful employment, modernizing equipment and technology, conserving energy and ensuring harmony with the environment.

New Science and Technology Policy adopted in 2003

Focus on providing soft loans for R&D
Building better networks and industry-academia linkages
Management of IP given due importance

In 2003, a new Science and Technology Policy was adopted with emphasis on:

- Optimal Utilization of Existing Infrastructure and Competence
- Strengthening of the Infrastructure for Science and Technology in Academic Institutions
- New Funding Mechanisms for Basic Research
- Human Resource Development
- Technology Development, Transfer and Diffusion
- Promotion of Innovation
- Achieve synergy between industry and scientific research
- Generation and management of Intellectual Property
- International Science and Technology Cooperation

Key Institutional Mechanisms

Department of Science and Technology

DST as a scientific agency was established on 3 M ay 1971 and was entrusted with the promotion and coordination of S&T activities throughout the country. It is the nodal agency that coordinates between the academic institutions and industry to promote technological developments. DST runs a number of schem es to provide soft loans at various stages of technology development.

Department of Scientific and Industrial Research

The DSIR has been providing project based support to industries under the Programme Aimed at Technological Self Reliance (PATSER) for the development and demonstration of indigenous technologies. Thirty-five technology development and demonstration projects were completed. These resulted in the commercialisation of products and processes and led to the filing of 20 patents.

Council for Scientific and Industrial Research

As the national R&D organisation, CSIR provides through its 40 laboratories and 80 field centres, scientific and industrial R&D for India's technological development and for meeting its strategic and defense needs.

Technology Development Board

Technology Development Board (TDB) was set up by Government of India on 1st September 1996 and the operation of fund was assigned to Department of Science & Technology, Government of India. The Board provides financial assistance in the form of equity, soft loans or grants. TDBÕs participation in a project generally does not exceed 50 per cent of the project cost. The projects funded by the Board include sectors such as medicine and

Science and Technology Entrepreneurship Parks

The major objectives of STEPs are to forge linkages among academic and R&D institutions and industry, to promote entrepreneurship among Science and Technology persons, to provide R&D support to the small-scale industry and to promote innovation based enterprises.

Key Technology Development Institutions

- Department of Science and Technology
- Department of Scientific and Industrial Research
- Council of Scientific and Industrial Research
- Indian Institutes of Technology
- Indian Institute of Science

National Innovation Foundation

The Government of India started National Innovation Foundation (NIF) in March, 2000 by providing a corpus fund of Rs 200 million. NIF is an autonomous body under the Department of Science and Technology, Government of India. NIF is developing a National Register of Green Grassroots Technological Innovations and Traditional Knowledge. It also seeks to develop a new model of poverty alleviation and employment generation by helping convert grassroots innovations into enterprises.

Technology Business Incubators (TBIs)

Department of Science & Technology (DST), Government of India initiated this scheme during 2000-2001. Under the scheme, grants-in-aid is provided by the Department, both on capital and recurring for a stipulated period. Presently, TBIs are being implemented at 12 locations in various academic institutes.

New Millennium India Technology Leadership Initiative (NMITLI)

The Government of India has recognized the power of innovation and had launched a new initiative during 2000 to enable Indian industry to attain a global leadership position in a few selected niche areas by leveraging innovation-centric scientific and technological developments in different disciplines.

In a very short span, NMITLI has crafted more than 25 path setting technology projects involving over 50 industry partners and 150 R&D institutions with an estimated outlay of Rs.1,600 million. These projects are setting new global technological paradigms in the areas such as nano material catalysts, industrial chemicals, gene-based new targets for advanced drug delivery systems, bio-technology, bio-informatics, low cost office computers, improved liquid crystal devices and so on.

The scheme is being implemented by Council of Scientific & Industrial Research (CSIR).

Conclusion

The research and development activities in India have been primarily government driven and private sectors have traditionally made little investment in R&D. India has achieved great success in developing and educating a significant chunk of human resources. The technical capabilities of these resources are well and truly recognized the world over. However, there have been institutional gaps leading to poor industry-academia interaction. The outcome has been low practical orientation of Indian research and lack of technology inputs to industry.

India has taken initial steps in rectifying this situation by redefining its Science and Technology policy, increasing the spend on R&D, establishment of mission mode projects and enforcing interactions between research institutions and industry. However, it still has a long way to go in catching up with the developed world and investing 2-3% of GNP in R&D, protecting Intellectual Property and establishing product innovation culture.

Section 4
Sector Profiles

Food Processing

Key Facts

Amongst world's largest producers of food
Over 40000 food processing units – mostly small
25% of produce is wasted due to lack of processing, storage and transportation facilities

India is amongst the world's largest producers of food, producing over 600 million tons of food products. India ranks first in the world in production of cereals and milk (91 million tons). It is the second largest fruit and vegetable producer (150 million tons) and is among the top five producers of rice, wheat, groundnuts, tea, coffee, tobacco, spices, sugar and oilseeds (210 million tons). India also ranks among the top few in terms of fish and egg production.

The Indian food processing industry is a high priority sector and is estimated to grow at 9-12%. Agricultural production and food processing accounts for 22% of India's GDP and employs more than 70% of its workforce. India's total food market is estimated at USD 70 billion, of which USD 22 billion is the share of the value- added food products.

There are an estimated 40,000 food processing units in India. However these units are able to process only a small percentage of production. According to the Indian Ministry of Food Processing, processing levels are a mere 2 percent in fruits and vegetables, 4 percent in fish and 2 percent in meat and poultry. The unorganized sector and small players process more than 70 percent of the industry output in volume terms and 50 percent in value terms.

It is estimated that the industry loses more than 25 percent of its produce due to poor post-harvesting equipment, inadequate food processing technology and storage facilities. The Indian government's move to put in place a policy for the food-processing sector is a step in the right direction.

The food-processing sector is being rapidly transformed into a high-volume, high value industry. According to a recent study, nearly 200 million people will move from subsistence foods like cereal and pulses to basic products that demand more processing like package dough and packaged homogenized milk. This will offer new opportunities in the high-growth, mass-based and high-volume markets such as the processed milk industry (USD 10 Billion), the poultry industry (USD 7.5 Billion), the packaged dough (USD 4 Billion) and the bakery products sector (USD 3 Billion).

Growth Indicators

Target to have 2% of global food trade
Increase the level of food processing from 2% to 25% by 2025

In a bid to double India's share of the rapidly growing global food trade to 2 percent by 2015, the Indian government has initiated steps to formulate a comprehensive food processing policy. The primary aim of the policy is to tap the huge potential arising from India's enormous production of vegetables, fruits, food grain, milk, fish and poultry. Efforts would be made to curtail wastage of food products and take corrective action to fill infrastructure bottlenecks that hinder post-production segments like storage, transportation, handling and processing. Emphasis will be on production of better grades of raw material and establishment of an efficient cold chain that will minimize wastage. The national policy aims to increase the level of food processing from the present 2% to 10% by 2010 and 25% by 2025.

The food processing industry in India is segmented into food grain/ pulse milling, fruit/ vegetable processing, milk and milk products, beverages, fish, poultry products, meat and meat products, aerated water/ soft drinks, beer/ alcoholic beverages, breakfast cereals, bread, biscuits, confectioneries, malt protein and edible oils / fats.

- India is the largest producer of milk in the world with an estimated production of 91mn tons in the year 2002-03. Milk and milk products account for a significant 17% of India's total expenditure on food and the popular milk products are cheese, butter, ghee, dairy whiteners and ice-creams.

- The Indian snack food market comprising bakery products, ready to eat mixes, curries, chips, namkeens and other processed foods is large, diverse and dominated by the unorganized sector.

The total size of the Indian snack food market is at an estimated over 400,000 tons in volume terms and Rs100bn in value terms and is growing at over 10% for the last three years (2000-2003). The three largest consumed categories of packaged foods are packed tea, biscuits and soft drinks

India is…

Largest producer of milk
Second largest producer of fruits and vegetables

- India is the second largest producer of fruits and vegetables. Its processing level is estimated to be around 2%, as compared to about 80% in Malaysia, 30% in Thailand, and 60-70% in the UK and USA. A strong and dynamic food processing industry is important for diversification and commercialization of agriculture. It ensures value addition to the agricultural products, generates employment, enhances income of farmers and creates surplus for export of agro foods.

- Marine products export was the single largest constituent of the total exports of processed foods contributing over 40% of total processed food exports.

Export Trend in Food Industry

Rs Crores ($1 - Rs 45)	2001-2002	2002-03	2003-04
Floriculture & Seeds	180	267	303
Fruits and Vegetables	1101	1207	1126
Animal Products	1500	1800	2025
Other Processed Foods	6880	9915	9402
Non-scheduled products	3289	3914	4782
	10170	***13829***	***14184***

Estimated Food Processing equipment demand

Million USD	2002	2003	2004
Import Market	79	91	106
Local Production	1471	1691	1971
Exports	37	43	49
Total Market	1587	1825	2126

Usage of new technologies including IT

Disintermediation
Effiiciency and productivity enhancements

Technology Enabled Emerging Success Stories In the Food Sector

Areas of success	Illustration
Improved information transparency and price realization through disinter mediation of the chain.	ITC's e – choupal uses an innovative technology enabled solution to directly procure wheat, Soya, etc from farmers. Cooperative such as NDDB, HOPCOMS and mahagrapes have integrated the chain and improved farm –gate prices.
Lower procurement costs and better quality through contract farming arrangements	Poultry industry in south India has franchise farming arrangements – farmer is provided feed DOCs, vaccination, assured off-take and fixed rates for growing poultry. Successful integrators have decreased cost by almost 40%.

Technology Status

R&D Expense:
USD 2.8 Billion

Government: 70%
Private Sector: 22%

India processes only 2% of its agriculture output. Over 70% of this is processed primarily through unorganized sector. Therefore the adoption and usage of technologies in the areas of food safety, preservation, transportation, processing and handling is quite low. Following are the important market features that determine the types of technologies and processing equipments required by India:

- The technologies for food processing in India are not at par with the global standards. This is despite having the capability of design, development and construction of process plant machinery matching international standards.
- There are many units producing jam, jelly, pickles marketed locally. These units are in the tiny and cottage sector and do not adhere to F.P.O quality standards. Also, they are reluctant to adopt new capital intensive technologies.
- There is a lack of in-house quality control and testing facilities in conformity with the international standards. This is proving to be critical bottleneck in exports of products as non-tariff barriers lead to stringent food import norms in developed countries.
- Poor infrastructure facilities such as irregular power supply, high inland transportation cost and lack of cold chain facilities etc.
- There is lack of adequate storage facilities and adequate infrastructure to facilitate the transportation and marketing of processed food products. This continues to impede the development of large scale processing in India.

Food processing is a high priority sector and several technologies are being developed. Some of the technological trends in agro/food processing sector in India include:

- ***Food extrusion Technology:*** The technology has been fully absorbed and adapted to suit Indian conditions. The technology is used especially in case of meat products

- ***Cold Chain Technology:*** The task of cold chain is to minimize damages to raw materials from farm to factory. India is now beginning to build the necessary cold chain infrastructure. The metro cities in India already have a well-connected cold chain. However, cost effective technologies are still required to grow food processing sector.

- ***Food preservation technologies:*** The increasing demand for high quality processed foods is driving industrial houses to adopt novel preservation techniques. These are aimed at increasing the shelf life of products and also at preserving the nutritional value of foods up to the point of consumption. The emerging food preservation technologies include Hurdle preservation, Ohmic heating, Ultra high pressure processing, Irradiation, modified atmosphere packaging and high – intensity pulsed electric fields, anti-microbial enzymes and active packaging. In addition to these technologies, research in non-thermal food preservation processes is being pursued in many university and industry R&D laboratories.

Technology Gaps

India would need food processing technologies and equipment in the following areas: processed meat, especially poultry, soft/fruit drinks, ready-to-eat/serve snacks, value-added dairy products, specialty processing equipment for bakery and confectionery items, and thermo-processing. New and used slaughter line equipment, dairy equipment, sausage casing/sausage making equipment, meat tenderizing equipment, pizza making machines, mixing tanks, and snack food making machinery are some major items in demand in India.

Technology Gaps

Food Processing Equipment
Cold Chain
Preservation
Packaging

Other kinds of food processing equipment/technology that have promising prospects in India include: technologies for extension of shelf life for foods especially made out of milk, fruits and vegetables and cereals; small capacity slicing and cutting machines for fruits and vegetables and meat products; de-shelling, de-husking machines to speed-up the process with oilseeds to reduce contamination due to microbial growth; processing equipment/technologies for honey; biosensors for food processing industry; and fruits and vegetable driers with uniform drying temperature. Industrial bakery and cooking and heating equipment also offers promising prospects.

Food-processing machinery for meat, poultry, and seafood is the fastest growing segment and demand will continue to increase. The cold–chain sector in India also offers promising prospects. In spite of India being the second largest producer of food in the world, the facilities required for food storage and refrigerated transportation infrastructure are grossly inadequate. Indian industry continues to seek out foreign technology and equipment suppliers. Estimated sales revenue for 2003-2004 for cold storages excluding insulated panels is $28.40 million; coolers is $112 million; freezers is $26 million; transport refrigeration $9.09 million; and industrial refrigeration $42 million. (Source: http://www.ramaindia.org/)

The Indian market for food processing machinery has been growing steadily with domestic demand for food and beverage products growing significantly in the last few years. This pattern is likely to continue as more food processing units are commissioned in India. The most promising areas of growth are fruit and vegetable processing, meat, poultry, dairy and seafood. In addition, the ready-to-eat/serve snacks and convenience foods segment, which is growing at a steady rate of 20 percent, also offers good potential.

The total Indian market for food processing equipment is estimated to increase to $2 billion in 2005. The total market is expected to continue to grow at an average annual growth rate of 15 to 18 percent over the next two years. Imports currently account for less than five percent of the total food-processing equipment market. Imported state-of-the-art equipment is much more expensive than locally available products but offer significant benefits in terms of yield recovery, lower maintenance and better quality output. Currently, imports from the U.S. represent 30 percent of the total imports of food equipment into India. Other major suppliers include Germany, Sweden, Switzerland and France.

Technology Development Initiatives

The Ministry of Food Processing Industries is presently operating a scheme for technology upgrading and modernization of the processed food sector. Under this scheme, financial aid is provided at the rate of 25 per cent of the project cost in general areas and 33.33 per cent in difficult areas, subject to a maximum of about US$113,000 and US$169,500, respectively. The scheme covers fruits and vegetables, milk products, meat, poultry, fisheries, oilseeds and horticultural produce for value addition and prolonging their shelf-life.

The Small Industries Development Bank of India (SIDBI) launched a World Bank-led consortium of line of credit and technical assistance program for the food processing sector. The multilateral consortium for small and medium enterprise financing and development projects consists of US$100 million from the World Bank and €43.5 million from KfW in Germany, besides a component of £20 million from DFID and €5 million from GTZ for providing technical assistance. SMEs will be supported in technology upgradation under the scheme.

Technology Development Initiatives

Priority Sector Status
CFTRI has applied for 105 US patents in 2002-03
Agro-Industrial Parks being set-up across the country
For. E.g Icrisat

The Central Food Technological Research Institute (CFTRI), India, has applied for 122 Indian patents and 105 international patents during 2002-03. The patents filed cover broader areas of food processing such as convenience foods, vegetables and fruits processing, plantation products and spices, equipment designs, meat-, fish- and poultry-based products, bakery products, fats, lipids and protein enriched foods, health and functional foods, and biotechnology products (enzymes). The institute's present patent portfolio has crossed 450 active patents.

The Ministry of Food Processing in India recently announced a new Food Park scheme as one of several measures to avoid wastage in the food processing industry. Each of the proposed park, with a basic grant of about US$725,000, would have a minimum of 20 food and processing units. New small and medium enterprises, which find it difficult to make capital investment, can make use of the facilities in the food park. Even the food packaging industry can avail itself of the scheme or function independently, but use the 25 per cent subsidy. Well-built infrastructure for vegetables and fruits, cold storage for milk processing, fish and meat products, and warehousing for rice and flour mills are some features of the Food Park scheme. Twenty such parks have already been identified.

World Class Agro-Industrial Park

A Memorandum of Understanding (MoU) has been signed between the Federation of Indian Chambers of Commerce and Industry and Sistema Italia Export, an Italian consortium, for developing a world-class Agro-Industrial Park in India. Once developed, this park will become the focal point for the entry of the very best Italian food processing industries in joint venture with Indian partners. Planned and designed according to the latest and most advanced specifications, the park will create a unique and competitive environment to process India's high potential agricultural products targeting quality improvements, European Union food and safety norms and higher value addition through technology and know-how transfers, better food chain processes and linkages to effectively increase India's productivity and quality in both the local and international markets.

The Sistema Italia Hyper Food City-India is set to be ensconced as the food processing centre par excellence, paving the way for a substantial increase in high-quality product exports to the Asian, Middle-East and European markets. The park, spread over 1,200 acres, will have an investment of 900 million euros. The park facilities will include: individual product refrigeration centres, EU certification, quality control, chemical and veterinary laboratories; environmental and general services; in-house banking and insurance offices; and cereal and milk silos. About two million tonnes of food will transit through the park each year for processing. The park will cater to the agricultural production of nearly 400,000 small farmers linked and networked into its logistical and outreach services.

Source: www.pib.nic.in

Comparison with China

According to the Ministry of Science and Technology (MOST) China, about US$59.85 million has been invested in developing advanced technologies on food processing. MOST initiated 29 projects, which attracted 82 companies, research institutes and universities for R&D. During the 2001-04 period scientists and technologists invented 211 new agricultural species, materials and equipment. The research teams also applied for 120 patents, with 31 already being granted. Experts have achieved remarkable progress in membrane separation technology, sterile filling technology, normal temperature squeezing technology, concentration technology and freezing chain technology. Some well-received products such as refrigerant meat, protein separated from soya and condensed apple juice have also been developed.

The Chinese Ministry of Science and Technology has stated that major breakthroughs have been achieved in the food safety sector – key testing techniques, instruments and control system. The latest developments include 18 instruments for testing pesticides, veterinary drugs and toxins, and 25 assays for the quarantine examination of veterinary drugs, pesticides, toxins, food additives and feed additives. Kits for testing bird flu and Newcastle Diseases Virus (NDV) drastically reduce testing time, and find application in nine quarantine bureaus. The test kits have been used in over 20 export-oriented cattle and poultry farms.

In addition, the food safety project has rolled out 54 techniques for the quarantine examination of pesticides, veterinary drugs, food contamination and toxins. Of these, the dioxin testing technique and associated testing criteria have won international recognition. The project also developed multi-residue testing techniques to identify 180 pesticide elements in tea, rice and fruit juice. Furthermore, an import and export monitoring, pre-warning and risk analysis and control system has been developed. This is the first such system in the country and is based on statistical analysis and in-depth digging of a large quantity of food safety data collected from import and export. In an effort to accelerate technology integration and applications, 10 demonstration zones have been created.

Conclusion

The food processing sector is a high priority sector that is poised to grown significantly in the next 10-15 years. However, the technological capabilities and technology adoption in Indian organizations is very low. India would require extensive technology development and import initiatives to realise its goals of being a export powerhouse and improving efficiencies in food sector.

Machine Tools

Overview:

Key Facts

Size: USD 353 million
Growth: 47% (FY04)
Expected Growth: over 25% per annum in next 5 years
75% of machine tool manufacturers have ISO certification
Dominated by Hindustan Machine Tools (32%)

Machine Tool industry is the backbone of any economy. It is the mother industry of Capital Goods Sector which in turn determines the share of manufacturing in GDP of any country. The Indian machine tool industry's growth is directly linked to the growth of the manufacturing/ engineering industry. The Indian engineering industry, user of machine tools of all types, manufactures goods worth $32.6 billion. Due to India's rapid modernization, engineering industry is now focusing on green field projects as well as the upgrading of existing facilities.

Machine Tool Industry

USD Million	2002	2003	2004
Market Size	299	316	353
Local Production	139	127	142
Exports	10	12	14
Imports	170	201	225

Data Table: U.S. $millions
Exchange rate 1 U.S. $= 2002 - Rupees. 47.50; 2003 - 46.50; 2004 - 45.50

The primary users of machine tools are in the automotive, automobile and ancillaries, railways, defense, agriculture, steel, fertilizers, electrical, electronics, telecommunications, textile machinery, ball and roller bearings, industrial valves, power-driven pumps, multi-product engineering companies, earth moving machinery, compressors and consumer products industry sectors. After an economic slow-down in 2000-2003, many of these industry sectors have shown positive growth trends in the fiscal year 2003-2004.

The Indian machine tool industry manufactures a range of both conventional and computer numerically controlled (CNC) products such as metal cutting and metal forming tools. Indian firms also offer many special purpose machines, robotics and handling systems. The Indian Machine Tools Manufacturers' Association (IMTMA) believes that CNC will be the growth driver for the Indian machine tool industry in the future.

Approximately 75 percent of Indian machine tool producers have received ISO certification. Government of India-owned Hindustan Machine Tools Limited (HMT) is the single largest producer with a 32 percent market share.

Public Sector Enterprises like Hindustan Machine Tools Limited and Heavy Engineering Corporation (HMTP) Limited besides Mysore Kirloskar Limited played significant role in industrialization of India in the pre-liberalization era. In a period of 50 years, India also established more than 1000 companies in private sector to produce machine tools both in small sector as well as medium sector to meet the need of the manufacturing sector. However, Liberalization of Indian Economy in 1991 seriously impaired the performance of this sector because of various ailments of protected economy: high cost, obsolete technologies, fragmented size, low investments, poor R & D base etc. Today, the structure of the machine tool industry is rather skewed, 80% production coming from 25 companies and balance from over 300 fragmented small size companies.

Trends in Machine Tool Sector

- The average growth in 2004-05 over 2003-04 was an amazing 47%. The Units expect to out perform the market growth achieving 35% over the next 2 years (2005-06 & 06-07) and 25% in the three years to follow (07-08, 08-09 & 09-10).

- Units have made dramatic productivity gains from Rs. 2 million to Rs. 3 million per employee.

- Investments in the last three years averaged a paltry USD 400,000 (17 million Rupees) per annum, per unit. Whereas units have committed average investments of USD 1.2 Million (67 million Rupees) per annum, per unit in the next two years. This is a clear indicator of their confidence in sustainability of growth rates and a positive response to enhancing volumes.

- Average bought out content will remain at 60%, an indicator that part out sourcing and part in house manufacture of critical parts will continue to remain as the business model of machine tool units in the near term future.

- After languishing at less than USD 0.7 million per unit per annum, exports are set to exponentially grow to USD 2 million per Unit per annum. A sign of growing acceptance of Indian Machine Tools in the world markets.

- On a scale of 10, 'Made in India' brand equity has moved from a score of 3 in 1995 to a score of 6 in 2005. This is an indicator of growing convergence of Indian Machine Tool Industry in the Global World of Manufacturing.

World Machine Tool Industry and India

India machine Tool Industry is way behind Global majors in production, ranking 21^{st} in 2003. However, considering the growth prospects over the next 3 years and investments planned by the local industry, it could jump several notches to about 15^{th} position in this period.

1. Japan	7. Korea	13. Austria	19. Turkey
2. Germany	8. Switzerland	14. Netherlands	20. Belgium
3. Italy	9. Spain	15. Brazil	**21. India**
4. China	10. France	16. Finland	22. Russia
5. USA	11. Canada	17. Sweden	
6. Taiwan	12. UK	18. Check Rep.	

Source – American Machinist -USA

Technology Status

Technology Status

Basic Level of technology competence
Superior Design Skills
Poor technology in precision and control
Low technology absorption and enhancement of imported technologies

The technological competitiveness of the Indian Machine Tools sector is low. Indian machine tools firms present a full spectrum of technological capabilities - while there are few firms close to the international frontier in terms of product design capability and process technology, technological capabilities of most players are extremely limited. The advantage due to high availability of quality engineers and scientists is lost, partly due to brain drain and partly due to stagnation of skill sets of scientists and engineers within India. India has a number of high quality R&D institutions, but the industry–institute interactions are low, thereby reducing the chances of creation of commercially viable technologies. Machine tools sector has a comparative disadvantage with respect to both product and process technologies. In the case of the Indian machine tools manufacturers, the human resources devoted to design and engineering activity is about 20 to 50 per cent less than in other industrialized countries. Although Indian firms are capable of achieving high levels of precision, they are unable to produce high quality products due to lack of supporting process technologies such as precision measuring, material engineering and process control.

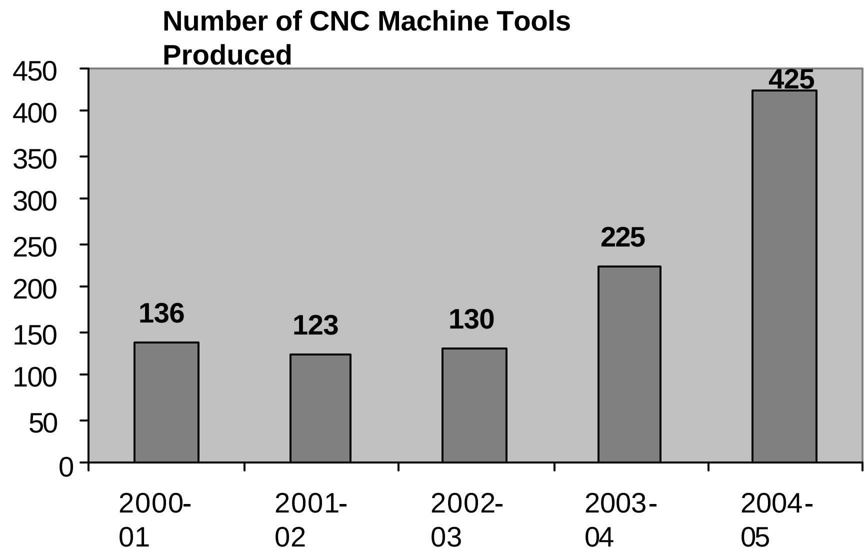
Firm level innovation is very low in India. Indian machine tools firms source technology, but very few of them improve upon it. The research spending as a percentage of sales amongst Indian firms is low when compared to the R&D spends of companies in Taiwan and Korea.

The major weaknesses are limited indigenous R&D capability and design innovation, low productivity, high capital investment requirement, process capabilities, finishing, safety features, costs, maintenance and operation, marketing and after sales service. Like the manufacturing sector in general, the machine tool industry also suffers from low volume production, high cost of finance and poor quality of power supply.

Technology Enhancements

The Indian machine tool industry has made efforts for upgradation in design and productivity of machine tools in the last few years. The industry upgraded a large number of older designs or machine tools and evolves new machine designs to adapt to the specific requirements of the user sectors. In view of the growing demand of user sectors for high productivity machines, the percentage of CNC machines in the metal cutting sector has significantly improved.

The number of CNC machine tools produced has increased more than threefold in just two years. This reflects increased acceptance of CNC Technology by user's especially small companies and greater price competitiveness of Indian CNC machine Tools. The most popular types of CNC machines produced are CNC lathes, Vertical and Horizontal Machining Canters, Wire Cut EDM, CNC External Grinders and Flexible CNC SPMs'.



Source: **IMTMA,**

Quality Move in Machine Tool Sector

Nearly 100 of the 400 organised sector companies are ISO 9000 certified. Many products (Over 50) are also 'CE' marked. Several machine tools are TPM Compliant (Total Productivity Maintenance), Indian machines now assure high CPK values, and some even guarantee uptime. Finish and Aesthetics have dramatically improved so also have fits and fittings, safety features and environment protection devices.

Technology Gaps

Technology Gaps

Specifications
Appearance
Precision
Reliability

There still remain technology gaps between Indian machines and machines from Germany or Japan who are world leaders. These gaps are broadly of the following types:

- **Specifications** – Rapid rates, tool change times, maximum spindle RPMS etc., are higher than those of Indian machines. This becomes clear if one compares specifications of Indian machines with those of the Japanese.

- **Appearance** – Though Indian machines have improved considerably over the years, they still lag behind those produced by countries such as Japan and Germany with respect to presentation details and appearance. This is because of the amount of attention that these countries pay to detail. Difference in appearance could be a combination of colour schemes, curvature and contours of the cladding, method of fastening the covers etc. These countries also pay attention to chip evacuation, providing slopes so that chips do not accumulate. A lot of industrial design inputs go into machine design.

- **Reliability** – Reliability is a part not reflected in appearance or presentation, but extremely important to a customer. Some Indian manufacturers score higher than imported machines on after sales service and spare parts supply. However, they are lower on specifications and uptime. Several imported machines have such negligible downtime that for the customer, Indian advantage is just not relevant. Indian manufacturers need to monitor MTBF (Mean Time Between Failures) and MTTR (Mean Time to Repair).

- **Technology** – Although Indian machine tool industry has succeeded to a significant extent in bridging technological gaps that existed vis-à-vis producers in advanced countries such as Japan, USA, Germany, significant gaps still exist in areas such as Turning Centres, Machining Centres and NC Grinders, and particularly in the area of Gear-Cutting machines. The following areas of technology development are still nascent in India:

  High speed Machining: Reduction of machining time by increase of cutting speeds. The basis of this is constituted by new machine concepts and the performance potential of cutting materials.

  Dry Machining /Minimum Quantity Lubrication: reduction or elimination of coolants in machining in order to reduce environmental and cost burdens.

  Hard Machining: cutting and specifically finish machining of hardened materials by means of a defined cutting edge (turning, milling, drilling boring)

  Complete Machining: Integration of various machining processes such as turing, milling gear cutting, grinding in a single machine to finish the work piece in one set –up.

  Micro processing: metal – cutting and non –metal – cutting processes for generation of miniaturized components, partially having geometric dimensions in the micron range.

  Linier Direct Drivers: new highly dynamic drive elements of simple construction for direct generation of linear movements.

  Rapid Prototyping: rapid realization of prototypes and preproduction series of new products for geometrical and functional testing.

  Internal high pressure forming: Generation of complex geometries from a single work piece by using high hydraulic pressure.

  Near Net Shape Forming: Generation of the final contour of a work piece as to shape, dimensional accuracy and surface quality, in a single forming process.

Technology Interventions

The industry has identified the following Key Factors of Success for making machine tool industry technically competitive. These are:

1. **Technology Up-gradation:**
   Current level of domestic taxation are not conducive to investments. In order to encourage investments, upgrade technologies and thereby competitiveness of manufacturing industry by following mechanisms:

   a. Establish "Manufacturing Technology Up-gradation Fund" which can provide finance at reduced interest rates on long term basis
   b. Credit Linked 20% capital subsidy to SSI for the purchase of CNC Machines (UK Model)
   c. Accelerated depreciation of equipments to encourage investments and continuously upgrade technology

2. **Manufacturing Infrastructure:**
   For managing ten fold growth, the machine tool industry has to invest heavily in the industry. At the same time investments will have to made in a manner that the manufacturing can remain competitive and meet global benchmarks of productivity.

   a. Encourage public private partnerships in establishing Machine Tool Parks at centers where machine tool manufacturing clusters are active. Bangalore Machine Tool Cluster meets 60% requirement of the country.

3. **Promote Research Design & Development:**
   All machine tool exporting countries have well established research institutions that develop new technologies & help industry to productionize these technologies like-Germany, France, Switzerland etc. Though Government of India established Central Machine Tool Institute in 1960, it has not been able to deliver its objective. The machine tool industry is starved of technology development in the country and it requires priority attention of the government.

   a. Revitalize activities of CMTI for development of Machine Tool Technologies for the benefit of Indian industries
   b. CMTI should have satellite centers at key locations where machine tool manufacturing SSIs are located to render service to them to improve their quality and technologies e.g. Ludhiana, Faridabad, Rajkot, Pune, Hyderabad etc.
   c. Encourage joint R & D projects resulting from Industry Institute interaction
   d. Government Laboratories to focus on developing technologies that have impact on manufacturing and machine tool technologies

4. **Availability of Qualified People:**
   The industry requires knowledge workers in the field and there is acute shortage of these people.

   a. Machine tool industry requires urgent focus on technology development. This requires post graduates and research scientists for designing new products as well as absorption of new technologies. More Engineering colleges need to be advised to offer graduate as well as post graduate courses in Machine Tool Engineering including mechatronics
   b. To meet the demand of expert workmen Government ITIs must produce workmen having basic knowledge of mechatronics - Diploma in Mechatronics needs to be introduced at institutions offering diploma in engineering.

Conclusion

The Indian machine tools industry has poor technology competence due to the inward looking economic policies and dominance of public sector organizations. While this helped India initially in attaining self-sustenance, it also led to adoption of obsolete technologies in the developed countries and limited efforts to absorb and improve the imported technology. This is in contrast to the experience of Japan and Korea which developed significant scale and technology competence. Today India's competence is primarily in design and tooling industry due to availability of low-cost skilled manpower. Significant gaps exist in CNC controls, precision bearings and sensors.

Pharmaceuticals

Overview

Key Facts

Revenue: USD 8.3 Billion
Growth Rate: 9.6% per annum
World Market Share: 8% by volume and 1% by value

Pharmaceutical sales in India grew at an average annual rate of 9.6% in 2000-04, faster than growth in GDP and real private consumption. The expected growth in 2005-09 is an average annual rate of 12%. As so many of India's healthcare requirements are being met by private expenditure, rising personal incomes should push pharmaceutical sales steadily higher. This is already being reflected in rising revenue for pharmaceutical companies.

Share of India's pharmaceutical industry in the world market is 8% by volume and 1% by value.

In the pharmaceutical sector, comparisons are now being drawn between India's increasingly successful drug companies—whose exports are growing rapidly—and its well-known information-technology (IT) companies. Indian firms such as Ranbaxy Laboratories and Dr Reddy's Laboratories, which derive more than 50% of their revenue from international sales, should grow steadily.

Exports have become a major growth area for Indian drug manufacturers. Domestic pharmaceutical companies have thrived by using their low labour and research costs to export generic drugs to developed-country markets, especially the US. Exports are likely to maintain strong growth during 2005-09 as US drugs worth around US$50bn in total are due to lose their patent protection by 2007. Opportunities in the developing world will also expand rapidly, following a 2003 World Trade Organisation (WTO) agreement that will improve poor countries' access to cheap patented medicines.

Market opportunities: Healthcare and pharmaceuticals

	2004	2005	2006	2007	2008	2009
Pharmaceutical sales (US$ m)	4,662	5,344	6,107	6,945	7,658	8,354
Sources: US Census Bureau; Economist Intelligence Unit.						

India has an estimated 24,000 drug manufacturers, accounting for nearly 3 percent of GDP. The industry is dominated by the private sector. The Indian pharmaceutical industry is expected to grow from $9 billion to $25 billion by 2010. Over 60 percent of India's bulk drug production is exported. Imports are generally limited to a small number of life-saving and newer drugs.

Technology Status

Technology Status

Historical R&D by reverse engineering – developed good process skills
Adoption of product patent regime has forced industry to acquire product development skills
Investments in R&D lower than global standards but growing at 32% per annum
Intermediate level of technology competence

The local production of copycat pharmaceuticals, patented in other countries, is widespread. Several multinational drug companies import bulk drugs from the parent company and process them for the local market. India is self-sufficient in terms of formulation technology, including those for sulpha drugs, vitamins, hormones and a number of new synthetic drugs. India is home to the largest number of pharmaceuticals plants (61) approved by the USFDA outside the U.S.

Indian pharmaceutical companies were confronted with a new legal regime starting in January 2005 that could significantly alter the competitive landscape. Under its WTO commitments, India has changed its patent regime to protect products as well as processes (these had been protected since 1970). The previous regime essentially allowed Indian companies to copy drugs patented in other countries and sell them in the Indian market, providing a firm growth foundation for Indian pharmaceutical companies. That advantage ceased in January; Indian drug companies can no longer sell drugs patented by other firms unless they are licensed to do so.

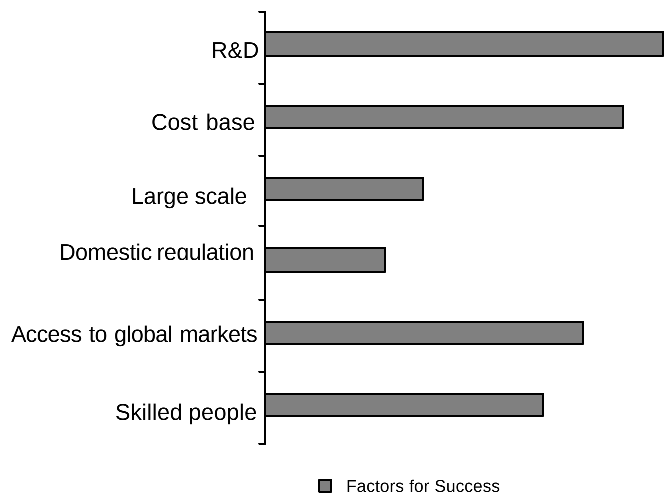
Driven by the change to a product patent regime and the opportunities offered in the international market, the mindset of Indian companies towards research has altered. Indian companies are shifting their focus to innovative research, that is, developing non-infringing processes, New Chemical Entities (NCEs), Novel Drug Delivery Systems (NDDS), Biopharmaceuticals etc. Thus Indian drug companies have started to invest more in research and development to produce their own patented formulations, or to affiliate themselves with large Western pharmaceutical companies and become outsourcing centres for some of those firms' activities, such as clinical trials.

Technology Acquisiton

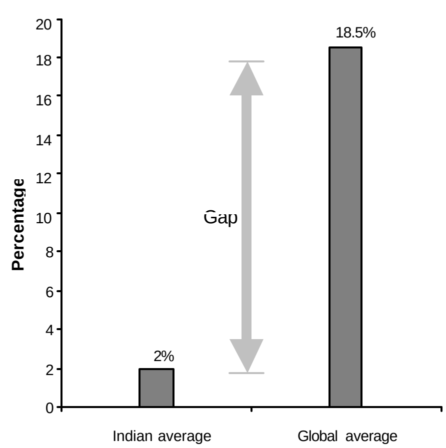
Higher investment in R&D
Acquiring foreign pharmaceutical companies
Collaboration for drug development and clinical trials

The better-financed companies are already attempting to develop their own drugs—to become innovators instead of just copiers. This is an expensive process, and will not yield results quickly, if ever. As an alternative, Indian firms are expanding their overseas sales of existing generic drugs. To that end, some have already established production facilities and equipment that meet regulatory standards in the US and elsewhere. Some Indian companies have also begun purchasing foreign pharmaceutical firms to improve their access to overseas markets and develop new profit streams. Finally, Indian firms have begun collaborating with Western drug companies on back-office clinical trials and other research-oriented activities, which Indian companies can often perform at a fraction of the developed-country cost.

Factors For Success And Increased Competitiveness Of The Indian Pharmaceutical Industry



Globally, R&D spend has been on the rise in the last few years and currently the average stands at 18.5 per cent of net sales. This is partly led by an increase in drug development costs.



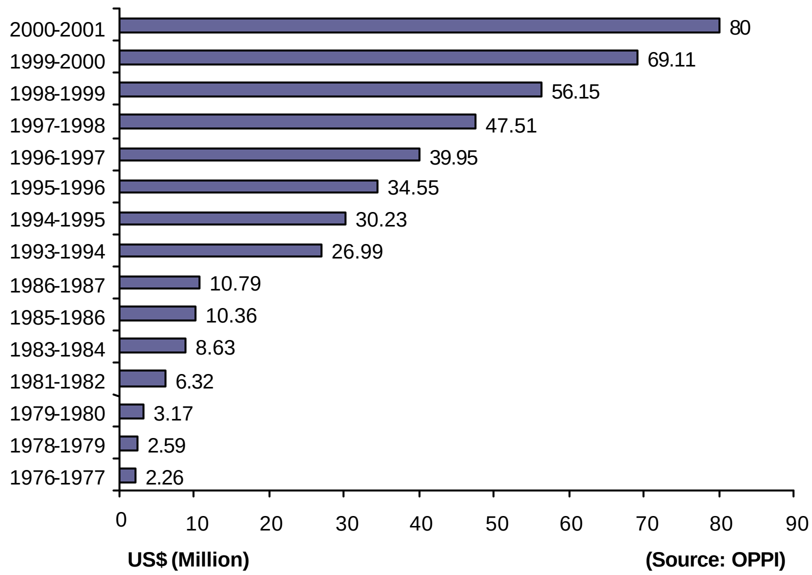
Source: Scope report on pharmaceuticals, 2001

R&D Budget

USD 80 M in 2001
6% of sales
18 New Chemical Entities developed in India undergoing clinical trials

The leading pharmaceutical companies in India have been increasing their R&D budgets over the years. The R&D expenditure of the Indian pharmaceuticals industry had increased from US$ 2.3 million in 1977 to US$ 80 million in 2001. During 1996-2002, the top 10 Indian pharmaceutical companies' annual recurring R&D expense increased 32.3 per cent year-on-year basis. These companies made a total capital investment of US$ 116 million over the same period. The average R&D expenditure of the major Indian companies has increased to nearly 6 per cent of sales during the financial year 2004 from nearly 2 per cent, two to three years ago. Indian pharmaceutical companies are likely to double their expenditure on R&D over the next 2 years. By financial year 2006, it is likely to go up to more than 12 per cent. There are as many as 18 New Chemical Entities (NCEs) developed by different pharmaceutical companies currently undergoing various phases of clinical trials.

R&D investment in the Indian pharmaceutical industry



In summary, while Indian pharmaceutical companies started their R&D effort by doing reverse engineering, they have acquired skills and confidence to engage into high-end research and technology development. The significant growth in R&D expense from 2% of sales to 6% is a very encouraging sign. The pharmaceutical sector is well-poised to compete internationally.

Conclusion

The Indian pharmaceutical industry developed excellent process skills due to reverse engineering focus pre 2005. Since the adoption of product patent regime, the industry has responded well by increasing the R&D spend upto 6% of sales – efforts are directed towards New Drug Delivery System (NDDS), New Chemical Entity (NCE) and new processes. Additionally, it is using low cost advantage in capturing significant share of global generics market. Finally, it has also started to acquire organizations in other countries as well as getting into technology partnerships with MNCs.

Technology Initiatives

High Priority Sector Government has set up fund and national facility for R&D Technology driven primarily by private sector

Pharma Research Initiative: Pharmaceutical Research & Development Support Fund (PRDSF)

During 2004-05, (PRDSF) has been set up by the Department of Science and Technology. Under this fund, the Government has created an initial corpus of USD 30 Million for providing financial assistance to R&D projects proposed by industry/academic institutions/ laboratories and also for creation of state-of-art facilities in the country. A Drug Development Promotion Board (DDPB) under the administrative control of DST has been constituted to operationalise the PRDSF. The earlier programme entitled "Drugs and Pharmaceuticals Research Programme" has now been merged with PRDSF. A national facility on Pharma-informatics is also established at National Institute of Pharmaceuticals Education and Research (NIPER), Chandigarh.

Following are some of the early successes of this program

- A large scale screening of plant materials for histone acetyltransferases (HATs) and deacetylases (HDACs) function and search for inhibitors of these enzymes were carried out. For the first time, polyisoprenylated benzophenone (garcinol) from Garcinia indica was reported as cell permeable HATs which alters the global gene regulations as observed by microarray analysis of garcinol- treated cancerous cells. Also, synthesized 10 different derivatives of Garcinol having interesting features of cancer management.
- Developed Antigen capture assay for HIV-1 and HIV-II using the combination of the affinity – purified rabbit –p24 polyclonal antibody and A16.4 monoclonal antibody. They could optimize the assay to detect as low as 10 pg/well of p24 in plasma samples with the sensitivity of 50 pg/ml.
- Prepared and characterized antitubercular drugs (rifampicin, isoniazid, pyrazinamide and ethambutol) coated with polylactide-co-glycolide for various physico chemical properties, pre clinical animal studies for toxicity, pharmacokinetic and bio availability studies in mice. The experiments have given very encouraging results facilitating the collaborators to apply for regulatory clearance for this innovative formulation of drug delivery system. Administration of PLG-MP formulation once in every ten days in TB infected mice/guinea pigs provided effective control of the disease.
- 300 NCEs of novel antitubercular and bacterial compounds were synthesized belonging to 17 different chemical scaffolds. 12 compounds belonging to dihydrpyridines, thiazolidinones, aminothiazoles, and quinolines showed good activity when tested for biological screenings.
- 31 different types of herbal products were screened for ectoparasiticidal properties for lice and ticks in the domestic animals for developing suitable veterinary drug for the management of these parasites. Based on various physicochemical parameters, 7 plant products were selected for further studies based on crude extracts.
- Bio evaluation studies of the Itone of M/s Deys Medical Stores Mfg. Ltd. were undertaken. It was observed to have anti inflammatory and anticataract effect.
- A library of 12,500 compounds has been screened for anticancer activity on the high thoroughput screening platform of CDRI. A total of 532 Hits' have been identified which were subjected to secondary screening. 182 compounds were identified as "Secondary Hits". These belong to 20 structural classes.
- 27 NCEs having potential antifungal property were synthesized relating to Fluconazole, voriconazole, sapidolide. One U.S. Patent for Fluconazole was filed.

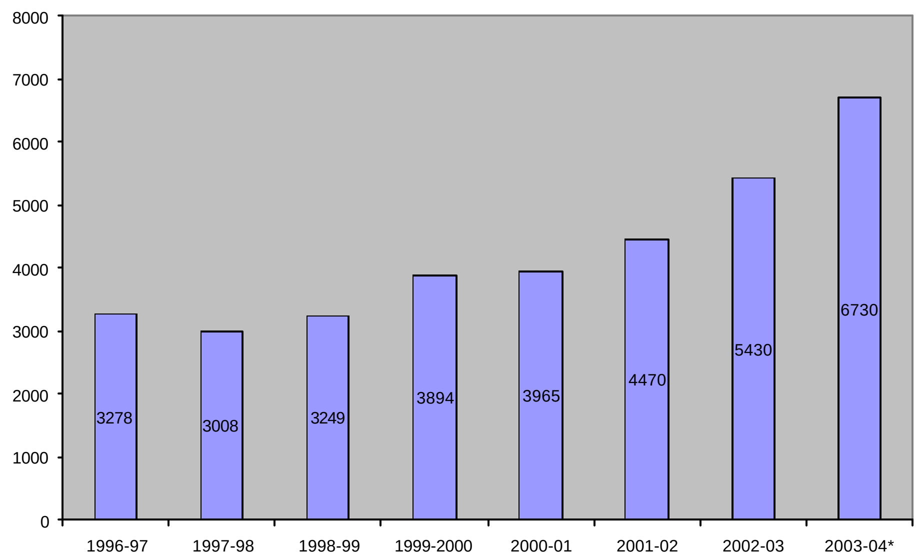
Auto Components

Key Facts

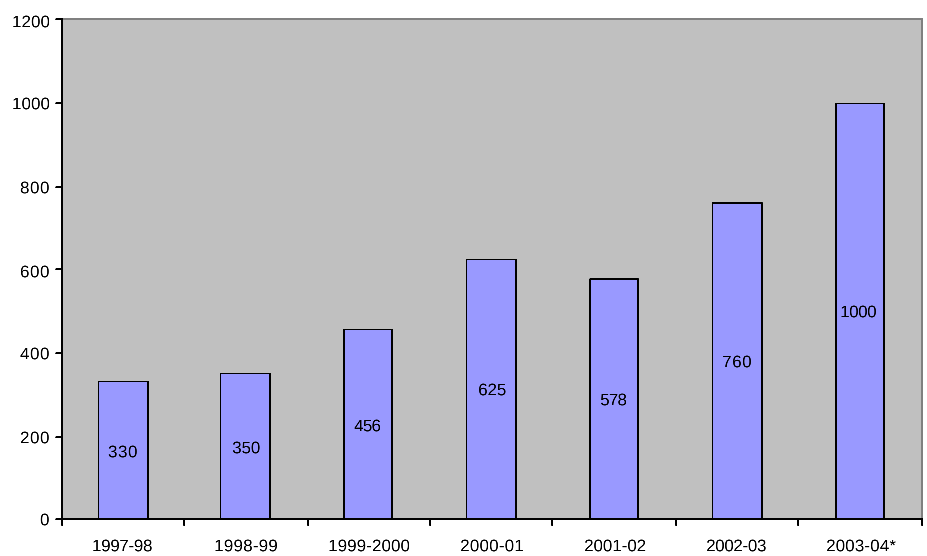
Size: USD 6.7 Billion
Exports: USD 1 Billion
Growth: 25% per annum

Indian auto component industry has grown from USD 3.9 Billion to USD 6.7 Billion in 3 years (2003-04) as India is becoming a preferred destination for sourcing by Original Equipment Manufacturers and growth of domestic auto industry. The attractiveness of Indian industry can be explained by the fact that presently around 12 global auto giants have set up international purchasing offices in India and 150 more are expected by 2010.

Auto Component Production (In US $ Million)



Auto Components Industry Export (In US $ Million)



India offers OEMs (original equipment manufacturers) a great cost-quality proposition, thus making it a preferred destination for outsourcing. Indian manufacturers enjoy the advantages of cheaper raw materials and availability of educated, qualified and skilled labor as well as engineers and designers at much lower costs. Technological advancements made by some of these domestic players have allowed them to become integrated partners rather than mere outsourcing partners. Indian automobiles and components are gaining increasing acceptance in world markets due to their cost-competitiveness. Auto components exports have shot up from $578 million in 2001-02 to $1000 million in 2003-04. The industry expects the growth to continue as domestic manufacturers acquire greater technological skills.

Superior Quality

Sourcing by General Motors, Mercedes, IVECO etc
Top international quality awards
Superior design skills

During the financial year 2003-04 the sector has been able to post a growth of 29%. The export growth is projected to be 30% in 2004-05. This high export growth rate can be attributed to the improvement in the industry's export capabilities and the increasing global recognition of this capability. Automotive components manufactured in India are of top quality and used as original components for vehicles made by top international companies such as General Motors, Mercedes and IVECO among others.

Quality Standards of Indian Automobile component manufactures	
Quality Parameter	Number of Indian companies
ISO 9000 certification	337
ISO 14001 certification	41
QS 9000 certification	193
TS 16949	25
Deming Prize	2
Japan Quality Medal	1

Source: ACMA

India's position in comparison with its major competitors

Parameter	India	China	Thailand	Taiwan
Quality of supply	1	4	2	3
Ability to supply consistent Quality	3	4	2	1
Price Competitiveness	4	1	3	2
Design & Engineering capability	1	4	3	2
Customer / After-sales Support	3	4	1	2
Maturity of the auto comp. Industry	1	4	3	2
Government regulations	4	3	1	2
Attractiveness of the domestic market	2	1	3	4
Compliance and Transparency	2	4	3	1

Source: Frost & Sullivan

Trends in Auto Components Sector

- India enjoys a distinct cost advantage with respect to auto-ancillary manufacturing capabilities. While developed nations' labour cost component is 30-35 per cent of sales, Indian labour cost is only around 8 -9 per cent of sales.

- The number of vehicles manufactured in India has risen from 3 million units annually in 1999 to 5 million units in 2002. This has also led to an increase in domestic demand for automotive components.

- This sector provides employment to 2.5 lakhs persons.

- The auto component industry is a highly fragmented sector. Mergers and acquisitions will consolidate the sector in terms of volumes and help the industry to be cost competitive.

Indian Auto Industry

2nd Largest Two –Wheeler Manufacturer in the World

1st Global Motorcycle Manufacturer in the World

2nd Largest Tractor Manufacturer in the World

5th Largest Commercial Vehicle Manufacturer in the World

4th Largest Car Market In Asia – Crossed the One Million Mark During the 2003-04

Technology Status

Moving up the value chain

Preferred destination for outsourcing design and development work

Indian companies are no longer restricting themselves to component manufacturing. They are also focusing on using their expertise in CAD/CAM and in designing and engineering capabilities by entering into designing and development of components for new product. For example, Toyota Kirloskar will be developing the transmission systems for the entire global requirements of the new vehicle platform of Toyota.

India's automotive component industry manufactures the entire range of parts required for vehicle manufacture. To meet international quality requirements and for tapping the global markets, the Indian auto ancillary units have entered into joint ventures with MNCs.

India is well positioned to potentially capture US$20-US$25 billion in exports. It should do so by primarily targeting components where it has an advantage over other Low Cost Countries (e.g., in skill-intensive components) or in components where it is comparable with them (e.g., simple labour-intensive components, steel, rubber and aluminum-intensive components). This competitiveness is due to its inherent advantages in engineering skills and emerging capability for continuous improvement when compared with other Low Cost Countries (LCCs).

Technology Excellence

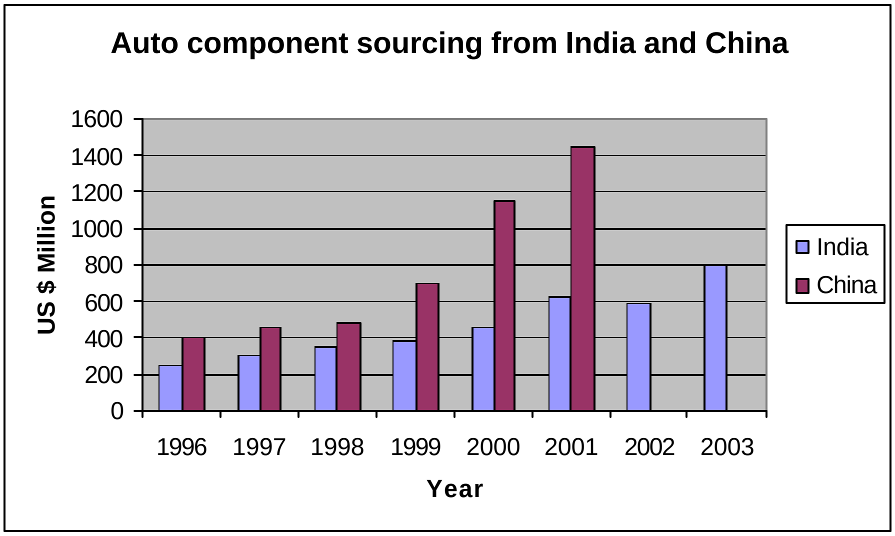
- **Engineering skills**: India's long manufacturing history and education infrastructure has created strong engineering and design capabilities.

- **Process engineering**: India's process-engineering skills, such as redesigning manufacturing processes to make them more labour-intensive and less capital-intensive, allow it to substantially lower overall costs. In specific components, de-automation of the production process used in Western factories can reduce up to 20 per cent of overall manufacturing costs.

- **Product engineering**: India's strengths include designing to lower costs or designing more quickly. Firms in India have lowered manufacturing costs by using design changes to optimize inputs. For example, the steering system of the Maruti Alto was redesigned so that its weight was lowered by 15 per cent. Through redesign, the stabilizer bar for another Indian car was reduced in weight by 40 per cent and in cost by 10 per cent. Faster design development has reduced development costs and lead times. For instance, Indian suppliers designed system within six months for an automotive OEM, after the OEM had tried to develop a similar system with suppliers in other LCCs for over four years with no success. Many OEMs are beginning to build design centres in India to capitalize on these design skills.

Exports still lagging behind China

- **Continuous improvement capability**: This is an emerging strength in India, with several leading suppliers already using operational excellence programmes and a cost-conscious mindset to create continuous cost improvements. An Indian brake linings company, for example, is now among the world's top five brake lining manufacturers through a continuous effort to achieve operational excellence. Between 1995 and 2001, the firm reduced raw material costs to 26 per cent of sales from 52 per cent, the scrap rate to 1.75 per cent from 8 per cent, and customer rejections to 500 parts per million from 12,000. Similar successes have been seen at other auto-component players in several component types: forgings, castings, fasteners, etc. This trend will continue to spread as more auto-component makers become aware of, and are exposed to, best-in-class continuous improvement practices.



Source: Bloomberg, China details for 2002, 2003 not available

Core Advisory Group of Research (CAR) Project

To provide key technology support to Indian automobile manufacturers, CAR (Core Advisory Group of Research), an industry-academia initiative has been firmed up. The Technology Information Forecasting and Assessment Council (TIFAC), Office of the Principal Scientific Adviser (PSA) to the Prime Minister, and representatives from the auto industry have formed two working groups under CAR to help the Indian auto sector bridge technology gaps and face the stiff challenge from the global automobile majors.

Conclusion

Indian Auto component industry was one of first to get exposed to global competition in early 1990s during the first phase of liberalization. Over last decade the industry has responded very well by acquiring both managerial and technical competencies. The result is in continuously increasing outsourcing from Tier 1 OEMs. Indian companies have won a large number of international quality awards. India is being widely recognized for its engineering design capabilities and is likely to be the growth engine.

Section 5
Technology Initiatives

Technology Initiatives

This section highlights the technology initiatives required to enhance the technical competitiveness of Indian manufacturing sector and profiles the initiatives of Korea to highlight the importance of such changes.

✍ **Develop and restructure technology infrastructure to support firms striving to improve their technological capabilities and competitiveness:**

- Drive public R&D institutes and laboratories to become more demand-driven and service-oriented, and make the resource allocation (government budgetary support) more performance driven. R&D institutes should acquire international accreditation for granting product certification in India and for providing, in competition with private consulting firms, effective technological extension services in order to help firms improve their manufacturing and design capabilities.
- Improve coordination among R&D programs through merger and consolidation of institutions that work in similar areas to create "Centres of Excellence". Institutionalise use of peer and technical panel reviews of public R&D proposals and programs to promote joint public/ private sector R&D activities for better monitoring and evaluation systems.
- Promote strong linkages between R&D institutes, universities, industrial extension agencies and manufacturing enterprises. Emphasize on international cooperation between R&D institutes and build linkages for technology development and technology transfer. Equip national institutes for providing contract R&D services to international players.
- Promote industry networks for a consortium approach to industry R&D activities and integrated development of new product designs and production processes, with the intensive involvement of and collaboration with suppliers.

✍ **Focus on selected manufacturing technologies and products**

- Encourage firms, through the dissemination of relevant information, to acquire arms' length technology through technology licensing, technology transfer agreement, reverse engineering and adaptation to build their own capabilities
- Establish Technology Trackers in leading countries (Germany, Taiwan, Japan and USA) to track development of technology in key segments
- Encourage application of technologies (like business-to-business e-commerce, CRM, TPM, TQM etc.) at the enterprise level through rapid build-up of awareness of need, diagnosis of critical technological requirements, technology transfer management, and monitoring and forecasting of technology, as well as entrepreneurship development.
- Promote technology-based FDI partnerships between foreign and local enterprises especially inmedium-scale SMEs with the view of developing India as global outsourcing and subcontracting base
- Establish entrepreneurship development programs at engineering and R&D institutes for goal-directed promotion of business ideas
- Maintain competitive pressures on the demand side by adopting a well-formulated competition policy and intellectual property protection regime. Promote application of environment-friendly and safety standards to upgrade the standardisation level to global level and hence promote export competitiveness

✍ **Upgrade Technological capabilities of SMEs**

- Provide an effective outreach program to SMEs through designated public R&D institutes, starting with effective dissemination of information on standards to help SMEs improve technological capability
- Develop subcontracting and encourage integration of SMEs in the overall manufacturing sector, through vendor improvement and certification programs, as suppliers of raw materials, intermediate inputs and components

✍ **Provide fiscal benefits to manufacturing firms for R&D**

- Provide tax exemption and other incentives for R&D and in-plant technical training by using any of the following instruments: tax credits for R&D expenses, and accelerated depreciation and reduced import duties for investments in R&D facilities
- Utilize Technology Development Fund (TDF) to finance indigenous R&D activities. Energize Technology Upgradation Fund (TUF) by extending this grant to select non-textile industry and providing flexibility in its usage

✍ **Develop technical education and training facilities**

- Revive interest for existing higher technical education towards core engineering stream by revising outdated curriculum, adopting interdisciplinary approach and increasing relevance to industrial application. Manufacturing industry should strive to attract and retain the best engineering talents.
- Encourage private sector to establish and operate demand-driven technical training centres through financial and other incentives, under carefully designed industry initiatives, supported and coordinated by government, for quality control and accreditation systems

Encouragement of Technological Activity in the Republic of Korea

Korea is the best known example of the use of strategic industrial policy to develop indigenous technological capabilities. It combined import-substitution with forceful export promotion, selectively protecting and subsidizing targeted industries that were to form its future export advantage. Korea drew extensively on foreign technology, but in forms that promoted local control: it was one of the largest importers of capital goods in the developing world, and allowed its firms unrestricted access to the latest equipment (except when it was promoting particular domestic products); it encouraged the hiring of individual foreign experts; it allowed licensing and, where necessary, foreign minority ownership (but foreign majority ownership was discouraged unless deemed necessary to gain access to closely held technologies or to promote exports in internationally integrated activities). It intervened in major technology contracts to strengthen the negotiating position of domestic firms, and sought to maximize the participation of local consultants in engineering contracts.

Technological effort in Korea was supported by the government in several ways. Private sector R&D was directly promoted by a number of incentives and other forms of assistance. These included tax exempt TechnologyDevelopment Reserve (TDR) funds, tax credits for R&D expenditures as well as for upgrading human capital related to research and setting up industry research institutes, accelerated depreciation for investments in R&D facilities and a tax exemption for 10 percent of cost of relevant equipment, reduced import duties for imported research equipment, and a reduced excise tax for technology-intensive products. The commercialization of research results was encouraged by a 6 percent tax credit or special accelerated depreciation of the relevant investments. The import of technology was promoted by tax incentives: transfer costs of patent rights and technology import fees were tax deductible; income from technology consulting was not taxed; and foreign engineers were exempted from income tax.

In addition to tax incentives, the government also gave financial grants and long term low interest loans to enterprises that participated in 'national projects'. Tax privileges and official funds were given to private and government R&D institutes to carry out these projects. SMEs (Small and Medium Enterprises) were helped with shop-floor advice and guidance to upgrade technical capabilities and productivity by KOPTEC (Korea Production Technology Corporation). KOPTEC complemented the help provided by the SMIPC (Small and Medium Industry Promotion Corporation), which also gave technical, training, and other services to SMEs. The KTAC (Korea Technology Advancement Corporation) helped firms to convert research findings into commercial applications.

Encouragement of Technological Activity in the Republic of Korea

The government launched a series of National R&D Projects in 1982. These were large scale projects which were regarded as too risky for industry to tackle alone but which were considered to be in the country's strategic industrial interest. National Projects were conducted jointly by industry, public research institutes and the government, and covered activities like semiconductors, computers, fine chemicals, machinery, material science and plant system engineering. "Centers of Excellence' were formed in these fields to boost Korea's long-term competitiveness. National Projects were a continuation of the strategy of interventions to identify and develop the country's dynamic comparative advantage, orchestrating the different actors involved, underwriting a part of the risks, and directly filling in gaps that the market could not remedy.

Strategic technological activities are still targeted and promoted. Other policy measures to stimulate technological effort in Korea include the setting up of Science Research Centers and Engineering Research Centres at universities around the country to support R&D activities and the common utilization of advanced R&D facilities, and the construction of science towns.

[Source: Sanjaya Lall, "Governments & Industrialization: The Role of Policy Interventions", UNIDO Background Paper]

Bibliography

The information and data used in this report has been sourced from a large number of web-sites, analyst reports, government publications and industry reports. This section mentions the key information sources:

1.