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Industrial Promotion and Technology Branch
TECHNOLOGY PAPER SERIES 5/05



National Programme for Development of the Machine Tool Industry in India:

A Success Story



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION

INDUSTRIAL PROMOTION AND TECHNOLOGY BRANCH

**National Programme for Development of
the Machine Tool Industry in India:
A Success Story**

TECHNOLOGY PAPER SERIES
TPS 5/05

December 2005



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Industrial Promotion and Technology Branch

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Introduction to the UNIDO Industrial Promotion and Technology Branch

Technology Paper Series

The UNIDO Industrial Promotion and Technology Branch Technology Paper Series (TPS) provides a means for: stimulating policy thinking; improving policy orientation among policy makers; assisting in the management of science and technology policy craft in industrialisation; and disseminating current thinking on technology, and its industrial dynamics, in broad relation to the economic development. Attention is paid to developing countries (DCs) and transition economies (TEs). The predominant orientation of TPS will be Science and Technology (S&T) policy, policy management, co-ordination dynamics of knowledge-based and public-private partnerships in relation to the role of technology in the industrialisation strategies of DCs and TEs.

The effective, and efficient, management of the policy and structural dimensions of technology, broadly encapsulating trends in innovation, R&D and science is increasingly viewed as crucial to economic development. The systemic aspects of national technology management in terms of incentives, institutional generation of knowledge and flows of technology (and investment) present policy challenges to DCs and TEs.

Strategic decisions at government level concerning the articulation of policy instruments, and co-ordination of supporting institutions with respect to economy-wide technological enterprise are vital to creating competitiveness, sustaining total factor productivity growth, and cohering the national system of innovation. Furthermore, the social capital – public sector as well as private sector – dimensions of the S&T intellectual infrastructure of DCs and TEs present opportunities for science and technology to be harnessed more productively for socio-economic advance.

The editorial board of TPS will welcome working papers, and work in progress, on aspects of technological development in DCs and TEs. The expectation is that submissions will focus on technology policy – craft, analysis, formulation and implementation – in relation to economic development manifest as higher levels of technology intensity in manufacturing industry. TPS will be published electronically on the UNIDO website as well as in hard copy form.

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MACHINE TOOL INDUSTRY IN INDIA - MOVES FORWARD

I. INTRODUCTION

The start of organized sector of the Indian machine tool industry took place in early years of the Second World War. Due to non-availability of imported machine tools, few British owned general engineering firms took up their manufacturing in India. This followed the start of centrally planned economy as reflected in a series of five-year plans. This process of planned economy resulted in the second phase of Machine Tool Manufacturing with start of Public Sector Investment in Machine Tools (HMT Ltd., 1953). These two initial phases of development of the Indian machine tool industry saw the production of general purpose machine tools most of which were produced under technical assistance from foreign collaborators (Oerlikon, Loudon, Ward, Herbert, Jones & Shipman, etc.).

The sixties marked the third phase of machine tool industry, typified by rapid growth in production and horizontal expansion in types of machine tools (multi spindle automats, gear cutting machines, SPMs, broaching machines, presses, etc.). The Fourth Phase beginning mid-eighties saw the advent of the Japanese machine tool makers through licensing arrangements (Mori-Seiki, Mitsubishi, Hitachi-Seiki, NachiFuji-Koshi, Murata, etc.).

The fifth and current phase began in early nineties after the new policies of Open Market Economy were introduced, which saw advent of Technocrats. With market share of big companies, shrinking public sector giants and those of these technocrat owned companies rising, in-house design capability, entrepreneurial spirit, greater technology friendliness, operational flexibility and lean managements were combined to give a

greater competitive edge to the technocrats resulting in a significant shift in machine tool production to these medium-sized companies, away from the bigger ones.

Thus, the Indian machine tool industry has undertaken a long way in the last decade since liberalization and economic reforms were ushered in. Now, the industry, which had a technology dependent status, boasts of successful products out of its own R&D efforts. The recent decrease in imports of machine tools was partly attributed to the growing competitiveness of Indian firms. However, the Indian market is small and the Indian manufacturers have to build volumes in order to survive at global markets. This issue is of even greater relevance to a large number of SMEs in the sector where a *large number of enterprises are manufacturing tiny and small component.*

It was visualized that in addition to building volumes, the SMEs would also have to upgrade their products and processes in terms of technology and quality in order to remain competitive at both local and global markets. Thus, the machine tool industry faced the dilemma of whether to remain as finished product supplier and face competition from large volume players or become sub-suppliers of components and / or sub-systems to OEMs.

The latent potential of this sector and its inherent strengths lent credence to the belief that the Indian machine tool industry can become a significant global player and carve a niche for itself in the high technology sunrise segment of NC/CNC machine tools. However, towards achieving this status, the industry does need to adopt a visionary approach and aim at a stretched goal of exponential growth, which must essentially be export-driven.

II. CHALLENGES

In the Indian context, stagnant demand, declining tariff barriers, pressures on margins, technology obsolescence have all put 'Fear' in the minds of SMEs, fear of their very survival. In many SMEs, fear is shrouded within the cloak of 'Uncertainty' about the future. There is also lack of confidence, mentioned by Schrage, that they can't face the future on their own. Such fear psychosis or uncertainty is maximum in this line of business and therefore differentiates this sector – on the very motivation behind its future progress.

1. **Technology Obsolescence:** Technology obsolescence in the machine tool business is extremely rapid. Product lifecycles are declining and currently average life cycle is no more than 3 years! Thus, in a globalized India, SMEs have been and will continue to face challenges they have not seen before. In the past, most of the products have been a result of 'Reverse Engineering'. Unlike the Japanese and Koreans, the Indian manufacturers have not graduated to the next level of 'Improving' the technology of reverse engineered products. Thus, product technology obsolescence is a major issue facing the Indian machine tools industry today.
2. **Higher Resource Requirement:** The restricted availability and the inability to raise resources are common to all types of small businesses. However, the machine tools sector, by its very nature, is a high financial outlay driven business. Average product costs are greater, gestation period of investments – longer, time to market – higher and a purchasing system – not yet fully matured. All this means greater, than most other businesses, financial resource requirement. This, in turn, puts the machine tool SMEs in a particular disadvantage.

3. **Vendor Linkages:** No other business requires such complex level of vendor linkages as the machine tools. For materials, electrical, electronics, hydraulics, pneumatics, metallurgy, tribology, measurement controls – the list of myriad technology linkages is endless. This requires exceptional networking capabilities and plenty of time to be spent by owner of accompany/CEO himself.
4. **Diversity:** The business has also a very large diversity. For example, it encompasses over 200 HSS codes! This further enhances the unique complexity of the business, which is more heterogeneous.

III. CURRENT REALITY OF INDIAN MACHINE TOOL INDUSTRY

The growing competition and technological developments in this sector are having inevitable effects on the Indian machine tool industry, as a whole. The Indian machine tool is faced with typical problems in the emerging globalization scenario as under:

1. Innovation is not happening as fast as it should.
2. Domestic market is too small.
3. Information about market is poor.
4. Lack of training including the concept of 5s.
5. Lack of professionalism.
6. Manufacturers sell different designs of machine – variety is too large.
7. Manufacturers sell machines not solutions.
8. Information sharing is poor.
9. Absence of a Center of Excellence for R&D.
10. Low volume operations and not able to reap benefits of scale.

11. Country is not industrializing at fast pace.
12. Exports are low.
13. After sales service is poor.
14. Poor product design and image.
15. Prices of machines are high compared to China /Province of Taiwan.
16. Small units cannot spend on R&D.
17. Absence of large number of service providers.
18. High cost of consultants.
19. High cost of production.
20. Input costs are high.
21. Small units have uneconomical procurement costs.
22. No formal channels of communication exist.

IV. WORLD TRADE ORGANIZATION SCENARIO

The introduction of WTO regime has necessitated extensive changes in the approach of the Indian machine tool industry to its further development. As a result, the Indian machine tool industry has been affected in some of their operations as under:

1. Strict Intellectual Property Rights means end to 'Reverse Engineering', SMEs will have to develop their own products.
2. Conformance to international standards requires system certification (like ISO) and product certification (such as CE).
3. Enforcement of environment protection measures will impact heat treaters, foundries and similar segments.

4. Enforcement of labour laws and new work culture will mean SMEs will need to improve their management styles.
5. Dilution of the role of state enterprises supporting SSI sector (NSIC, SIDBI, SISI etc.) and inability of the Government to intervene in international trade means individual companies have to stand on their own feet.
6. Early awareness about WTO and its impact on SMEs is necessary, may be through different awareness programmes.
7. Permanent monitoring mechanism is to be created, may be within the Secretariat of the Indian Machine Tool Manufacturers' Association (IMTMA), to analyse the impact of the above-mentioned provisions of WTO on a regular basis and results circulated among all member companies.

These challenges need to be addressed comprehensively by the Indian machine tool industry for remaining competitive at the market. Sustainability is the key word.

V. GOVERNMENT POLICIES FOR DEVELOPMENT OF MACHINE TOOL INDUSTRY

The quantitative restrictions (QRs) were removed from the machine tool business well ahead of any other product group. The first list that was published in 1984 on "Open General License" included 18 items of machine tools. By 1992, all remaining physical barriers to import machine tools were eliminated. The duty on the machine tools has been consistently reduced from 110% to 20% and is further expected to be reduced in consonance with the WTO needs. Thus, no QRs applied to machine tools and, therefore, it is not an issue of significance in this industry.

The industrial policy for investment and technology upgrading has been generally liberalized since 1991. The avenues for free investment without prior approval have been created. The major components of the industrial policy include the following:

1. **De-licensed Environment:** The machine tool industry is completely free from any controls. Anyone (even a foreign company) can set up a plant anywhere (outside urban limits) with 100% equity and managerial control without having to obtain permission for it. (Known in India as the 'Automatic Route', Examples: Makino, Fanuc, Wendt, Seiko, Guhring etc.).
2. **Export related Incentives:** To enable enterprises in getting inputs for production at international prices for competing in export market, special facilities such as duty free import of capital goods, raw material and components etc., are offered to export oriented units (EOUs).
3. **Institutional Backup:** The Central Manufacturing Technology Institute, Bangalore, the Institute of Machine Tool Technology, Batala, the Central Institutes of Tool Design, Hyderabad, etc. offer institutionalised support for research & development, special projects and technical training.
4. **Introduction of VAT:** With introduction of VAT from 01/04/2005, a large part of multiplicity of tax problem may be solved making cross border trade within India without hassles and without excessive tax burden.
5. **Patent Regulations:** A comprehensive Bill 'The Indian Patents Act' has been promulgated fully conforming with requirements under TRIPS of WTO.

It would thus be seen that the overall policy environment in India is very conducive for the machine tool industry. The machine tool enterprises can manufacture and market their produce in the domestic as well as export market without any constraints.

VI. STATUS OF MACHINE TOOL INDUSTRY IN INDIA

Currently, there are about 160 units in the organized sector and another around 800 in the tiny and small-scale sector, producing machine tools and related products. The estimated consumption, production and import of machine tools are as under:

INR Million

Year	Production	Import	Export	Consumption	Import Penetration %
94-95	6510	3790	480	9820	38
95-96	7420	5980	200	13200	45
96-97	8240	11460	290	19410	59
97-98	7550	8040	430	15160	53
98-99	6570	8940	590	14920	60
99-00	6170	5060	310	10920	55
00-01	5870	3410	300	8980	38
01-02	5200	3110	480	7830	40
02-03	5490	4510	360	9640	47
03-04	7970	9650	550	17070	57
04-05 (E)	10000	12000	1000	21000	57

Source: Indian Machine Tool Manufacturer's Association (IMTMA), New Delhi

Geographically, important machine tool producing segments are Guindy in Bangalore in South India, Pune, Rajkot, Jamnagar and Surendranagar in Western India and Batala, Jalandhar, Ludhiana and Faridabad in North India.

Size-wise, the industry structure is very lop-sided. 31% of the value of production comes from a Government owned public sector company (HMT). Another 53% comes from 20 mid-sized private sector companies and balance 16% from small-scale and unorganized sector. Looking at it from another angle, the top 21 companies in public and private sector account for 84% of the production.

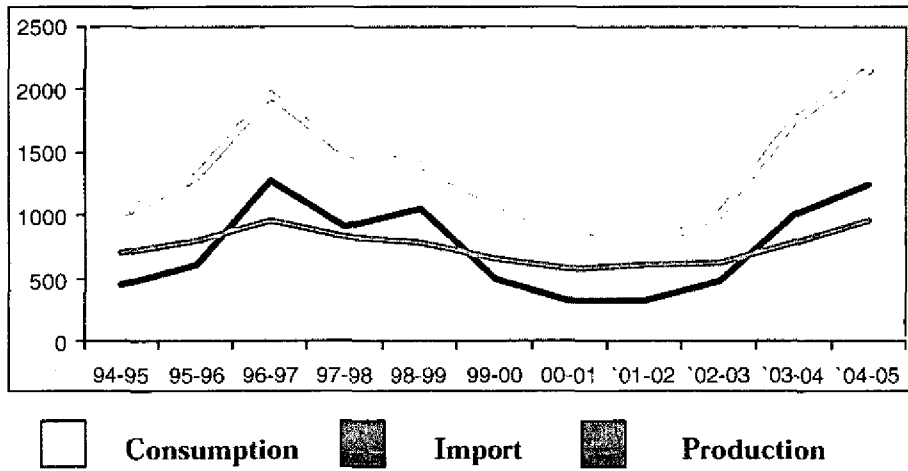
VII. PERFORMANCE OF INDIAN MACHINE TOOL INDUSTRY

In the global scenario, Asia accounted for 37-38% of world production in 1994 and 1995. According to an OECD report, the six "Asian Dragons" (Singapore, Hong Kong, Malaysia, the Republic of Korea, the Province of Taiwan & Thailand) will continue to act as major engines of world trade and economic growth over the next few years. The study had visualized an average growth rate of 7% to 8%. Crucial element in the high growth economies of Asia and the Pacific is the issue of price sensitiveness. This will force shift of the machine tool production from high cost areas to more competitively priced Asia and the Pacific.

The Indian machine tool industry is way behind the global majors in production, improving its ranking from 22nd in 2002 to 21st 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 the 15th position in this period. This is the golden chance for the Indian machine tool industry.

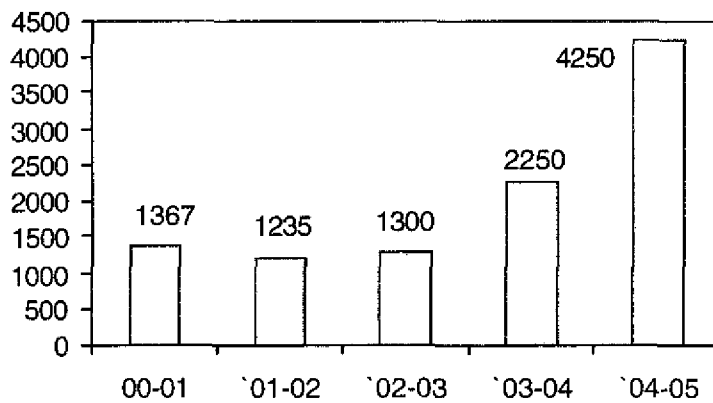
Industry Performance Pattern

INR Million



Source: Indian Machine Tool Manufacturers Association (New Delhi)

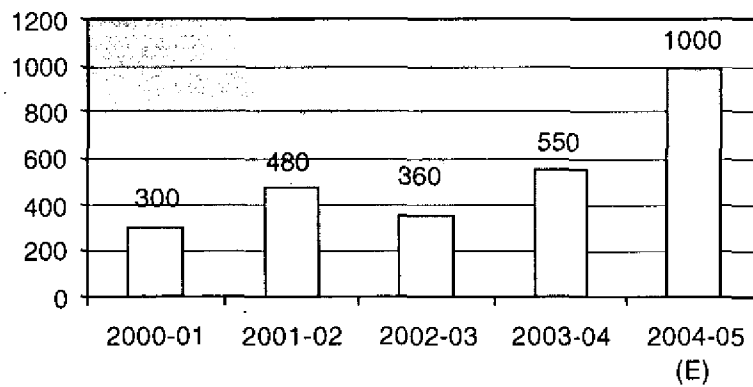
Number of CNC Machine Tools Produced



Source: Indian Machine Tool Manufacturers Association (New Delhi)

The most popular types of CNC machines produced are CNC lathes, vertical and horizontal machining centres, wire cut EDM, CNC external grinders and flexible CNC SPMs. In fact in stand alone CNC machine tools Indian machine tool industry is achieving a key advantage of the volume driven competitiveness. This substantial growth makes CNC machine tools a sunrise segment of the Industry.

Export Competitiveness of Indian Machine Tools



Source: Indian Machine Tool Manufacturers Association (New Delhi)

The export performance of the Indian machine tool industry has not been noteworthy in the past. After 50 years of an import substitution mindset, it was about to look outwards in 2002 (BIMU 02 + EMO 03 Participations in Italy) when the exponential growth in the domestic market started. This has put all machine tool manufacturers in a capacity crunch. Although demand of machine tools, particularly in the European market, is increasing, there is simply no exportable surplus, at least for the moment. However, progressive companies have not lost site of the export advantages

and select companies plan to increase exports to INR 100,0 million from INR 30,0 million in the next 3 years. The principal reasons why the export has not taken off are:

- a) The Indian machine tool industry's preoccupation with the domestic market.
- b) The creation of export infrastructure is both time consuming and costly, the kind of resource the Indian machine tool industry did not possess.

VIII. INDIAN MACHINE TOOL INDUSTRY - "SWOT" ANALYSIS

A concerted effort was made by the Indian machine tool industry, the Government and other concerned agencies to evaluate the capabilities of the Indian industry for evolving measures to address the emerging challenges.

Strengths:

1. Skilled manpower.
2. Economic low volume production.
3. Technical base in diverse fields.
4. Availability of basic raw materials.
5. Wide range of products at industry level,
6. Rising class of technical entrepreneurs.
7. Strong and visible industry association (IMTMA).
8. Component manufacturing capabilities (foundry castings).
9. Central Manufacturing Technology Institute, Bangalore.
10. Business acumen.
11. Tooling up machines/complex custom built machines.

Weaknesses

1. Very low volumes.
2. Poor process capability.

3. No focus on export,
4. Lack of vision:
 - Technical.
 - Global focus.
 - Low goals.
5. Technology gaps:
 - Quality.
 - Reliability.
6. Lack of focus on core competencies.
7. Poor image – both internal and external.
8. Poor Infrastructure in ancillaries – component sub systems.
9. Weak in technological innovation (R&D).
10. Lack of pride in workmanship.
11. Insensitivity to customers.
12. Lack of cooperation amongst machine tool manufacturers.

Opportunities:

1. Win market share from high cost competitors in Japan, Germany and USA.
2. Liberalized economy making 'make or buy' decisions easier.
3. Low cost manufacturing base – enabling strategic alliances.
4. Better systems to compete against China.
5. Large and growing domestic market in areas such as:
 - Consumer durables.
 - Automotive components and accessories.
 - Casting/forgings.
6. Liberalization.
7. Present market conditions – an opportunity to change to customer needs.

Threats:

1. Competition from international players manufacturing in India.
2. Emerging new machine tool manufacturing countries – China, the Province of Taiwan, and the Republic of Korea.
3. Non tariff barriers:
 - CE norms.
 - Third party liabilities.
 - High cost of distribution (in export markets).
4. Privatization of machine tools producing public sector undertakings.
5. 'Direct' marketing by foreign machine tool manufacturers in India through their own selling set ups.
6. Rise of 'Regional' distributors selling on 'Stock and Sale' basis, on behalf of foreign manufacturers.

Most of the machine tools produced in India up to the period 1991 (pre-liberalization era) were manufactured under license of some major foreign companies. The technology so received was well imbibed and digested by the machine tool manufacturers. However, having done that successfully, most manufacturers neither improved on technology nor kept pace with the latest technological developments. The protected economic environment did not put any compulsion on the part of any industry segment in India to become technologically advanced or at least competitive.

Besides the problems of technology obsolescence or price, the major issues of concern have been:

1. Poor quality of machines.
2. Lack of performance reliability (high break-down times).
3. Inconsistency in accuracy.
4. Poor process capabilities.

5. Leakage of hydraulics.
6. Poor aesthetics.
7. Lack of safety features.
8. Failure of electric and electronic parts.
9. Poor after sales service.

However, since 1995, the industry has become increasingly concerned about these issues and although all these problems have not been solved fully as yet, domestic producers have made substantial improvements. The SME sector faced a challenge to not only its competitiveness of enhancing its share in the total consumption of machine tools in the country but also to being completely overtaken.

IX. UNIDO NATIONAL PROGRAMME FOR DEVELOPMENT OF MACHINE TOOL INDUSTRY (NPDMI)

To enable the Indian machine tool industry in technological upgrading for becoming globally competitive, UNIDO and the Ministry of Small-Scale Industries, Government of India initiated in September 2001 a National Programme for Development of Machine Tool Industry (NPDMI). The main aim of the programme was to facilitate the machine tool industry for the consolidation of its market share in domestic market from current 50% and have significantly higher exports.

1. Development Objective

To strengthen the competitive position of the Indian machine tool industry, increase its share in the world market by enhancing the manufacturing capacity, strengthening its technological and market development capacity, as

well as by fostering strong linkages with the SSI sector giving it a pivotal role in the industry's drive towards becoming a global player.

2. Immediate objectives

- To go on a technology over drive.
- To ensure exponential growth through enhancing demand for machine tool.
- To achieve a quality level exceeding customer satisfaction and meet international requirements and standards.
- To leverage IT as an enabler for enhanced competitiveness.
- To attain cost leadership.
- To sustain business excellence.
- To enhance export of the Indian machine tool industry.
- To build up training capacity and develop programmes for sustained growth.

3. Major Programme Deliverables

- Benchmark the selected 20-25 companies against best in class by 2004 on technology, quality and cost.
- Double the export of the Indian machine tools in 3 years, treble in five.
- Achieve high growth in CNC machine tool production.
- Maintain and consolidate the market share at 50 % + of consumption.
- Establish strong international linkages with components and subsystem suppliers, technology sources and markets.
- Establish 'Made in India' label in machine tools as one stated with the same respect as awarded to software companies.
- Utilize UNIDO expertise in becoming the world class industry.

- Usher in an era of e commerce in machine tool trade.
- Build up capacities for servicing global markets.

This programme is being implemented by the Indian Machine Tool Manufacturers Association (IMTMA), one of the stakeholders for upgrading the machine tool industry in the country. IMTMA also participates financially in this programme and all services are being rendered to the industry on payment basis. The range of activities pursued under the programme includes training, exposure, marketing, demonstration, etc. with the aim to address the specific needs of machine tool manufacturers in different parts of India.

The achievement of these project deliverables is expected to ensure an annual growth of 35% in the machine tools sector with 30% export of its production. This will be possible with focus on attaining cost leadership through volumes and ancillarization/*vendor development and continuous redefining of quality benchmarks.*

X. METHODOLOGY OF TECHNOLOGY TRADE & TIE UP

Under the Programme (NPDMI), the industry has been facilitated in mapping of technology within the country vis-à-vis the technology obtaining in countries like the USA, Germany, Italy, China, etc. The gaps in technologies were identified, documented and disseminated amongst industry to prepare the SMEs in evolving suitable mechanism for technology upgrading to remain competitive at both domestic and international markets. Specific technology mapping studies were instituted under the Programme during:

1. **EMO 2001**: This included a delegation of machine tool units to see for themselves the developments in the machine tool sector on display and identify the avenues for adoption.
2. **IMTS 2002**: A group of experts was sponsored to compile information on technological developments on display, which are of relevance to the Indian machine tool industry.

The documentation of technology included the basic information on characteristics of the new technologies, machine tool features and their applications along with their sources and commercial compatibility. The major gaps in technologies as identified during the mapping study included the following:

1. **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 or German products.
2. **Appearance**: Though Indian machines have improved considerably over the years, when an Indian machine and a Japanese/German machine are placed next to each other, anyone can find out which is which without being told. Everyone knows that this is because of the amount of attention that they pay to detail. Also, the machine that is being sent to exhibitions are the same as machines that be given to any other customer, unlike the Indian manufacturers who pay special attention to 'exhibition' machines. If one were to ask what would be the difference in appearance: a combination of colour schemes, curvature and contours of the cladding, method of fastening the covers, etc. In short, everything is in place and it is very harmonious. They

also pay attention to chip evacuation, providing slopes so that chips do not accumulate. A lot of industrial design inputs go into machine design.

3. **Reliability:** Reliability is a part not reflected in specs or appearance, but extremely important to a customer. Some (not all) Indian manufacturers score higher than imported machines on after sales service and spare parts supply (essentially due to problems of agents). However they are lower on specifications and uptime. Several imported machines have such negligible downtime that for the customer, Indian advantage was just not relevant. The Indian manufacturers need to monitor MTBF (mean time between failures) and MTTR (mean time to repair). This is the only way in which they will be able to compete in future.

4. **Technology** - So far, the Indian machine tool industry was distinctly behind major international machine tool builders from Japan, Germany and U.S.A. There has been a big improvement on this score if one were to judge by the technological features of modern Indian machine tools today. (In just 3 years the Indian industry has bridged a technological gap of 10 years, thanks mainly to the winds of change and to the liberalized regime). Nonetheless, we are still behind advanced countries by 3 years in the Turning Centres, Machining Centres and NC Grinders; but we are certainly more than 5 years behind in the realm of gear-cutting machines.

The emerging technologies and the **new developments** identified during the mapping included the following:

1. **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.

2. **Dry Machining/Minimum Quantity Lubrication:** Reduction or elimination of coolants in machining in order to reduce environmental and cost burdens.
3. **Hard Machining:** Cutting and specifically finishing machining of hardened materials by means of a defined cutting edge (turning, milling, drilling, boring).
4. **Complete Machining:** Integration of various machining processes such as turning, milling gear cutting, grinding in a single machine to finish the work piece in one set-up.
5. **Micro-processing:** Metal-cutting and non-metal-cutting processes for generation of miniaturized components, partially having geometric dimensions in the micron range.
6. **Linear Direct Drivers:** New highly dynamic drive elements of simple construction for direct generation of linear movements.
7. **Rapid Prototyping:** Rapid realization of prototypes and pre-production series of new products for geometrical and functional testing.
8. **Internal High-Pressure Forming:** Generation of complex geometries from a single work piece by using high hydraulic pressure.
9. **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.
10. **Lasers in Material Processing:** Laser beam sources: Distinctly higher output, miniaturization, increased flexibility by means of new beam control.
11. **Laser systems** Cutting systems with extremely high process dynamics, particularly compact and easy-to-integrate marking and inscribing systems, innovative solution for welding.

12. **Increased accuracy:** Due to thermal effect compensation, geometric compensation through CNC, real-time compensation for tool wear, and dynamic compensation of die-height for effects of thermal and speed variations.
13. **Improved operations:** Due to more capable CNC that can download instructions, use remote diagnostics, visually show cycle progress at the machine, contour more accurately, program at the machine, and automatically change dies.
14. **Improvements in components:** Of machines including switch from hydraulic drives to electric drives; use linear drives, higher speed spindles, and variable spindles speeds; change dies faster.
15. **Improved tool materials:** Provide longer tool life and allow more aggressive machining due to coated carbides, cubic boron nitride (CBN) grinding wheels, and ceramic tools.
16. **Increased capabilities:** Of machining centers with greater tool storage, ability to handle and control many more pallets, and, incorporation of live tool stations on turning centers for multi-tasking machining, allowing multiple operations to be performed with a single machine setup.
17. **Combining processes:** In one machine including milling, turning and grinding.
18. **Other developments** include high-speed presses, high-speed machining, wire EDM machining, water-jet machining, laser machining, and rapid prototyping.
19. **Metal Forming** machines for Die less forming, Hydro forming, Hybrid bending, Axis tube bending, etc.

As a result of knowledge gained through the technology mapping, the Indian machine tool industry started preparing to effect changes in their products, production technologies and marketing approach for enhancing its competitive strengths. With the help of documented information, the machine tool manufacturers have been able to:

Improve the appearance of the machine.

1. Select & adopt features for improved performance of the machine.
2. Produce machines conforming to CE and other international standards to meet the quality and productivity aspirations of the users.

The documented information is being updated regularly and made available to the industry for taking timely decisions for tapping the emerging potential. About 20 major SMEs have benefited from such information and have also been able to tie up or develop linkages for:

1. Production of CNC machines.
2. Sourcing of components including electronic and electrical.
3. Effective marketing in Europe.
4. Improvements in production lines.
5. Verification of designs.
6. Import of machine tool technology.

XI. TECHNOLOGY ABSORPTION

The Central Machine Tool Technology Institute (CMTI), Bangalore and the Institute for Machine Tool Technology (IMTT), Batala are the two major institutions devoted exclusively for development of machine tool industry in India. Besides these two premier institutions, there is a network of the Small Industries Service Institutes (SISIs) across the country.

These institutes disseminate machine tool related information amongst the industry at major clusters in the country at Batala, Ludhiana, Delhi, Pune, Bangalore, etc. These institutes also conduct regular training programmes for design development, quality improvement, standardization, marketing, management practices, 5S, machine tool application etc. in association with machine tool industry as per local needs.

Specialized workshops and seminars at national and international level are also organized by the IMTMA (the leading association of machine tools in India representing small, medium and large enterprises). Some of the important programmes which have benefited the SMEs a great deal include the following:

1. Ergonomics & aesthetics in the machine tools sector.
2. International seminars on metal cutting.
3. International seminars on metal forming technology.
4. IPR in machine tool industry.

A manual on Intellectual Property Rights (IPR) for machine tools industry has also been compiled to enable industry be prepared for meeting the globalization challenges. Industry is now convinced that IPR is more of an opportunity rather than a threat and can be utilized for exploiting the innovations and original work to the advantage of SMEs in India.

XII. STRATEGY

A simple strategy of motivating the Indian SMEs to meet the emerging challenges of competition has been pursued. The industry associations and the government institutions have helped the industry in understanding the potential both in the domestic and overseas market. The structured approach consisted of:

1. Understanding the implications of the SWOT analysis.

2. Identification of the potential weaknesses in product, features, quality, etc.
3. Development of an action plan for addressing the weaknesses.
4. Exposure of the industry for updating the knowledge and information to correct the weaknesses through adoption of improved designs, improved manufacturing practices, high machining techniques, standardization etc.
5. In house capacity building of SMEs for design development, verification and evaluation.
6. Development of market linkages particularly in Europe for expanding the market base.
7. Participation of SMEs in national and international exhibitions for enhancing share of export market.
8. *Training in key areas to facilitate industry in reducing production cost.*
9. Identification of product range and the related target market.
10. Concurrent focus on domestic and export markets.
11. Proactive marketing of machine tools.

The strategy formulated, particularly for the export market involved greater focus on the production and marketing of the following product groups and machines:

1. **Metal Cutting Group**

- CNC lathes.
- Vertical machining centres.
- Grinding machines (conventional and CNC).
- Sawing and cut off machines.
- Electric discharge machines (EDMs).

2. **Metal Forming Group**

- *Bending and forming group.*

- Punching and notching presses.
- Shearing and punching presses.

3. Accessories

- Chucks and work holding devices.
- Cutting tools.

As a part of the strategy, information was disseminated amongst the industry to understand the emerging trends and needs of machine tool users. The industry realized the following aspects with a fair degree of clarity:

1. General purpose machines (GPMs) do not seem to be items of major imports into the target markets. It is not surprising, therefore, that India's exports of GPMs are declining at an alarming rate.
2. The most significant products in world machine tool imports are metal forming machines. The Indian machine tool industry seems to have totally ignored this market segment. A simple item like Sawing and Cutting off machines has a high potential in world markets, but Indian manufacturers have not focused on this product.
3. The price sensitive markets of turning and machining centres are fundamentally volume driven. There are enormous economies of scale to be derived by volume manufacture of these machines. With current major players like Japan, the Republic of Korea and the Province of Taiwan having their own problems with rising inflation, wages and currency values, there is a large target market for these machines, provided Indian producers manufacture these machines in volumes.
4. The area of grinding machines is fundamentally technology driven with too many sub-elements that constitute overall product performance.

5. The gear cutting machines is another area where Indian industry does not produce in significant volumes.
6. With world production increasing and product zones shifting, India is positioned to export these machines provided they are manufactured with focus on export markets rather than domestic markets alone.

Based upon aforesaid analysis, the machine tool industry in India has identified broadly the following group of products for the selected target markets:

1. General purpose machines and plastic processing machinery – target developing and third world countries.
2. Stand-alone, NC/CNC machine tools – target the USA and European markets.
3. Presses and metal forming equipment – target Asia.
4. EDMs, sawing and cut-off machines and accessories – develop them on a targeted product basis for global market coverage.
5. Machining centers – focus should be on building up production volume in order to boost exports. Ideally, domestic production volumes should cross a minimum number of 500, while individual exporting companies should earmark a production volume of 200 machining centres per annum.

XIII. AVENUES FOR TECHNOLOGY TRADE & TRANSFER

The major avenues for accessing technology in the machine tool sector have been the following:

1. Foreign collaboration – the individual machine tool manufacturers can tie up with a counterpart in a developed country for production of selected machine tools including buy back arrangements. It includes technical assistance from

the foreign collaborators. Some of the Indian companies obtained technical assistance up to 60s from major world machine tool manufacturers like Oerlikon, Louden, Ward, Herbert, Jones & Shipman, etc. This involves invariably long term payments to the foreign collaborator and has proved rather expensive. As a result, this is not a preferred option for the industry. However, the Government policies permit collaboration freely.

2. Licensing arrangements – The Indian companies entered into a licensing arrangement with some leading machine tool manufacturers of the world for production of specified machines as per their designs and standards. Some of the Indian companies entered into licensing arrangement with the leading machine tool manufacturers of the world like Mori-Seiki, Mitsubishi, Hitachi-Seiki, NachiFuji-Koshi, Murata, etc.
3. Foreign Direct Investment (FDI) – This is a most preferred option for development of the machine tool industry in India. However, due to limitation of production and longer gestation period associated with machine tool industry, not many cases of FDI from overseas companies into the machine tool sector in India have been seen. There is a potential for investment of US\$100,0 million for production of machine tools and machine tool components, considering the existing capabilities and skills available in India.

In the machine tool sector in general and Indian scenario in particular, the best avenue for adoption of emerging technology, as generally practiced, consists of:

1. Identification of technology needs after appropriate exposure in the international and export markets.
2. Development of machine tool design and features to suit the needs of machine tool user based upon emerging technology practices.

3. Outright purchase of technology features for adoption within the WTO framework – this is generally an expensive option and at times affects the viability of the enterprise.
4. Training on available technology options for building in house capacity of enterprises, for production of new machines based upon emerging technologies. (This has been a successful approach since a large number of enterprises have started producing CNC machines, laser machines etc. in India with this concept.

XIV. IMPACT & EVALUATION

The impact of policy and programme interventions coupled with initiatives of the industry in the globalization era has helped the industry in achieving the following:

- 25% increase in production of machine tools – from US\$115,0 to US\$144,0 million.
- 101% increase in export of target group of machine tools – from US\$6,6 to US\$13,3 million.
- 142% increase in turnover of CNC machine tools – 1235 to 3000 nos.
- Generation of large export orders in domestic exhibitions (viz. NMTS, Tooltec, Imtex, etc.).
- 50% increase in production of components and accessories.
- Export orders of over US\$6,0 million in BIMU 2002.
- Export orders of over US\$10,0 million in EMO 2003.
- Adoption of faster machining and higher metal removal rates.

- Upgradation of 45 units for demonstrative effect in Rajkot, Ludhiana, Batala and Bangalore with enhanced visibility of 'Made in India' Brand .
- Introduction of machines with linear motors.

The recent trends in the Indian machine tool industry indicate:

- The average growth in 2004-2005 over 2003-2004 was an amazing 47%. The Units expect to out perform the market growth achieving 35% over the next 2 years (2005-2006 and 2006-2007) and 25 % in the three years to follow (2007-2008, 2008-2009 and 2009-2010).
- Units have made dramatic productivity gains from INR 2,0 million to INR 3,0 million per employee; also a clear indicator that the supply chain is playing its due role.
- Investments in the last three years averaged a paltry INR 17,0 million per year, per unit. Whereas units have committed average investments of INR 67,0 million per year, 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 perhaps 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 US\$600,000 per unit per year, exports are set to exponentially grow to US\$25,0 million per Unit per year. A sign of growing acceptance of Indian machine tools in the world markets as well as the fact that the Indian machine tool manufactures have their infrastructure for exports in an "All Go" mode.

- Reflecting in these export figures is the assessment that on a scale of 10, the 'Made in India' brand equity has moved from a score of 3 in 1995 to a score of 6 in 2005 and continues to be improved. This is also an indicator of growing convergence of the Indian machine tool industry in the global world of manufacturing.

As would be seen, the Indian machine tool manufacturers are now able to produce and sell high quality CNC machines at competitive prices in Germany, Italy and other developed countries. The sizeable orders received by the Indian machine tool enterprises during international machine tool exhibitions in Italy and Germany in the last couple of years have provided the much needed impetus for tapping the export potential. The general growth in economy has opened new vistas for machine tool enterprises.

The machine tool industry is now making huge investments to expand their production base for meeting the growing domestic and overseas markets. The growth of over 30% is expected during the next 5 years. This might however necessitate strengthening the existing institutional framework for development of machine tool industry in the country.

XV. CONCLUSIONS

The Indian machine tool industry is in geared to grow. The achievements in the past few years only need to be improved further to tap the growing market and meet the higher expectations of the users. The industry would inevitably require special support for meeting the emerging challenges of competition by addressing the following needs:

1. High speed machining.
2. High RPM spindles.
3. Single hit machining.
4. MT for TPM, lean, cellular manufacturing.
5. Rapid tool change.
6. Machine level automation.
7. Exposure through outbound missions.
8. Capacity expansion.
9. International alliances in design, development, manufacture and marketing.

These constraints will require institutional backup to facilitate upgrading the manufacturing enterprises in a WTO compatible manner. The manufacturing units do not have the option of 'reverse engineering' due to WTO obligations and necessarily have to opt for innovative developments to keep pace with the technology. The industry will need to be sensitized and updated regularly on the WTO provisions and the related opportunities.

Outright purchase of technology or licensing arrangements for sustainable upgrading have generally not proved economical or even viable. Technology exposure with appropriate in-house capacity building to absorb the modular technology procured from the technology provider is the best option for remaining competitive based upon experience of the recent past. This will in turn promote better trade in technology and

also facilitate more and more application of new developments in the field of machine tool manufacture.

The expansion of the trading base for available technology as well as availability of machine tool components, accessories and sub-assemblies will also result into reduction in cost and improve commercial viability of technology options. This will further open avenues for technology cooperation and technology marketing in developing and developed countries. The technology seekers will also become technology providers over a period of time in this chain of developments. Trading in technology thus is seen as a more effective and faster mechanism of addressing the technology obsolescence issue.

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