

TABLE OF CONTENTS

1 INTRODUCTION	3
1.1 Trans-nationalization of small and medium enterprises.....	3
1.2 Role of public policy	3
1.3 Importance of the machine tool industry.....	4
1.4 Scope of study	5
2 STUDY METHODOLOGY	6
2.1 Industry definition	6
2.2 Survey design	6
2.3 Respondent summary	7
3 GLOBAL MACHINE TOOL INDUSTRY	8
3.1 Industry characteristics.....	8
3.2 Key statistics	8
3.3 Technology trends	10
3.4 Market trends.....	12
4 GOVERNMENT POLICIES.....	14
4.1 Country specific policy interventions.....	14
4.1.1 Japan.....	14
4.1.2 South Korea.....	14
4.1.3 China	15
4.1.4 European Union (EU)	16
4.1.5 Taiwan	17
4.2 Promotion of trans-nationalization	17
4.3 Results of policy interventions	18
5 STUDY FINDINGS	19
5.1 Indian machine tool industry – current status.....	19
5.2 Other findings.....	23
6 TRANS-NATIONALIZATION OF INDIAN MACHINE TOOL INDUSTRY	25
6.1 Current status.....	25
6.2 Experience of companies through joint marketing.....	26
6.3 Trans-nationalization – opportunity and necessity.....	27
6.4 Success stories: case studies.....	28
7 RECOMMENDATIONS.....	35
7.1 Context	35
7.2 Machine tools - a strategic industry.....	36
7.3 Other recommendations	36
8 ANNEXURES	41
9 REFERENCES	58

LIST OF TABLES

Table 1: Stages of trans-nationalization:	3
Table 2: Policy measures	4
Table 3: Survey respondent summary	7
Table 4: Government support for machine tool industry in South Korea.....	15
Table 5: India machine tool exports and imports	19
Table 6: Machine tool accessory exports.....	21
Table 7: Leading machine tool / accessory exporters.....	21
Table 8 : Technology benchmarking	22
Table 9: Export orientation of Indian SMEs.....	25
Table 10: FDI by Indian machine tool firms	26
Table 11: Export market analysis	27
Table 12: Policy recommendations	37

LIST OF FIGURES

Figure 1: Global machine tool production- 2006.....	9
Figure 2: Global machine tool exports - 2006	9
Figure 3: Global machine tool imports – 2006	9
Figure 4: Trend in machine tool production	10
Figure 5: Machine tool market share	10
Figure 6: Technology evolution in machine tools	11
Figure 7: European Union’s NEXT initiative.....	17
Figure 8: Market share of imported machine tools.....	20
Figure 9: Policy goals – firm performance linkage	35

1 INTRODUCTION

1.1 Trans-nationalization of small and medium enterprises

Trans-nationalization has become increasingly important to the competitiveness of enterprises of all sizes. Even small and medium-sized enterprises (SMEs) with a global strategy can move quickly to exploit opportunities for revenue growth and enhance capabilities for long-term competitiveness.

SME trans-nationalization can take different forms - including exporting, alliances / mergers across national borders, technology transfers and the establishment of operations or offices in other countries. The process is often sequential with clearly identifiable stages –

- i. Exports of products (directly, through agents or buyback arrangements)
- ii. Alliances - sales via licensing or franchising, technology transfers
- iii. Foreign Direct Investment (FDI) including overseas mergers / acquisitions

This approach has the advantage of minimizing risk and investment required at each stage of growth while allowing for learning and experience gathering before further expansion. The benefits and challenges at each stage of trans-nationalization is summarized below –

Table 1: Stages of trans-nationalization:

	Exports	Alliances	FDI
Benefits	Low investment, cost/commitment	Requires limited resources and market knowledge	Development of new knowledge and capabilities
	Flexible, fast		Minimizes transaction related risks
	Lower risk		Location based advantages
Challenges	Tariffs and non tariff trade barriers	Identifying the right partner	Complex, time consuming
	Transportation costs of goods can be high	Structuring partnership	High upfront investment and greater risk
			Least flexible

1.2 Role of public policy

Despite the broad acceptance of the importance of trans-nationalization of SMEs, there are significant internal and external barriers that impede its progress. Public policy at local, regional and national levels can play a significant role in reducing these barriers and also pro-actively promoting trans-nationalization through interventions in areas where private sector initiatives are absent or inadequate.

As a first step, data is needed about the SME population in a given country and industry before appropriate actions or policies can be developed. Once the SMEs are identified, they should be segmented according to size and growth orientation. Further assessment is then required to determine the needs of those groups of SMEs. It is important to reach out to SMEs and get their perspective on the challenges and opportunities they face.

There are a number of areas in which actions can be taken to reduce the barriers to conducting business abroad and many efforts are already in place or being tested in various countries and regions, as shown below.

Table 2: Policy measures

Policy Area	Measures
Creating an openness to trans-nationalization	Promoting successful firms as role models to create awareness of international business opportunities
Information dissemination	Providing information on tax rules, regulation and finance in foreign countries
Provision of business support services	Counseling, consulting and competence development through functional workshops and related activities
Reforming education	More international content in curricula, encouraging faculty with international experience, creating internships for young students to work in foreign countries
Building networks	Cluster development programmes, collaborative research and technology transfers between public and private institutions
Financial assistance and incentives	Export marketing funds
Legal framework	Protection of intellectual property, enforcement of laws on anti-competitive and unfair trade practices that hurt SMEs

1.3 Importance of the machine tool industry

The machine tool industry is universally recognized as a strategic industry for driving industrialization of a country. Known as a ‘mother industry’, it produces capital goods such as lathes and machining centres for a broad spectrum of the manufacturing sector. The demand for machine tools is largely from the automotive (including ancillaries and component manufacturers), capital goods and consumer durable sectors. Intermediate goods sectors such as auto ancillaries, bearings and electronic components are also important sources of demand.

Measured in terms of output and employment, the machine tool sector is amongst the smallest in the manufacturing industry in the developed countries. At the peak of US dominance in the late seventies, the sector accounted for only 0.3% of total value of manufactured goods in that country. The industry also tends to be heterogeneous in the product offerings and comprises of large number of small firms. The situation, in the Indian context, is similar.

Despite its small size, the machine tool industry is far more important than its share of industrial value add or employment would suggest. Machine tools are the core machinery in the metal working sectors of industry. Moreover, the organization and control of production in the metal working industry is closely tied to the characteristics of the machine tools used. Therefore the machine tool sector plays a very important role in influencing the productivity and competitiveness of larger manufacturing sectors. Several industry experts have argued that leading industrialized countries have invariably had a strong domestic machine tool sector and that the decline of US manufacturing is a direct consequence of the loss of competitiveness of its domestic machine tool industry.

Beneficiaries of advanced manufacturing processes enabled by new machine tool technologies are producers who use machine tools. The benefits to them include improved productivity; shorter product cycle times, energy savings, and improved product quality. Another major beneficiary of machine tool technologies is the consumer who buys the products made by the tools. The principal benefits to the consumer are lower prices, improved quality, greater reliability, and higher energy efficiency. Benefits also flow to the overall economy as inflation is held in check, the global competitive position improves, workers acquire training and skills concomitant with the new technologies, and productivity growth spurs real wage growth.

The role of manufacturing in job creation is an issue of enormous importance to India. Manufacturing currently employs about 45 million people (or 11% of the workforce). It also

serves as a transitional alternative to manpower in agriculture. In expanding manufacturing, India creates a channel through which low skilled labour in agriculture can access more value added jobs. Manufacturing has the highest “multiplier effect” among all economic sectors as a manufacturer’s need for raw materials, suppliers, distributors and other services spurs the creation of jobs, investment and innovation in the rest of the economy. Several global economic studies have estimated that every job created in manufacturing has a multiplier effect, creating 2-3 jobs in services. Also, there is an increasing level of 'software' or services involved in manufacturing.

There is growing optimism that India can become a primary sourcing and manufacturing base for skill intensive sectors such as automobiles and auto components. Research by the McKinsey, the global consulting firm, indicates that the export potential for auto components from India could be about \$ 25 billion by 2015. Leading Indian suppliers possess world-class product and process engineering capabilities. Almost all big global automakers already source components in India. Many automakers are now creating engineering and design centres in India to capitalize on these skills.

The automobile and machine tool sectors have a symbiotic relationship. The Japanese auto industry has had an enormous impact on that country’s machine tool sector. Data from the Japan Association of Machine Tool Builders indicates that domestic auto and auto part makers create about 30-40% of induced domestic demand for machine tools. This point is well reflected by the fact that the Japanese machine-tool industry was the largest producer in the world one year after the Japanese became the world’s largest automakers. If India has to emerge as an important global sourcing base for automobiles and auto components, the machine tool sector will have a crucial role to play.

Viewed in this perspective, the role of the machine tool sector in India has crucial strategic importance. A vibrant domestic machine tool industry is the key to increasing competitiveness of Indian manufacturing. The strengths of the Indian machine tool industry can also be leveraged to increase its scale and competitiveness in international markets.

1.4 Scope of study

Recognizing the link between competitiveness and the degree of trans-nationalization of an industry, the Department of Scientific and Industrial Research (DSIR), New Delhi initiated a study for defining the role of government to promote trans-nationalization efforts of Indian small/medium enterprises (SMEs) in the machine tool industry. The study had the following objectives -

- a) Evaluate trans-nationalization objectives of Indian SMEs in the machine tools sector.
- b) Benchmark technological capabilities of Indian SMEs vis-à-vis global competition.
- c) Identify impact of industrial policy for machine tool sector adopted by leading machine tool manufacturing countries e.g. Japan, Korea, China, US and European Union with special reference to:
 - i. strengthening industry linkages
 - ii. raising local content
 - iii. Foreign Direct Investment (FDI) strategy
 - iv. Research & Development support
- d) Recommend policy measures to support the Indian machine tool sector through innovation & technology development, entrepreneurship promotion, infrastructure and enabling facilities, trade and fiscal policy.

2 STUDY METHODOLOGY

2.1 Industry definition

The machine tool industry comprises manufacturers of the following types of machinery and its accessories -

- a) Metal cutting machinery such as lathes, milling machines, drilling / boring machines, and
- b) Metal forming machinery such as presses, punches, forges jigs and fixtures etc.

Based on technology, machine tools can be classified into Computerized Numerically Controlled (CNC) and some NC machines and Conventional.

The machine tool component industry includes manufacturers of the following systems-

- CNC systems: A form of programmable automation in which the machine tool is controlled by a program in computer memory.
- Servo motors: A servo motor is an automatic device which uses error-sensing feedback to correct the performance of a mechanism. The term applies to systems where the feedback or error-correction signals help control mechanical position or other parameters.
- Spindles, bearings, guide ways and ball screws
- Cast iron products such as beds, columns and saddles
- Hydraulic systems: Hydraulic machinery refers to the machines and tools which use fluid power to do work.

2.2 Survey design

- a) A structured questionnaire comprising the following five sections was developed and the same is provided in Annexure.
 - i. **Unit** : year of establishment, initial investment in plant & machinery, nature of products and by-products produced, number of workers, both skilled and unskilled, number of supervisory, technical and managerial staff, their qualifications, experience, entrepreneurial background, etc.
 - ii. **Technology**: nature of technology in use, its cost, capacity and capabilities, etc.
 - iii. **Product**: capacity of production, number, quantum and value of output, capacity utilization, etc.
 - iv. **Innovation** : development of new / improved products / processes, substitution of raw materials, reverse engineering, quality improvement, cost reduction, etc. and facilities available for the same.
 - v. **Internationalization strategy**: products / markets for export, closest competitors, sales channel, foreign investment plans etc.
- b) 90 machine tool industrial units were identified for the survey, from the following sources:
 - IMTMA Directory
 - Participants in the IMTEX 2007 machine tool exhibition
 - Participants in EMO-Hanover machine tool fair – see Annexure
 - Suppliers to major machine tool manufactures such as HMT, ACE Designers, MICO Bosch and Bharat Fritz Werner.
 - Export details as per shipment data

The following criteria was adopted to select units for the survey –

- i) All IMTMA member units with export sales – both assembly and accessory manufacturers
 - ii) Coverage of units in all major machine tool manufacturing centres in India – Bangalore, Coimbatore, Hyderabad, Mumbai, Rajkot, Indore and Pune
 - iii) Select machine tool importers and multi-national firms – to get a perspective of technology trends in the industry.
- c) Subsequent to e-mailing of questionnaire to all the 90 machine tool units identified for Survey, field visits to 63 machine tool manufacturers and ancillary units were carried out in Bangalore, Hyderabad, Mumbai, Rajkot, Indore and Coimbatore.
- d) Details of industrial policy on machine tool sector in countries such as Japan, US, European Union, China and South Korea have been obtained from academic journals and trade publications that have addressed this subject. Information from the commercial department of the Indian embassy in Germany was also obtained.

2.3 Respondent summary

A total of 63 firms responded to the survey and questionnaire. The table below provides a summary of the size and business focus of these firms. Details are provided in Annexure . As firms did not provide information on the size of their investment in plant & machinery, the classification as small, medium and large enterprises was made subjectively based on turnover (below 50 cr-small; 50-100 cr-medium and above 100 cr-large).

Table 3: Survey respondent summary

Item	No. of Respondents
Unit operations:	
Assembling and marketing machine tools	22
Assembling and selling jigs, fixtures & accessories	28
Tools, dies, moulds	10
Supplying imported CNC packages	3
TOTAL	63
Size of units:	
Large units (turnover more than Rs.100 crores)	10
Medium units (turnover Rs.50 to 100 crores)	4
Small units (turnover below 50 crores)	46
MNCs	3
TOTAL	63
No. of employees:	
Total number of employees above 100	10
Total number of employees 50 to 100	11
Total number of employees below 50	43
TOTAL	63
Exporting units:	
No of firms exporting or with other trans-nationalization operations	21
No of firms deriving more than 50% of turnover from exports	3
Large units	15
MNCs – importers	3
Medium size units	7
Small units	38
Location of units:	
Bangalore	43
Coimbatore	10
Hyderabad	3
Mumbai	2
Indore	2
Rajkot	3
Total	63

Note: Firms based in Pune did not respond to the survey questionnaire.

3 GLOBAL MACHINE TOOL INDUSTRY

3.1 Industry characteristics

Highly heterogeneous

It is estimated that there are over 3000 different types and sizes of machine tools. The machine tool industry is made of mostly small and medium sized firms. In Germany, for example, there are about 320 machine tool companies employing 65,000 employees with an annual turnover of about \$ 10 billion. Only 3% of the manufacturers employ more than 1000 people. Similarly, the industry in Italy comprises of about 450 firms, 70% of which employ less than 50 people.

High capital intensity

This results from the large requirements for working capital due to small batches, low degree of automation in production and large variety of products.

Foreign direct investment is low though international trade is significant

The small size of machine tool firms makes foreign investment impractical while the presence of wide network of machine tool distributors worldwide often makes it unnecessary.

3.2 Key statistics

Source: Gardner Inc (2007 World Machine Tool Output and Consumption Survey)

- The global machine tools industry had a turnover of about US\$ 59.55 billion in 2006.
- Japan is the leading machine tool manufacturing country, accounting for about 23% of global production.
- China is the leading consumer of machine tools, with US\$ 12.94 billion worth of consumption – approx. 21% of machine tools consumed worldwide.
- Germany is the largest exporter with exports totaling US\$ 7.52 billion or 25 % of world trade in machine tools.
- International trade is a very important feature of the industry – 55% of total production is exported.
- Globally, India ranks 18th in production (US \$ 0.41 billion) and 11th in consumption (US \$ 0.88 billion).

Figure 1: Global machine tool production- 2006

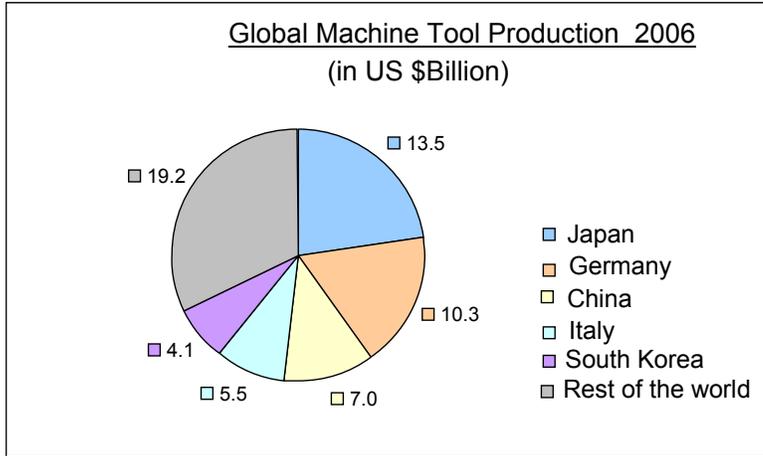


Figure 2: Global machine tool exports - 2006

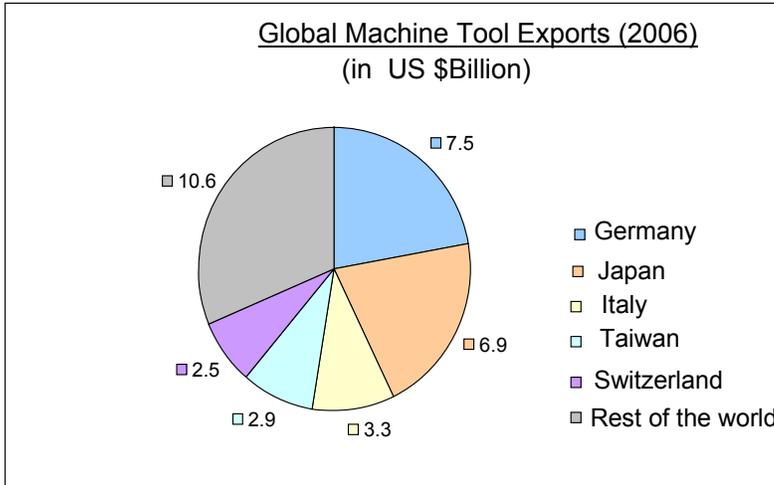


Figure 3: Global machine tool imports – 2006

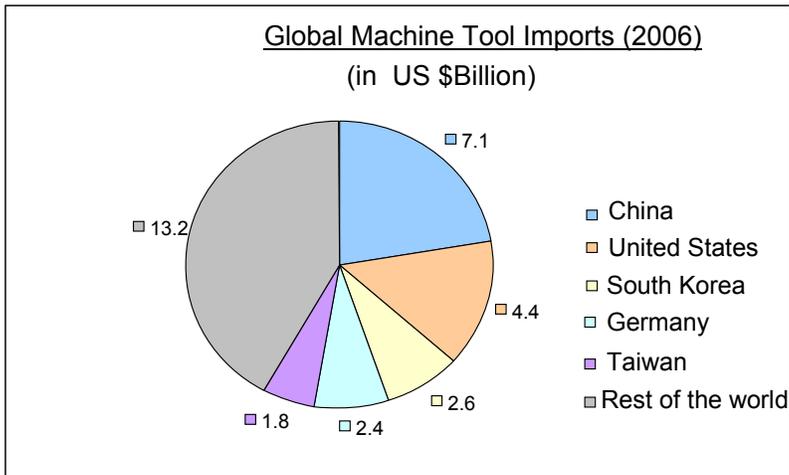
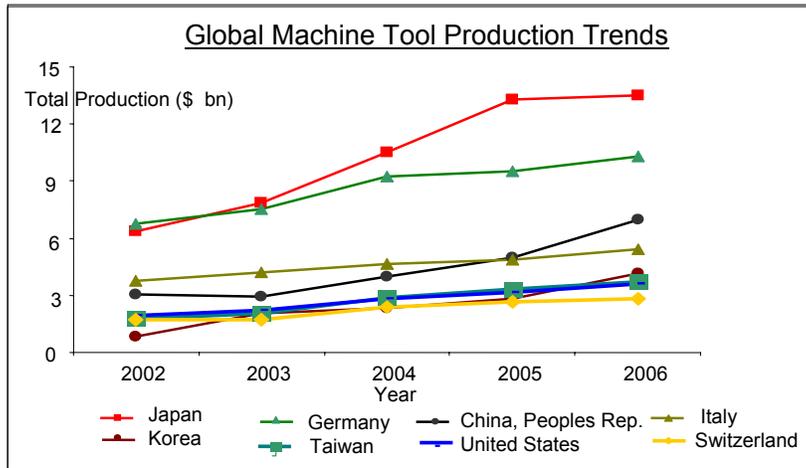


Figure 4: Trend in machine tool production



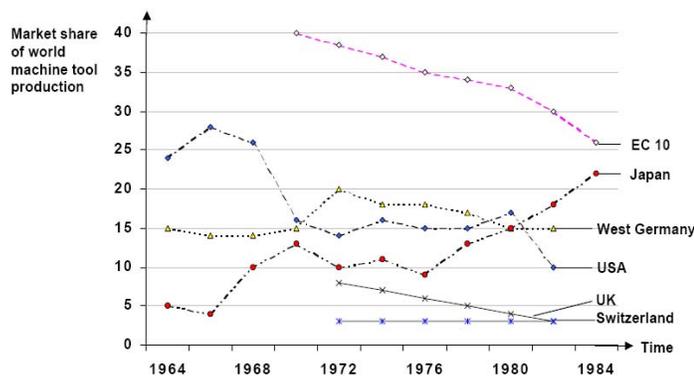
3.3 Technology trends

✚ **Historically, technological innovation has had a considerable impact on the industry structure and the competitive strength of companies.**

The introduction of Numerical Control (NC) and later Computer Numerical Control (CNC) technology in the late seventies catapulted Japanese manufacturers to a dominant position in the global market. The US machine tool industry suffered a major decline.

In conventional machine tools, the machine tool manufacturers themselves produced the hydraulic and pneumatic controls. Companies that had perfected the art of producing machines with high accuracy gained significant competitive advantage. But numerical controls soon enabled most manufacturers to produce accurate machines.

Figure 5: Machine tool market share



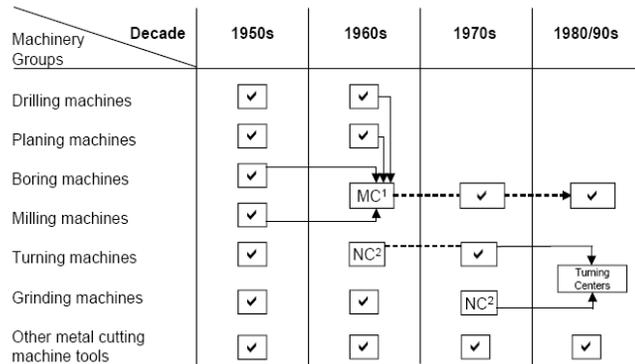
Source: “The recent history of the machine tool industry and the effects of technological change”, Institute for Innovation Research and Technology Management, University of Munich – Nov 2001

i. Changes in machine tool technology have fundamentally changed the nature of the product itself.

The shift to computer-based and particularly microcomputer-based numerical controls considerably increased the versatility and flexibility of machine tools, simplified

programming and allowed for more functions to be controlled automatically. Several machine tool groups, each representing one specific function, converged into multi-purpose machines.

Figure 6: Technology evolution in machine tools



Source: “The recent history of the machine tool industry and the effects of technological change”, Institute for Innovation Research and Technology Management, University of Munich – Nov 2001

The Japanese success can be attributed to the creation of two specific products - NC multifunctional machining centres and NC lathes. Both types of machines are standardized general purpose machine tools.

ii. Technology development occurred outside the machine tool industry and went beyond the mechanical technology base of the typical machine tool company.

In CNC machine tools, the technologies involved directly are mechanical engineering, control engineering, and computer software engineering. A CNC machine tool also depends on a number of generic technologies, e.g. semiconductor, laser, fiber optics, and heat treatment technologies.

In the early years of CNC technology, the technological superiority of the Japanese was sustained by the close technological collaboration between CNC manufacturers and the machine tool producers. The relationships were usually exclusive and long term in nature.

The contribution of CNC makers to the machine-tool industry is considerable. This point can be partially confirmed by the cost ratio of CNC-related parts and software to the total cost of machine-tool building. It sometimes amounts to even 30- 40%.

iii. General purpose machine tool building has become primarily an assembly operation

The quality of a machine tool depends enormously on key sub systems namely – servo motors, spindles, guide ways, precision bearings and ball screws. As is the case with CNC systems, these sub systems can be sourced from leading global manufacturers. This has reduced machine tool building to a mere assembly operation. The value creation in the industry occurs mainly in the machine tool ancillary industry.

iv. However, many special purpose machines require high degree of technical sophistication

There is a clear trend toward greater use of multi-configuration machine tools. Tools are becoming increasingly complex in terms of being multi-functional, multi-spindle with sub-spindles, multi-turret, and multi-axis. Lathes with 12 or so axes are being put into production, and the use of four-axis lathes and turn / mill machines is commonplace. The milling capability is comparable to that of some machining centres. Parts that previously required multiple turning and milling machines are now being produced on a single machine. This requires advanced software to effectively use the machines and may also requires powerful

postprocessors to drive the tools. However, the savings in setup time and the increase in production efficiency can be significant.

v. Technology improvements are incremental in core machining functionality

VDW, the German Machine Tool Builders Association, has identified the following current trends in machine tool technology.

- 1 High performance machining
- 2 Reduction of machining time by increase of cutting speeds.
- 3 Dry machining
- 4 Reduction or elimination of coolants in machining to limit environmental damage
- 5 Micro-processing
- 6 Metal-cutting and non-metal-cutting processes for generation of miniaturized components, partially having geometric dimensions in the micron and surfaces
- 7 Rapid prototyping
 - Rapid realization of prototypes and preproduction series of new products for geometrical and functional testing

vi. While, exciting developments are occurring in machine tool software

Availability of off-the-shelf PC software applications has forced the more traditional control manufacturers to re-examine their core competencies and differentiate their products by introducing the control architecture itself. CAD/CAM developers are striving to undertake much of the toolpath conditioning functions traditionally considered to be the domain of control manufacturers.

Significant improvement is being made in software for machine simulation, tool-path verification, and rendering. Realistic simulation of the entire machining process including the machine tool, holders, machine components, cutting tools and stock can be made. Simulation of the tool path is provided to verify its accuracy. Gouges, undercuts and any discrepancies between the target part and the machined part are shown. Users can compare the in-process model with the designed work-piece. Rendering software provides for photorealistic images of the machined part.

Software is evolving from the use of basic instructions to full-process automation. For instance, wizards can be used for processes such as electrode design or tooling assembly creation. Full five-axis processes including the machine tool, controller, tool path generator and postprocessor are available from some vendors for milling of intricate products such as impellers, turbine blades, tubes, pipes, aerospace components, dies and deep cavities within moulds.

3.4 Market trends

i. Manufacturers are responding to customer demands for more automation

Development in the machine tool industry is moving towards unattended machining. High speed machining equipment is moving forward with better controls and machine drives. Automated parts' loading; tool changers backed by tool life management; spindle sensors to

guard against broken cutters; automated tool length sensing; and advance machine controls and data management are features that make “lights out” machining possible.

A survey done by the Fraunhofer [23] Institute for System and Innovation Research (ISI), Germany predicts that in the near future machine tools will be fitted with self-monitoring, failure protection and tele-service functions.

ii. Machine tool manufacturers are emphasizing customer orientation rather than just product development

- Success of Italian machine tool manufacturers in the US market is attributed to the emphasis on application engineering and service presence.
- Significant investments made in infrastructure for product and technical support in key markets.
- Italian manufacturers have moved their personnel and setup relationships with distribution channels.

iii. New business models are emerging [24]

The European Union has initiated a 4 year (2005-09) project titled “NEXT Generation Production Systems (NEXT)”, which aims to take the European production machinery industry to new frontiers in diverse fields. The project has made the following observations on demand trends in the machine tool industry.

- a. Customers in end user industries are focusing more on product engineering, branding and marketing. Investment in production equipment and manufacturing are no more considered as a pre-requisite for competitiveness. Customers are more interested in buying machine tool functions rather than the product itself.
- b. As product life cycles are getting shorter and demand for production capacity more uncertain, customers want to adopt flexible production systems. Investment in machine tools is viewed as being incompatible with this strategy.
- c. More than ever before, customer focus is on life cycle costs of machine tools rather than upfront purchase costs.

The project included a survey of new business concepts in nineteen machine tool companies in Germany, Italy, UK, Austria and Spain during Nov. 2005 to may 2006. The survey revealed that these firms had a variety of business practices-

- i. Build- own – operate at customer site
- ii. Own and operate at customer site with final purchase option
- iii. Multi-ownership for big and complex projects - operating joint venture company established by different stakeholders owns production machines that are operated and maintained by the equipment supplier.
- iv. Machine tool producer acting as an ancillary vendor to the customer

The study suggests that there is a discernible shift in customer preference, especially in the European markets, that will require machine tool builders to transform themselves from product vendors to service providers.

4 GOVERNMENT POLICIES

4.1 Country specific policy interventions

4.1.1 Japan [25]

- i. Ministry of International Trade & Industry (MITI) attempts to rationalize the industry through mergers and divestments of product lines.
- ii. Recommendation to focus on CNC technology
- iii. Government funding for R&D to be coordinated by the machine tool association
- iv. Special depreciation allowances to stimulate purchase of CNC machines by Japanese firms
- v. Setting up of state owned laboratories, nationwide, to assist small medium businesses in adopting NC technology.

4.1.2 South Korea

- i. The government sponsored the establishment of the Korea Institute for Science & Technology (KIST) KIST was instrumental in developing the first CNC machine in Korea with Hwacheon in 1977.
- ii. Direct investment policy was made attractive to foreign semiconductor companies such as Fairchild, Motorola and Toshiba.
- iii. The government provided financial incentives to the chaebols (large business conglomerates) to enter the CNC machine tool industry. Daewoo, for example, was provided with government guaranteed loans to absorb the investment risks.
- iv. On the demand side, the government established a buyers' credit system made up of the Procurement Fund for Locally-Produced Machinery for domestic users and Long-term Export Credit Financing for foreign buyers.
- v. The government established Korea Institute of Machinery & Material and Changwon National University in the regional base of Changwon Machinery Industrial District. The two institutions developed CNC technologies since their establishment. Most CNC machine tool builders and user firms were based in the region.
- vi. The Korean government also provided financial support to Korea Industrial Electronics, a joint venture of Korean firms for developing CNC control technology. The company had a foreign partner, Allen Bradley, with relevant technology expertise.

Table 4: Government support for machine tool industry in South Korea [26]

	Embryo (before 1977)	Infant (1977–1987)	Adolescent (after 1987)
Industrial organization	<ul style="list-style-type: none"> • 'Conventional' machine tool industry consisting of 154 firms was developed • The emergence of the Chaebol system 	<ul style="list-style-type: none"> • Hwacheon first produced a CNC lathe for commercialization (1977) • CNC machine tool industry consisting of 9 firms (mainly chaebol affiliates such as Daewoo, Kia, Hyundai, etc.) was developed 	<ul style="list-style-type: none"> • The industry consisted of 31 builders • Foreign users entered in the system as a new actor • The emergence of venture capital firms
Institutional infrastructure	<ul style="list-style-type: none"> • Korea Institute of Science and Technology (KIST) (1966) • Many universities had machinery and electronic engineering department 	<ul style="list-style-type: none"> • Korea Institute of Machinery and Material (1981) 	<ul style="list-style-type: none"> • Korea Institute of Industrial Technology (1990) • CNC technology – focused research centers at major universities
Technological infrastructure	<ul style="list-style-type: none"> • The emergence of semiconductor technology (1966) 	<ul style="list-style-type: none"> • The accumulation of technological knowledge through technology transfer from foreign builders • The development of 4D RAM 	<ul style="list-style-type: none"> • The reinforcement of technological infrastructure by the R&D partnerships
Government policy	<ul style="list-style-type: none"> • HCI drive policy 	<ul style="list-style-type: none"> • Credit policy • Import restriction • The stimulation of demand 	<ul style="list-style-type: none"> • 'G7' Project (1992) • Mid-term Technology Development Project (1995)
Major interactions/connectivity	<ul style="list-style-type: none"> • Imports of CNC machine tools 	<ul style="list-style-type: none"> • Interactions within a Chaebol • Technological cooperation between domestic and foreign builders 	<ul style="list-style-type: none"> • R&D cooperation among domestic firms • Industry-university-research organization linkages • Foreign user-domestic builder linkages
Critical mass		<ul style="list-style-type: none"> • Entrepreneur • Chaebol system 	<ul style="list-style-type: none"> • Cooperation induced by government's R&D programs
Bridging institutions		<ul style="list-style-type: none"> • KOMMA 	<ul style="list-style-type: none"> • The government (MOICE)

Source: The evolution of a technological system: the case of CNC machine tools in Korea, Journal of Evolutionary Economics, 2003

4.1.3 China

The Chinese government has established a Cabinet level program to nurture its machinery manufacturers to become globally competitive by 2010. Precision machine tools are specifically targeted as an industry to be built up. The National Development and Reform Commission stated in June 2006, that “*our country's machining industry is weak in innovation and heavily reliant on foreign involvement, the industry's structure is irrational and it is not internationally competitive.*” To build up the machining industry, the Chinese government will encourage the purchase and use of China-made equipment in key projects.

Several incentives have been created for Chinese industry to buy from domestic producers -

- i) China's notification to the World Trade Organization (WTO) shows that if Chinese producers buy die products produced by one of 160 specified Chinese die manufacturers, they would be eligible to get 70 % value-added tax (VAT) refund.
- ii) China's notification to the WTO stated that if Chinese purchasers bought casting or forging products from one of 284 specialized Chinese casting and forging companies rather than purchasing foreign imports, they could get a refund equal to 35 % of the VAT paid on those products.
- iii) 70 Chinese machine tool companies making computer numerically controlled (CNC) machine tools and related products can have 50% of the VAT rebated to them. As the VAT rate is 17%, it gives them a significant competitive advantage over import competition.

The following are key objectives laid down in China's technology policy (11th Plan 2006-2010) for the machine tool industry [27]:

- i. Reduce dependence on imports
- ii. Develop all important mechanical components
- iii. Develop its own CNC, motors and drives
- iv. Develop CNC turning, machining, milling and boring machines; high precision, 4+ axes machines, high precision grinders, EDM and wire EDM, metal forming and special machines
- v. Eventually, export these machines

4.1.4 European Union (EU)

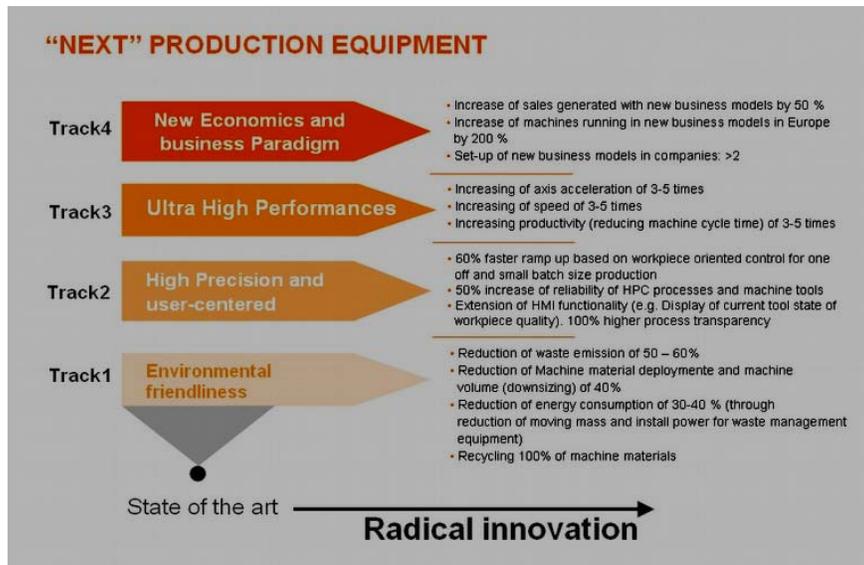
The EU's NEXT programme has the identified five major objectives –

- a) Performance - 5x improvement in machine productivity, as well as an order of magnitude improvement in machine accuracy, compared to current available machines
- b) User centricity - get machines that help the operator in all his tasks by providing a complete set of features (added applications, ergonomic aspects, improved maintenance aspects) to automatically recognize machining tasks, process conditions etc
- c) Environment friendliness - aim is to develop machines that consider environmental aspects through their entire life-cycle: use of recycled materials for machine elements, reduction of energy consumption, zero waste production, dismantling and recycling of machines.
- d) Training - academic and professional training, by the generation of new contents arising from the research and establishing the means to reach the target audience - machine using and building SMEs all over Europe
- e) New business concepts – Promoting new business models to achieve full life cycle service orientation

The NEXT project brings together institutions from several scientific disciplines - Mechanical Engineering / Mechatronics / Material Science / Microsystems & Adaptronics / Automation & Control / Manufacturing Processes / Industrial Design / Ergonomics & Eco-Design / Marketing.

The approach has been to employ multi-disciplinary teams that span the complete value chain of the production machinery industry to provide a strategic direction to the industry at large. As can be seen from the illustration below, the goals of the project have been clearly defined in terms of the technical capabilities that next generation machine tools will be required to possess.

Figure 7: European Union’s NEXT initiative



The program has a budget of 24 million EUR with EU and various national funds contributing 70% of the corpus.

4.1.5 Taiwan

- i. Establishment of Industrial Technology Research Institute to accelerate industrial technology development. ITRI helped advance Taiwan's machine tool industry to the level of process-intensive precision production, assisting local manufactures outgrowing the conventional tool production. More than 50 new machine tool models have been developed.
- ii. Taiwan’s Ministry of Economic Affairs is promoting the Taichung Precision Machinery Technology and Innovation Pak to assisting product development by providing machine tool makers with technological support from various research institutes and industry development centres.
- iii. National support programme for developing linear motors and advanced spindles.

4.2 Promotion of trans-nationalization

The primary objective of government support in all these countries was to create an advanced indigenous machine tool technology capability. Trans-nationalization itself is not an explicitly stated goal in the policy statements. But it can be convincingly argued that the support provided by the government greatly improved the technological capability and competitiveness of the respective machine tool industries which later contributed to the success of their export strategy.

4.3 Results of policy interventions

It is widely accepted that government policies played a key role in crafting Japan's dominance in machine tools. The Japanese share of the world market (excluding Japan, i.e., exports only) for CNC lathes grew, in terms of units, from 12.6 percent in 1975 to nearly 50 percent in 1984. During the same period, Japan's market share in total machine tool production increased from 9% to about 22%, making Japan the global leader overtaking the United States and erstwhile West Germany

South Korea was a late comer to the machine tool industry but has rapidly caught up with leaders such as Japan and Germany. The first CNC machine was produced in the country in 1977, 25 and 19 years respectively after similar developments in the United States and Japan. By the late 1990s, the South Korean industry could produce all kinds of CNC machine tools such as CNC lathes, machining centres, CNC milling machines, etc. Technological competences also increased. The number of CNC machine tool-related patents applied to Korean Intellectual Property Office by domestic applicants increased from 10 (36% of the total) in 1986 to 56 (86%) in 1995.

Government policy interventions were both extensive and evolutionary. In the early stages (pre 1987), machine tool industry policy in South Korea sought to provide direct support to individual firms, especially the chaebols. In the adolescent stage, government support has been more indirect in nature. It consisted of measures such as providing a "vision for the future" and acting as a bridging institution by creating linkages between industry, academic and research institutions.

5 STUDY FINDINGS

5.1 Indian machine tool industry – current status

✚ Industry is fragmented

The Indian machine tool industry comprises about 450 units spread all over the country. Of these, only about 150 can be considered as organized sector units with annual turnover of more than Rs.2 crore. Moreover, the number of units assembling complete machine tools is much lower.

The ten largest firms, comprising industrial groups such as HMT Machine Tools, Ace Designers, Jyoti CNC, Bharat Fritz Werner (BFW), Ace Manufacturing Systems, Lakshmi Machine Tools (Machine Tool Division), TAL Manufacturing Solutions, Perfect Machine Tools, Lokesh Machines and PARI account for more than 50% of India's assembled machine tool production.

There are about 25 units such as Pragati Automation (Bangalore), Electropneumatics (Pune), Janatics Pneumatic (Coimbatore) and ISGEC (Noida) that have sales in the range of Rs. 40 - 100 crores. The product range of these companies are very wide. ISGEC manufactures hydraulic and mechanical presses. Janatics manufactures valves, cylinders, silencers etc. Electropneumatics specializes in the manufacture of hydraulic and pneumatic presses and some special purpose machines. Pragati manufactures machine tool components like turrets, tool changers.

In the Rs. 5 crore to Rs. 50 crore turnover range, there are about 60 units spread all over the country. They mainly assemble for larger brands mentioned above or manufacture accessories.

Source: IMTMA

✚ Machine tool exports from India is insignificant – valued at just over Rs 60 crore in 2006-07, as can be seen in Table 5. It should be noted that this represents export numbers reported by IMTMA members only.

Table 5: India machine tool exports and imports

Type	Quantity - nos		Value (Rs cr).		Growth	
	2005-06	2006-07	2005-06	2006-07	2006-07 nos	2006-07 value.
Metal cutting						
Domestic	6640	7300	1173	1535	10%	31
Imports - new	7477	11328	1891	2892	52%	53%
Imports - used	8828	10498	387	557	19%	44%
Exports	208	284	40	63	37%	56%
Exports (% of domestic production)	3%	3.8%	3.4%	4.1%		
Metal forming						
Domestic	924	1853	248	468	83%	89%
Imports - new	1537	NA	NA	NA	NA	NA
Imports - used	992	NA	NA	NA	NA	NA
Exports	14	15	2.4	2.9	7%	9.6%
Exports (% of domestic production)	1.5%	0.9%	1.0%	0.6%		

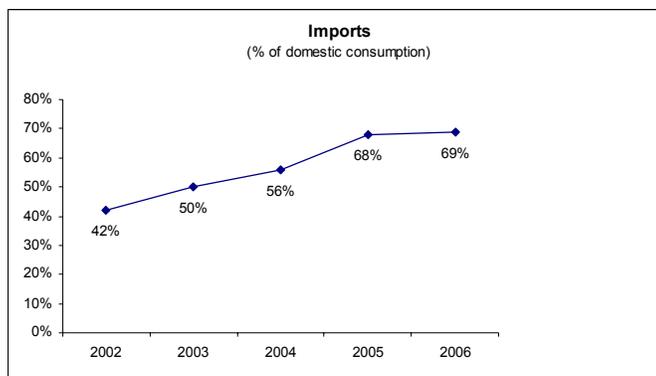
Source: As reported by IMTMA members

Note: Data reported for metal cutting machines (codes 8456-8461 under the Harmonized Tariff System) and for metal forming machines (8462-8463) are for complete machines only, not including parts or rebuilt machines.

- ✚ Industry has experienced strong growth in recent years but is rapidly losing market share to imports

Riding on a buoyant domestic economy, the Indian machine tool industry has grown at over 35% p.a. during the last five years. But its inability to meet domestic demand because of capacity limitations and technology limitations, has led to a surge in imported machine tools. Anecdotal evidence suggests that even second hand machine tools are being imported from countries such as Germany. Imports now account for 70% of domestic machine tool consumption, up from 42% in 2002.

Figure 8: Market share of imported machine tools



- ✚ Besides, import content of domestically manufactured machine tools is high, especially for CNC machines

The industry is dependent on imports for critical items such as

- Linear guides and ball screws
- Precision bearings
- Servo motors, drives and CNC systems
- Spindles

- ✚ However, export of machine tool accessories is significant – over Rs 600 cr in 2006-07

Data provided by the Director General of Commercial Intelligence & Statistics indicates that exports of accessories are about 55% higher than the total exports of assembled machine tools – both cutting and forming machines.

Table 6: Machine tool accessory exports

Harmonized Tariff no./ITEM	2005-06 Rs cr.	2006-07 Rs cr.	Export destination
8456- special m/c tools- removal my laser, photon beam etc	21	14	Germany, USA, Mexico
8457- machining centres, unit construction machines	9	15	UAE, USA, Italy, Nigeria
8458-lathes, turning centres	63	93	USA, South Africa, Nigeria, Thailand, Singapore
8459- unit head machines-drilling, tapping, milling, treading etc	39	67	UAE, USA, South Africa, Singapore ,Nigeria, Indonesia
8460-deburring, sharpening etc	21	25	USA, Singapore, Sri Lanka,
8461- shaping, slotting, grinding etc.	32	30	USA, Kuwait, USA
8462 – Metal forming- presses, forge and hammers	111	115	UAE, China, South Korea, Germany, USA
8463- other machine tools	28	28	USA, UAE, Australia, Belgium
Total: Assembled machine tools (cutting and forming)	324	387	
8466 –parts & accessories for all above machines	556	607	UAE, USA, Mexico
TOTAL : assembled machine tools and accessories	880	994	

Source: Director General of Commercial Intelligence and Statistics (DGCIS)

Note: Export figures provided by DGCIS will not match those reported by IMTMA because of issues related to product classification and partial reporting by IMTMA members.

Many units covered in the survey derive a large proportion of their sales from exports of accessories to developed markets.

Table 7: Leading machine tool / accessory exporters

Company	Products	Exports Rs. cr – FY 2006-07	Exports (% sales) FY 2006-07	Strategy & Countries
Pragati Automation, Bangalore	Tool turrets, automatic tool changers	32	45.7%	Exhibitions, country office, distributors: Germany, Brazil, Italy, Spain
ETA Technology, Bangalore	Friction welding, valve straightening	12	29.27%	Unique product, collaboration: Europe, China
UCAM, Bangalore	Rotary index tables, pallet changer	3	12%	Exhibitions, direct selling: UK, Italy, China, Iran, Taiwan
Jyoti CNC Automation, Rajkot	Turning centres, vertical machining centres	30	10.7%	Distributors, acquisition of French company: Europe, Canada
Lakshmi Automatic Loom Works, Coimbatore	CNC tool holders	12	50%	Collaboration & buy back arrangement with Eppinger Tooling Asia Private Limited, Germany
Shanthi Gears, Coimbatore	Gear boxes, gears	30	12	Agents, R&D for product development, exhibitions: Germany, China

✚ Technology gap vis-à-vis leading global competitors persists

Indian machine tools lag behind in the following features –

- High speed, high productivity machining
- Multi-axes, multi – function capabilities
- Higher accuracy, form and surface finish
- Ability to machine hard components
- Sustained accuracy, high reliability
- Active vibration control
- Automation

The following table illustrates the technology gap that Indian manufacturers have to bridge. It is clear that key sub-systems are not manufactured in India and that India lags considerably behind even China in this respect.

Table 8 : Technology benchmarking

Parameter	State of technology	China	India
Spindle speeds	➤ Highest speeds upto 75,000 rpm	➤ Less than 15,000 rpm	➤ Spindle motors imported
Tool changers	➤ now a part of all CNC machines, including lathes and milling machines ➤ Robotic arm tool change time of < 1.5 seconds ➤ Change time quoted in machine specifications	➤ Tool change time : 3-4 seconds	➤ Tool change time : 1-2 seconds
Precision ball screws	➤ Precision: 0.002 / 300mm ➤ Speed: 80-160 m/min	➤ Precision: 0.004 / 300mm ➤ Speed: 45 m/min	➤ Indian and Imported
Way covers	➤ Speed: 30-40 m/min	➤ 15 m / min	➤ 30 m/min
Numerical Control systems	➤ Mean Time Between Failure : 30,000 hours	➤ Mean Time Between Failure : 10,000 hours	➤ Imported
Linear guideways	➤ Precision: 0.003/1,000mm ➤ Speed: 200 m/min	➤ Precision: 0.005 /1,000mm ➤ Speed: 100 m/min	➤ Imported
Lathes	➤ with live milling spindles, the lathe is evolving into a multifunction machining centre ➤ full tool changers and auto parts loaders	➤ Manufactured in China	➤ Imported
Machine frames	➤ fabricated thin metal hollow filled with poly cement to provide mass and compressive structure with the added advantage of dampening vibration	➤ N.A	➤ Cast iron / steel frames
Grinding	➤ 7-axis CNC cutter grinders are now standard ➤ CNC OD grinders can now cut flat-sided OD and unique shapes	➤ Manufactured in China	➤ Manufactured in India
Axis drive systems	➤ for high speed machines ball screws have a cooling passage	➤ N.A	➤ Imported

Source: Canadian Tooling & Machining Association, China Machine Tool Builders' Association

5.2 Other findings

The following is a summary of other key survey responses and opinions expressed by industry experts interviewed for the study -

- ✚ The Indian machine tool industry and automobile industry are not moving in step with each other. Unlike the experience of Japan, South Korea or Germany, the Indian machine tool industry has not capitalized on tremendous growth of the automobile and auto-component industry. The Indian automobile industry prefers to import high precision machine tools at significantly higher costs as Indian machine tools are perceived to be less reliable and accurate.
- ✚ India is falling behind other major world competitors such as Korea, Taiwan, Japan and China in machine tool technology. Indian manufacturers are being propelled by a cyclical upturn in the economy but structural weaknesses in the industry are significant.
- ✚ With the exception of a few firms, the Indian machine tool industry has not pursued transnationalization. However, firms that have actively targeted export markets have achieved encouraging results.

✚ Broadly three strategies adopted by machine tools exporters are discernible –

- i) Export of standard products where absence of branding is not a constraint – adopted by HMT, BFW, Ace Designers and others

These are value for money products that include CNC machines, drilling / milling machines, low cost presses etc. The primary export markets for these products are emerging markets in Asia as well as developed countries.

- ii) Riding on the brand image of the importer - adopted by LMW and Jyoti CNC.

The focus here is on exporting machine tools to advanced markets such as Switzerland, Germany, USA and Italy. This strategy is adopted by the larger companies in India who have developed long term relationships with the principal overseas manufacturers. The relationship is usually collaboration or a contract manufacturing arrangement. An example of this is the strategy that has been adopted by LMW, BFW which export machines to be sold under the importers' brand name.

A related development is the establishment of wholly owned subsidiaries in India by foreign machine tool manufacturers. TUSSOR, a Spanish company has a manufacturing facility in Coimbatore for manufacturing machines for export under their brand name. Some of the components/sub assemblies are supplied by local vendors.

- iii) Export of complete projects, which include machine tools built by a third party – adopted by MICO Bosch (for their captive consumption in BOSCH plants worldwide)

These are turnkey projects involving engineering design, erection and commissioning. Engineering and design often accounts for 40%-50% of the total project cost. Machine tools are exported as a part of the total project solution and can be sourced from many suppliers.

- ✚ Barriers to exports and other trans-nationalization measures by SMEs from India are – (in order of importance)
 - Capacity constraints
 - High marketing costs
 - Extreme competition on price from Korean, Chinese and Taiwanese manufacturers
 - Inability to attain quality and accuracy levels required by foreign buyers
 - Many customers increasingly want suppliers to offer total solutions rather than individual machine tools
 - Human resource talent shortage
 - Non tariff barriers in export markets such as China

- ✚ Investment in R&D is negligible. What is often claimed as product development is usually a case of reverse engineering of machines manufactured abroad. There is no significant investment in basic/applied R&D in machine tools. Even the Central Manufacturing Technology Institute, Bangalore is engaged in testing and building advanced machines and tools for defence, space and atomic energy rather than in machine tool R&D.

- ✚ The most advanced machine tools are manufactured and imported into India by world leaders like DMG (Germany), Mazak, Makino (Japan).

- ✚ Exports of engineering design and process services for manufacturing industry are growing, especially from cities such as Bangalore and Pune. But these are mainly for auto and aerospace companies abroad, not for machine tools.

- ✚ Participation of Indian companies in international machine tool exhibitions is poor. For example, at the EMO Hanover (the industry's most prestigious trade show) in 2007, there were only 29 companies from India of which only seven were machine tool companies, rest being either tooling companies or component/accessory manufacturers. Estimates of the number of participants from the industry in China and Taiwan are much higher – 70 to 100.

6 TRANS-NATIONALIZATION OF INDIAN MACHINE TOOL INDUSTRY

6.1 Current status

Stage 1: Exports

To better understand the approach of Indian SMEs to exports, survey respondents can be segmented into four categories as shown in the framework below –

Table 9: Export orientation of Indian SMEs

Segment	Description	Firms	Markets	Marketing strategy
Domestic marketing	The firm is only interested in the domestic market and does not export at all. The firm is not interested or willing to experiment with exporting. The export/sales ratio is nil	About 63% of the firms surveyed are entirely focused on the Indian market and have no plans to export.	----	----
Pre - export	The firm searches for information and evaluates the feasibility of exporting activities. The export/sales ratio is at or near 0.	Bombay Machines, Acumac Machine Tools etc., mostly small firms	----	Agents, Participation in exhibitions
Active involvement	There is a systematic effort to increase sales through export to multiple countries. A suitable organizational structure is in place to support these activities. The export/sales ratio usually varies from 10-39 percent.	<u>Component vendors</u> UCAM, Shanti Gears, VJ Industries, Bipico Industries, Fenwick & Ravi, , Janatics Pneumatics, Kladon Design <u>Machine Tool Builders</u> Maxpreci, India Precision Engineers, CNC India Tools, Shoma Enterprises, Mecpros Machine Tools, Macpower CNC Machines, Shailesh Machines, Forbes Gokak, Lokesh Machines, HMT, Ace, BFW	China, Taiwan, Iran, US, Russia, Europe Asia, Europe, Africa	Agents, Participations in exhibitions, direct sales
Committed involvement	The firm depends heavily on foreign markets. Firm is continuously faced with choices for the allocation of limited resources to either domestic or foreign markets. The export/sales ratio is 40 percent or more.	Pragati Automation, ETA Technology, Lakshmi Automatic Loom Works	Italy, UK, Spain, Germany, Brazil, China	Overseas offices, exhibitions, buy-back arrangements

Framework : From Gankema, Harold , Snui, Henoch , Zwart, Peter , The Internationalization Process of Small and Medium-sized Enterprises: An Evaluation of Stage Theory, *Journal of Small Business Management*, October 2000.

Analysis of the export orientation of Indian firms reveals that firms have adopted a range of different export marketing strategies simultaneously – direct sales, appointing agents, participating in exhibitions and buy back arrangements.

Firms with buy-back arrangements with foreign companies have been able to sustain high level of exports consistently. Significantly, these exports are often to developed markets. Indotech and ITL in Indore export bandsaw machines to Germany. Bharat Fritz Werner produces sophisticated 5 axes machining centres for Starrag Heckert of Switzerland.

Stage 2: Alliances

Indian firms have not used franchising or technology licensing in overseas markets. However they have entered into technical collaborations to upgrade their technology. Examples of such firms are Micromatic Grinding which has a collaboration with Toyoda of Japan and Lokesh Machines with Grob of Germany.

Stage 3: Foreign Direct Investment

There are a few instances of Indian firms setting up manufacturing facilities or acquiring companies abroad and even these are recent in origin.

Table 10: FDI by Indian machine tool firms

Firm	Nature of investment	Rationale
Jyoti CNC Automation	Acquired French high precision CNC machine manufacturer - Huron Graffestaden.	Access to customers in the Aerospace and Automobile industries in developed markets of Europe
Batliboi	Acquisition of Quickmill Inc, Canadian company manufacturing large area CNC Gantry and Bridge Milling and Drilling Machines.	Access to wider markets in several industries and developed countries.
Electronica Machine Tools	i) Marketing office in Switzerland ii) Assembly plant in China	Access to European market Lower operational costs in China
ACE Group	Established local office in China	Sales and support centre

6.2 Experience of companies through Joint export marketing:

Towards early part of 2000s several Indian machine tool companies joined together to export machines to Germany and European markets through a distributor based in Germany. The idea was to share the cost of establishing a showroom in Germany which is very high. Marketing was arranged through a distributor who also set up the showroom at his cost and recovered the proportional cost on the sale price of the machines. The product range consisted of general purpose and CNC machines. The plan however was not entirely successful due to the high cost of the establishment and the cost of holding machines in Germany while generating orders. These added substantially to the end price of the machines, which already was required to be around 20% cheaper than equivalent Korean brands. Thus the prices became non competitive, and the experiment had to be closed within a short period.

The learning from this experience is manifold:

- Unless the costs of local market presence is managed at low levels the export of machines to highly developed markets such as US and Europe is very difficult.
- Customers expect low price, immediate delivery, high quality and prompt after sale service.
- There is no alternative to having showrooms, machines in stock and a presence of marketing/sales/application engineers to get orders.
- Extensive travel is also a necessity to meet customers in different regions.

- The need for a local distributor with good market reach and customer knowledge cannot be over emphasised.
- The marketing commission alone is around 20-30 percent.
- Even in the era of “internet”, sales cannot be done over the net, it requires physical presence in the target market to instill customer confidence in Indian manufacturers.
- Competition from Korea, Spain, Brazil and Taiwan is intense.

It is necessary to build an Indian brand for machine tools through concerted effort over a period of time, as the Korean, Taiwanese, Spanish and Brazilian companies have done, with active support from their government.

6.3 Trans-nationalization – opportunity and necessity

Indian machine tool manufacturers possess the following strengths –

- i. Ability to produce standard machine tools with quality levels at par with competitors such as Korea and Taiwan. Most Indian firms now possess ISO quality certification.
- ii. Competent design skills, though there are concerns that this strength is being eroded due to attrition of talent.
- iii. Capable of building tooled up and special purpose machines engineered to meet customer needs. In this segment of the market, Indian manufacturers are very price competitive against similar machines from Europe. Korean, Taiwanese and Chinese manufacturers do not have any large presence in this segment.

Considering that world trade in machine tools is about \$ 65 billion annually, India’s presence in the global market is insignificant – less than 1%. It follows that, given the strengths of the industry and the size of the global market, Indian firms have significant export and trans-nationalization potential.

The table below provides information on important markets that Indian companies should target.

Table 11: Export market analysis

Market	Attractiveness	Target products	Competition
ASEAN – mainly Thailand & Indonesia	Large auto component industry in the region emerging	Standard CNC machines and some Special Purpose Machines	Korea, Taiwan and China ; Japan and Europe in certain types
SAARC	Small market but mostly ignored by competitors	General Purpose Machines	Not significant
Middle East – mainly UAE and Saudi Arabia	Oil, petrochemical and steel industries	Heavy duty machines	Germany, Italy and Spain
Europe – mainly Germany, France, Italy & UK	Large manufacturing sector	Standard CNC machines	Korea, Taiwan, Spain apart from local cos.
Africa – mainly South Africa, Kenya, Nigeria, Egypt, Algeria	Nascent engineering industries ; petrochemical, auto industries	Both CNC and conventional machines	Korea and Taiwan in CNC machines ; Taiwan, China in conventional machines

Indian firms have largely focussed on meeting only domestic demand. However, this makes them financially vulnerable during an economic downturn as was experienced during the

recession period of 1998-2002. The industry is conservative in expanding capacity because of large demand fluctuations and consequently suffers from serious capacity constraints when economic growth revives. This has allowed foreign manufacturers to enter the Indian market thereby structurally weakening the domestic industry. It is therefore imperative for Indian firms to pursue foreign markets to reduce their vulnerability to fluctuations in domestic demand.

Trans-nationalization of Indian machine tool companies, especially SMEs, is nascent - predominantly exports. As pointed out earlier, even globally, exports are the most important type of trans-nationalization in this industry. Only very large firms in the industry make direct investments in foreign markets. Therefore a focus on exports alone in the near term (3-5 years) can yield substantial benefits for Indian SMEs.

6.4 Success stories: case studies

i) Jyoti CNC Automation

Jyoti CNC was established in 1988 by P G Jadeja and S L Jadeja in Rajkot. The company initially manufactured gear boxes for small lathes. In 1994, Jyoti made a foray into manufacturing special purpose machines for the textile machinery components industry.

By 1997, Jyoti had developed the capability to design and manufacture CNC machining centres. In 2001, Jyoti developed a vertical milling centre with linear motors and in 2004 it designed and manufactured a CNC laser cutting machine for diamond industry.

In FY 2006-07, the company achieved exports of Rs 30 cr on a turnover of Rs 280 cr. Jyoti has actively participated in international machine tool exhibitions such as EMO since 2003. Jyoti obtained the ISO 9001:1994 quality certification in 2000.

Key milestones in the company's trans-nationalization strategy have been -

- 2006 – Export House Certification
- 2006 – Alliance with Huron Graffenstaden, France for contract manufacture of CNC machines
- 2007 – Acquisition of Huron Graffenstaden

The acquisition of Huron Graffenstaden in 2007 has provided the company immediate access to customers in European markets such as France, UK, Portugal, Germany, Netherlands, Hungary, Poland, Spain, Austria and Switzerland besides Canada. Jyoti is represented by agents in Italy, Czech Republic & Slovakia, US and Iran.

Jyoti CNC is perhaps the best example of an Indian machine tool company strongly pursuing trans-nationalization. The company has rapidly progressed from being a machine tool component manufacturer to a conventional machine tool builder to developing expertise in CNC machine design and development. The acquisition of Huron Graffenstaden is a bold move to establish a strong market presence in the developed markets. It has also added Huron's specialized 3 and 5 axes high speed machining centres to Jyoti's product portfolio.

The ability to design and manufacture increasingly complex machine tools coupled with a keen focus on exporting to developed markets has been key to Jyoti's success in trans-nationalization.

Product range - sample



Vertical Machining Centre with linear motors

Horizontal Machining Centre

ii) Pragati Automation

Pragati Automation, an Ace Micromatic Group company, was established in Bangalore in 1977. Pragati manufactures machine tool accessories such as tool turrets for CNC lathes, auto tool changers for machining centres, power chucking cylinders, copy turning attachments etc. The company achieved a turnover of Rs 70 cr in FY 07 with exports of Rs.32 cr.

Key features of Pragati's trans-nationalization strategy are -

- supply to all large machine tool manufacturers in India and then expand in overseas markets – Italy, Germany, Spain, USA & Brazil are some of the important export markets.
- maintain prices at same level anywhere in the world and compete all over the world for supplies to OEMs,
- maintain sales offices in key locations (USA,Italy) and use distributors in other markets
- participate in exhibitions all over the world – from China, Taiwan, Europe to USA and South Africa
- offer complete range of products to OEMs so that they need not go to other suppliers
- plan new country entry strategies with great detail and perseverance – Pragati has taken more than 2 years to enter China to break through import restrictions & barriers,

Pragati is an excellent example of a company that has placed product development and quality above everything else. It has succeeded in developing world class products and then focussed on highly efficient production to attain international price competitiveness.

Product range – sample

Automatic tool changers



Servo turrets



Index tables



iii) ETA Technology

Established in 1991 in Bangalore. ETA has been very successful in the export of its products. However, the model followed by this company is different from that followed by Jyoti CNC and Pragati Automation. ETA Technologies has selected highly specialized, niche area for its operations: it started with friction welding machines, and

subsequently took up specialized products in hot upsetting, assembly/testing machines, servo controlled presses and special automobile components.

The machines require special engineering inputs, and are custom built to user specifications. By focussing on specializations of this nature the company is relatively free from competition from the South-Asian countries, and has established a reputation in the advanced markets of the world, besides the Indian market. Its export accounts for 50% of the company's turnover. The experience of ETA Technologies clearly brings out the avenues open for companies to transnationalize in niche, high technology product areas with less competitive threats from other countries.

Important export markets for ETA are Spain, Germany, Turkey and USA.

Product range – sample

Friction welding machine



Electrical upsetter



iv) **Ace Micromatic Group**

Besides Pragati Automation, the Ace Micromatic Group consists of –

- Ace Designers - manufacturer of CNC lathes and turning solutions
- Ace Manufacturing Systems – manufacturer of vertical machining centres
- Micromatic Grinding Technologies– manufacturer of cylindrical grinders

Ace Designers was promoted by Mr Srinivas Shirgurkar, Mr A.V. Sathe, and Mr B. Machado in Bangalore in 1979 as a machine tool design company. Ace's foray into manufacturing took off with special purpose machines for the engine valve industry, followed by semi automatic multi-slide lathes for the auto industry. In 1986 Ace launched its first CNC chucker LC-16 which was adjudged as the best designed machine at IMTEX 86, the premier machine tool exhibition. In 1996, the company became the largest CNC lathe manufacturer in the country.

Having begun as a machine tool design unit, the emphasis on R&D has always been very strong at Ace. It has been the backbone of the company's strong presence in the machine tool industry and has also been responsible for the string of successful machines and the constant endeavour to make these machines affordable.

Ace began its export foray in the eighties with exports of Auto Lathes with automatic load/unload systems for the bearing Industry. A large number of these machines are in use and regularly exported to Brazil, Egypt, Germany, Spain, UK & USA. Ace has about two hundred CNC Lathes at customer sites in Italy Australia, France, and USA.

Important steps taken by Ace to trans-nationalize have been –

- setting up a wholly owned subsidiary Ace International Inc. in Michigan USA to establish a foot hold in the competitive US markets in 1992.
- establishing distributor network in Italy, France, and Australia.
- efforts are on way to set up a distributor network in Germany, Benelux, UK & Spain

Ace Manufacturing Systems (AMS) was setup in 1994 to develop CNC machining centres. The company obtained its first export order from Italy in 2000 for supplying vertical machining centres. In 2002, AMS started working with M/s. Howa Machinery & SCMS of Japan to export horizontal machining centres. In 2004, the company exported 24 horizontal machining centres to Japan.

The Ace Micromatic group achieved a turnover of Rs 560 cr in FY 07.

The strategy of the Ace Micromatic group has been to manufacture standard CNC machines in volume to high quality and export them to the advanced as well as developing markets. The products face severe competition from Korea, Taiwan, Spain brands. The foray into the USA market was not profitable due to the high costs of market presence in the USA. So the company withdrew from the US market and is now focussing on the South Asian, Middle-East, Turkey and similar emerging markets.

Product range – sample



Machining centre



Turning Centre



Auto Lathe CNC

v) **Shanthi Gears**

Shanthi Gears manufactures speciality gears that range in weight from a few grams to more than 20 tonnes. The gears are used in products ranging from looms to power-generating turbines and aircraft.

The company was started in 1969 by P Subramaniam in Coimbatore and initially produced gears for the textile machinery industry. In the late seventies the company began to manufacture worm gear boxes. By the mid eighties Shanti gears had begun to produce helical gears, bevel helical gears and geared motors.

To gain better control over production, in 1986 the company built its own foundry. This integration helped the company improve the quality and delivery times of its products. The foundry caters to the needs of grey iron and spheroidal graphite castings, as well as non-ferrous ones such as phosphor bronze, aluminium etc. As a part of backward integration, a forging plant was commissioned simultaneously.

Shanthi Gears also makes its own hobbing and milling cutters, cutting down the delivery time of special orders, which have become a hallmark of the company. With its in-house design, manufacturing and quality-control facilities, the company is able to fill orders for practically any custom-made gears. Today, nearly 50 percent of the company's business involves special orders. Shanthi Gears has a team of over 80 engineers providing engineering design solutions as an outsourced service.

The company commenced exports in the mid nineties and now has a liaison office near Duesseldorf, Germany to provide sales and service support to the European market. In 2006-07, the company had exports of Rs 30 cr. Shanthi Gears has an ISO 9001:2000 certification.

Shanthi Gears exemplifies how Indian companies can use excellence in product development and manufacturing technology to break into developed export markets. The company has always stressed high product quality as its strength in export markets.

Product range- sample

Worm gear box



Helical and bevel helical gear box



Geared motor



vi) Lakshmi Automatic Loom Works

Lakshmi Automatic Loom Works Ltd., is a leading weaving and circular knitting machine manufacturer based in Coimbatore. The company is part of the well known Lakshmi Mills group.

The company has two divisions, namely - the weaving machinery and knitting machinery.

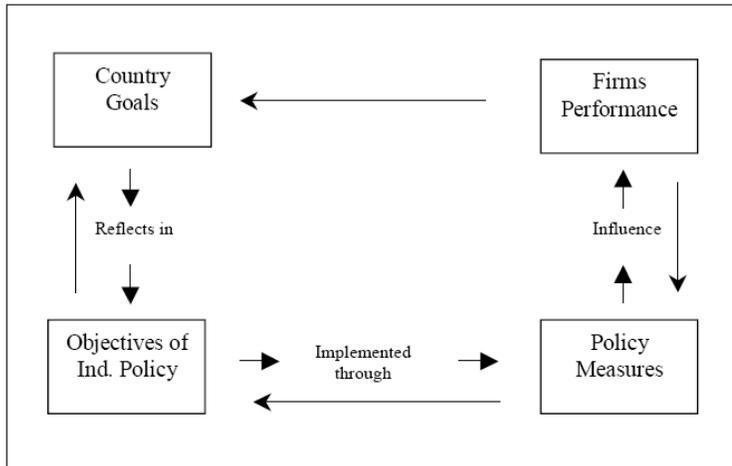
The knitting machinery division has a 100% export oriented unit manufacturing accessories such as tool holders for CNC machines. Lakshmi Automatic has entered into a buy back arrangement with Eppinger Tooling Asia Private Limited, Germany for exporting tool holders. Exports in 2006-07 were Rs 12 cr.

7 RECOMMENDATIONS

7.1 Context

Policy measures designed to improve performance of firms in the machine tool industry should be formulated within the context of national goals and the broad objectives of industrial policy.

Figure 9: Policy goals – firm performance linkage



The National Manufacturing Competitiveness Council (NMCC), an autonomous body constituted by the Government of India in 2004 serves as the policy forum for the manufacturing sector. The NMCC has articulated the need to achieve a growth rate of 14% p.a. in the manufacturing sector in the coming decade and increase its share of national GDP to 30% from the current level of 17%. To achieve this goal, NMCC has identified the following policy objectives for the manufacturing sector -

- a) Enhance Government focus on manufacturing competitiveness
- b) Creating conditions for investment in and growth of the manufacturing sector
- c) Lowering the cost of manufacturing
- d) Investing in innovation
- e) Strengthening education and training at all levels
- f) Adoption of global best practices in manufacturing
- g) Right market framework, competition and regulation
- h) Infrastructure development

The recommendations proposed in this study are within this context of national goals outlined by the NMCC.

7.2 Machine tools - a strategic industry

The following features and developments in the machine tool industry need to be underscored -

- i. A vibrant and technologically advanced domestic machine tool industry is critical for the growth and development of India's manufacturing sector. The industry has an enormous multiplier effect on manufacturing output (typically 1:100) and hence employment generation. Economic studies suggest that a one rupee value of machine tool production creates a ten rupee output for the broader capital goods industry and a hundred rupee output in downstream consumer goods.
- ii. A technologically advanced machine tool industry is vital to meet the requirements of programmes in India's strategic sectors – Space, Defence and Nuclear Energy.
- iii. Advanced manufacturing countries have always supported the machine tool industry as a strategic industry. Most recently, China and Taiwan have revealed ambitious plans to secure global domination of the industry.
- iv. Indian machine tool industry has inherent strengths but it is not keeping pace with highly dynamic competitors such as Korea, Taiwan and China in technological capabilities.
- v. Current and future path of technology of key machine tool sub-systems is controlled by a few large global firms that are unlikely to make state-of-art technology available to Indian firms. India must ensure technological self-reliance in the machine tool industry.

We, therefore, recommend that the machine tool industry be declared a strategic industry. A **national programme** for developing indigenous technology must be instituted. The objective of this programme should be the development and commercialization of key machine tool components and subsystems - spindles, CNC controls, servo motors, precision bearings and guideways – for the benefit of Indian manufacturers.

7.3 Other recommendations

The study findings strongly suggest that a wide range of initiatives spanning technology development, marketing, human resources and industry co-ordination are needed to strengthen the competitive position of Indian SMEs and promote their trans-nationalization. As these initiatives are beyond the capability of individual firms and the industry collectively to implement, a set of policy recommendations are being made to the Government of India.

It is envisaged that while these measures will aid all firms in the industry, those which already have an international orientation (active and committed exporters, and firms which have made manufacturing / marketing investments abroad) are likely to be the biggest beneficiaries.

Specific policy measures that are recommended are given in Table 12 below:

Table 12: Policy recommendations

Policy Area	Recommendation	Rationale	Implementing Agency
Technology	a) Central Manufacturing Technology Institute (CMTI), Bangalore should have a dedicated centre of excellence for machine tool technology with links to academic / R&D institutions in India and abroad. An Advanced Machine Tool Testing Facility should be set up at CMTI on priority to help SMEs and larger companies to test, upgrade and develop machines, accessories, sub-systems and parts to international standards.	CMTI is an R&D organization with facilities located in Bangalore which has the largest number of SME units. It is rendering limited assistance to the industry in the area of design, & development of machine tools, control systems and can develop this expertise provided modern facilities are set up. CMTI can also play a key role in tracking technology developments globally in machine tools.	Ministry of S&T/Heavy Industry
	b) Support and drive a “National Program for the Development of Machine Tool Electronics and Precision Elements” : This is a very important technology issue for SMEs and large units, all of which are solely dependent on imports for the critical components of modern machine tools.	Required for technology security and for cost reduction. The R&D program (estimated to cost around Rs.300 cr) can spawn an entirely new set of high-tech SMEs in the machine tool and industrial machinery sector with high prospects for domestic and export markets.	Ministry of S&T/Heavy Industry
Taxation	a) Weighted deduction for expenditure incurred on technology development/R&D should be allowed	This is already being allowed for 7 other industries and machine tools should be included as well.	Ministry of Finance
	b) No service tax should be levied on services utilized for machine tool exports	ST on certain inputs like inland transport, clearing/customs house charges etc. may be exempted for exports	Ministry of Finance
	c) Fringe Benefit Tax treatment should be at par with the IT industry		Ministry of Finance

Investment	a) Establish machine tool parks along the lines of software technology parks and textile parks. A Public – Private – Partnership model with international participation can be considered	<p>Geographical proximity of SME units facilitates capacity integration and economies of scale. <i>This factor has immensely benefited SMEs in Italy. Italy's machine tool industry is located in the Milan region. Most of the suppliers to the industry are likewise located in this part of the country. Machine Tool Parks have placed Taiwan among the top producers and exporters of machine tools;</i></p> <p><i>Taiwan has become one of the top machine tool producing and exporting countries through the establishment of machine tool parks, in Taichung, for instance.</i></p>	Ministry of Heavy Industry
	b) Establish common facility centres in at least three regions – North, South and Western India – to provide SMEs with facilities for precision machining, CAD/CAM/CAE, metrology and heat treatment	Modern facilities in core areas are required to upgrade technology among SMEs and to some extent even larger companies.	Ministry of Heavy Industry

Market Development	a) Establish large showrooms in important locations overseas in consultation with IMTMA. This could be taken up by Engineering Export Promotion Council (EEPC). A nominal charge can be recovered from machine tool companies. (EEPC has set up showrooms in Johannesburg and Chicago but not to accommodate machine tools)	Space requirements to display machine tools are large. Showrooms currently used by EEPC are insufficient in size. The costs of large showrooms are too high to be borne entirely by Indian SMEs. Foreign manufacturers such as Makino, Mazak and DMG have leveraged their showrooms in India to increase sales. The American Machine Tool association has also announced its intention to open a display centre for US machines.	Engineering Export Promotion Council / Ministry of Commerce
	b) EEPC schemes for participation in exhibitions and market research may be administered by IMTMA and given more publicity.	The “Made in India” brand image for machine tools needs to be enhanced. Exhibitions will provide an opportunity for SMEs to market themselves as ideal partners for contract manufacturing for bigger international players. This strategy of riding on international brands should be pursued till the “Made in India” brand is established. There is a large export market for custom built machines where Indian manufacturers can compete since this segment is dominated by German manufacturers that supply very expensive machines. Market research will help SMEs identify target markets and products.	Engineering Export Promotion Council / Ministry of Commerce
	c) Part fund quality training / certification programmes and consultancy services	Need for quality consciousness in the industry needs to be reinforced.	Engineering Export Promotion Council / Ministry of Commerce
	d) Rupee invoicing of exports should be taken as a strategy.	Appreciation of the rupee against the dollar has had an adverse impact on Indian export competitiveness especially against China. MoC may examine steps required to promote acceptance of rupee invoicing abroad.	Ministry of Commerce
	e) Establish a design and consulting company that can design and supply manufacturing facilities for automobile, auto ancillary and other engineering industries. This company could be similar to Engineers India Limited.	Customers increasingly prefer project solutions to buying individual machine tools. Expertise in engineering design, CNC programming and automation is already available in the country. Korean companies have benefitted from this model.	Ministry of Industry

Manpower	Make a critical assessment of manpower and skills requirement for the next 10 years and plans to meet this through suitable upgradation of academic, vocational and training mechanisms in the country.	There is concern at the scarcity of the specialized talent that is required to continuously drive the machine tool industry to higher technology and international arena. This has to be tackled urgently	TIFAC; Ministry of HRD
Education and Training	<p>a) Introduce Manufacturing Engineering as a distinct discipline in engineering colleges and industrial training institutes and upgrade curriculum and facilities to suit modern requirements of machine tool and manufacturing industries.</p> <p>b) Fund overseas long duration (1-2 year) training programmes in machine tool technology for personnel in Indian SMEs. Training programmes can be designed by IMTMA in co-ordination with foreign machine tool associations.</p> <p>c) Opportunities for exchange programmes for Indian machine tool employees to work abroad; similarly for foreign professionals to work with Indian firms for 1-2 years; partially paid for by government</p> <p>d) Provide training and participation in the “World Skills” competition for machine tool related skills: will require facility creation/augmentation and training</p>	<p>There is a critical shortage of competent manpower at all levels in the machine tool industry – technicians, engineers, and sales. The problem is particularly acute in SMEs. The current Mechanical Engineering curriculum in the country does not prepare graduates for a career in manufacturing.</p> <p>Industry personnel must be exposed to best global manufacturing practices and technology. A critical mass of foreign trained engineers must be created for Indian industry to catch up with the competition. These programmes will also improve the image of the metal working industry especially in comparison to the IT industry, and help to attract and retain talent.</p> <p>Exchange visits improve skills and technology especially in Indian SMEs</p> <p>India has become a member of World Skills organization but needs great improvement to reach international skill levels. This will have a beneficiary effect on engineering skills across all industries</p>	<p>Ministry of Education/Human Resources Development</p> <p>Ministry of Human Resources Development</p> <p>Ministry of Industry</p> <p>Ministry of Education/HRD</p>
Trade policy	a) Include Indian machine tools in list of goods for preferential treatment in trade agreements.	Overcomes trade barriers currently experienced by the industry in export markets.	Ministry of Commerce

8 ANNEXURES

8.1 Global Production, Consumption & Trade Data Source: Gardner Inc (2007 World Machine Tool Output and Consumption Survey)

A. Machine Tool Production - 2006

Rank	Country	Total (US\$ billion)	Metal Cutting (US \$ billion)	Metal Forming (US \$ billion)	Metal Cutting (%)	Metal Forming (%)
1	Japan	13.5	11.9	1.6	88%	12%
2	Germany	10.3	7.5	2.8	73%	27%
3	China	7.0	5.2	1.8	74%	26%
4	Italy	5.5	2.8	2.7	51%	49%
5	Korea	4.1	3.0	1.2	72%	28%
6	Taiwan	3.7	2.8	0.8	77%	23%
7	USA	3.6	2.9	0.8	79%	21%
8	Switzerland	2.8	2.3	0.5	84%	17%
9	Spain	1.2	0.8	0.4	64%	36%
10	France	1.1	0.6	0.5	54%	46%
11	Canada	1.1	0.7	0.4	60%	40%
12	Brazil	1.0	0.8	0.2	81%	19%
13	U.K.	0.9	0.7	0.2	78%	22%
14	Netherlands	0.5	0.1	0.4	20%	80%
15	Czech Republic	0.4	0.4	-	92%	8%
16	Turkey	0.4	0.1	0.3	30%	70%
17	Austria	0.4	0.3	0.1	60%	40%
18	India	0.4	0.4	-	88%	12%
19	Belgium	0.3	-	0.3	10%	90%
20	Finland	0.3	-	0.3	16%	84%

B. Machine Tool Consumption – 2006

Rank	Country	Consumption (US\$ billion)
1	China	12.9
2	Japan	7.4
3	United States	6.3
4	Germany	5.2
5	Korea, Rep. of	5.0
6	Italy	3.6
7	Taiwan	2.5
8	France	1.6
9	Canada	1.6
10	Brazil	1.4
11	India	1.3
12	Mexico	1.3
13	Spain	1.1
14	Turkey	1.1
15	Switzerland	0.9
16	United Kingdom	0.9
17	Netherlands	0.4
18	Czech Republic	0.4
19	Sweden	0.4
20	Russia	0.4

C. Machine Tool Exports - 2006

Rank	Country	Exports (US \$ Billion)	Exports (as % of production)
1	Germany	7.5	73%
2	Japan	6.9	51%
3	Italy	3.3	60%
4	Taiwan	2.9	79%
5	Switzerland	2.5	89%
6	USA	1.8	50%
7	Korea	1.7	40%
8	China	1.2	17%
9	UK	0.9	101%
10	Spain	0.7	57%
11	Belgium	0.7	219%
12	France	0.7	58%
13	Czech Republic	0.5	107%
14	Austria	0.5	114%
15	Netherlands	0.3	71%
16	Turkey	0.3	69%
17	Canada	0.3	25%
18	Finland	0.2	82%
19	Sweden	0.2	86%
20	Brazil	0.1	16%

D. Machine Tool Imports – 2006

Rank	Country	Imports (US \$ Billion)	Imports (as % of 2006 consumption)
1	China	7.1	55%
2	United States	4.4	71%
3	Korea, Rep. of	2.6	51%
4	Germany	2.4	47%
5	Taiwan	1.8	70%
6	Italy	1.4	38%
7	Mexico	1.1	98%
8	France	1.1	70%
9	Turkey	1.0	88%
10	United Kingdom	0.9	101%
11	Japan	0.8	11%
12	Canada	0.8	46%
13	Belgium	0.7	213%
14	India	0.9	69%
15	Brazil	0.6	44%
16	Spain	0.6	52%
17	Switzerland	0.5	62%
18	Czech Republic	0.4	108%
19	Sweden	0.4	92%
20	Austria	0.3	119%

8.2 Survey questionnaire

Defining the Role of Government in Trans-nationalization Efforts of Indian SMEs in Machine Tool Sector

1. Name & address of respondent company –
2. Name & address of respondent –
3. Year of establishment of business –
4. Names of sister concerns within the group-
5. List of main customers –
 - a. India-
 - b. Abroad
6. Main products of the company (*collect brochures*) -
 - a. –
 - b. –
 - c. –
7. Number of employees -
8. Data on turnover- (value Rs. Lakhs)

	2005-06	2006-07
Turnover from Machine Tools –		
Number of machine tools sold		
Turnover from other products –		
Turnover from supply of spares and other accessories		
Income from consultancy, design etc. (if any) –		
Purchase of outsourced local components from vendors		

9. Details on imports (details of main imported items) – value Rs. Lakhs

TOTAL IMPORTS	2005-06	2006-07
Direct imports of Machine Tools - attachments/ tooling		
Import of other products CNC elements		
Import of tooling		
Purchase of imported assemblies from agents/ stockists		
Purchase of design and drawings from abroad (if any) –		

10. Details on exports (details of main export items)- value Rs. Lakhs

TOTAL EXPORTS	2005-06	2006-07
Turnover from export of Machine Tools –		
Turnover from export of other products –		
Export of technical consultancy		
Export of design and detailing		
Any other exports (kindly give details)		

11. If no exports give reasons –
12. What are the names of other manufacturers in India in the SME sector (turnover below Rs. 60 crores) in India who compete with you in the product range you have?
13. Have you tried for any risk capital for funding up gradation of technology in your unit or your group?
YES/ NO
14. In case you have competed with imported machine tools in some customer enquiries within the country and did not get the contract, kindly give the reasons for loosing the order –

- a. Lack of appropriate technology-
- b. Lack of capacity-
- c. Tight delivery schedules-
- d. Lack of high tech automation components-
- e. Could not match customer's requirements of design –
- f. Imported machines were much cheaper (kindly give details of how cheap the machines were)-

15. Do you know of any technology funding programmes from Government of India? **YES / NO**
16. If **YES** what are the programmes?
17. Have you ever competed in enquiries from overseas Companies? **YES / NO**
18. If **YES** which country and the details of outcome of enquiry-
19. Have you attended any of the machine tool exhibitions in India and abroad in the last few years- kindly give a list-
20. What should be the focus countries for Indian machine tool manufacturers in the SME sector to become globally competitive?
21. Are you interested in setting up a manufacturing facility abroad as Joint Venture or supply of turnkey projects? **YES / NO**
22. If **YES** what are the constraints faced and facilities required?

8.3 List of Participants in EMO-Hanover 2007 Trade Fair

1	M. K. International	Aurangabad
2	Gaurav Engineers	Aurangabad
3	ACE Designers Ltd	Bangalore
4	Bharat Fritz Werner Ltd	Bangalore
5	Cobra Carbide Pvt. Ltd	Bangalore
6	Fenwick and Ravi	Bangalore
7	Pragati Automation Pvt. Ltd	Bangalore
8	Uday Computer Aided Mfg. Pvt. Ltd.	Bangalore
9	Proteck Circuits and Systems Pvt. Ltd	Chennai
10	Airtech Private Ltd	Dharwad
11	Micromatic Grinding Technologies Limited	Ghaziabad
12	ITL Industries Ltd.	Indore
13	Sharp Chucks & Machines Ltd.	Jalandhar
14	Khushbu Engineers	Kolhapur
15	Bipico Industries (Tools) Pvt. Ltd.	Mumbai
16	Forbes Gokak Ltd	Mumbai
17	Krishna International	New Delhi
18	Shobha Industries	New Delhi
19	Ind-Sphinx Precision Limited	Parwanoo - HP
20	Carbtools (India) Pvt. Ltd	Pune
21	Electronica Machine Tools Ltd.	Pune
22	Universal Engg. & Mfg. Industry	Pune
23	Jyoti CNC Automation Pvt. Ltd.	Rajkot

8.4 Survey respondents

Bangalore

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	ETA Technology Pvt. Ltd	Bangalore	P.S.Nair. M.D.	29	12	41	Small	Friction welding, CNC Grinding	niche market designs	niche market, direct orders- very less competition worldwide
2	UCAM P Ltd	Bangalore	Lakshmi, Finance Dir.	22	3	25	Small	Rotary Tables, Indexing table	high quality products	participate in exhibitions- direct marketing & agents
3	Maxpreci Machines Pvt. Ltd	Bangalore	Thamby Alapat, E.D.	3	0.9	3.9	Small	Eng. Rebuilding m/cs	niche product	give good margin to agents in Dubai & Sri Lanka
4	Indian Precision Engineers	Bangalore	Thirumala, GM	1.4	0.35	1.75	Small	Electromagnetic clutches & brakes	niche product	direct sales
5	CNC India Tools	Bangalore	V. Phadnis, Astd. Mgr	1.7	0.6	2.3	Small	Toolings & reconditioning	service based tooling	direct sales-agents
6	Shoma Enterprise	Bangalore	K.Appunni, Mgr	1.6	0.4	2	Small	CNC Machines- aerospace, press tools	design based products	indirect exports through m/c tools
7	Fenwick & Ravi	Bangalore	Fenwick Thomas, Partner	5.5	1	6.5	Small	CNC Lathe accessories	Own designs	exhibitions, agents
8	Kladon Designs Pvt. Ltd	Bangalore	Suresh, Director	3.6	0.45	4.05	Small	Product design, sound proof enclosures	custom designs	indirect exports through m/c tools
9	Mecprosyst M/c tools Pvt. Ltd	Bangalore	Suryanarayan, M.D.	1.8	0.2	2	Small	Fixtures, auto m/c tools	None	indirect exports through m/c tools

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
10	Tool Grinding Tech	Bangalore	Santosh Prabhu	6	0	6	Small	CNC Tool and Grinding m/c, Cutting Tools	None	None
11	Cosmos Engg	Bangalore	Biswas S	5	0	5	Small	Pressed Products	None	In process
12	VJ Industries	Bangalore	Nagabhushan	5.5	1.5	7	Small	Pressed Comp, Sheet Metal Prod	None	US export
13	Sunmas Machine Tools	Bangalore	Shiva Shankar DGM	4	0	4	Small	Special Purpose M/C	None	None
14	Enconpass	Bangalore	KR Saji	5.25	0	5.25	Small	Control Panels	None	No orders
15	Metalica Pressings	Bangalore	Ranjith K	3.5	0	3.5	Small	Pressed Products	None	No orders
16	Chandra Engg Works	Bangalore	Rakesh	4.15	0	4.15	Small	SPM assemblies, parts for earth movers	None	Not Tried, already overloaded
17	Ashwini Engg Works	Bangalore	Suresh Kumar	4.1	0	4.1	Small	CNC m/c Comp	None	None
18	Radiant Tech	Bangalore	Mrs. Rama - Proprietor	4	0	4	Small	Aerospace Components	None	In process
19	Technomech Engineering	Bangalore	Suresh M	3.7	0	3.7	Small	Cutting Tools, Dyes and Bushes	None	Bargaining
20	Acumac Machine Tools	Bangalore	Milind Jalihal	3.13	0	3.13	Small	CNC Internal Grinding m/c, Centre Hole Grinding m/c, Spindles	None	Market Penetration Difficult

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
21	Machine Elements	Bangalore	Harish Asrani - Partner	2.9	0	2.9	Small	MTA, MTS, Reconditioning of m/c tools	None	None
22	Protocol Ind	Bangalore	V.Shankar	2.5	0	2.5	Small	Pressed Components, Brass Precision Thermal	None	None
23	Sushma Industries	Bangalore	Ravi Kumar Marketing Manager	2.3	0	2.3	Small	Testing Eqp, Instrumentation Software soln	None	Lack infrastrucutre to export
24	Unique Instruments & Mfrs Pvt. Ltd.	Bangalore	Jatil Bhavsar - Marketing Manager	2.19	0	2.19	Small	Caliberation Inspections, Precision measurements, CNC millings	None	Trying to export
25	V.M. Engg,	Bangalore	Chandra Kumar, CEO	2	0	2	Small	Spark Erosion m/c, CNC Engraving m/c	None	Lack quality for exports
26	Akshaya Special m/c Pvt Ltd	Bangalore	Arivalagan - MD	1.3	0	1.3	Small	Special m/c tools	None	technology & manpower
27	Krafield Tool Room,	Bangalore	Kishore Kumar	1.15	0	1.15	Small	Tooling, Diemaking and Aerospace Comp	None	Bargaining,getting enquiries
28	Pratham Pressings	Bangalore	Yogesh Shah	1.14	0	1.14	Small	Pressed Comp, Electro plated pressed tools	None	Planning to export
29	Geetha Consulting Engg	Bangalore	Chiranjeev Sharma	0.92	0	0.92	Small	Design and Consultancy for m/c tools	None	Small Co., Less Delivery time, Short on Man-power

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
30	Jyothi Industries	Bangalore	Sharath Kumar, Partner	0.6	0	0.6	Small	m/c Tool accessories, SPM for metal cutting tables	None	Not Ventured into Export Brands
31	Bombay Machines	Bangalore	Girish Hosmani Director	0.27	0	0.27	Small	M/C Tools, CNC Lathe	None	not decided, lack of finance
32	MICO BOSCH	Bangalore	N.Umesh, GM & B.H.	45	8	53	Medium	Industrial Equipments	None	BOSCH- gets orders
33	Batliboi Ltd.	Bangalore	H.K.Prasanna Kumar, Sales Mgr	87	5	92	Medium	Milling m/c, CNC lathe	SPMs	order basis- no strategy
34	HMT Ltd	Bangalore	A.V.Kamat, CMD	340	8	348	Large	M/c tools	None	Direct through HMT International
35	HMT Machine Tools Ltd	Bangalore	K.H.Suresh, GM	280	6	286	Large	M/c tools	N.A.	N.A
36	BFW Ltd	Bangalore	Ashok N Badhe, GM	278	25	303	Large	M/c Tools	R&D center in Pune	Swiss buyer- back to back technology transfer
37	Micromatic Machine Tools Pvt. Ltd.,	Bangalore	T.K.Ramesh, Vice President	560	10	570	Large	M/c tools	None	None
38	Kennametal India Ltd	Bangalore	J.Prabhakar, Sr. Mgr	288	N.A.	288	Large	SPMs	SPMs	N.A.
39	Pragati Automation Pvt. Ltd	Bangalore	Atul S. Bhirangi, M.D.	38	32	70	Large	Tool Turrets, Tool Disc	own designs- new formats	direct offices, agents, exhibitions
40	DMG India Pvt. Ltd	Bangalore	S.G.Narayan, M.D.	N.A.	N.A. (importer)		NA	Imported m/c tools	N.A.	N.A
41	Siemens India	Bangalore	Raghavendra Mutalik	N.A.	N.A. (importer)		NA	CNC Systems & drives	N.A.	N.A
42	Fanuc India Pvt. Ltd	Bangalore	Ms. Sonali Kulkarni, President & CEO	N.A.	N.A. (importer)		NA	CNC systems	N.A.	N.A
43	Liebherr Machine Tools India Ltd	Bangalore	Anil Aggrawala, MD.	N.A.	N.A.		NA	Gear cutting/ gear hobing	SPMs	N.A.

Rajkot:**(Fig for FY 2006 – 07)**

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	Shailesh Machines Pvt Ltd	Rajkot	Shailesh Kawa, MD	25	5	30	Small	Presses, lathes	None	African countries, dealers
2	Macpower CNC Machines Pvt. Ltd.	Rajkot	Rupesh J Mehta, M.D.	54	8	62	Medium	CNC Turning centers, VMC m/c	standard m/cs	export to Africa & UK-known distributors
3	Jyoti CNC Automation Pvt. Ltd	Rajkot	P.G.Jadeja, M.D	250	30	280	Large	CNC Turning centers, turn-mill centers	collaborate with European majors	join with large European manufacturers

Mumbai:

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	Bipico Industries Pvt Ltd	Mumbai	Pramitbhai Patel	15	2.5	17.5	Small	Metal cutting saws	none	export to Russia, Europe, Asia
2	Forbes Gokak Ltd	Mumbai	Abhay Jain	35	4	39	Small	Tapping /threading tools	own metallurgy	target developed markets -direct selling

Hyderabad:

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	Precision Tools	Hyderabad	Narasimha Reddy, M.D.	1.1	N.A.	1.1	Small	Surface & centerless grinding m/c	NA	NA
2	Praga Tools Ltd	Hyderabad	M.Shankar, Chief Mktg	13	N.A.	13	Small	Lathes, machining centers	NA	NA
3	Lokesh Machines Ltd	Hyderabad	M.Lokeswara Rao, M.D.	110	4	114	Large	Range of m/c tools	low cost high volume products	exports on low prices

Indore:

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	ITL Industries Ltd.	Indore	S.B.Naik, M.D.	26	13	39	Small	Bandsaw machines	technology partner-Kasto - Germany	buy back with partners
2	Indotech Machines	Indore	Mukul Gogate, GM	44	18	62	Medium	Bandsaw machines	technology partner-Bomar-Czech & Exact Cut-Germany	buy back with partners

Coimbatore:

(Fig for FY 2006 – 07)

No	Name of unit	Location	Person contacted	Domestic Turnover (Rs cr)	Export Turnover (Rs cr)	Total turnover (Rs Cr)	size	Products	Product Feature	Transnationalization strategy
1	PSG Industrial Institute	Coimbatore	Subramaniam- Production and vendor development incharge	4	N.A.	4	Small	Complete range of m/c tools	N.A.	N.A
2	Gedeewailer	Coimbatore	Nithiayanandam	12	N.A.	12	Small	Range of m/c tools	N.A.	N.A
3	Teakrafts	Coimbatore	Sangeet Bagaria	21	1.2	22.2	Small	Tea Processing Mechanisation, Agro m/c	develop own designs	export through large export house
4	Lakshmi Automatic Loom Works	Coimbatore	Mani N	12	12	24	Small	CNC Tool Holders	collaboration & reverse engineering	buy back arrangement
5	G-Tech Engg	Coimbatore	Ganesan	11	N.A.	11	Small	Injection Moulding m/c, Hydraulic, Rubber moulding m/c	N.A.	N.A
6	Reshmi Industries	Coimbatore	Murali	30	10	40	Small	Conewinding machines	Niche product	West Africa
7	Janatics India Pvt. Ltd.	Coimbatore	Ganapathy Subramaniam,	60	2	62	Medium	Pneumatic Items, Industrial Automations	reverse engineering	N.A
8	Lakshmi Ring Travellers Ltd	Coimbatore	Anbalagan, Prodn Head	650	N.A.	650	large	Ring Travellers for spinning mills	N.A.	N.A
9	Shanti Gears Ltd.,	Coimbatore	Kurup	220	30	250	Large	Gear Box, Motors, CNC m/c tool	specislised in gear & gear box designs	export high tech machines, agent in Germany
10	Laksmi Machine Works	Coimbatore	Annandurai	110	5	115	Large	Spinning mill m/c, Machine Tools	collaboration & reverse engineering	exhibitions, projects

8.5 Survey respondents contact list and addresses

BANGALORE

No	Name of unit	Person contacted	Address
1	ETA Technology Pvt. Ltd	P.S.Nair. M.D.	# 484 D, 13th Cross, 1vth phase, Peenya
2	UCAM P Ltd	Lakshmi, Finance Dir.	# A-11/A-12, 1st stage, 1st cross, Peenya,
3	Maxpreci Machines Pvt. Ltd	Thamby Alapat, E.D.	# A-373, 4TH Main, 8th Cross, Peenya
4	Indian Precision Engineers	Thirumala, GM	# 8/9, Shankarmutt Rd
5	CNC India Tools	V. Phadnis, Astd. Mgr	#349, Srinivasa Complex, 1 st Floor, 6 th Main, Outer Ring Rd. Narasimha Layout
6	Shoma Enterprise	K.Appunni, Mgr	# C-28, 2nd Stage, Peenya
7	Fenwick & Ravi	Fenwick Thomas, Partner	#10/3, Lakshmipura Main Road, Abbigere
8	Kladon Designa P. Ltd	Suresh, Director	# Lakshmi Venkateswara Ind. Est, No. 1 8 th Main Rd., Peenya 2 nd stage
9	Mecprosys M/c tools Pvt. Ltd	Suryanarayan, M.D.	# B-178, 4TH Main Road, 2nd Stage, Peenya
10	Tool Grinding Tech	Santosh Prabhu	#467-469, 4th Phase, 12th Cross, Peenya
11	Cosmos Engg	Biswas S	#B-246, 4th Main, 2nd Stage, Peenya
12	VJ Industries	Nagabhushan	#A290, 6th Main, 2nd Stage, Peenya
13	Sunmas Machine Tools	Shiva Shankar DGM	#432/1, 4th Main, 12th Cross, 4th Phase, Peenya
14	Enconpass	KR Saji	#74/2A, Krishnappa Ind Estate, Hegganahalli
15	Metalica Pressings	Ranjith K	#B-192, 2nd Stage, Peenya
16	Chandra Engg Works	Rakesh	#52, Koramangala Ind Estate
17	Ashwini Engg Works	Suresh Kumar	#14, 4th Cross, 4th Stage, Rajajinagar Ind Town
18	Radiant Tech	Mrs. Rama - Proprietor	#177/26, 4 Main Road, Ind Towm, Rajajinagar

No	Name of unit	Person contacted	Address
19	Technomech Engineering	Suresh M	#12, 4th Main, 4th Cross, Rajajinagar Ind Town
20	Acumac Machine Tools	Milind Jalihal	#472-A, 12th Cross, 4 Phase, Peenya
21	Machine Elements	Harish Asrani - Partner	#48, 2nd Phase, Peenya Ind Estate
22	Protocol Ind	V.Shankar	#192/A, 7th Main, 6th Cross, Rajajinagar
23	Sushma Industries	Ravi Kumar Marketing Manager	#18E, Block B, 1st C Main Road, 2nd Phase, Peenya
24	Unique Instruments & Mfrs Pvt. Ltd.	Jatil Bhavsar - Marketing Manager	#423, 11th Cross, 3rd Main, Peenya
25	V.M. Engg,	Chandra Kumar, CEO	#B-30, 1st Stage, 1st Cross, Peenya
26	Akshaya Special m/c Pvt Ltd	Arivalagan - MD	#A-279, 2nd stage, Peenya Industrial Estate Bangalore
27	Krafield Tool Room,	Kishore Kumar	#9/2, 4th main, 6th Cross, Rajajinagar Ind town
28	Pratham Pressings	Yogesh Shah	#D-432, 10th Main, Peenya
29	Geetha Consulting Engg	Chiranjeev Sharma	#1297, 8th Cross, 1st Phase, JP Nagar
30	Jyothi Industries	Sharath Kumar, Partner	# A-18, HMT Ind Estate
31	Bombay Machines	Girish Hosmani Director	# C-88, 2nd Stage, Peenya
32	MICO BOSCH	N.Umesh, GM & B.H.	# Hosur Road
33	Batliboi Ltd.	H.K.Prasanna Kumar, Sales Mgr	# 99/2,N.R.Road
34	HMT Ltd	A.V.Kamat,CMD	# 59, Bellary Rd.
35	HMT Machine Tools Ltd	K.H.Suresh, GM	# HMT P.O.
36	BFW Ltd	Ashok N Badhe, GM	# off Tumkur Rd
37	Micromatic Machine Tools Pvt. Ltd.,	T.K.Ramesh, Vice President	#533, 10 th Main, 4 th Ph. Peenya

No	Name of unit	Person contacted	Address
38	Kennametal India Ltd	J.Prabhakar, Sr. Mgr	# Tumkur road
39	Pragati Automation Pvt. Ltd	Atul S. Bhirangi, M.D.	# 413, Ivth Phase, Peenya
40	DMG India Pvt. Ltd	S.G.Narayan, M.D.	# Al Latheef, no.2/1,Union Street
41	Siemens India	Raghavendra Mutalik	# Du Park Trinity, M.G.Road
42	Fanuc India Pvt. Ltd	Ms. Sonali Kulkarni, President & CEO	# 41 A, Electronics City
43	Liebherr Machine Tools India Ltd	Anil Aggrawala, MD.	#353-354, 9th Cross, 4th Main, Ivth Phase, Peenya

RAJKOT

No	Name of unit	Person contacted	Address
1	Shailesh Machines Pvt Ltd	Shailesh Kawa, MD	#10, Bhaktinagar Station Plot,Rajkot - 360 002
2	Macpower CNC Machines Pvt. Ltd.	Rupesh J Mehta, M.D.	# Plot 2234, GIDC, METODA, Kranti Gate,Lodhika Vill. Metoda, Rajkot
3	Jyoti CNC Automation Pvt. Ltd	P.G.Jadeja, M.D	# G-506, Lodhika, GIDC, Vill. Metoda, Rajkot Distt

MUMBAI

No	Name of unit	Person contacted	Address
1	Bipico Industries Pvt Ltd	Pramitbhai Patel	#506-A, Lotus House, 5th Floor, 11, Sir V. Thackersey Road, Mumbai-020
2	Forbes Gokak Ltd	Abhay Jain	# Saki Powai Road, Chandivili, Mumbai

HYDERABAD

No	Name of unit	Person contacted	Address
1	Precision Tools	Narasimha Reddy, M.D.	# Balanagar Indl Area, Hyderabad
2	Praga Tools Ltd	M.Shankar, Chief Mktg	#6-6-8/32, Kavadiguda Rd., Secunderabad
3	Lokesh Machines Ltd	M.Lokeswara Rao, M.D.	# B-29, EEIE, Stage 2, Balanagar, Hyderabad

INDORE

No	Name of unit	Person contacted	Address
1	ITL Industries Ltd.	S.B.Naik, M.D.	#111, Sector B, Sanwer Road Industrial Area-452015
2	Indotech Machines	Mukul Gogate, GM	#28-29, RR Private Indl. Est., Nr. Shivna Spinners Sanwer Rd,indore-452015

COIMBATORE

No	Name of unit	Person contacted	Address
1	PSG Industrial Institute	Subramaniam- Production and vendor development incharge	# Peelamedu, Coimbatore
2	Gedeweiler	Nithiyanandam	# VELLALORE, Coimbatore
3	Teakrafts	Sangeet Bagaria	#18, SIDCO, Kurichi, Coimabtoe
4	Lakshmi Automatic Loom Works	Mani N	# Singarampalyam, Kinathukadavu Post
5	G-Tech Engg	Ganesan	#3, 2nd Street, Textool, Ganapathy
6	Reshmi Industries	Murali	#Ammankulam Road, Pappanaickenpalayam
7	Janatics India Pvt. Ltd.	Ganapathy Subramaniam,	#E-25, SIDCO, Kurichi, Coimbatore
8	Lakshmi Ring Travellers Ltd	Anbalagan, Prodn Head	# Unit 2, Muthugoundermpudur, Coimbatore
9	Shanti Gears Ltd.,	Kurup	#304A, Singanallur
10	Laksmi Machine Works	Annandurai	# Perianaickempalayam

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