EXECUTIVE SUMMARY

1. INTRODUCTION

The Indian engineering industry, with its annual turnover of about Rs.50,000 crores, is very much dependent upon the mother machines-the machine tools for its production. The production of engineering industry forms nearly a third of the total industrial output. The introduction of CNC machines has made it possible to produce goods of repeatable consistent quality, apart from enabling the industry to optimise productivity with a high degree of flexibility in production batches. Though the size of the machine tool production is only Rs.400 crores per annum, its impact on the engineering industry is very profound indeed. Hence, the need for paying due attention to the growth of the machine tool industries on sound and state-of-the-art lines. In the machine tool production, throughout the world, great emphasis is being laid on the increased application of CNC machines. India, having realised this fact very late, has to take bigger strides in this area to have the desired impact on the engineering industry, both for internal and external markets.

India, which had been almost self-reliant in machine tools in the 1970's has had to resort, in recent years, to import nearly half its requirement, in monetary terms. This clearly indicates that the Indian Machine Tool Industry has not kept itself abreast with the changing requirements of the user industries.

The Country, which was beginning to be accepted internationally as a reliable source of machine tools, has in recent years yielded place to other newly industrialised countries of Asia, like Taiwan and Korea.

Both these factors point to lack of adequate forward planning and guidance of development efforts in the needed direction.

In the decade of 1980's CNC machines have played a key role throughout the world in increasing: reliability, productivity and production versatility. The result has been a steady growth of proportion of CNC machines in the number of machines installed all over the world. The production of CNC machine tools as a percentage of total machine tool production in countries like Japan, West Germany, Italy and France, has reached a figure of 60-70%, as compared to only 10-15% (by value) in case of India. Generally the share of

turning machines and machining centres in the overall CNC machines production is predominant throughout the world. In India also these machines form over 60% of the total NC machines production every year. This report concentrates on these groups of machines

2. CAPACITY/PRODUCTION - IMPORTS/EXPORTS

There are 46 units having licences for manufacture of CNC machines and 27 of them are for manufacturing CNC lathes and machining centres. 22 units are in production of CNC machines, out of which 17 are for CNC lathes and machining centers. For CNC systems and controls, 13 licences have been issued and 5 units are in production.

IMTEX '89 showed new CNC machines and CNC systems manufactured in the small scale sector also, which will give a big boost to the CNC industry.

The production of CNC machines and systems has increased from a level of Rs.76.3 million in 1984 to nearly tenfold in four years. However, the bulk of India's requirement continues to be imported. In 1986, out of a total of 1180 NC machines installed, 1044 were of imported origin. Though separate figures for CNC machine imports are not available, a bulk of the Rs.3700 million machine tool imports are CNC machines.

In recent years, India has made a beginning by exporting indigenously manufactured machining centres to even developed countries. With the available broad base for production of main machine tool components and assemblies, India has a good potential for stepping up of exports of CNC machines. However, design innovations would have to be continuously updated, to keep in line with international developments.

3. INTERNATIONAL SCENE

CNC machines, in the advanced countries, are generally replacing the older generation conventional machines, during the last 10-15 years. Presently, over 60% of the machine tools produced in advanced countries, are accounted for by CNC machine tools.

There has been an increasing trend of not only induction of CNC production machines on the shop floor, but also resort to more and

more of automation. This has encompassed robotic work handling, flexible machining cells, and automated factories, including automation in production planning, inventory management, work centre management, quality control, ensuring a product quality, interchangeability, product diversification and high productivity

The CNC system has played a key role in the making of the modern automation systems and, as such, rapid progress has been made in this field. Apart from encompassing a multi-axis capability of machine monitoring of dimension during machining, monitoring of tool wear and tool breakage, increased capacity of tool magazines and multiple pallet changers, there has been a development of ease of programming and user friendliness. Very high mean time between failures are becoming normal features. The introduction of dual 32 bit processors and built-in communication ability (LAN/MAP) to work with other machines as a system in flexible machining system, have further stretched the capability of the modern CNC systems. The increasing trend of using Computer Aided Designing, has brought in features of CNC system software capabilities of accepting the standard CAD files and automatically working out machining schedules, even taking care of tolerancing dimensions as required by the tool/die design.

The interfacing of the machine tool and electronic controls has made possible the production of universal machining centres with jig boring accuracy, which would find a place of pride in future tool rooms.

The higher spindle speeds made possible in the modern CNC machines, has led to use of cermet and ceramic tools, which not only substantially increase the material removal rate, but also enable grinding finish to be obtained in normal turning, milling and boring operations.

4. CONCLUSIONS

The machine tool industry, ably lead by HMT, continuously grew both in content and quality upto the seventies. The industry not only achieved a high degree of self reliance, but also made a good beginning in entering export markets.

With the advent of CNC technology, though initial efforts at development were made by HMT and CMTI, the Indian industry could not match the international competition by way of features and reliabil-

ity of systems. Hence, not only did Indian Machine Tool Industry lose its growing export market, but it became inevitable for the user industry to resort to import of machine tools.

The decline in the growth of the machine tool industry was studied by special groups and specific recommendations were made (Perspective Plan - Indian Machine Tool Industry - Mansukhani Committee, July 1983 and CNC Machine Tools - A Perspective, DGTD, 1987), but the recommendations were not acted upon in time and in full measure. The industry lost its zest for internal development and has adopted a short cut strategy of design and component imports, to exploit the available domestic market.

The machine tool census, held in 1986, brought out that the number of CNC machine tools installed was 1186, 88% of which were of imported origin and nearly 61% of these were turning and machining centres.

CNC machines have formed a thrust area throughout the world and the share of CNC machines in the annual production in advanced countries has grown phenomenally (60%) in recent years. However, in India, one of major reasons for sluggish growth of the industry has been the user industries putting up with old machines. The 1986 census brought out the fact that the age of more than 52% of the 13 lakh machine tools installed, is over 10 years and nearly 22% are older than 20 years. CNC machine population of 1186, in 13 lakh machine tools, is insignificant. The value of CNC machines produced now is about 10% of total machine tool production. Whereas the developed world has realised the value of CNC machines, India has not yet made any significant thrust in this all important area of machine tools.

CNC machine tools production is at its infancy in the country, with a production of about 300 nos., valued at Rs.75 crores. Significantly, HMT has mostly depended on its own development and, so also, a couple of technocrat oriented units. However, other major machine tool manufacturers are dependent on import of designs. The indigenous efforts of HMT and other technocrat oriented units have amply proved the country's capability for development of CNC machine tools of modern concepts and also the capability of the ancillary industries of casting, forging, and machining the desired accuracies, as also to supply tools, hydraulics and others.

However, the industry is dependent on imports for several components of CNC machine tools, like CNC systems, the AC spindle and servo drives, encoders and scales for DROs, curvic couplings, precision ball screws and ball bearings, sensing and feed back units. Further, there are problems in the area of high pressure oil seals, proximity switches, dependable voltage stabilisers and uninterrupted power supply systems. The environmental conditions in India necessitate the use of temperature/humidity and dust controlled environments, apart from dependable and stabilized mains power supply. All these, urgently require attention for a proper development of the CNC machine tool industry.

The Indian CNC systems, though have made a beginning with both imported technologies and indigenous development, the technologies adopted in this field are comparatively outdated and do not incorporate recent development and, also, are found to be wanting in terms of meantime between failures. There is a high degree of obsolescence in this area. It is an acknowledged fact that latest developments in these fields are not effectively transferred by advanced countries, under the normal technology transfer. Under these circumstances, a long term strategy for keeping abreast in this important sphere, by self reliant efforts, needs to be speedily evolved.

The indigenous development of CNC system assumes greater significance, for ensuring the rightful place for India in the field of international markets for machine tools, since India has inherent strengths and capabilities in the field of machine tool design and production

Retrofit CNC systems and Digital Read Outs are being manufactured in the country by a couple of units. Already, over 300 systems have been installed. Retrofits and DROs have a very significant role in enhancing the quality and productivity in the small and medium industries, despite their limitations, compared to full-fledged CNC machines. Since the small and medium industries generally are ancillaries to the major units, the improvements brought out by their introduction, in terms of repeatability of accuracies and productivity, would have very significant impact on the engineering goods production in the country for internal and export use.

The introduction of CNC machines in the small and medium scale industries requires, in the first instance, an awareness of the utility of these machines. Training programmes, in case of CNC machine

tools, offered by CMTI need to be popularised, specially in small and medium scale industries. The programmes have to be taken to various industrial centres, across the country. The education, theoretically imparted on CNC machine operation in universities and ITIs, has to be practically supported by work on actual machines. At present such facilities are conspicuous by their absence. It is learnt recently, that CNC machines are being introduced in ITIs, through a World Bank aid.

It would be necessary to specially arrange training programme for tutors in CNC machines, to enable them impart proper education in the field. It is also necessary to introduce vernacular training material by way of books, audio visual media, video's, etc., to effect proper education of operators.

IMTEX '89 has shown CNC machines manufactured by SSI units. The popularisation of these, and proper support, would indeed play an important role in boosting the use of CNC machines in Indian industry.

Internationally, as earlier mentioned, the benefits of CNC machines have been fully understood and these machines have gradually replaced the conventional general purpose machines, during past 10-15 years, in all advanced countries. Presently, in most of these advanced countries, 60% of the machine tools are CNC machines.

The International Machine Tool Fair, held at Chicago in September, 1988, has clearly brought out the latest trend in machine tools and the leading role of CNC machines. The salient new trends in CNC machine tools have been:

(a) Universal machining centres, useful for prototype production and tool rooms, and capable of converting the CAD files into input data for machining; sequencing of operations; timing and tool change, and implementing these programmes on the machine.

(b) Jig boring accuracies attained in some of the new CNC machines.

(c) Introduction of 32-bit and multi-processor CNC systems.

(d) The interaction of machine/work axes and work handling devices, have enabled upto five faces of a work to be finished without setting changes.

(e) Tool changers, holding upto 120 tools and chip to chip tool change time of 2 seconds, have been achieved.

(f) Higher spindle speed and higher feed rates have enabled use of ceramic tools, for optimum material removal rate, with very good surface finishes.

(g) The latest CNC controls are capable of acceptance of programme in conversational language, in addition to normal machine tool programming lanuage, improving thus the programming ease.

(h) The availability of non-volatile memories have made possible resumption of execution of programme from the point left, in the event of unschedule stoppage of routine.

(i) Laser machining has still been limited, largely, to profile cutting of sheets.

(j) Digital drives for spindle and feed have become very common. These can be interfaced with any CNC systems.

(k) In-line gauging sytems have been intoduced.

(l) Extensive use of LAN/MAP for inter-communication.

The availablity of these latest features have brought the technology nearer to achievement of the objective of totally automated factories.

5. RECOMMENDATIONS

A major effort is needed for induction of increased volume of CNC machines, specially with the small and medium industries. This could be done by customer education regarding the advantages of CNC machines, by way of productivity and the quality of output.

Though the facilities available at Central Machine Tool Institute in Bangalore are being utilised by organised industries, CMTI needs to

popularise its facilities on a wider scale, to enable wider dissemination of CNC technology and its advantages.

CMTI has a data bank for machine tool industry, but this needs to be augmented and updated to make the latest information available to the industry, to provide not only an awareness service, but also assist the indigenous development of CNC machine tools, by providing these services as a tool for planning. The data bank should contain information like: specifications, indigenous production, import and export, of machine tools. In organising this, CMTI may be given assistance by organisation, like IMTMA.

CMTI should carry the CNC education to various regions of industrial concentrations, by arranging popularisation programmes and specific courses on CNC technology in such regional centres, mostly aimed at small and medium scale industries. At present, the Institute imparts training at Engineer's level, who in turn will train people working in the industry. In conducting such courses, the facilities (CNC machines) available at universities, ITIs, prototype production centres, central tool rooms, etc., should be utilised. The help of CNC machine manufacturers, CEI and IMTMA should also be sought for popularisation of courses, to educate the participants about the availability and features of indigenous CNC machines. To buy these machines for education purposes, excise duty and ST can be exempted.

A good beginning already made by the industries manufacturing Digital Read Outs (DRO) and CNC Retrofits, should be carried further by making available capital for such modernisation, on easy terms to user industries.

The CNC industry also requires development of other ancillary industries in the country, like: ball screws and CNC tooling. For development of these ancillaries, the existing industries, capable of introducing these products, should be encouraged.

The PCBs, used in the CNC system hardware, require special production facilities, to build in the high reliability, which is the prime requirement. The industries, now in production in these areas, would have to examine utilising modern developments, like surface mounted components, surface mounting devices, semi-automated/automated PCB populating equipment, e.g. pick and place machines and connected soldering devices, and automatic circuit test equipment.

The development of software for CNC systems, should take into account the present trends of dual language capability of utilising standard machine code languages presently adopted, but also capable of programming in conversational language, which would be more user friendly. The system should also take into account tool management, in-line gauging, etc., which are common features in advanced CNC systems abroad and are very useful additions to optimise production yield.

The CNC industry being in its infancy in the country, the requirement of some of the materials, like special steels, needed to be imported by this industry, may be made easily available to actual users. It is desirable that the Indian forging/casting components match international standards and it should also be the endeavour of the CNC manufacturers to take care of the available input materials in the country, while designing the hardware/software of the CNC machines and systems.

The CNC manufacturers should be allowed to import CNC machines/systems and accessories of latest designs, to assist them in developmental R & D and training activities to keep abreast with modern trends. The industry should aim at organising these facilities as a common facility.

When major buyer of CNC machines, like: Public Sector Industries, Ordnance Factories, Railways, etc., require a number of same type of machines, opportunity has to be examined from the point of view of encouraging joint manufacturing programmes, wherein manufacture of components and assemblies can be shared between the Indian manufacturers and foreign technology suppliers, enabling a more economic production and induction of these machines for the industry. This also assists in transfer of proper technolgy.

In the interest of maintaining the installed CNC machines, both indigenous and imported, in good running condition, it is necessary that spares, which are to be imported, should be easily available, to ensure minimum down time of machines. The normal stock and sale licences, for such imported items, may be considered for not only indigenous manufacturers, but also agents of imported machines, already installed in the country. Though HMT and other manufacturers have started repairing of PCBs, instead of merely replacing them, efforts are needed to make testing and repairing facilities for

PCBs more common, to reduce the maintenance cost and to increase the operating time of CNC machines.

To make a dent in the international markets, there is a need to have consortium approach, in which HMT can play a leading role. The process details and designing part can be entrusted to CMTI, whereas manufacturing could be carried out by small and medium scale industries, and quality control, inspection and international marketing could be carried out by HMT. The export market should be explored in developed countries, like USA, Japan, West Germany, where countries like Korea and Taiwan have already made inroads.

Universities, IITs and other professional colleges do have, in their syllabus, education on CNC machines, but the syllabus needs to be modified to incorporate education in combined mechanical, electrical and electronics (Mechatronics) engineering, to help in operating and maintaining CNC machines. However, to impart this education, there are hardly any CNC machines in these educational centres. This needs a special effort by organisations, like University Grants Commission and Ministry of Labour, to provide grants-cum-aid for purchase of latest models of CNC machines by these educational institutions.

There is an urgent need for training in maintenance of CNC machines.

The design of CNC machines should be modified to suit Indian working conditions, like voltage fluctuations, temperature, humidity and dust. CNC machines should have an in-built system, to take care of voltage fluctuations and environment requirements.

CMTI is the only organisation in the country, which is equipped to undertake testing and calibration jobs. Activities of CMTI, in this regard, should be strengthened and regional centres should be promoted, as the CNC machine tool manufacturing develops.

A beginning has already been made by HMT in the introduction of Flexible Manufacturing Cell. The flexible manufacturing system is very relevant to Indian industry, where the normal mass production quantities are not available. Thus, the CNC machine tool industry should lay emphasis on flexible manufacturing system by scouting the sectors of industry, where such introduction is beneficial, and encourage these sectors to adopt this new technology.

At present, there are no national standards for the CNC machine tool industry. However, the industry, through the IMTMA and CMTI/ BIS, are introducing industry standards. It is felt that national standards, compatible with international standards, are necessary and may be developed by BIS, in consultation with the industry. This would assist in international trade development, apart from providing much needed confidence to the Indian user industry, in indigenous machines.

The technology upgradation scheme of the IDBI does not include CNC tooling systems and peripherals. This also would have to be included in the scheme, in addition to CNC machines, so that the users of this scheme could take full benefit of the scheme.

In view of the ambiguous classifications of the CNC systems, in the Customs tariff and Import Trade classification, problems have arisen at the time of custom clearance. This has to be looked into and, if necessary, new items introduced for the requirement of the CNC industry.

Fiscal incentives for the small and medium industries may be provided by Government and other concerned user industries, to facilitate speedy introduction of CNC machines. These could be done in the following manner:

(a) Draw-back to these industries, of amounts paid as excise and customs on: CNC machines, retrofits, parts, components, tooling, accessories and spares. To encourage use of CNC machines, the Government has reduced excise duty from 15% to 5%, on CNC machines.

(b) Low rate of interest and easy availability of loans, from banks and financing institutions, for purchase of CNC machines by Small Scale Industries. The S.S.I. limit should be increased to facilitate adequate investments.

(c) For effective use of CNC machines in SSI sector, subsidised consultancy services should be made available to them for employing CNC machines.

(d) CNC machine sharing system should be developed wherein single CNC machines, in a centralised set-up, could be shared by many nearby Small Scale Units.

(e) In view of the quicker obsolescence of CNC machines, these machines may be considered for a higher rate of depreciation, not only in the small and medium industries, but also in other industries using CNC mahines, to enable these industries to obtain models with new developments, as and when they are introduced. This would help the industry keep abreast with developments.

(f) Liberal incentives need to be provided to the machine tool manufacturers, especially for the manufacture of low cost CNC machines, for introduction in small and medium scale industries. This can be offered by way of providing differential excise and differential customs on necessary imported components, apart from offering to the user industries easy financing of such low cost equipment.

(g) In the interest of development of machine tool industry, it is necessary to give special tax incentives for this industry on R & D expenditure.

A major problem of the CNC machine manufacturers has been the availability of state-of-the-art CNC systems for incorporation in the machines. For any serious inroad into world market, the Indian capability for CNC systems has to be strengthened. It is suggested that a national level technology mission be constituted with experts from the industry, both commercial and technical, with an apex body, to fulfil the following objectives:

(i) To draw out a macro plan, for the next 10 years, with the clear objective of attaining a status in development, compatible with international standards, not only at present but also in future years.

(ii) To arrive at typical specifications for models to be developed by the Indian CNC industry, taking into account, on the one hand, need for low cost machines for indigenous use, and, on the other, more sophistcated controls needed for machines to be exported as well as used by organised industry in the large scale sector.

(iii) To recommend a state-of-the-art production methodology of CNC systems, to ensure sufficiently large meantime between

failures for the sytem compatible with the international standards.

(iv) To recommend a standard software for national consumption, and also recommend softwares to be adopted for export, keeping in view the preferential practices. Cognisance be taken of the potential already developed in this field at CMTI, IITs and other educational institutions. The software should not only include those required for CNC system operation, but also should encompass other related areas, like Inventory Management, Production Planning and Controls, so that the country can prepare itself for total automation, as is being introduced abroad.

(v) To arrive at a list of micro-processors and ICs to be used in this industry, to enable rationalisation from the point of view of economic quantities and also from the point of rationalisation of spares.

(vi) Lay down standards for electronic components to be used in CNCs, to the extent they are different from the normal industrial standards obtained in the country.

(vii) To devise quality standards for such systems, and also organising facilities for 3rd party test and certification, in one of the existing agencies.

(viii) To recommend policies and programmes to the Goverment for utilising local talent and facilities for development and upkeep of CNC systems, machines and components in the country.

(ix) To study and make recommendations regarding programming language and methods, to enable shop floor operators to adapt to CNC machines with ease.

(x) The apex body could add more objectives and programmes, as needed, to attain indigenous capability for production of CNC systems, updating the same in tune with international developments and, more than this, to ensure that a reliable and state-of-the-art CNC system is developed indigenously, which only can ensure a due place for India in the international machine tool markets.

(xi) This apex body could also serve as a focus for monitoring the industries' input requirement and formation of Governmental policies, to aid and assist the CNC industry to attain its objectives in a time bound manner.

(xii) The apex body should also focus its attention on related electrical/mechanical components of the CNC machines, like: precision bearings, special materials, sensing elements, encoders, scales and digital drives.