DETAILED PROJECT REPORT
ON
REPLACEMENT OF CONVENTIONAL GEAR HOBBING MACHINE TO CNC GEAR HOBBING MACHINE
(BANGALORE MACHINE TOOL CLUSTER)











ENERGY IS LIFE
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Prepared By

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Reviewed By

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REPLACEMENT OF CONVENTIONAL GEAR HOBBING MACHINE CENTER

TO

CNC GEAR HOBBING MACHINE CENTER

BANGALORE MACHINE TOOL CLUSTER

BEE, 2010

Detailed Project Report on Replacement Of Conventional Gear Hobbing Machine Center To CNC Gear Hobbing Machine Center

Bangalore Machine Tool cluster, Karnataka (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.:

For more information

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan
R. K. Puram, New Delhi – 110066

Telephone +91-11-26179699
Fax +91-11-26178352
Websites: www.bee-india.nic.in
Email: jsood@beenet.in/ pktiwari@beenet.in

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Shri Dr. Ajay Mathur, Director General

Smt Abha Shukla, Secretary

Shri Jitendra Sood, Energy Economist

Shri Pawan Kumar Tiwari, Advisor, SME

Shri Rajeev Yadav, Project Economist, BEE

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Petroleum Conservation Research Association

Bangalore

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List of Abbreviations

BEE	Bureau of Energy Efficiency
CNC	Computer Numerical Controlled
DPR	Detailed Project Report
DSCR	Debt Service Coverage Ratio
EE	Energy Efficiency
GHG	Green House Gas
GoI	Government Of India
INR	Indian National Rupee
IRR	Internal Rate Of Return
kWh	kilo Watt Hour
NPV	Net Present Values
O&M	Operational & Maintenance
MSME	Micro Small and Medium Enterprises
PAT	Profit After Tax
PBT	Profit Before Tax
ROI	Return on Investment
SIDBI	Small Industries Development Bank of India
MoMSME	Ministry of Micro Small and Medium Enterprises

EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE) appointed Petroleum Conservation Research Association as the executing agency for Machine Tools of Bangalore under BEE's SME programme. Under this project, the executing agency carried out studies in the Machine Tools of Bangalore. Out of a total of 100 machine tools units, study was conducted in 30 units. Preliminary audits were undertaken in all the 30 units whereas detailed energy audits were conducted in 10 of these units.

Bangalore has evolved as one of the most important production centers in the Machine tool sector despite there being nothing favorable for proliferation of a cluster. The place lacks all possible resources, from raw materials to fuels and to skilled man power newer technologies as well which is the most important for processing of Machine tools. Today there are 100 units in Bangalore alone and the production capacity of machine tool units in Bangalore cluster is in the range of 1500 kg per Annum –1050000 kg per Annum.

Energy forms a major chunk of the processing cost with over 30% weight age in the cost basket. As per the preliminary and detailed energy audit findings, there exists potential of saving over 30% electricity and 50% fuel in the applications in power process industries with over all general payback period of less than six year. The payback period in these industries is higher due to their working schedule and lower utilization of facilities.

Based on the energy audits, the executing agency submitted their report to BEE in form of a cluster manual with recommendations for energy conservation & savings potentials in the Machine Tools sector. The recommendations made in the cluster manual are listed below:

Replacement of conventional Gear Hobbing Machine with CNC Gear Hobbing Machine or new CNC Gear Hobbing Machine

The most significant advantage of CNC gear hobbing machine against its traditional and mechanical gear hobbing models is that the gear cutting production time can be shortened significantly (about 5 ~ 10 times faster), because for CNC models, the carbide tipped hobs with approximately 160 m/min surface speed can be utilized verses only the 16 m/min HSS-cutters for the traditional mechanical models. The CNC machines have additional advantages against its mechanical counterparts, for example, the production of gears can be programmed and recorded within the CNC control system, which can be used competitively; manufacturing gears of more complicated shapes, such as spiral bevel gears; the structure of the machine is simplified and it is easier for operation and maintenance. And under proper maintenance will serve the owner for a period of up to 20 years.

This bankable DPR also found eligible for subsidy scheme of MoMSME for "Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises" under "National Manufacturing and Competitiveness Programme". The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

S. No	Particular	Unit	Value
1.	Project cost	`(in lakhs)	225
2.	Electricity saving	kWh	68928.3
3.	Monetary benefit	`(in lakhs)	72.27
4.	Simple payback period	Year	3.11
5.	NPV	`(in lakhs)	96.78
6.	IRR	%age	18.93
7.	ROI	%age	20.21
8.	DSCR	Ratio	1.47
9.	CO_2 reduction	Tonnes/annum	51.7
10.	Procurement and implementation schedule	week	10

The projected profitability and financial indicators shows that the project will be able to earn profit from inception and project is financially viable and technically feasible.

ABOUT BEE'S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Gujarat Dairy Cluster is one of them. The BEE's SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

***Major activities in the BEE -SME program are furnished below*:**

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stake holders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.

1 INTRODUCTION

1.1 Brief about the SME cluster

About SME cluster

The Machine Tools Cluster of Bangalore is located in the Bangalore district. Bangalore, also known as Bengaluru is the capital of the Indian state of Karnataka, located on the Deccan Plateau in the south-eastern part of Karnataka. Bangalore was inducted in the list of Global cities and ranked as a "Beta World City" alongside Geneva, Copenhagen, Boston, Cairo, Riyadh, Berlin, to name a few, in the studies performed by the Globalization and World Cities Study Group and Network in 2008. These machine units have been classified into following clusters within the district:

- Abbegere
- Bommasandra
- Peenya

Bangalore is the “HUB” for machine tools in India. The cluster accounts for 60% of the value of production of machine tools in the country. Bangalore is predominantly a metal cutting cluster. The structure of machine tool industry in Bangalore has at its apex 6 large machine tool manufacturers, about 100 small and medium machine tool manufacturers, their suppliers and vendors in large numbers.

Product Manufactured

In SME cluster of Machine Tools at Bangalore, there are varieties of products manufactured that include spindles, centre hobbing machines, ID hobbing machines, Self centering Steady Rests, Bar feeding attachments, Rotary tables, Index tables, Special purpose machines, Co-ordinate Measuring machines, aerospace fixtures, CNC Machine enclosures, Sound proofs, armature rewinding machines etc. There are supporting industries like heat treatment are also located in the cluster. These products/ machines are usually utilized in automobile industry, aerospace industry, CNC Machine industry across the globe. These are products custom made to suit the requirements of ISRO, HAL, BEML, MICO, BHEL, Kirloskar Electric, Bayforge Ltd etc.

Production Process

Typically, process for machine tool units in Bangalore is not the same for all industries involving various activities, as the end products of the industry are different for each industrial unit. Therefore, there is some variation in the flow of activities depending on the customized requirement of the products. However, these activities could be grouped together as shown below, though not in the same order as mentioned.

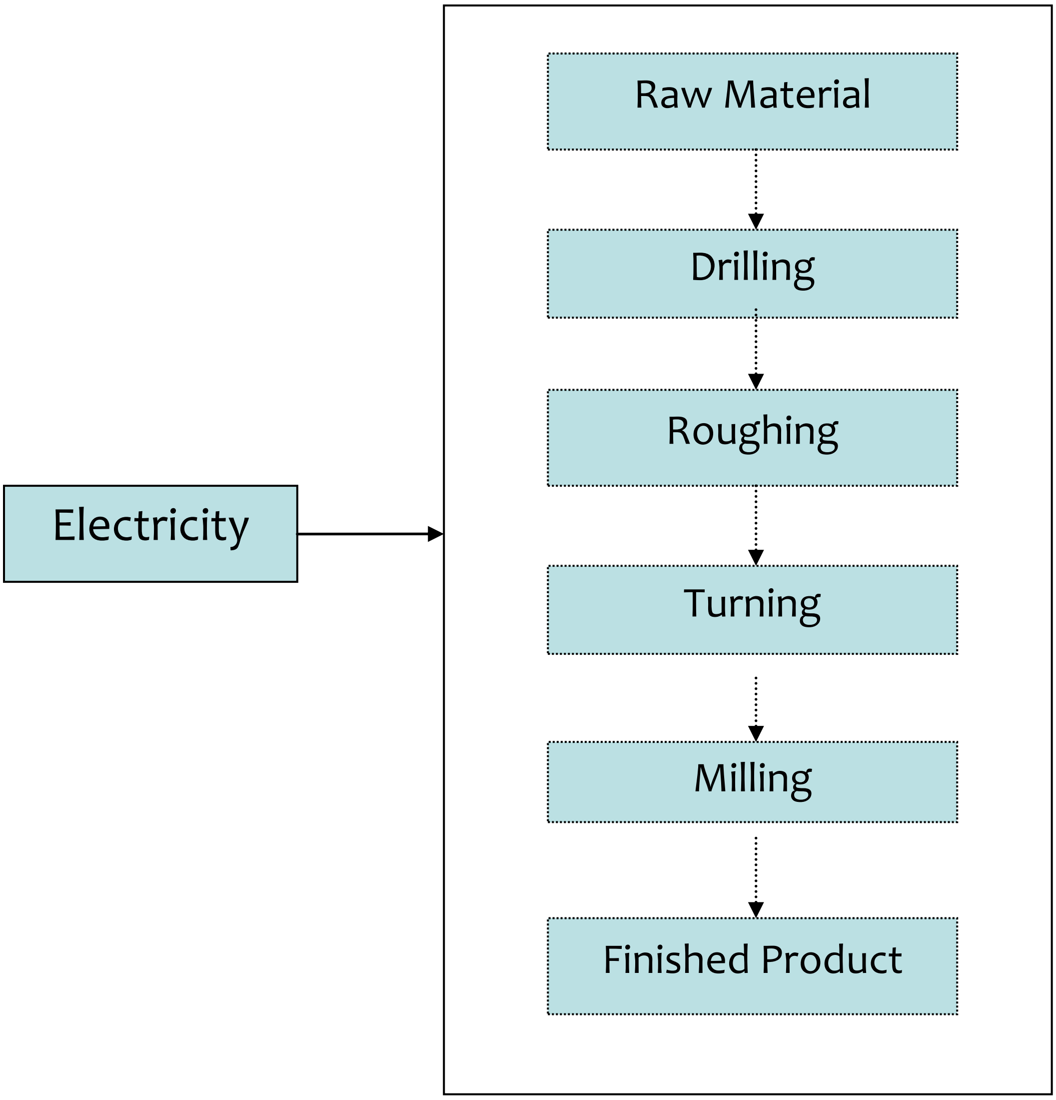
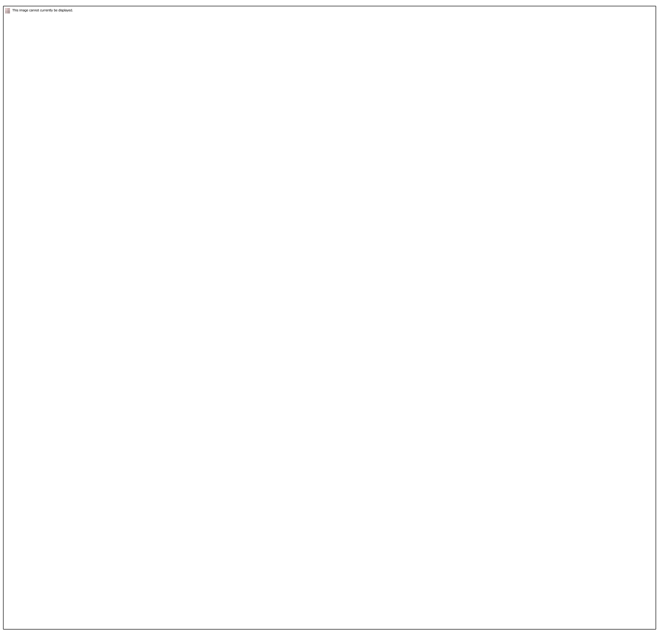


Figure 1.1 Process flow chart of typical Machine Tools Unit

Drilling Process



Drilling is the most common machining process whereby the operation involves making round holes in metallic and nonmetallic materials. Approximately 75% of all metal- cutting process is of the drilling operation. Drills usually have a high length to diameter ratio that is capable of producing deep hole, however due to its flexibility, necessary precaution need to be taken to maintain accuracy and prevent drill from breaking.

Drilled holes can be either through holes or blind holes. A through holes is made when a drill exits the opposite side of the work; in blind hole the drill does not exit the workpiece.

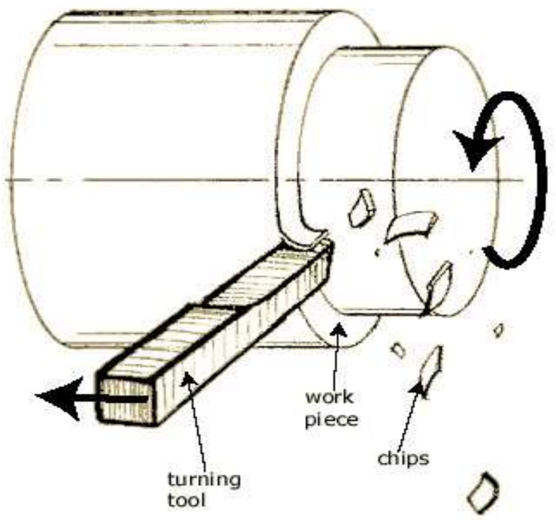
Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion at the stressed surface.

For fluted drill bits, any chips are removed via the flutes. Chips may be long spirals or small flakes, depending on the material, and process parameters. The type of chips formed can be an indicator of the machinability of the material, with long gummy chips reducing machinability.

When possible drilled holes should be located perpendicular to the work piece surface. This minimizes the drill bit's tendency to "walk", that is, to be deflected, which causes the hole to be misplaced. The higher the length-to-diameter ratio of the drill bit, the higher the tendency to walk.

Turning Process



Turning is a form of machining, a material removal process, which is used to create rotational parts by cutting away unwanted material. The turning process requires a turning machine or Gear Hobbing, work piece, fixture, and cutting tool. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to the turning machine, and allowed to rotate at high speeds. The cutter is typically a single-point cutting tool that is also secured in the machine, although some operations make use of multi-point tools. The cutting tool feeds into the rotating work piece and cuts away material in the form of small chips to create the desired shape. Turning is used to produce rotational, typically axi-symmetric, parts that have many features, such as holes, grooves, threads, tapers, various diameter steps, and even contoured surfaces. Parts that are fabricated completely through turning often include components that are used in limited quantities, perhaps for prototypes, such as custom designed shafts and fasteners. Turning is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that turning can offer, it is ideal for adding precision rotational features to a part whose basic shape has already been formed.

Turning is the process whereby a single point cutting tool is parallel to the surface. It can be done manually, in a traditional form of Gear Hobbing, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated Gear Hobbing which does not. This type of machine tool is referred to as having computer numerical control, better known as CNC, and is commonly used with many other types of machine tool besides the Gear Hobbing.

When turning, a piece of material (wood, metal, plastic, or stone) is rotated and a cutting tool is traversed along 2 axes of motion to produce precise diameters and depths. Turning can be either on the outside of the cylinder or on the inside (also known as boring) to produce tubular components to various geometries. Although now quite rare, early Gear Hobbings could even be used to produce complex geometric figures, even the platonic solids; although until the advent of CNC it had become unusual to use one for this purpose for the last three quarters of the twentieth century. It is said that the Gear Hobbing is the only machine tool that can reproduce itself.

The turning processes are typically carried out on a Gear Hobbing, considered to be the oldest machine tools, and can be of four different types such as straight turning, taper turning, profiling or external grooving. Those types of turning processes can produce various shapes of materials such as straight, conical, curved, or grooved work piece. In general, turning uses simple single-point cutting tools. Each group of work piece materials has an optimum set of tools angles, which have been developed through the years.

The bits of waste metal from turning operations are known as chips (North America), or swarf (Britain). In some areas they may be known as turnings.

Turning specific operations include:

Hard turning

Hard turning is a turning done on materials with a Rockwell C hardness greater than 45. It is typically performed after the work piece is heat treated.

The process is intended to replace or limit traditional hobbing operations. Hard turning, when applied for purely stock removal purposes, competes favourably with rough hobbing. However, when it is applied for finishing where form and dimension are critical, hobbing is superior. Hobbing produces higher dimensional accuracy of roundness and cylindricity. In addition, polished surface finishes of Rz=0.3-0.8z cannot be achieved with hard turning alone. Hard turning is appropriate for parts requiring roundness accuracy of 0.5-12 microns, and/or surface roughness of Rz 0.8–7.0 microns. It is used for gears, injection pump components, hydraulic components, among other applications.

Facing

It is part of the turning process. It involves moving the cutting tool at right angles to the axis of rotation of the rotating workpiece. This can be performed by the operation of the cross-slide, if one is fitted, as distinct from the longitudinal feed (turning). It is frequently the first operation performed in the production of the work piece, and often the last- hence the phrase "ending up".

Parting

This process is used to create deep grooves which will remove a completed or part-complete component from its parent stock.

Grooving

Grooving is like parting, except that grooves are cut to a specific depth by a form tool instead of severing a completed/part-complete component from the stock. Grooving can be performed on internal and external surfaces, as well as on the face of the part (face grooving or trepanning).

Non-specific operations include:

Boring

Machining of internal cylindrical forms (generating) a) by mounting work piece to the spindle via a chuck or faceplate b) by mounting work piece onto the cross slide and placing cutting tool into the chuck. This work is suitable for castings that are to awkward to mount in the face plate. On long bed Gear Hobbings large work piece can be bolted to a fixture on the bed and a shaft passed between two lugs on the work piece and these lugs can be bored out to size. A limited application, but one that is available to the skilled turner /machinist. In machining, boring is the process of enlarging a hole that has already been drilled (or cast), by means of a single-point cutting tool (or of a boring head containing several such tools), for example as in boring a cannon barrel. Boring is used to achieve greater accuracy of the diameter of a hole, and can be used to cut a tapered hole.

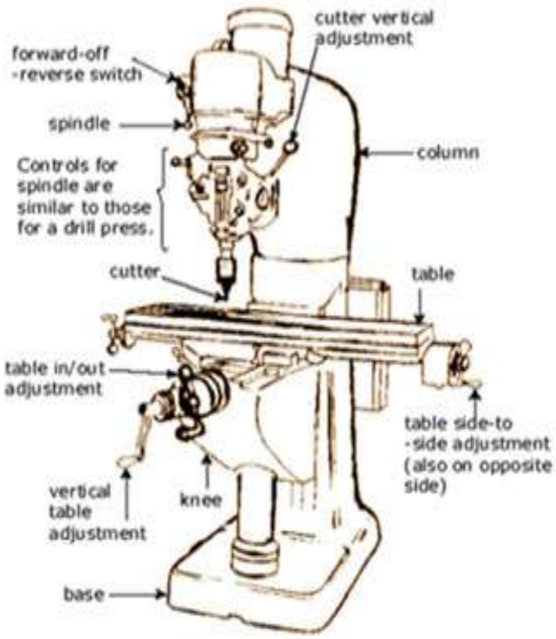
There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end. Lineboring (line boring, line-boring) implies the former. Backboring (back boring, back-boring) is the process of reaching through an existing hole and then boring on the "back" side of the workpiece (relative to the machine headstock).

Knurling

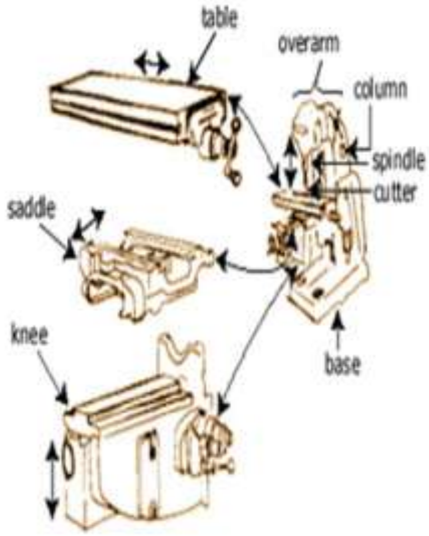
The cutting of a serrated pattern onto the surface of a part to use as a hand grip using a special purpose knurling tool. Threading both standard and non-standard screw threads can be turned on a Gear Hobbing using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) Either externally, or within a bore. [Generally referred to as single-point threading. tapping of threaded nuts and holes a) using hand taps and tailstock centre b) using a tapping device with a slipping clutch to reduce risk of breakage of the tap threading operations include a) all types of external and internal thread forms using a single point tool also taper threads, double start threads, multi start threads, worms as used in worm wheel reduction boxes, lead screw with single or multi start threads. b) by the use of threading boxes fitted with 4 form tools, up to 2" diameter threads but it is possible to find larger boxes than this.

Milling Process

Milling is the most common form of machining, a material removal process, which can create a variety of features on a part by cutting away the unwanted material. The milling process requires a milling machine, work piece, fixture, and cutter. The work piece is a piece of pre-shaped material that is secured to the fixture, which itself is attached to a platform inside the milling machine. The cutter is a cutting tool with sharp teeth, which is also secured in the milling machine and rotates at high speeds. By

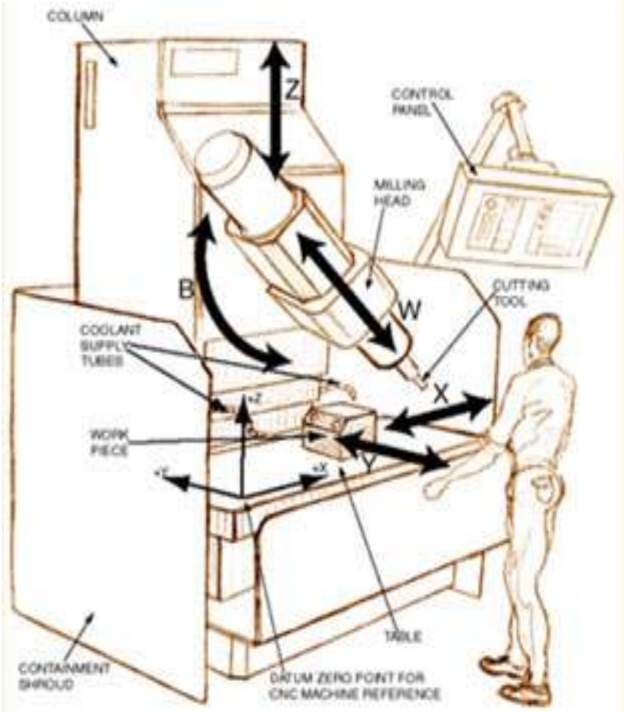


feeding the workpiece into the rotating cutter, material is cut away from this work piece in the form of small chips to create the desired shape.



Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three-dimensional surface contours. Parts that are fabricated completely through milling often include components that are used in limited quantities, perhaps for prototypes, such as custom designed fasteners or brackets. Another application of milling is the fabrication of tooling for other processes. For example, three-dimensional molds are typically milled. Milling is also commonly used as a secondary process to add or refine features on parts that were manufactured using a different process. Due to the high tolerances and surface finishes that milling can offer, it is ideal for adding precision features to a part whose basic shape has already been formed.

Milling is as fundamental as drilling among powered metal cutting processes. Milling is versatile for a basic machining process, but because the milling set up has so many degrees of freedom, milling is usually less accurate than turning or hobbing unless especially rigid fixturing is implemented. For manual machining, milling is essential to fabricate any object that is not axially symmetric. Below is illustrated the process at the cutting area. A typical column-and-knee type manual mill is shown. Such manual mills are common in job shops that specialize in parts that are low volume and quickly fabricated. Such job shops are often termed 'model shops' because of the prototyping nature of the work.



The parts of the manual mill are separated below. The knee moves up and down the column on guide ways in the column. The table can move in x and y on the knee and the milling head can move up and down.

CNC Milling: Computer Numerical

Control (CNC) Milling is the most common form of CNC. CNC mills can perform the functions of drilling and often turning.

1.2 Energy performance in existing situation

1.2.1 Fuel and electricity consumption

The machine tool industries in this cluster use electricity from grid to meet their electrical energy requirement. Some of the industrial units having the backup power generator (Diesel Based) to meet the demand in case of grip power supply failure or scheduled power cut from the grid. The main and primary energy for machine tool industries is the electricity for operation of production and utility services. In manufacturing of some category of products, heat treatment process required to achieve the desired material properties. In heat treatment units of the clusters, which are very few in numbers (only 14 %) are using electricity as the main source of energy even in the process of heat treatment, which is usually outsourced. The percentage segregation of used energy in the cluster is given in figure 1.2, which reveals that the 95.9% of energy used in the cluster is drawn from the Bangalore Electricity Supply Company Limited (BESCOM) grid whereas only 4.1% of total energy required is being generated by thermal energy (High Speed Diesel) using DG sets.

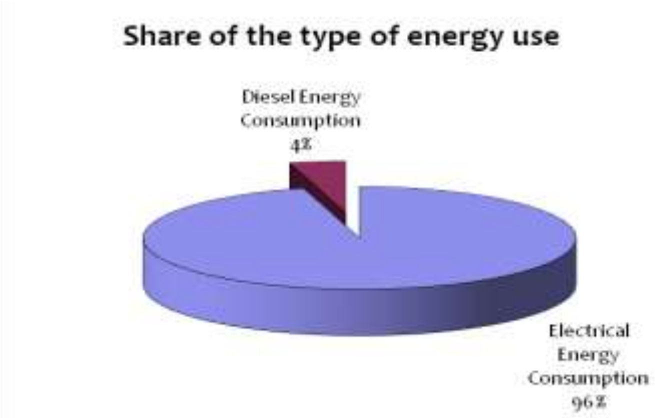


Figure 1.2: Share of Energy Type used in the Machine Tool Units

1.2.2 Average production

Production capacity of machine tool units in Bangalore cluster depends on the type of product being produced in unit. Production capacity of machine tool units in Bangalore cluster is in the range of 1500 kg per Annum –1050000 kg per Annum. The following figure shows the classification of machine tool units in Bangalore cluster based on production capacity. The production capacity as the weight of the metal removed in case of components, accessories and SPM making industries. In case of Heat treatment, weight of the material treated has been considered as the production capacity. The above methodology is adopted as major energy is spent towards removing the metal, as per the specifications of the product, while carrying out jobs such as milling, turning, hobbing and drilling. In case of heat treatment units, major energy is spent in the heat treatment furnaces. Hence, the weight of material processed is taken as production capacity.

1.2.3 Specific energy consumption

The specific energy consumption depends on the final product being manufactured by the machine tool units; therefore SEC has been classified according to the types of products produced in the cluster. Details of the SEC depending on the type of products is shown in the following table

Table 1.1 Energy Consumption Pattern of Machine Tools Cluster

Type of units	Specific Energy Consumption, GJ/Tonne	Specific Energy Consumption, kWh/Tonne
Components	24.8	6472
Accessories	19.7	5118
Machines	2.2	600
Heat Treatment	64.2	15057
Average	27.7	6811.8

1.3 Identification of technology/equipment

The existing process or technology used in the cluster is mixed type. Some units are using 2 axis CNC machines and performing jobs in two or three steps for CNC Gear Hobbing Projects whereas some units also using the conventional machines which are completely depends on operators skills.

The existing technology required two or three times setup of the job on 2 – axis CNC machine and result in higher energy consumption and lower production rate. The error in product and material rejections also increased due the multiple setup requirements for a job.

1.3.1 Description of technology/equipment

The machine tools industry can be divided into metal cutting and metal forming sectors. The metal cutting sector can be further classified into conventional and computer numerically controlled (CNC) machines, while the metal forming sector can be segregated into conventional and numerically controlled (NC) machines. Some commonly used metal cutting machines include electrical discharge machining systems (EDMS), machining centers, Gear Hobbings and automats, boring, milling, drilling, hobbing, honing and polishing machines, total NC machines and so on. Metal forming machines include bending, folding, straightening, flattening machines, punching and/or shearing machines, die casting machines and others.

The NC machines developed in the 1950s and 1960s did not possess CPU's. The CNC machine tools are essentially NC machines with microprocessors as the CPU.

The first American machine tools with a CNC system was developed in 1972 and the first Japanese machine tools with a CNC system was developed in 1976. CNC systems made it possible for microprocessors and programmable logic controllers to work in parallel. This allowed simultaneous servo position and velocity control of several axes of a machine, monitoring of the controller and machine tools performance, and monitoring of the cutting process. For a basic three axes milling machine, with the CNC systems, there could be coordination of feeding velocity and position control of all the three axes. The spindle speed could also be controlled simultaneously. These features enhanced the versatility of a traditional milling machine. Moreover, by employing multiple CPU's, the versatility of the machine tools was increased manifold.

As with CNC turning centers, the Indian machine tools industry produces a range of CNC machining centers covering small to very large sizes. These machines are technologically more complex than turning machines. Typically, a CNC machining center has 3 linear movements, one rotary movement, apart from features such as tool changers, pallet changers etc. Indian machine tools meet the basic requirement of machining center operations, and a number of models are produced with both Gear Hobbing and vertical spindle configurations. Machines with spindle speeds of upto 10000 rpm, traverse rates of upto 60 mpm are produced by the Indian industry.

The current trend in machining centers is to have additional axes of movements to take on complex machining requirements (sometimes as many as 6 or 7), high traverse rates of 100 to 120 mpm, spindle speeds of 10000 to 50000 rpm, some turning and even hobbing capabilities on the machining center. Internationally, machining centers are mostly built with at least 5 axes. Modern machines incorporate linear motors for high traverse rates, and integral motor spindles are universally used. At the simpler end of the product spectrum, machines are configured to occupy very small floor space suitable for line integration for mass production of auto components.

1.3.2 Role in process

Machining is a critical process in machine tools manufacturing industries. Design standards in all application areas are becoming increasingly more demanding. Expectations in terms of ergonomics, the air drag coefficient (CW value) or simply aesthetic appeal are creating a need for more complex surface geometries to be achieved in less time and with greater precision. The design primarily comes from CAD systems, the machining programs from CAM stations.

Nevertheless, the skilled machine tool operator still has overall responsibility (in terms of technology) for the quality of the mold and the complete tool. Conventional machining, one of the most important material removal methods, is a collection of material-working processes in which power-driven machine tools, such as Gear Hobbings, milling machines, and drill presses, are used with a sharp cutting tool to mechanically cut the material to achieve the desired geometry. Machining is a part of the manufacture of almost all metal products, and it is common for other materials, such as wood and plastic, to be machined. A person who specializes in machining is called a machinist. A room, building, or company where machining is done is called a machine shop. Much of modern day machining is controlled by computers using computer numerical control (CNC) machining. Machining can be a business, a hobby, or both.

1.4 Benchmarking for existing specific energy consumption

The baseline data has been established based in the energy audits conducted in a total number of 30 machine units out of which 20 were preliminary audits and 10 were detailed audits. The total production cost estimated based on the various technology dependent cost of production of these units. It can be onserved that the total production cost is about Rs. 16411752 anually and Rs.325630 per tonne.

Table 1.2 Energy Consumption Pattern of Existing Technology

S. No	Particular	Benchmarking	
		Unit	Value
1	Specific Energy Consumption	kWh/Tonne	3126
2	Average Energy Cost	`/Tonne	15630
3	Cost of Material	`/annum	300000
4	Other Cost (Man Power/Utility)	`/tonne	10000
5	Average Production	`/tonne	325630
6	Annual Production	Tonne/annum	50.4
7	Annual Production Cost	`/annum	16411752

1.4.1 Design and operating parameters /specification

In present scenarion of the machine tools industries, machine cannot afford to breakdown, frequent change of the job settings and dependency on manpower since the investment cost of the machine is high. Each downtime is a lost for the investor. From economic point of view, in order to produce part at effective cost is by producing at high volume. Machine components become expensive which requires new type of maintenance to cater this problem.

S. No.	Type of Fuel	Unit	Value	Equivalent Energy (GJ)	%age Contribution
1	Electricity	kWh/year	68460	246.5	89.6

*****Based on measured actual electricity consumption by the existing technology (50.4 tonnes produced annually)***

1.4.2 Operating efficiency analysis

To determine the Energy use and technical study, individual units were identified within different locations of the Bangalore Machine Tools clusters in Bangalore district. It is integral to target different units in the clusters as it accounts for deviations in type of prudcts, job properties, sourcing of raw materials, and variations in manufacturing and housekeeping operations. The overall step by step methodology followed for Energy use and technical study is as below:

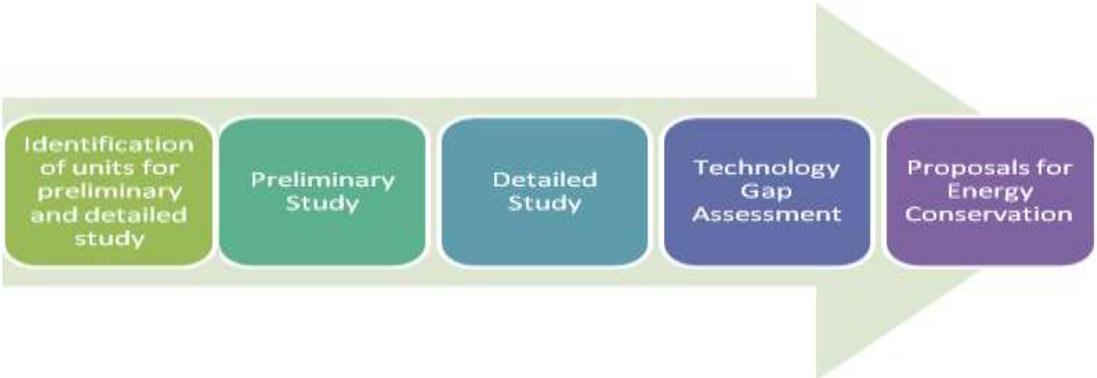


Figure 1.3 Energy auditing methodology

Preliminary energy study

The preliminary study is the first stage in conducting an energy and technology assessment of the machine tools manufacturing units in the cluster. The aim of the preliminary study is collecting information relating to production, machinery and energy use to get an overview of energy sources, raw materials, processes involved, etc of the units within the cluster. Preliminary energy studies were conducted at 30 machine tools manufacturing units in the Bangalore cluster and the time taken for each study was 1 – 2 days.

Detailed energy study

Detailed energy studies are conducted to get an in depth break up of energy usage of each of the associated processes in the machine tools manufacturing. It covers the quintessential steps in preliminary study and provides a thorough analysis of the functioning of units. Since electricity is the main source of energy used, there are some guidelines which need to be maintained while analyzing and measuring the electricity consumption pattern of the individual unit.

1.4.3 Specific fuel and electricity consumption

The main and basic energy used in the manufacturing process of machine tools is electricity in this unit. The liquid fuel (HSD) energy is mainly using to operate the diesel power generators during the power cut/non-availability of the electrical power from state electricity board.

1.5 Barriers for adoption of proposed technology/equipments

1.5.1 Technological Barrier

Technology obsolescence in the machine tool business is extremely rapid. Product lifecycles are declining and currently average life cycle is no more than 3 years! Thus, in a globalized India, SMEs have been and will continue to face challenges they have not seen before. In the past, most of the products have been a result of ‘Reverse Engineering’. Unlike the Japanese and Koreans, the Indian manufacturers have not graduated to the next level of ‘Improving’ the technology of reverse engineered products. Thus, product technology obsolescence is a major issue facing the Bangalore machine tools industry today. There is a definitive void in development and existing facilities for Research and Development in this sector. Institutes in the past have been integral in facilitating technology transfers and improvement in the machine tools manufacturing cluster all over India, However there is need for continuous Research and Development associated processes.

1.5.2 Financial Barrier

The restricted availability and the inability to raise resources are common to all types of small businesses. However, the machine tools sector, by its very nature, is a high financial outlay driven business. Average product costs are greater, gestation period of investments – longer, time to market – higher and a purchasing system – not yet fully matured. All this means greater, than most other businesses, financial resource requirement. This, in turn, puts the machine tool SMEs in a particular disadvantage.

1.5.3 Manpower Skill

Machine downtime ranged from 1 percent to as high as 20 percent in some cases. Labour efficiency ranged between 60 percent to 95 percent. Lower labour efficiency and labour utilization has manifested in lower employee productivity. Labour utilization has been lower as compared to other sectors because of surplus labour since only 26 percent of the companies have undergone downsizing and lack of awareness of productivity methodologies.

Only 65 percent of the companies used CNC or NC machines because most of the smaller players get almost 95 percent of their products outsourced and they only do assembling. In fact, as high as 17 percent of the companies get 100 percent of the manufacturing activities subcontracted. However, on an average 75 percent of the companies subcontracted some amount of their manufacturing. The subcontracting was mainly done due to capacity constraints followed by cost considerations.

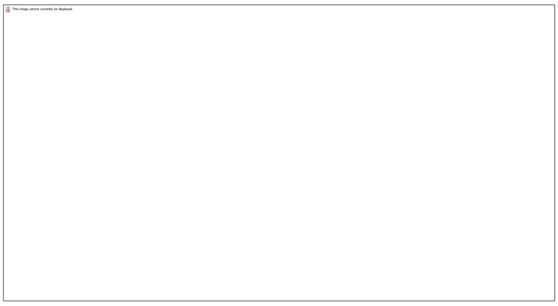
1.5.4 Vendor Linkages:

No other business requires such complex level of vendor linkages as the machine tools. For materials, electrical, electronics, hydraulics, pneumatics, metallurgy, tribology, measurement controls – the list of myriad technology linkages is endless. This requires exceptional networking capabilities and plenty of time to be spent by owner of accompany/CEO himself.

2 TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS

2.1 Detailed description of technology selected

2.1.1 Description of technology



Hobbing is a machining process for making gears, splines, and sprockets on a *hobbing machine*, which is a special type of milling machine. The teeth or splines are progressively cut into the workpiece by a series of cuts made by a cutting tool called a *hob*. Compared to other gear forming processes it is relatively inexpensive but still quite accurate, thus it is used for a broad range of parts and quantities. It is the most widely used gear cutting process for creating spur and helical gears and more gears are cut by hobbing than any other process since it is relatively quick and inexpensive. Hobbing uses a hobbing machine with two non-parallel spindles, one mounted with a blank workpiece and the other with the hob. The angle between the hob's spindle and the work piece’s spindle varies, depending on the type of product being produced. For example, if a spur gear is being produced, then the hob is angled equal to the helix angle of the hob; if a helical gear is being produced then the angle must be increased by the same amount as the helix angle of the helical gear. The two shafts are rotated at a proportional ratio, which determines the number of teeth on the blank; for example, if the gear ratio is 40:1 the hob rotates 40 times to each turn of the blank, which produces 40 teeth in the blank. Note that the previous example only holds true for a single threaded hob; if the hob has multiple threads then the speed ratio must be multiplied by the number of threads on the hob. The hob is then fed up into workpiece until the correct tooth depth is obtained. Finally the hob is fed into the workpiece parallel to the blank's axis of rotation. Up to five teeth can be cut into the workpiece at the same time. Oftentimes multiple gears are cut at the same time. For larger gears the blank is usually gashed to the rough shape to make hobbing easier. A hobbing machine, often shortened to grinder, is a machine tool used for hobbing, which is a type of machining using an abrasive wheel as the cutting tool. Each grain of abrasive on the wheel's surface cuts a small chip from the workpiece via shear deformation. Products can be produced by modern technology, which uses computer software, hardware and firm

A Vertical Hobbing Machine

ware in industries. It is needed to use CNC Gear Hobbing machine to get more accurate dimensions and irregular shape.

2.1.2 CNC Gear Hobbing Machine operations

Modern hobbing machines, also known as *hobbers*, are fully automated machines that come in many sizes, because they need to be able to produce anything from tiny instrument gears up to 10 ft (3.0 m) diameter marine gears. Each gear hobbing machine typically consists of a chuck and tailstock, to hold the workpiece or a spindle, a spindle on which the hob is mounted, and a drive motor. For a tooth profile which is a theoretical involute, the fundamental rack is straight-sided, with sides inclined at the pressure angle of the tooth form, with flat top and bottom. The necessary addendum correction to allow the use of small-numbered pinions can either be obtained by suitable modification of this rack to a cycloidal form at the tips, or by hobbing at other than the theoretical pitch circle diameter. Since the gear ratio between hob and blank is fixed, the resulting gear will have the correct pitch on the pitch circle, but the tooth thickness will not be equal to the space width.

Hobbing machines are characterized by the largest module or pitch diameter it can generate. For example, a 10 in (250 mm) capacity machine can generate gears with a 10 in pitch diameter and usually a maximum of a 10 in face width. Most hobbing machines are vertical hobbers, which mean the blank is mounted vertically. Horizontal hobbing machines are usually used for cutting longer workpiece; i.e. cutting splines on the end of a shaft.

A HORIZONTAL HOBBING MACHINE

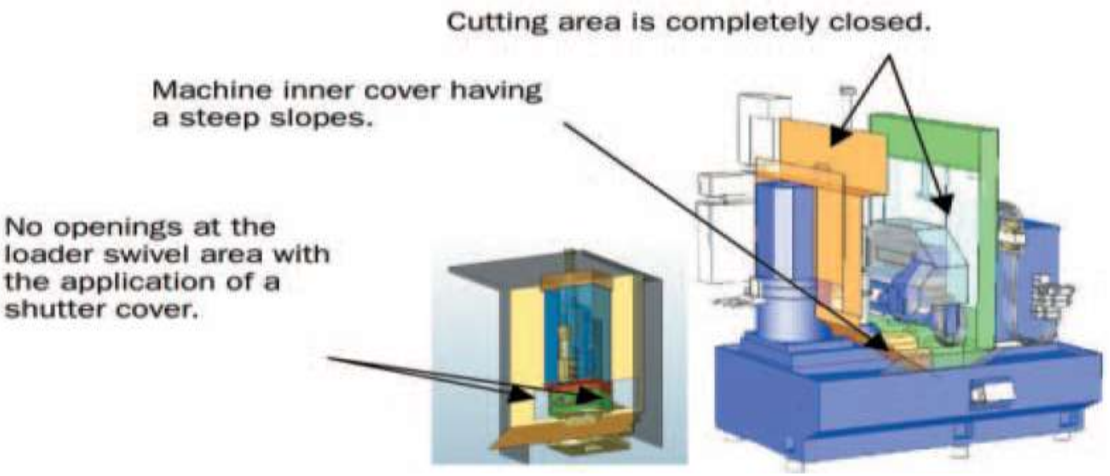
A GEAR HOB IN A HOBBING MACHINE WITH A FINISHED GEAR.

Hobbing is used to produce most throated worm wheels, but certain tooth profiles cannot be hobbed. If any portion of the hob profile is perpendicular to the axis then it will have no cutting clearance generated by the usual backing off process, and it will not cut well.

Figure 2.1 CNC Gear Hobbing Machine operations

2.1.3 Technology specification

Gear hobbing is considered to be the most productive and viable of all a generating process. With Gear hobbing process toothed wheels of gears are manufactured with high quality and gives excellent performance. However, Hobbing is only used to produce spur and worn gears. Internal gears or shoulder gear cannot be worked up in Hobbing process. The hobbing process works like this. The hob is applied for generating the involute teeth. The hob is essentially a cylindrical tool which is positioned straight. In hobbing process the hob as well as the workpiece rotates continuously displaying a rotational relationship. A thread having the similar cross section as that of rack tooth is helically wound around the Hob. The Hob is then subsequently rotated. The gear blank is fed onto the hob based on the depth of cut. The helix pattern of a rotating hob is identical to that of a moving rack. Gear hobbing is an efficient process however it comes with complicated process



kinematics, and somehow difficult tool wear mechanisms. The main specifications are shown in Table 2.1.

Table 2.1 Equipment Speciation

Machine Speciation	
Nominal Workpiece Diameter	126 mm
Maximum Module	2.5 mod
Maximum Axial Cutting Length	457.2 mm
Maximum Hob Diameter	100 mm
Maximum Hob Length	152 mm
Maximum Hob Swivel	+/- 45°
Maximum Hob Shift	152 mm
Hob Speed Range (RPM)	100-2000
Work spindle Maximum Speed (RPM)	750
Hob Drive Power	7.5 kw
Width (Approximate)	1626 mm
Height (Approximate)	1829 mm
Length (Approximate)	1982 mm
Weight (Approximate Net)	3230 kg
B axis	hob servo motor
C axis	work spindle servo motor
X axis	radial feed servo motor
Y axis	tangential/hob shift servo motor
Z axis	axial feed servo motor
A axis	hob swivel

2.1.4 SUITABILITY OR INTEGRATION WITH EXISTING PROCESS

Hobbing Machines which is designed for dry hobbing. The Hobber can accommodate cylindrical gears with a maximum diameter of 210 mm and occupies significantly reduced floor space. Hobbing Machines are shaving machines as well as the threaded wheel grinding machine. All of the Hobbing machines share a common platform and have a small, compact machine footprint. The platform is designed to enable the user to install and re-locate the machine with no special lifting equipment or special foundations, and consolidates hydraulics, lubrication, and pneumatics into one easy-access location. The Hobber is designed for and is particularly well-suited for dry hobbing. The work area is completely isolated from the machine frame to minimize thermal expansion caused by contact with hot chips; it incorporates a stainless steel cutting chamber with steep inclination to ensure that chips fall completely clear of the work area. The Hobbers are equipped with an innovative new mechanical cam-driven double gripper loader fully integrated into the machine. As a result, costly non-productive time can be cut to a minimum, with part load/unload times as short as three seconds. Unlike conventional hobbing machines, the Hobbers utilize a new, patent-pending hob drive system to eliminate complicated mechanical and hydraulic clamping systems. Instead a simple "D-Drive" system enables the spindle to transmit more torque, with less run out, and at the same time accommodate the use of larger diameter hobs for greater performance and longer tool life. The Hobbers also features direct-drive spindle motors, which further reduces setup and machining times by eliminating the need for mechanical adjustments and change gears. Higher acceleration/deceleration rates and increased torque, combined with faster axis motions reduce non-cutting time between cycles and increase overall productivity during machining. The most significant advantage of CNC gear hobbing machine against its traditional and mechanical gear hobbing models is that the gear cutting production time can be shortened significantly (about 5 ~ 10 times faster), because for CNC models, the carbide tipped hobs with approximately 160 m/min surface speed can be utilized verses only the 16 m/min HSS-cutters for the traditional mechanical models. The CNC machines have additional advantages against its mechanical counterparts, for example, the production of gears can be programmed and recorded within the CNC control system, which can be used competitively; manufacturing gears of more complicated shapes, such as spiral bevel gears; the structure of the machine is simplified and it is easier for operation and maintenance.

2.1.5 SUPERIORITY OVER EXISTING TECHNOLOGY

- An Easy Access Service Module that consolidates hydraulics, lubrication and pneumatics into one location.
- Optional on-board chamfering and debarring capability.
- Availability of the latest SIEMENS or FANUC controls and the latest software running in a true Windows® environment.
- Alternate chip conveyor arrangements from either the side or rear of the machine to meet any cell/system arrangement.

- Automatic single and double cut cycles, Speed and feed change between cuts
- Crown hobbing cycle, Taper hobbing cycle, Radial and tangential feed worm gear cycles, Operator friendly data entry HMI screens
- Machine painted one standard color, Selectable number of cuts & Work light
- Programmable, multi-surface cutting capability
- Base machine with NUM 1060H CNC control, Wired for 460 volts, 3 phase, 60 Hz
- Total enclosure, Anti friction hardened and ground ways
- Steel way covers for Z axis and tail center, Pneumatic live center, position adjustable
- CNC programmable hob swivel setting, Manual grease lubrications to all bearing surfaces
- Electrical panel to AMT and ANSI-NFPA 79 Codes
- Wet or dry cutting, with coolant tank/pump assembly

The CNC Gear Hobbing features a control panel that permits the Gear Hobbing to be operated manually. This panel includes a multiple-line LCD display, an easy-to-use membrane keypad, an error indicator/pause button, and a key-released emergency stop push-button.. During the turning, the control panel displays the X and Z axes coordinates of the cutting tool, the feed rate, and the spindle speed. The CNC Gear Hobbing is designed for maximum safety. If the control is considered to be the brain of the machine, it's a natural assumption that the work spindle could be considered the heart. In order to transmit smooth motion, high torque, and the necessary work spindle speeds ranging from hobbing to inspection, a nontraditional approach was necessary. A safety door provides protection during machining. Magnetic interlocks located on this door stop the spindle and the axes if the door is opened during Bias compensation (twisted tooth correction) software.

2.1.6 Availability of technology

CNC based technology providers are basically multinational companies providing the services in all the major cities of the country. The technology is widely available and lots of national and multinational manufacturers are suppling their products to these industries including the machine tools industry.

2.1.7 Source of technology

This technology is already in use in some machine tools units in the cluster where the production requirment is ame. They also got the results of reduction in energy consumption as well as reduction in rejection of material and the technology is running successfully.

2.1.8 Service/technology providers

There are about 5 technology providers are available in the cluster for this system including Ace Micromatic Machine Tools Pvt. Ltd., Haas Automation, Jyoti CNC automation Pvt. Ltd., DMG Mori Seiki India Machines and Services Pvt. Ltd. And Mazak company is the service provider for this technology. They have the experience in supplying the multi – axis machine and provided consultancy & implementation support. The detailed contact information of all service providers is provided in annexure - .

2.1.9 Terms and condition of sales

Sales and after implementation of technology support information is provided in the annexure.

2.1.10 Process down time during implementation

The installation of CNC Gear Hobbing machine can be done in the 4 - 5 days, However the CNC Gear Hobbing machine is end to end solution of Gear Hobbing machine production process, implementation will not affect production. Thus implementation of this technology will not affect the process.

2.2 Life cycle assessment and risks analysis

In case installation of CNC Gear Hobbing machine, the technology and machine will continue to work up to 12 to 16 years under proper maintains. No need to any further huge modification after one time installation, in case of risk analysis there is a need of proper maintains and timely oiling.

2.3 Suitable unit/plant for implementation of proposed technology

CNC Gear Hobbing machine is suitable for the units involved in the production of more fast machining than conventional Gear Hobbings hense increase in productivity and Quality of the product is defenitely enhanced.

3 ECONOMIC BENEFITS FROM NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel saving

High speed generating hobbing with precision synchronous control of the spindle units for the hobbing wheel and the workpiece table. The crossed axis angle between the wheel and the workpiece axes is set over 10 degrees to obtain high sliding velocity at the hobbing point. The hobbing wheel is barrel-shaped. The hobbing wheel is vitrified bonded and then easily formed and dressed on the hobbing machine. The dressing unit is mounted to the machine bed with the dressing motion controlled by CNC.The gear Hoppers, are setting new benchmarks in the production of ultrahigh precision helical and spur gears. A production cell within one machine, combining high power for deep hobbing operations with ultra-high levels of accuracy of finish and the ability for quick set-up to optimize production and operating costs. All in all the fuel (eletricity) saved is about 25% which costs about ` 4000 per month. The advanced and highly integrated design enables an operator to take a typical design drawing and enter the specification – including such parameters as helix angle, pressure angle module and number of teeth - directly into the

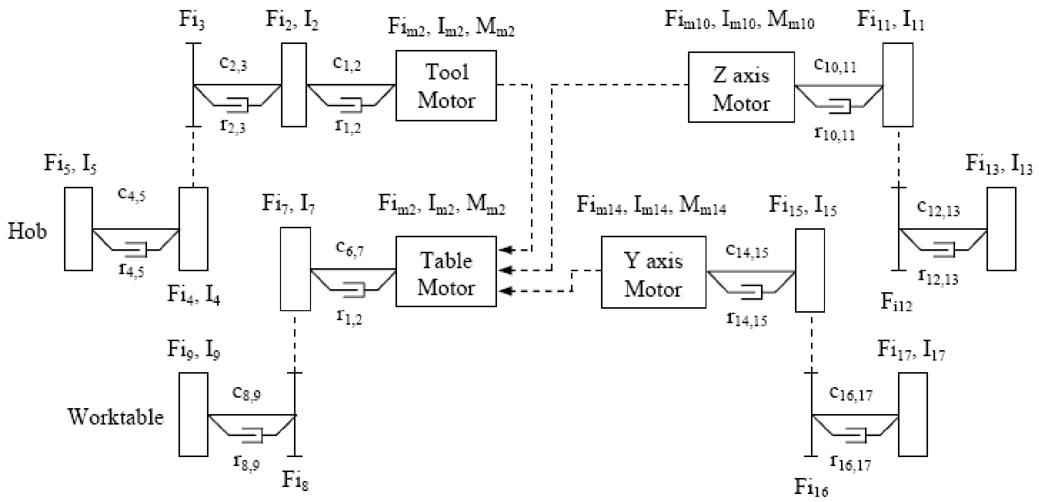


Fig. 3 Dynamic model of CNC gear hobbing machine

control, after which the machine performs its production cycle automatically. Optimizing the production efficiency of the machine are 3D measurement and correction probes. These improve production rates by removing the need for off-machine inspection. As a result, parts can be placed in the machine, accurately ground and then measured, and any deviations automatically corrected before completion of the cycle.CNC Gear Hobbings are rapidly replacing the older production Gear Hobbings (multispindle, etc) due to their ease of setting and operation. They are designed to use modern carbide tooling and fully utilize modern processes. And over all they are saving many a working hours for the same and thus saving eletricity on same production output. The above mentioned features makus them to save eletricity exponentially which as much ah 1200 kwh per month. The part may be designed by the Computer-aided manufacturing (CAM) process, the resulting file uploaded to the ma chine, and once set and trialled the machine will continue to turn out parts under the occasional supervision of an operator. The machine is controlled electronically via a computer menu style interface, the program may be modified and displayed at the machine, along with a simulated view of the process. The setter/operator needs a high level of skill to perform the process, however the knowledge base is broader compared to the older production machines where intimate knowledge of each machine was considered essential. These machines are often set and operated by the same person, where the operator will supervise a small number of machines (cell). And saving capacity of the producting unit is enhanced without effecting the annual production of the unit.The design of a CNC Gear Hobbing has evolved yet again however the basic principles and parts are still recognizable, the turret holds the tools and indexes them as needed. The machines are often totally enclosed, due in large part to Occupational health and safety (OH&S) issues. Installation of CNC Gear Hobbing machine is the ability to machine complex shapes in a single setup. This reduces the machinist setup time and incerease the production rate. The main advantage of CNC Gear Hobbing machining is the ability to save time by machining complex shapes in a single set-up. Additional benefit comes from allowing the use of shorter cutters that permit more accurate machining. Oil-air lubrication system this oil-air lubrication system insures constant and reliable lubrication to the spindle bearingspreventing periodic repacking of grease or replacement of bearings in case of the grease pack lubrication system. Productivity increases are huge. Not 10 or 20% but numbers like 500% and 1000% are realistic in many cases. This is especially true when using a tombstone to mount multiple parts on all 4 sides. One tool can complete, for example 16 or 20 parts, when stacked 4 or 5 high on each side. Tool changes take 12 to 15 seconds on most machines. That non-chip making time is lost only once to machine 16 or 20 parts with the one tool before it is changed. Larger parts like gear boxes and housings are obvious winners on this machine. Being able to complete most operations on 5 sides in a single set up leads to large reductions in lost time AND much improved tolerances because the part is not re-fixtured. When a large component is mounted on a rotary table, the size of the part that can be swung to allow machining on the front and back only can reach about 78” on the diagonal. This machine will produce parts to general commercial tolerances of just under one thou. It is not meant to replace traditional Gear Hobbing machining centers weighing and costing 2 to 3 times these machines, producing very fine tolerances. Energy & Cost saving including the energy, material rejection, man power cost and utility cost for a typical unit by installation of CNC Gear Hobbing machine are tabulated below:

Table 3.1 Energy savings estimation for CNC Gear Hobbing machine

S. No	Particular	Unit	Conventional Gear Hobbing machine	CNC Gear Hobbing machine
1	Specific Energy Consumption	kWh/Tonne	3126	2344.5
2	Average Energy Cost	`/Tonne	15630	11722.5
3	Cost of Material	`/annum	300000	227973
4	Other Cost (Man Power/Utility)	`/tonne	10000	4000
5	Average Production	`/tonne	325630	243695.5
6	Annual Production	Tonne/annum	50.4	50.4
7	Annual Production Cost	`/annum	16411752	12282251
8	Reduction in Production Cost	`/Tonne		81934.5
9	Annual cost reduction	`/Annum		4129501

A CNC Gear Hobbing machine will not only reduce the operartional cost of production but also increase the rate of the production in the same time. The estimated or feedback received from amny users of CNC Gear Hobbing machine revels that the CNC Gear Hobbing machine may produce two times production/ material at same time and at same energy consumption.

***Note:-** *As in the proposed DPR Conventional Gear Hobbing machine is replaced by CNC gear Hobbing Machine, it is assumed that it improves the overall productivity by 1.75 times i.e. 50.4 Tonnes/Annum in earlier case to 88.2 Tonnes/Annum after implementation. Accordingly, the energy saving could be achieved.Consequnetly, the O&M cost of machinery shall increase to 5 % with annual Escalation of 5 %.*

3.1.2 Improvement in product quality

CNC Gear Hobbing machine is presently one of the most versatile machine tools available and they are becoming increasingly common. This machening not only improve the quality of the product which is totly desinged by CNC machine with comparision to the exisitng manual set up based product.The rejection of material in CNC Gear Hobbing machining is almost nill while comparing with existing system/technology. Finally, high-speed cutting parameter coordination is executed by a CNC cycle for easy set-up and user-friendly activation of advanced motion control features. Excessive programming time is eliminated, because the adaptation of the CNC set-up is done according to the particular machining technique being employed.

3.1.3 Increase in production

A CNC Gear Hobbing machine will not only reduce the operartional cost of production but also increase the rate of the production in the same time. The estimated or feedback received from amny users of Conventional Gear Hobbing machine machines revels that the CNC Gear Hobbing machine may produce two times production/ material at same time and at same energy consumption, as the processes in the figure shows.

3.1.4 Reduction in raw material consumption

The rejection of material in CNC Gear Hobbing machining is almost nill while comparing with existing system/technology. However, in the cost calculation about 40% of the existing rate of rejection is considered.

3.1.5 Reduction in other losses

Installation of CNC Gear Hobbing machine will result in reduction of the utility system like compressed air system to operate the numetic system and other general utility expanses due to fast rate of the production with comparision to the existing technology. Some of them are listed below:-

- Efficient chip disposal
- Years of unerring accuracy due to heavily ribbed bed, box type column, and special heavy duty slides
- Minimum quantity lubrication compatibility for environment protection.
- Improved servo system for rapid response to signals from the spark-gap monitoring circuits
- New mechanical design for increased rigidity and reduced thermal distortion
- Surface-finish capabilities 50% better than conventional achievable surface finishes

3.2 Monetary benefits

Monetary savings in a typical unit after installation of CNC Gear Hobbing machine has been estimated around ` 72.27 lakh per annum. This figure has been arrived based on the annual reduction in energy, rate of material rejection and manpower cost savings in a typical unit multiplied by average annual production of the unit.

3.3 Social benefits

3.3.1 Improvement in working environment

The design of a CNC Gear Hobbing has evolved yet again however the basic principles and parts are still recognizable, the turret holds the tools and indexes them as needed. The machines are often totally enclosed, due in large part to Occupational health and safety (OH&S) issues.With the advent of cheap computers, free operating systems such as Linux, and open source CNC software, the entry price of CNC machines has plummeted.

3.3.2 Improvement in skill

Intervention of any new technology in any process/ industry requires improvement in skill set of workforce so as to run the process efficiently. This will also provide the development of skill sets of operators for CNC which will lead to energy efficient operations and quality product.

3.4 Environmental benefits

3.4.1 Reduction in effluent generation

As the existing and proposed technology is based on the low energy conservation and maximum output with saving of fuel and eletricity, hense saving nature and producing low carbon output per tonne.

3.4.2 Reduction in GHG emission such as CO2, NOx, etc

There are significant reductions to be achieved in Green House Gas emission by adoption of advance CNC technology like CNC Gear Hobbing machine in machine tools industries. Reduction in electricity consumption translates into GHG reductions is estimated to be 51.7 tonne of CO^2 per annum.

3.4.3 Reduction in other emissions like SOx

As the existing and proposed technology is based on the clean fuel based operation therefore Sulphur is not present in electricity; hence there is no impact on SOX emissions.

4 IMPLEMENTATION OF NEW ENERGY EFFICIENT TECHNOLOGY

4.1 Cost of technology implementation

4.1.1 Cost of technology

The costs of equipments that will be required for Installation of CNC Gear Hobbing machine are provided in Table 4.1 below:

Table 4.1 Cost of equipment

S. No.	Particulars	Cost
1	Cost of CNC Gear Hobbing machine	`22400000

4.1.2 Other costs

Table 4.2 Cost of civil work and consultancy

S. No.	Particulars	Cost
1.	Cost of civil work	`55,000/-
2.	Electrical & Utility Expenses	` 15,000/-
3.	Cost of Consultancy and installation	` 30,000/-
Total	One lakh only/-	` 100,000/-

Total project cost works out to be ` 225.00 lakh.

4.2 Arrangements of funds

4.2.1 Entrepreneur's contribution

Entrepreneur will contribute 25% of the total project cost & financial institutes can extend loan of 75%.

4.2.2 Loan amount.

The term loan is 75% of the total project cost, with repayment of 5 years excluding moratorium period of 6 months considered for the estimation purpose.

4.3 Financial indicators

4.3.1 Cash flow analysis

Detail cash flow analysis for new proposed technology is given in Annexure–5.

4.3.2 Simple payback period

The estimated payback period is about 3.11 years.

4.3.3 Net Present Value (NPV)

Net Present Value of new project would work out ` 96.78 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 18.93%. Thus the project is financially viable.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 20.21 %.

Table 4.4 Financial indicator of proposed technology

Particulars	Unit	Value
Simple Pay Back period	Years	3.11
IRR	%age	18.93
NPV	` in lakh	96.78
ROI	%age	20.21
DSCR	ratio	1.47

4.4 Sensitivity analysis

In different situation energy saving may increase or decrease on the basis of this scenarios a sensitivity analysis in realistic, pessimistic and optimistic has been carried out on the basis of two scenarios as considers. (**Fuel saving increase by 10%, Fuel saving decrease by 10%)**

Table 4.5: Sensitivity analysis

Particulars	IRR	NVP	ROI	DSCR
Normal	18.93	96.78	20.21	1.47
10% increase in fuel savings	19.07	98.29	20.25	148
10% decrease in fuel savings	18.79	95.28	20.17	1.46

Assuming all provision and resource input would be similar during economic analysis

4.5 Procurement and implementation schedule

The installation of CNC Gear Hobbing machine can be done in the 10 – 14 days, However the CNC Gear Hobbing machine is end to end solution of CNC Gear Hobbing machineing production process, implementation will not affect production. Thus implementation of this technology will not affect the process.

Table 4.6: Implementation Schedule

S. No.	Activities	Weeks						
		1	2	3	4	5	6	7
1	Procurement and Delivery							
2	Civil & Electrical Work							
3	Commissioning							
4	Training							

ANNEXURE

Annexure 1: Energy audit reports used for establishing

The results of detail energy audit for 2 Bangalore Machine tool cluster production units with specefic energy consuption are given below:

Audit No. 1 Energy Consumption Pattern of Existing Technology

S. No	Particular	Benchmarking	
		Unit	Value
1	Specific Energy Consumption	kWh/Tonne	3126
2	Average Energy Cost	`/Tonne	15630
3	Cost of Material	`/annum	300000
4	Other Cost (Man Power/Utility)	`/tonne	10000
5	Average Production	`/tonne	325630
6	Annual Production	Tonne/annum	50.4
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Energy savings estimation for CNC Gear Hobbing machine

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7	Annual Production Cost	`/annum	16411752	12282251
8	Reduction in Production Cost	`/Tonne		81934.5
9	Annual cost reduction	`/Annum		4129501

S. No	Particular	Unit	Conventional Gear Hobbing machine	CNC Gear Hobbing machine
6	Annual Production	Tonne/annum	50.4	88.2
7	Annual Production Cost	`/annum	16411752	21493943
8	Reduction in Production Cost	`/Tonne		81934.5
9	Annual cost reduction	`/Annum		7226622.9

*****The savings are due to increased production and reduced production costs.***

- ✓ ***`81394.5*** Cost reduction per tonne
- ✓ ***88.2 tonne*** increased production

81934.5 x 88.2 = 7226623

Annexure 2: Process sequence of dealing a workpiece at CNC Gear Hobbing machine

One of the ways to increase the productivity of gears production in job shop is the usage of a CNC gear hobbing machine. In the case of production of gears using gear hobbing, the economics of the production process restricts cutting in and cutting off stages of the cutting cycle. These stages last comparatively a long time during which not all power possible is used the power reaches the rated power only when all teeth of the hob being in contact with the workpiece are cut in on the full predator-mined depth.

The length of the travel stage from the first contact of the hob with the workpiece till the moment of usage of the rated power required for full depth cutting is big enough and together with the cutting off stage consists of 80-100% of the width of the workpiece in most cases. Modification of the forced cutting process is possible using CNC Machine for gear hobbing. This allows various combinations of axial feed-indexing motions, which help to improve process efficiency. The time moment of switching on or switching off of the forced feeding can be determined by using the closed loop according to the hob axis motor power used. Using the pulse type feed during cut in (cut off) stages, the indexing process also takes place during the forced feeding and the point of angular position on the workpiece surface at the end of the forced feeding overruns the angular position of the first contact point of the hob and workpiece. So, the position of switching on of each forced feed motion changes.

The hob tooth cutting edge trace in the workpiece is composed of three additives created due to three relative motions the rotation of the hob around its axis, indexing motion between the hob and the workpiece, and axial feeding. These motions can be divided into two pairs, which determine the thickness of the chip cut: the first pairi s the hob rotation together with axial feeding motion and the chip is cut due to axial feeding, the second one is the hob rotation together with indexing motion and the chip is cut due to indexing motion.

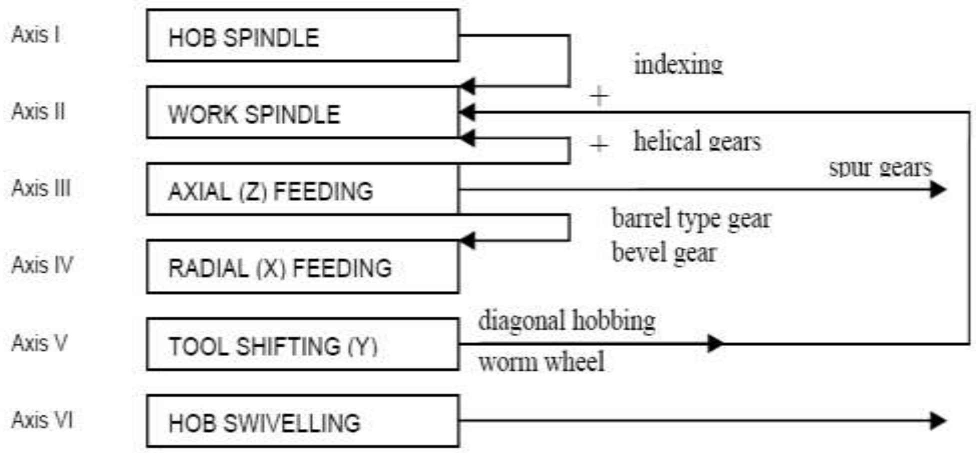
The first pair just determines the forced feed power, and the second one determines the biggest part of power, which is used during conventional hobbing. Methods exist, where forced cutting in feed is used instead of an accepted cutting-indexing cycle feed, during which the axial feed is increased significantly, and the hob axis motor reaches the possible rated cutting power.

After reaching a particular cutting depth, the forced feed is switched off leaving the indexing process only, and when the workpiece will make a full turn, the forced feed is switched on for the next time, and the cutting cycle is repeated. The hobbing wheel and workpiece are meshed with a generating motion. In order to improve hobbing performance and hobbing ratio, the hobbing wheel spindle and workpiece table are rotated synchronously with high speed. One feature of this machine is the crossed axis angle between the wheel and the workpiece axes from 20 to 35 degrees. This provides an elevated sliding velocity at the hobbing contact point. By high speed hobbing, gear accuracy—including pitch, profile and lead deviation—is improved, with tool life also extended.

Hobbing wheel shape: The hobbing wheel for this machine is barrel-shaped to avoid interference between the hobbing worm and ring gear undercut surface. The profile of the barrel shaped hobbing worm and the dressing method are analyzed theoretically to develop the process. Dressing method: The hobbing wheel also requires dressing to maintain the hobbing worm profile like other hobbing wheels. Possible dressing methods are as follows.

Dressing gear (master gear): The master dressing gear, which has identical geometry to the finished workpiece, is electroplated with diamond on its toothed surface. The dressing gear is automatically loaded and clamped to the workpiece fixture during the dressing cycle, similar to workpiece hobbing. Disk-type dresser: The profile of the disk-type dresser is similar to that of the tooth profile of the ring gear (the contact line between the hobbing wheel and the ring gear). The hobbing wheel is dressed one thread at a time. The dressing motion is shown in.

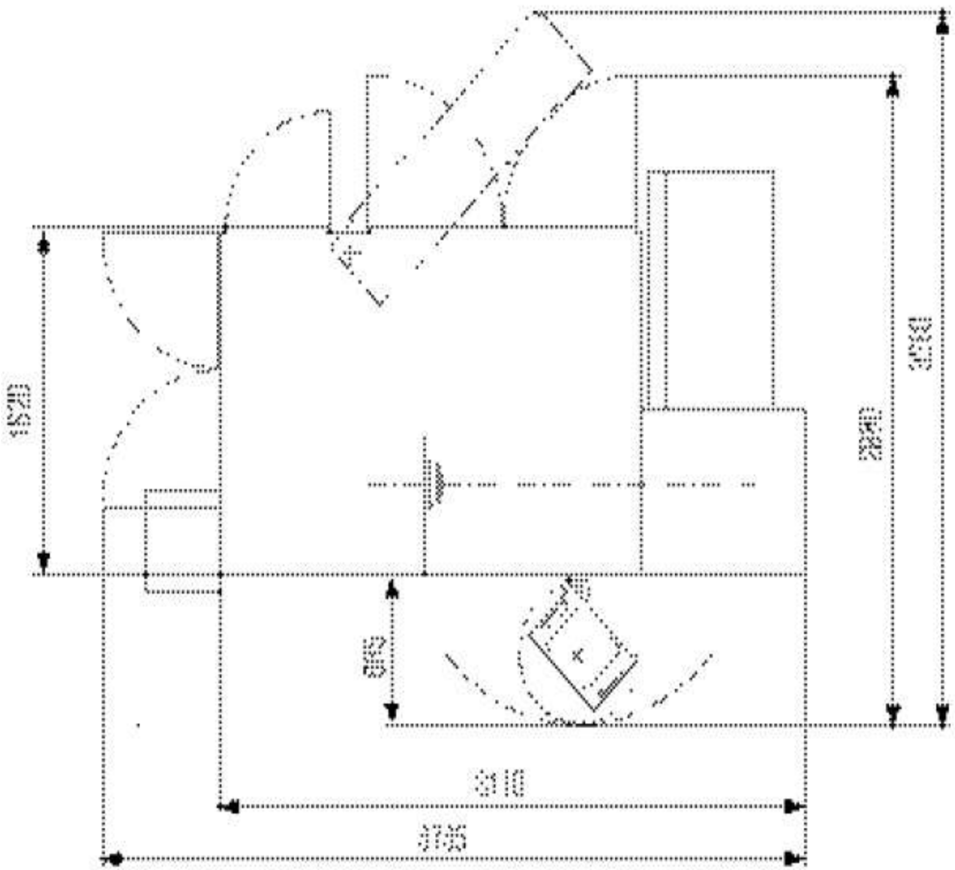
This method offers flexibility compared to that of the master dressing gear because of the ability to modify the tooth profile. Tool life: Unlike the case for hobbing external gears, the hobbing wheel for internal gears is to be dressed with higher frequency since its diameter is small and less than that of the workpiece. This is not ideal in terms of cycle time and tool life. To solve this problem dressable vitrified CBN hobbing wheels—with longer life than conventional vitrified wheels—are used in the machine. Furthermore, with the high speed spindles, in conjunction with the large crossed axis angles, it is possible to achieve more than 20 m/s hobbing speed. The working process is illustrated below in the figure.

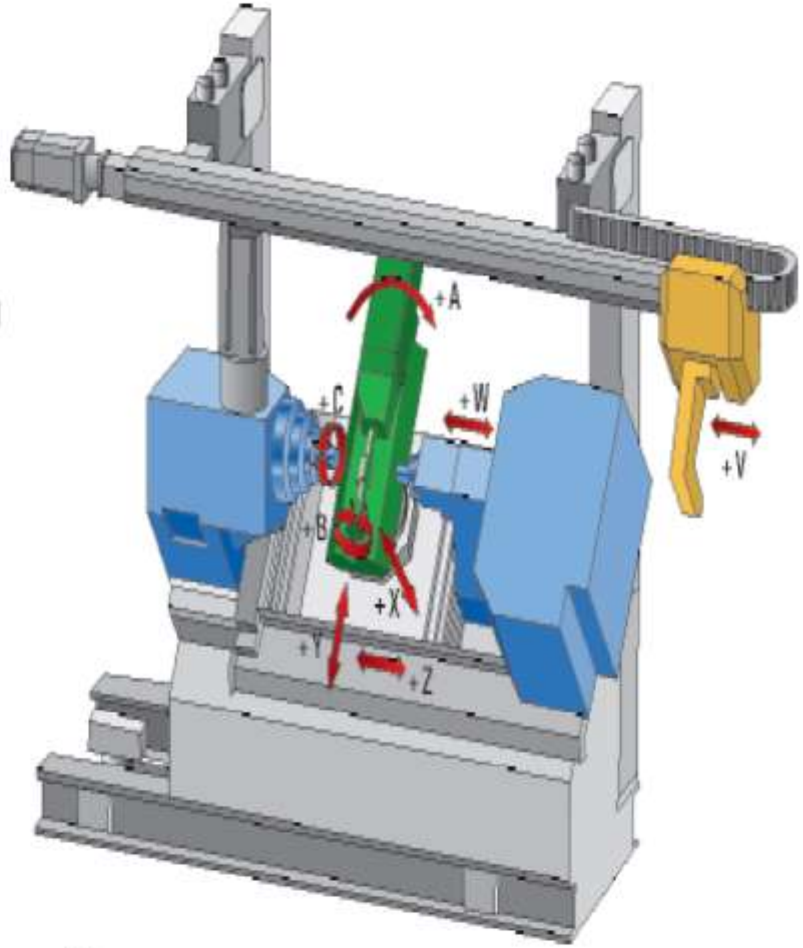


Annexure 3: Technical Drawing of CNC Gear Hobbing machine

Floor plan K 160

Measurements in mm





NC axes:

A – Hob head swivel movement

B – Hob rotation

C – Workpiece rotation

W – Tailstock travel

X – Radial movement

Y – Axial movement of hob

Z – Axial movement

V – Gantry loader travel

High-speed dry hobbing of planetary gears

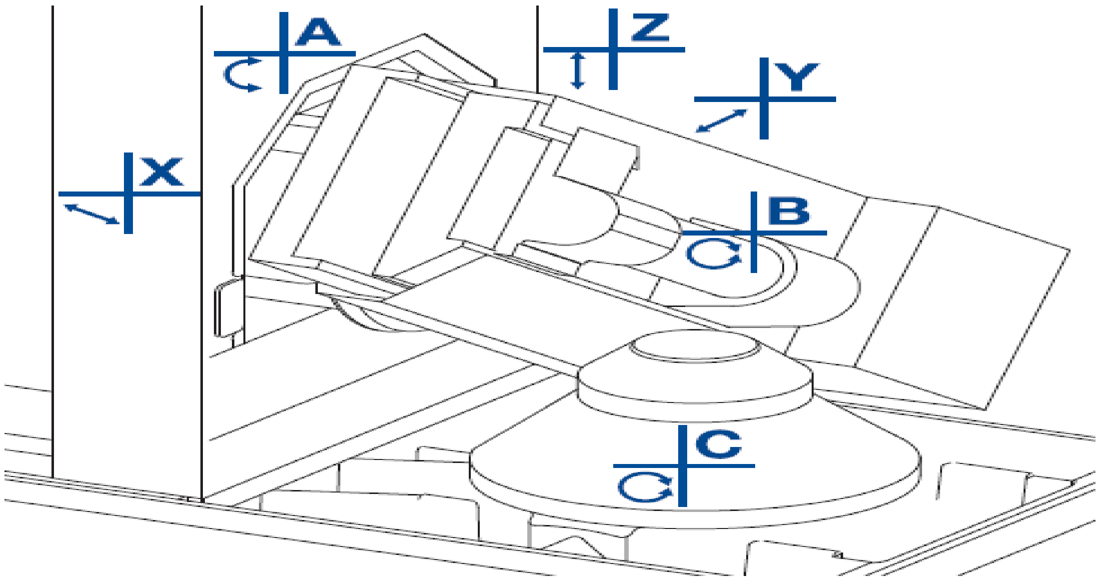
High-speed dry gear cutting of armature shafts

Worm gears can not only be radially milled, as is the common practice, but – where greater precision is demanded – they can be tangentially milled, with the shank cutter being clamped in a hydraulic expansion chuck

The CNC Gear Hobbing Machine (Process)

Steering pinions: soft pre-milling
and hard finish-milling (skiving)
of the gearing.
Manufacturing quality:
Pre-milling (soft) to DIN 7–8
Skiving (hard) to DIN 7

A Tool head swivel
B Tool spindle rotation
C Work spindle rotation
X Radial movement
Y Tangential movement
Z Axial movement



Annexure 4: Detailed financial calculations & analysis for financial indicators

Assumption

Name of the Technology	CNC Hobbing Machine		
Rated Capacity			
Details	Unit	Value	Basis
No of working days	Days	300	Feasibility Study
No of Shifts per day	Shifts	2	Feasibility Study
Proposed Investment			
Plant & Machinery	` (in lakh)	224	Feasibility Study
Cost of modification in civil construction	` (in lakh)	0.55	Feasibility Study
Electricity & utility expenses	` (in lakh)	0.15	Feasibility Study
Cost of consultancy	` (in lakh)	0.30	Feasibility Study
Total Investment	` (in lakh)	225	Feasibility Study
Financing pattern			
Own Funds (Equity)	` (in lakh)	56.25	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	168.75	Feasibility Study
Loan Tenure	years	7	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	90	Assumed
Interest Rate	%age	10.00	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	5.00	Feasibility Study
Annual Escalation	%age	5.00	Feasibility Study
Estimation of Revenue			
Electricity saving	kWh/Tonne	781.5	
Total production	Tonne/annum	88.2	
cost	`/kWh	5	
Other saving	`/Annum	78027	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	15.00	Income Tax Rules
Income Tax	%age	33.99	Income Tax

Estimation of Interest on Term Loan (` in lakh)

Years	Opening Balance	Repayment	Closing Balance	Interest
1	168.75	9.00	159.75	19.56
2	159.75	18.00	141.75	15.16
3	141.75	20.00	121.75	13.30
4	121.75	21.50	100.25	11.22
5	100.25	25.00	75.25	8.94
6	75.25	28.25	47.00	6.27
7	47.00	30.50	16.50	3.33
8	16.50	16.50	0.00	0.48
		168.75		

WDV Depreciation

Particulars / years	1	2
Plant and Machinery		
Cost	225.00	45.00
Depreciation	180.00	36.00
WDV	45.00	9.00

Projected Profitability

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Revenue through Savings										
Total Revenue (A)	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27
Expenses										
O & M Expenses	11.25	11.81	12.40	13.02	13.67	14.36	15.08	15.83	16.62	17.45
Total Expenses (B)	11.25	11.81	12.40	13.02	13.67	14.36	15.08	15.83	16.62	17.45
PBDIT (A)-(B)	61.02	60.45	59.86	59.24	58.59	57.91	57.19	56.44	55.64	54.81
Interest	19.56	15.16	13.30	11.22	8.94	6.27	3.33	0.48	-	-
PBDT	41.46	45.30	46.57	48.03	49.65	51.63	53.86	55.95	55.64	54.81
Depreciation	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
PBT	29.58	33.42	34.69	36.15	37.77	39.75	41.98	44.07	43.76	42.93
Income tax	-	3.16	15.83	16.32	16.88	17.55	18.31	19.02	18.91	18.63
Profit after tax (PAT)	29.58	30.26	18.86	19.82	20.89	22.20	23.67	25.05	24.85	24.30

Computation of Tax *`(in lakh)*

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Profit before tax	29.58	33.42	34.69	36.15	37.77	39.75	41.98	44.07	43.76	42.93
Add: Book depreciation	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
Less: WDV depreciation	180.00	36.00	-	-	-	-	-	-	-	-
Taxable profit	(138.54)	9.30	46.57	48.03	49.65	51.63	53.86	55.95	55.64	54.81
Income Tax	-	3.16	15.83	16.32	16.88	17.55	18.31	19.02	18.91	18.63

Projected Balance Sheet *`(in lakh)*

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Liabilities										
Share Capital (D)	56.25	56.25	56.25	56.25	56.25	56.25	56.25	56.25	56.25	56.25
Reserves & Surplus (E)	29.58	59.84	78.70	98.52	119.41	141.62	165.29	190.34	215.19	239.50
Term Loans (F)	159.75	141.75	121.75	100.25	75.25	47.00	16.50	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	245.58	257.84	256.70	255.02	250.91	244.87	238.04	246.59	271.44	295.75
Assets										
Gross Fixed Assets	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00	225.00
Less: Accm. Depreciation	11.88	23.76	35.64	47.52	59.40	71.28	83.16	95.04	106.92	118.80
Net Fixed Assets	213.12	201.24	189.36	177.48	165.60	153.72	141.84	129.96	118.08	106.20
Cash & Bank Balance	32.46	56.60	67.34	77.54	85.31	91.15	96.20	116.63	153.36	189.55
Total Assets	245.58	257.84	256.70	255.02	250.91	244.87	238.04	246.59	271.44	295.75
Net Worth	85.83	116.09	134.95	154.77	175.66	197.87	221.54	246.59	271.44	295.75
Dept equity ratio	2.84	2.52	2.16	1.78	1.34	0.84	0.29	0.00	0.00	0.00

Projected Cash Flow: *`(in lakh)*

Particulars / Years	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Sources											
Share Capital	56.25	-	-	-	-	-	-	-	-	-	-
Term Loan	168.75										
Profit After tax		29.58	30.26	18.86	19.82	20.89	22.20	23.67	25.05	24.85	24.30
Depreciation		11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
Total Sources	225.00	41.46	42.14	30.74	31.70	32.77	34.08	35.55	36.93	36.73	36.18
Application											
Capital Expenditure	225.00										
Repayment of Loan	-	9.00	18.00	20.00	21.50	25.00	28.25	30.50	16.50	-	-
Total Application	225.00	9.00	18.00	20.00	21.50	25.00	28.25	30.50	16.50	-	-

Net Surplus	-	32.46	24.14	10.74	10.20	7.77	5.83	5.05	20.43	36.73	36.18
Add: Opening Balance	-	-	32.46	56.60	67.34	77.54	85.31	91.15	96.20	116.63	153.36
Closing Balance	-	32.46	56.60	67.34	77.54	85.31	91.15	96.20	116.63	153.36	189.55

Calculation of Internal Rate of Return ***`(in lakh)***

Particulars / months	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Profit after Tax		29.58	30.26	18.86	19.82	20.89	22.20	23.67	25.05	24.85	24.30
Depreciation		11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
Interest on Term Loan		19.56	15.16	13.30	11.22	8.94	6.27	3.33	0.48	-	-
Cash outflow	(225.00)	-	-	-	-	-	-	-	-	-	-
Salvage value											106.20
Net Cash flow	(225.00)	61.02	57.29	44.04	42.92	41.72	40.36	38.88	37.42	36.73	142.38
IRR	18.93%										
NPV	96.78										

Break Even Point ***`(in lakh)***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Variable Expenses										
Operation & Maintenance Exp (75%)	8.44	8.86	9.30	9.77	10.26	10.77	11.31	11.87	12.47	13.09
Sub Total (G)	8.44	8.86	9.30	9.77	10.26	10.77	11.31	11.87	12.47	13.09
Fixed Expenses										
Operation & Maintenance Exp (25%)	2.81	2.95	3.10	3.26	3.42	3.59	3.77	3.96	4.16	4.36
Interest on Term Loan	19.56	15.16	13.30	11.22	8.94	6.27	3.33	0.48	0.00	0.00
Depreciation *(H)*	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
Sub Total (I)	34.25	29.99	28.28	26.35	24.24	21.74	18.98	16.32	16.04	16.24
Sales (J)	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27	72.27
Contribution (K)	63.83	63.41	62.96	62.50	62.01	61.50	60.96	60.39	59.80	59.18
Break Even Point (L= G/I) (%)	53.66%	47.29%	44.91%	42.16%	39.09%	35.36%	31.14%	27.03%	26.81%	27.45%
Cash Break Even {(I)-(H)} (%)	35.04%	28.56%	26.04%	23.16%	19.93%	16.04%	11.65%	7.35%	6.95%	7.37%
Break Even Sales (J)*(L)	38.77	34.18	32.46	30.47	28.25	25.55	22.50	19.53	19.38	19.84

Return on Investment ***`(in lakh)***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Net Profit Before Taxes	29.58	33.42	34.69	36.15	37.77	39.75	41.98	44.07	43.76	42.93	384.10
Net Worth	85.83	116.09	134.95	154.77	175.66	197.87	221.54	246.59	271.44	295.75	1900.49
ROI	96.78%										

Debt Service Coverage Ratio ***`(in lakh)***

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Cash Inflow										
Profit after Tax	29.58	30.26	18.86	19.82	20.89	22.20	23.67	25.05	24.85	24.30
Depreciation	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88	11.88
Interest on Term Loan	19.56	15.16	13.30	11.22	8.94	6.27	3.33	0.48	0.00	0.00
Total (M)	61.02	57.29	44.04	42.92	41.72	40.36	38.88	37.42	36.73	36.18

Debt

Interest on Term Loan	19.56	15.16	13.30	11.22	8.94	6.27	3.33	0.48	0.00	0.00
Repayment of Term Loan	9.00	18.00	20.00	21.50	25.00	28.25	30.50	16.50	0.00	0.00
Total (N)	28.56	33.16	33.30	32.72	33.94	34.52	33.83	16.98	0000	0.00
Average DSCR (M/N)	1.47									

Note: - As the proposed machinery is CNC Gear Hobbing Machine it is expected that the machine will be fetching good market value even after the project period of 10 Years. Therefore, in this case the Salvage value is expected to be at least net value after providing Depreciation for the project life and this value is considered as the cash flow in the last i.e. 10th year of the project life for simplification. In the alternative case we have to consider the other model where cash flow has to be calculated beyond the project life of 10 Years (perpetuity).

Annexure 5: Details of procurement and implementation plan

S. No.	Activity	Weeks										
		1	2	3	4	5	6	7	8	9	10	11
1	Service Contract											
2	Civil Modification											
3	Commissioning											
4	Training											
5	Trail operation											

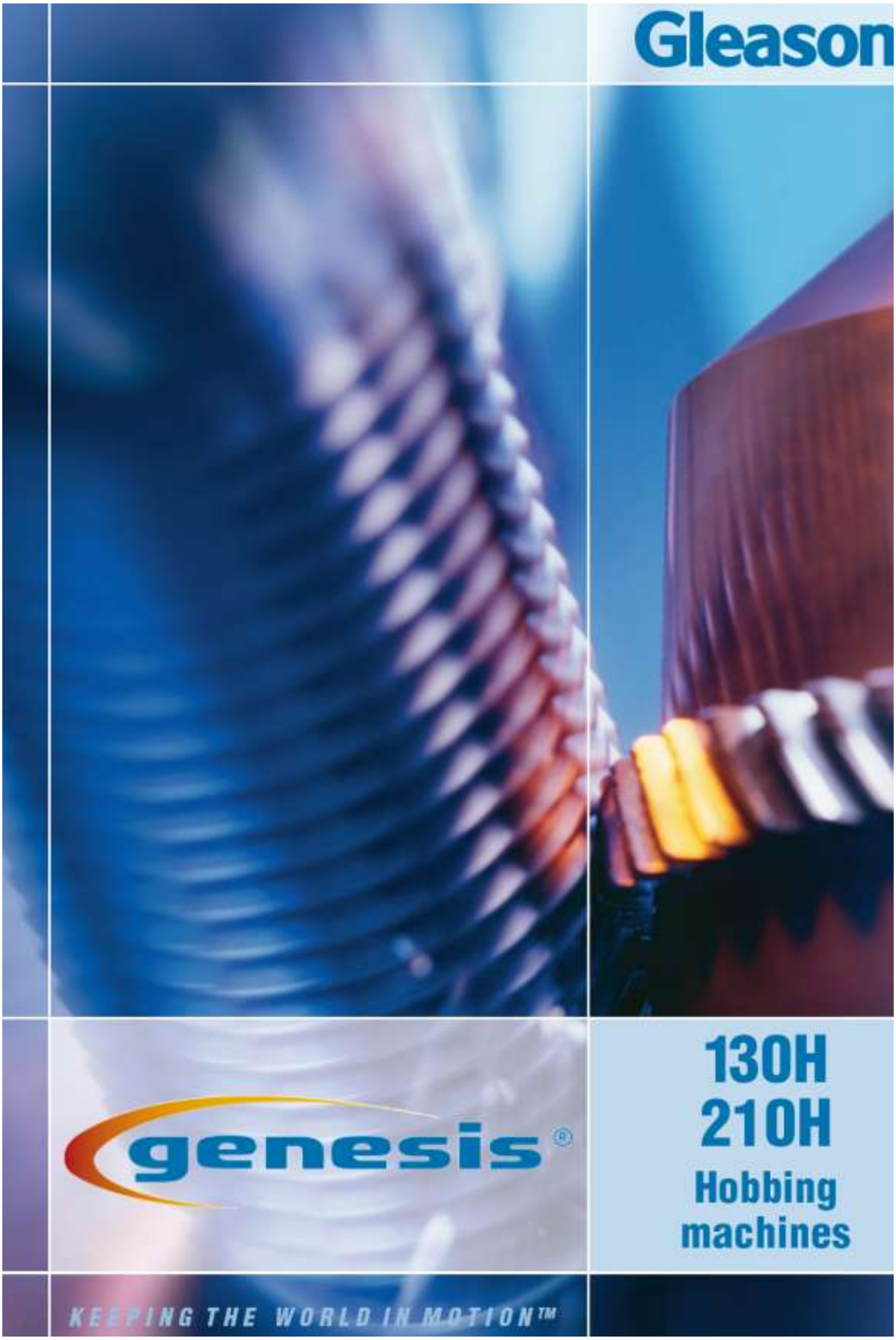
Annexure 6: Details of technology/equipment and service providers

Name of Organization	Communication Address	Contact No.
Gleason India, Bangalore	Eldho John Commercial Executive Ph: 080-28524315/16/76 Fax: 080-28524377	E-mail: eldho@gleason.in bangalore.sales@gleason.in web: www.gleason.com
DMG Mori Seiki India Machines and Services Pvt Ltd	"Parimala Towers" #64 Jalahalli Camp Cross, Off MES Road, Yeshwanthpur IN-560022 Bangalore.	Phone: +91 80 40896508
Haas Automation	Manav Marketing Pvt Ltd 430-431,12TH cross, 4th Phase, Peenya Industrial Area, Bangalore 560058 India	91-80-4117 9452/53
Intelmac machine tools Pvt.ltd.	No.95/90, "Sowjanya" 1st Floor, 19th Main,1st 'N' Block, Rajajinagar, BANGALORE - 560 010. INDIA	kiran@intelmacindia.com Tel: +91-80-32982722, +91-80-23577655. Fax: +91-80-23474508
Mazak company	Concord Towers, 14th Floor, UB City, Bangalore	

Annexure 7: Quotations or Techno-commercial bids for new technology/equipment

Technical Specifications for CNC Gear Hobbing Machine

Machine Speciation	
Nominal Workpiece Diameter	126 mm
Maximum Module	2.5 mod
Maximum Axial Cutting Length	457.2 mm
Maximum Hob Diameter	100 mm
Maximum Hob Length	152 mm
Maximum Hob Swivel	+/- 45°
Maximum Hob Shift	152 mm
Hob Speed Range (RPM)	100-2000
Work spindle Maximum Speed (RPM)	750
Hob Drive Power	7.5 kw
Width (Approximate)	1626 mm
Height (Approximate)	1829 mm
Length (Approximate)	1982 mm
Weight (Approximate Net)	3230 kg
B axis	hob servo motor
C axis	work spindle servo motor
X axis	radial feed servo motor
Y axis	tangential/hob shift servo motor
Z axis	axial feed servo motor
A axis	hob swivel


Gleason
genesis®
130H
210H
Hobbing
machines
KEEPING THE WORLD IN MOTION™

technology genesis

Genesis® 130H and 210H Hobbing Machines: The next generation in gear production technology.

Genesis®: Gleason's new family of gear production equipment, built on a common platform to optimize capabilities – and better serve the entire world of gearing.

The Genesis® 130H and 210H Hobbing Machines are vertical hobbers capable of producing gears and shafts with an outside diameter as large as 130 mm respectively 210 mm.

The Genesis Hobbers were designed as totally new products incorporating the most modern features and capabilities required by today's gear production.

These include:

- Small footprint: 7 sq. meters (73 sq. ft.), including all hydraulics, lubrication, chip removal, coolant and pneumatic systems.
- Fully self-contained machine, easily moved as a single unit without disconnecting auxiliary support systems.
- Easy Access Service Module to consolidate hydraulics, lubrication and pneumatics into one location.
- Single-piece, mineral cast polymer composite base/frame providing superior vibration damping and thermal stability.
- Designed for wet or dry hobbing, with a clean uncluttered work chamber to more effectively contain cutting and divert chips.
- High speed hob and workspindles capable of utilizing the most advanced cutting tools.
- High speed loading system to reduce load/unload cycles to as little as 3 secs.
- New "D-drive" hob drive system with dramatically higher mounting accuracy, stiffness and torque.
- Direct-drive spindles for reliability and wide speed and torque range.
- Siemens or FANUC CNC controls.
- Windows® based user-friendly software and PC front-end.
- Quick-change workholding tooling for fast, easy changeover.
- Optional chamfering and deburring capability.
- Common design with common parts shared by all the models in the Genesis family.

common platform

Genesis machines use the optimally designed common platform, improving leadtimes and machine performance and serviceability.

Common platform, superior results.

The Genesis machines share the same single-piece frame, cast from an advanced polymer composite material. The polymer composite is an ideal substitute for conventional cast-iron because the castings can be made to very tight finished tolerances faster and more precisely. In addition, the column, typically machined separately and then assembled, is instead integrated right into the casting, helping ensure maximum rigidity.

The use of the same common platform design is an important element of lean manufacturing, dramatically reducing lead times for the Genesis machines.

Designed for wet or dry.

The Genesis series of machines has been designed to deliver exceptional performance in either wet or completely dry cutting conditions. The work area is contained by an internal guard and funnel that is completely separate from the machine's base/frame to minimize the thermal expansion that results from hot chips coming in contact with the base. In addition, the funnel that directs chips to the chip conveyor has been designed with a steep inclination to ensure that chips fall completely clear of the work area.

Polymer composite material offers many highly desirable performance characteristics that make it well-suited for gear production, including:

- **superior vibration damping**
- **thermal stability**
- **chemical- and corrosion-resistant**

The Genesis 130H is a compact, yet powerful and highly productive hobber.

Hot chips are fully contained in the work chamber and fall free without contacting base/frame.

3

features **genesis**

New Genesis cam-driven double gripper loader reduces load/unload time to as little as 3 seconds.

Faster floor-to-floor times.
Significant advances in machine and cutting tool performance have combined to reduce the time spent cutting a gear. As a result, the non-productive time required for the load operation can become an increasingly large portion of overall floor-to-floor times.

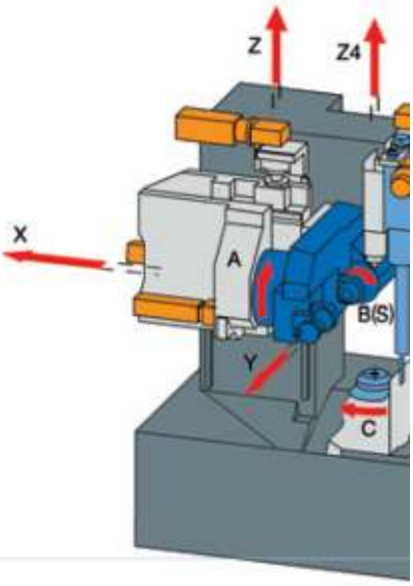
That's why the Genesis machines 130H and 210H are equipped with an innovative new mechanical cam-driven double-gripper loader fully integrated into the machine. The new Genesis double-gripper loader system can perform the load/unload sequence in as little as 3 seconds (bore-type gears on 130H).

In addition, it can easily accommodate disk or shaft-type gears, and readily integrates with all types of common parts handling systems including palletized, gantry, blue-steel and robot systems for maximum throughput.

Faster speeds.
Direct-drive, high speed, high torque motors are used on the hobhead and workspindle to achieve hob speeds up to 4,000 rpm and take full advantage of the most advanced tool materials and coatings.

Direct-coupled axis drives are used to achieve higher travel speeds. This, combined with faster spindle speeds and higher acceleration/deceleration rates, results in even further reductions in non-productive time.

Hob drive system breakthrough.
A new (patent pending) hob drive system has been developed for the Genesis machines to improve hobbing performance and simplify the overall design. Conventional hob drives have relied on complicated systems to provide the clamping force on the drive end of the hob. The new Genesis hob drive system eliminates collets, rotary couplings, springs, and all other mechanical and hydraulic clamping components.
The drive end of the hob is designed with a taper having a "D" shaped end.



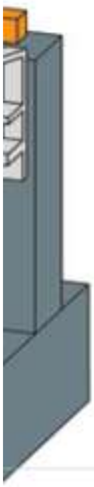
performance

Shank-type hob with "D" style drive end eliminates conventional clamping systems.

This fits into a tapered spindle pocket, where a floating rotary key makes contact with the additional surface area created by the "D" shaped end.
The result is a spindle that can transmit considerably more torque, with less runout, than possible with conventional designs.
Larger diameter hobs can be used for greater performance and improved tool life.

Revolutionary new hob clamping system.
The Genesis machines also use a completely new clamping system. Now, both the cutter spindle slide and outboard support slide both travel tangentially on the same set of linear guideways, on identical roller bearing assemblies, to clamp the hob.
This differs significantly from conventional hob clamping designs, where the spindle slide and support slide each travel on their own independent set of guideways with different bearing diameters. The end result is a simpler, extremely rigid clamping system that delivers more consistent gear quality across the entire shift pass, and longer tool life.

Tangential slides travel on the same set of linear guideways and on identical roller bearing assemblies, to deliver more consistent quality and longer tool life.



6-axis design featuring direct-drives and shorter travels, helps reduce cycle times.

5

operation

genesis

Availability of FANUC or Siemens controls and Gleason's Windows® based front end makes it simple and efficient to operate anywhere in the world.

Powerful, user-friendly controls.
The Genesis machines are available with the latest FANUC or Siemens CNC control system to meet customer preference anywhere in the world. In addition, Gleason provides new operating software and network capabilities to allow easy integration into any modern production environment:

- Equipped with the Gleason software to make setup and operation control easy and intuitive by running in a true Windows® environment.
- Fully network-ready to support remote diagnostics. This allows quick, on-line access to Gleason engineers, or the customer's own off-site personnel for software upgrades and technical support.

Designed for serviceability.
Servicing and maintaining hydraulics, lubrication, coolant and electrical services has been made easier and more efficient on the Genesis machines. By locating all of the service components in one modular sub-assembly, operations and maintenance personnel can more quickly and effectively locate and react to any maintenance issue.

Fast, simple installation and relocation.
The Genesis common-platform construction offers several other advantages, including:

- The machine is readily transportable with no special lifting equipment, and can be installed on three mounting pads without the need for special foundations.
- Designed into the base are provisions to re-locate the chip conveyor from either the side or rear of the machine to meet any cell/system arrangement, now and in the future.

On-board chamfering or deburring capability.
With the Genesis machines come the option to integrate post-hobbing operations such as chamfering or deburring right into the machine.

By putting services in one easy-access module, maintenance is faster and less expensive to perform.

From: Eldho <eldho@gleason.in>
Date: Fri, 24 Jun 2011 18:38:59 +0530
To: Thanga Durai A<thangadurai@pcra.org>
Cc: Sivakumar V<shivkumarv@pcra.org>; Sharma MVV<sharmamvv@pcra.org>
Subject: Fw: Budgetory Quote for CNC Hobbing Machine

Dear Sir,

We thank you for your message narrating your project initiative with respect to CNC Hobbing Machines. We have attached brochure of Genesis 130H Hobbing Machine which is matching with the machine specifications indicated in the attachment.

The approximate cost of the Genesis 130H Hobbing Machine is EUR 350,000.00. This is for the base machine with basic features and options. For the fully tooled up machine, you can anticipate a 20% increase in the total price.

Trust we have been of assistance to you and looking forward to your kind feed back.

Thanks & Regards,

Eldho John
Commercial Executive
Gleason India, Bangalore
Ph: 080-28524315/16/76
Fax: 080-28524377
E-mail: eldho@gleason.in
bangalore.sales@gleason.in
web: www.gleason.com
----- Original Message -----
From: Soudararajan
To: Eldho John
Sent: Wednesday, June 22, 2011 4:41 PM
Subject: Fw: Budgetory Quote for CNC Hobbing Machine

Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

PCRA, Southern Region
Petroleum Conservation Research Association T.M.B. Mansion, First Floor, 739, Anna Salai,
Chennai – 600002
System & Solution (India)
www.sas.ind.in
ems@sas.ind.in

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri,
New Delhi-110058
Tel: +91-11-28525534,
Fax: +91-11-28525535
Website: www.techsmall.com