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











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Bureau of Energy Efficiency

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REPLACEMENT OF CONVENTIONAL LATHE MACHINE

TO

CNC LATHE MACHINE/

INSTALLATION OF NEW CNC LATHE

BANGALORE MACHINE TOOL CLUSTER

BEE, 2010

Detailed Project Report on Replacement of Conventional Lathe Machine to CNC Lathe Machine

Bangalore Machine Tool cluster, Karnataka (India)

New Delhi: Bureau of Energy Efficiency;

Detail Project Report No.:

For more information

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Acknowledgement

We are sincerely thankful to the Bureau of Energy Efficiency, Ministry of Power, for giving us the opportunity to implement the ‘BEE SME project in Bangalore Machine Tool cluster’. We express our sincere gratitude to all concerned officials for their support and guidance during the conduct of this exercise.

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Petroleum Conservation Research Association is also thankful to “Karnataka Small Scale Industries Association, Bangalore, Peenya Industrial Association, Bangalore and Bangalore Machine Tool manufacturers Association, Bangalore” for their valuable inputs, co-operation, support and identification of the units for energy use and technology audit studies and facilitating the implementation of BEE SME program in Bangalore Machine Tool cluster.

We take this opportunity to express our appreciation for the excellent support provided by Machine Tool Unit Owners, Local Service Providers, and Equipment Suppliers for their active involvement and their valuable inputs in making the program successful and in completion of the cluster manual.

PCRA is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

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
EA	Energy Audit
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
MSME	Micro Small and Medium Enterprises
O&M	Operational & Maintenance
PAT	Profit After Tax
PBT	Profit Before Tax
ROI	Return on Investment
MoMSME	Ministry of Micro Small and Medium Enterprises
SIDBI	Small Industries Development Bank of India

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.

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. One of the recommendations made in the cluster manual is Replacement of conventional lathes with CNC lathes or new CNC Lathes

CNC lathes are rapidly replacing the older production lathes (multispindle, etc.) due to their ease of setting and operation. They are designed to use modern carbide tooling and fully use modern processes. The part may be designed and the toolpaths programmed by the CAD/CAM process, and the resulting file uploaded to the machine, 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). The design of a CNC lathe 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.

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)	40.80
2.	Electricity Savings	kWh/Year	105311
3.	Monetary benefit	` (in lakhs)	14.88
4.	Simple payback period	Year	2.74
5.	NPV	` (in lakhs)	25.45
6.	IRR	%age	22.87
7.	ROI	%age	21.05
8.	DSCR	Ratio	1.68
9.	CO_2 reduction	Tonne/ Annum	79
10.	Procurement and implementation schedule	week	7

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 grinding machines, ID grinding 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.

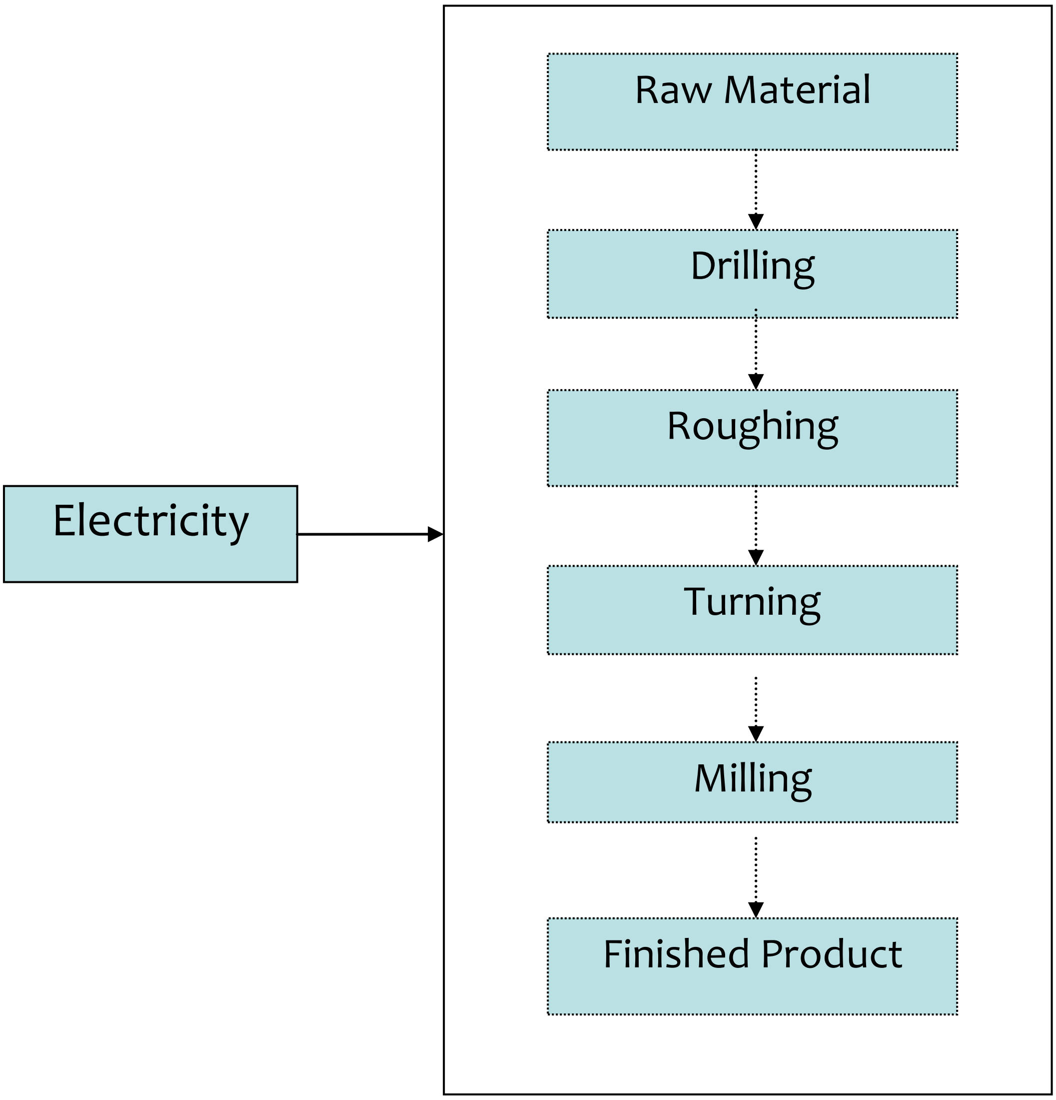
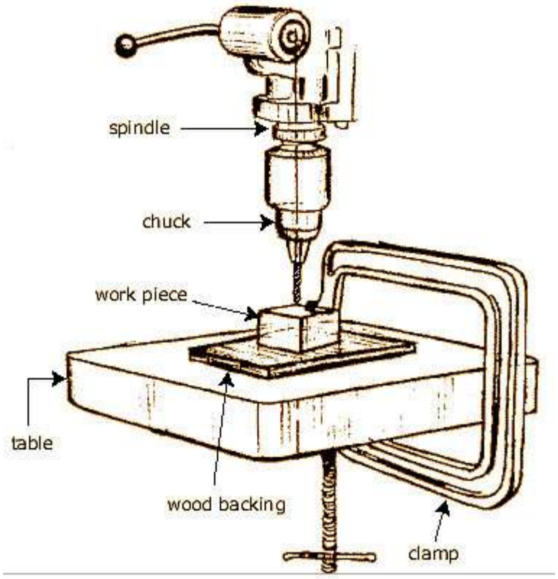


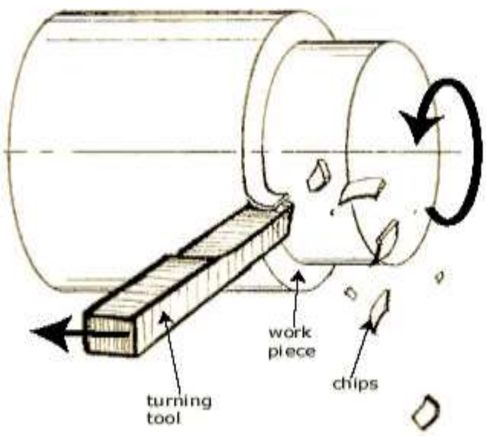
Figure 1.1 Process flow chart of typical Machine Tools Unit

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.



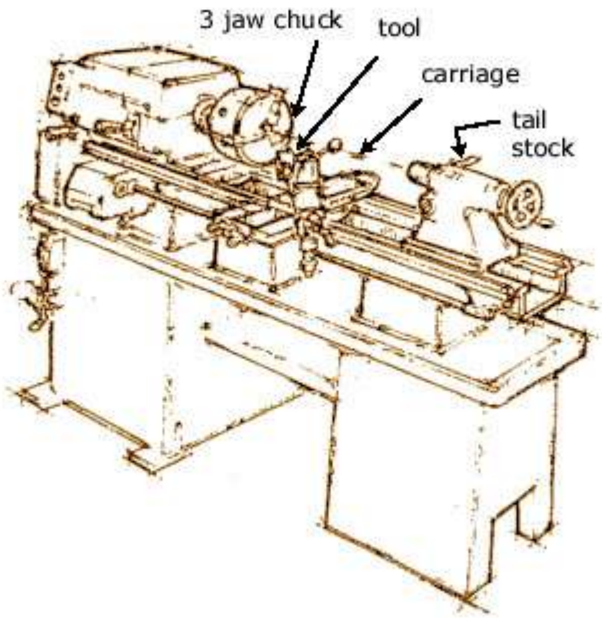
Drilled holes are characterized by their sharp edge on the entrance side and the presence of burrs on the exit side (unless they have been removed). Also, the inside of the hole usually has helical feed marks.

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 lathe, 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 lathe, which frequently requires continuous supervision by the operator, or by using a computer controlled and automated lathe 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 lathe.

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 lathes 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 lathe is the only machine tool that can reproduce itself.

The turning processes are typically carried out on a lathe, 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 grinding operations. Hard turning, when applied for purely stock removal purposes, competes favorably with rough grinding. However, when it is applied for finishing where form and dimension are critical, grinding is superior. Grinding 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 lathes 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.

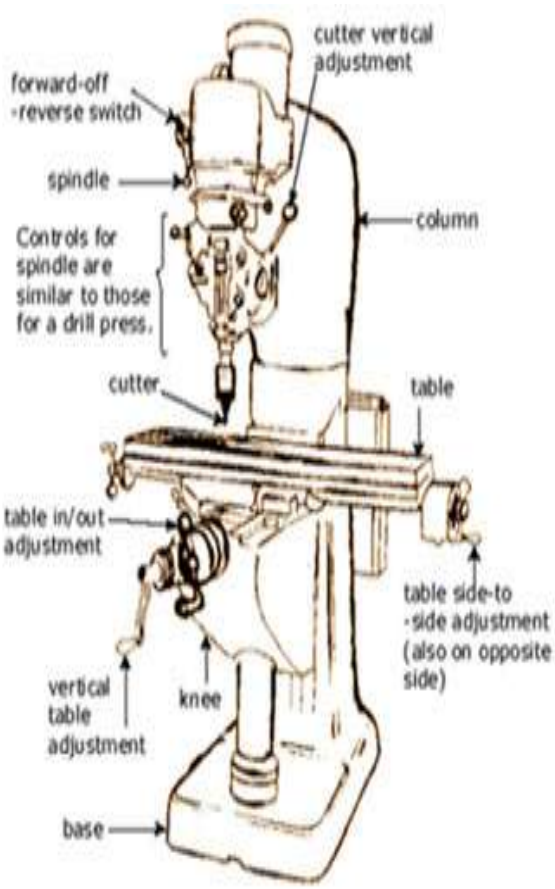
There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end. Line boring (line boring, line-boring) implies the former. Back boring (back boring, back-boring) is the process of reaching through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

- ***Knurling***

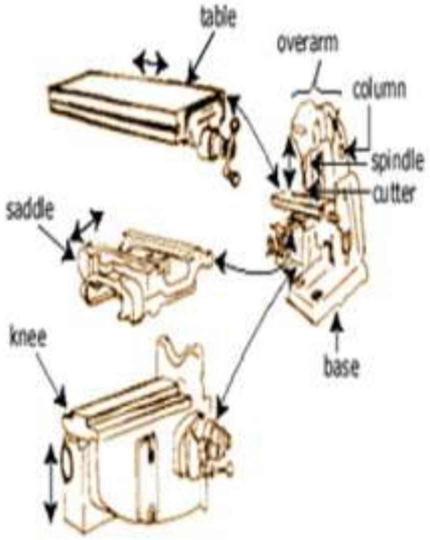
The cutting of a serrated pattern onto the surface of a part to use as a hand grip using a special purpose knurling tool. Threading both standard and non-standard screw threads can be turned on a lathe using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) Either externally, or within 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.

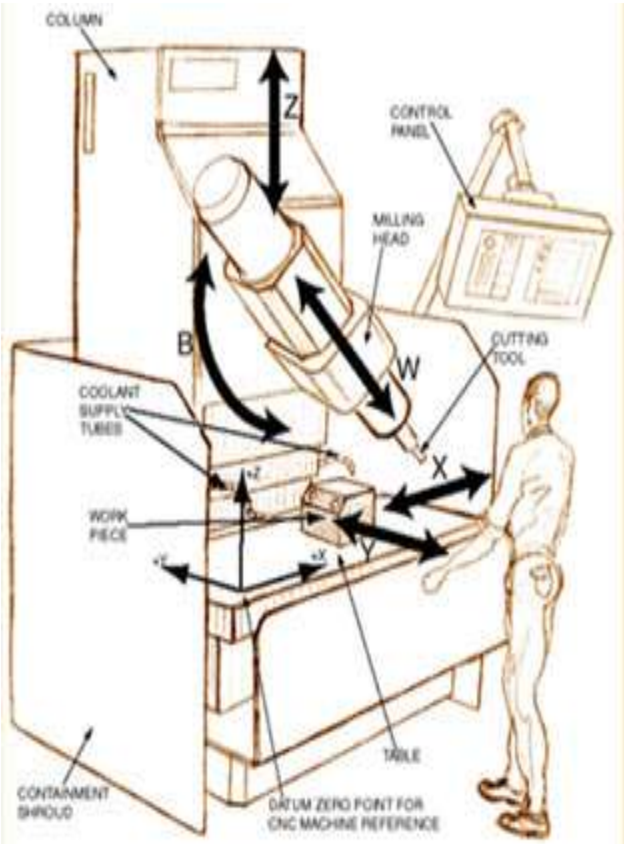


Milling is typically used to produce parts that are not axially symmetric and have many features, such as holes, slots, pockets, and even three-dimensional



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 grinding 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. CNC Mills are classified according to the number of axes that they possess. Axes are labeled as x and y for horizontal movement, and z for vertical movement, as shown in this view of a manual mill table. A standard manual light-duty mill is typically assumed to have four axes: Table X, Table Y, Table Z and milling head Z.

A five-axis CNC milling machine has an extra axis in the form of a horizontal pivot for the milling head. This allows extra flexibility for machining with the end mill at an angle with respect to the table. A six-axis CNC milling machine would have another horizontal pivot for the milling head, this time perpendicular to the fifth axis.

CNC milling machines are traditionally programmed using a set of commands known as G-codes. G-codes represent specific CNC functions in alphanumeric format.

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.

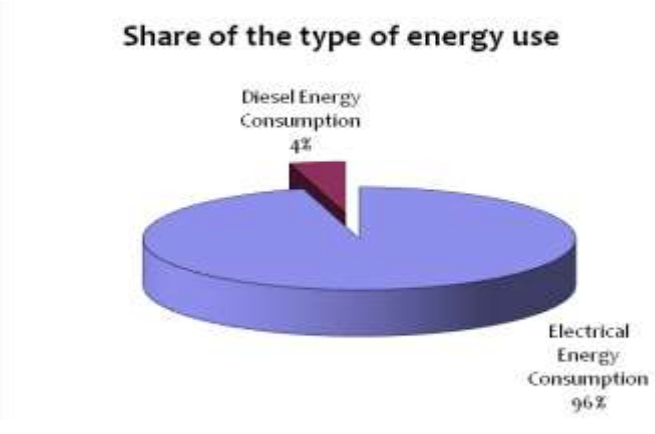


Figure 1.2: Share of Energy Type used in the Machine Tool Units

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, grinding 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 CNC Lathe machines and performing jobs in two or three steps for CNC Lathe Projects whereas some units also using the conventional machines which are completely depends on operators skills.

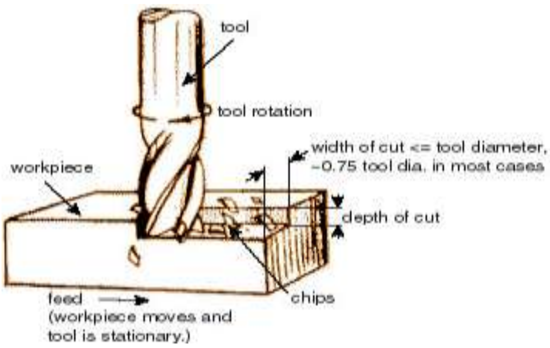
The existing technology required two or three times setup of the job on the lathe machine and results in higher energy consumption and lower production rate. The error in product and material rejections also increased due the multiple setup requirements for a job.

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, lathes and automats, boring, milling, drilling, grinding, 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 horizontal and vertical spindle configurations. Machines with spindle speeds of upto 10000 rpm, traverse rates of upto 60 mpm are produced by the Indian industry.

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 lathes, 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.

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,of which 2 have been using Lathe machines in their current production process. 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 ` 82145 per tonne and `2562950 annually on average 31.2 tonnes produced.

Table 1.2 Energy Consumption Pattern of Existing Technology

Particular	Unit	Bench Mark		
Name of cluster unit studied		Case 1	Case 2	Value
Specific Energy Consumption	kWh/Tonne	1358.34	11500	6429.17
Average Energy Cost	`/Tonne	6791.7	57500	32145.85
Raw material cost	`/tonne	40000	40000	40000
Other Cost (Utility)	`/tonne	10000	10000	10000
Average Production cost	`/tonne	56791.7	107500	82145.85
Annual Production	Tonne	50.4	12	31.2
Annual Production Cost	`/annum	2862301.7	1290000	2562950.5

1.4.1 Design and operating parameters

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.	Particulars	Value
1	Annual Electricity Consumption, kWh	68,460
2	Annual Fuel (HSD) consumption, Lt	00
3	Annual Energy Consumption, GJ	275.0
4	Total Annual production, Tonne	50.4
5	Average Specific Energy Consumption, GJ/T	5.5

S. No.	Particulars	Value
1	Annual Electricity Consumption, kWh	139,020
2	Annual Fuel (HSD) consumption, Lt	00
3	Annual Energy Consumption, GJ	529.0
4	Total Annual production, Tone	12
5	Average Specific Energy Consumption, GJ/T	44.08

*****Energy consumption Pattern of existing system on the basis of annual electricity usage***

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

In new modern manufacturing industry, machine has become more efficient, complicated and fully automated. This type of new generation machines only required fewer man powers to operate because of automation functions. Thus this new feature, able to increase the volume of production but it requires new maintenance principles.

Products can be produced by modern technology, which uses computer software, hardware and firm ware in industries. It is needed to use CNC lathe machine to get more accurate dimensions and irregular shape. So, CNC machines are becoming more and more important in modernized industrialization, it is required to convert these conventional lathe machines into semi automatic control lathe machine. Developing and changing into semi automatic control lathe machine, there are three required portions, namely, mechanical, electronics and mechatronics. From the mechanical point of view, the design of hydraulic circuit is dramatically needed. The functions of hydraulic circuits for semi automatic control lathe are analyzed in this paper. These consist of changing the tool, working the machining processes and locating the tool in turret. In this research paper, the hydraulic circuit design which can be changed four kinds of tools by using hydraulic motor is made and also constructed. The hydraulic circuit comprises vane pump, hydraulic motor, and two directional control valves for changing the tool; 4/3- way valve and 4/2-way valve. The transfer function of each component is derived and the whole system is analyzed

A lathe is a machine tool for producing cylindrical, conical and flat surfaces. It can be used for drilling and boring holes which may be cylindrical or conical in shape. The basic engine lathe, one of the most widely used machine tools is very versatile when used by a skilled machinist. However, it is not particularly efficient when many identical parts must be machined as rapidly as possible. Numerical control is based on the use of numerical data for directly controlling the position of the operative units of a machine tool in machine operation. Today, a more popular adaptation of the basic process of NC is called Computer Numerical Control or CNC. Computer numerical control is the process of manufacturing machined parts using a computerized controller to command motors which drive each machine axis. In no field of engineering development has progress been so rapid in that of hydraulic operation. Therefore, hydraulic devices and control systems have become more and more important due to automation and mechanization. Similarly, in changing the tool in CNC lathe machine, hydraulic is used to control the manufacturing processing of this machine.

Closed loop systems are very accurate. Most have an automatic compensation for error, since the feedback device indicates the error and the control makes the necessary adjustments to bring the slide back to its position. They use AC, DC or hydraulic servomotors. These various motors are mounted by hydraulic circuits or system. The term ‘hydraulic circuit’ is a group of components such as pumps, actuators, control valves, accumulators, restrictors, and pipelines.

2.1.2 CNC Lathe Machine operations

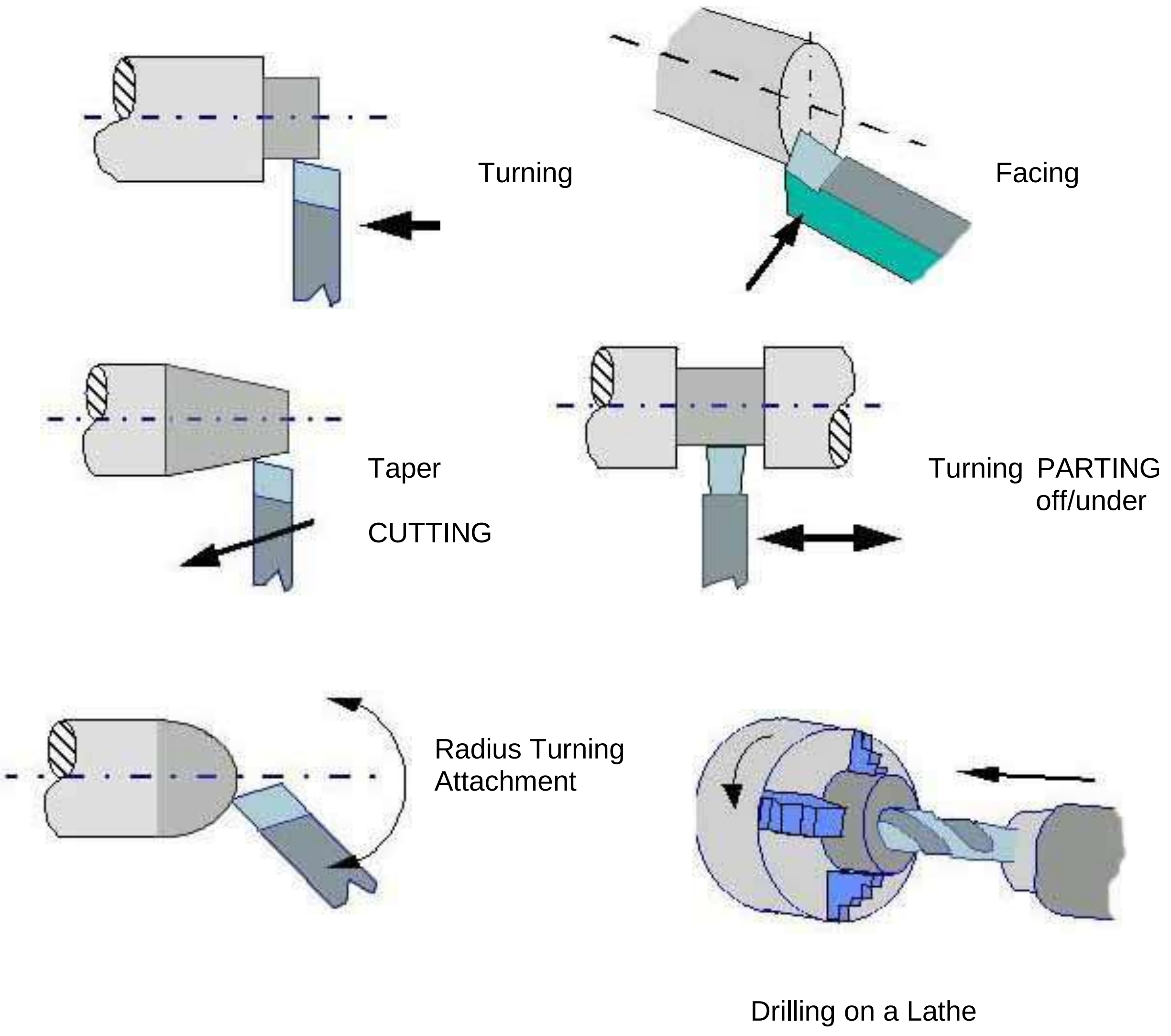


Figure 2.1 CNC Lathe Machine operations

2.1.3 Technology specification

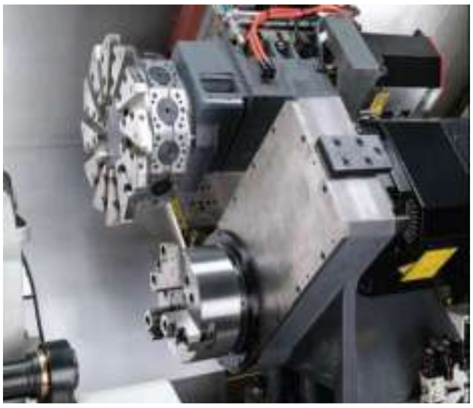
Table 2.1 Equipment Speciation

CNC Lathe		120 V – 60 Hz	220 V – 50 Hz	240 V – 50 Hz
Power Requirement	**Current**	**3 A**	**1.5 A**	**1.5 A**
Lathe	Swing Over Bed	90 mm (3.5 in)		
	Center Height	101.6 mm (4 in)		
	Distance Between Centers	200 mm (8 in)		
	Swing Over Cross Slide	48 mm (1.9 in)		
	X-Axis Travel	47.8 mm (1.88in)		
	Z-Axis Travel	105.4 mm (4.15in)		
	Resolution	±0.00318 mm (±0.000125 in)		
Headstock	Spindle Bore	10 mm (0.405 in)		
	Spindle Taper	Morse No 1		
Tailstock	Tailstock Taper	Morse No. 0		
	Sleeve Stroke	38.1 mm (1.5 in)		
Main Spindle Drive	Programmable Speed Range	0-2800 r/min		
	Motor	160 W (0.21 hp), overload protected		
Feed Motors	Type	Stepper		
	Resolution	400 steps/r		
	Rapid Traverse Speed	356 mm/min (14 in/min)		
Accessories included				
Carbide Insert Tool with Tool Post		35E right-hand insert		
Carbide Tool Set with Tool Post	Types	AR4, AL4, BR4, BL4, C4 and E4		
Null Modem Serial Cable	Length	3.05 m (10 ft)		
	Connectors	DB9 female/female		
TTL/IO Cable	Length	3.05 m (10 ft)		
	Connectors	DB15 male/male		
Ethernet Crossover Cable	Length	2.13 m (7 ft)		
	Connectors	RJ45 male/male		
Set of Tools	Content	hex keys, cleaning brush, digital caliper and tool bag		
Fuses	Current Rating	1.0 A		
	Voltage Rating	250 V		
Physical Characteristics	Dimensions	(H x W x D) 750 x 864 x 597 mm (29.5 x 34 x 23.5 in)		
	Net Weight	268 kg (592 lb)		

2.1.4 SUITABILITY OR INTEGRATION WITH EXISTING PROCESS

Depending on the user's needs, these lathes can function as a high precision manual lathe, a lathe with digital readout, a lathe with power feed and jog modes, a lathe with a TEACH mode for CNC turning or a lathe with full CNC capability. A frequency drive and servo drive provide infinitely variable speed and feed rate. The spindle speed automatically adjusts to varying diameters, giving the machine constant surface speed and the capability to deliver high accuracy, consistent repeatability and superior surface finish. These new generation lathes feature conversational & G-code control, heavier bed, more rigid tailstock design and a higher cam and worm gear ratio that ensure very smooth gear changes regardless of chuck or work piece weight. The spindle bore is machined in one setup to ensure perfect alignment at all times. Extensive tool path programming is no longer needed because of the machine's factory programmed machining cycles such as rough and finish passes, profiling, chamfering, grooving, threading, drilling and tapping. Tool compensation and gear change are automatic.

2.1.5 SUPERIORITY OVER EXISTING TECHNOLOGY



Sub-spindle

The CNC Lathe features a control panel that permits the lathe 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. The lathe parameters, including the spindle speed, the feed rate, the reference point, and the X and Z axes coordinates of the cutting tool are adjusted by accessing different menus. 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 Lathe is designed for maximum safety. 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 machining. Limit switches prevent the bed from over-traveling and the cutting tool from crashing into the chuck. Pressing the emergency stop push-button on the control panel cuts off the power to the spindle motor and stops the axes. The CNC Lathe supports low-voltage communications with robotic units. For this purpose, the CNC Lathe features a 15-pin TTL/IO port providing four 5-V digital input and four 5-V digital output lines for TTL communication to an automation work cell. The CNC Lathe also features a 5-pin solenoid driver port providing connections for up to four auxiliary devices. The TTL/IO and solenoid driver ports are M code supported through the CNC Lathe Software.

- FANUC Controller

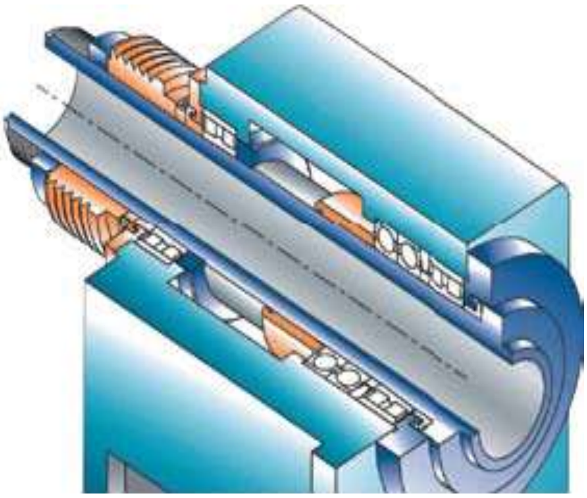
- Rigid bed construction
- Pretension ball screw that minimizes
- Thermal displacement
- Overload protection on X, Z-axis traverse
- Hydraulic chuck accompanied with both Hard
- Jaws and Soft Jaws standard
- Meehanite base, saddle and headstock casting.
- Modular design with many options for cost effective combination of bar feeder, parts catcher, tool presetter, bar puller, etc.
- Automatic lubrication system
- High pressure coolant supply system
- Powerful FANUC high torque spindle motor

CNC Controller

The HL series comes standard equipped with a choice of a state-of-the-art controller like this FANUC CNC controller.

Precision Spindle

The heavy duty precision spindle has cylindrical roller bearings combined with angular thrust ball bearings designed to sustain radial as well as thrust loads.



The tool presetter reduces setup time with 4 point contact of each tool with the measuring sensor.

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 Lathe machine can be done in the 10 – 14 days, However the CNC Lathe machine is end to end solution of Lathe 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 Lathe machine, the technology and machine will continue to work up to 12 to 17 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 Lathe machine is suitable for the units involved in the production of more fast machining than conventional Lathes 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

Coolant is supplied through the turret and ejected through the tool holder to allow the coolant to reach the cutting point more effectively.

CNC Lathes are rapidly replacing the older production lathes (multispindle, etc) due to their ease of setting and operation. They are designed to use modern carbide tooling and fully utilize modern processes. 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 lathe 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 lathe 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 lathe 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. Energy & Cost saving including the energy, material rejection, man power cost and utility cost for a typical unit by installation of CNC lathe machine are tabulated below:

A CNC lathe 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 lathe machine revels that the CNC lathe machine may produce two times production/ material at same time and at same energy consumption.

Table 3.1 Energy savings estimation for CNC lathe machine

S.No	Particular	Unit	Conventional Lathe machine	CNC Lathe machine
1	Specific Energy Consumption	kWh/Tonne	6429.17	4500.4
2	Average Energy Cost	`/Tonne	32145.85	22502
3	Cost of Material	`/annum	40000	28061
4	Other Cost (Man Power/Utility)	`/tonne	10000	4330
5	Average Production	`/tonne	82145.85	54893
6	Annual Production	Tonne/annum	31.2	31.2
7	Annual Production Cost	`/annum	2562951	1712661.6
8	Reduction in Production Cost	`/Tonne	27252.85	
9	Annual cost reduction	`/Annum	850288.92	

***Note:-** *As in the proposed DPR Conventonal Lathe is replaced by CNC lathe, it is assumed that it improves the overall productivity by 1.75 times i.e. 31.2 Tonnes/Annum in earlier case to 54.6 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 %.*

****Detailed breakup of savings is provided in the annexure 1***

3.1.2 Improvement in product quality

CNC lathe 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 lathe 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.

The parts conveyor permits for efficient parts collection and unmanned operation.

3.1.3 Increase in production

A CNC lathe 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 lathe machine machines revels that the CNC lathe machine may produce two times production/ material at same time and at same energy consumption.

3.1.4 Reduction in raw material consumption

The rejection of material in CNC lathe 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 lathe 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:-

- The automatic lubricator delivers 3~6cc of lubricant in 15 minute intervals to both slide ways and ball screws.
- The precision ball screw is pretensioned to minimize thermal displacement.
- The hydraulic power system provides stable and powerful hydraulic pressure for the machine.
- The chain-type chip conveyor automatically removes chips from the machining environment allowing for non-stop operation.

3.2 Monetary benefits

Monetary savings in a typical unit after installation of CNC lathe machine has been estimated around ` 14.88 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 lathe 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 lathe machine in machine tools industries. Reduction in electricity consumption translates into GHG reductions is estimated to be 79 tonne of CO_2 per annum for given energy saving and production.

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 lathe machine are provided in Table 4.1 below:

Table 4.1 Cost of equipment

S. No.	Particulars	Cost
1	Cost of CNC Lathe machine	`4000,000

Cost of machine is in Dollar at the rate of (1$ = INR 45)with 37% of Taxes and Duties.

4.1.2 Other costs

Table 4.2 Cost of civil work and consultancy

S. No.	Particulars	Cost
1.	Cost of civil work	`45,000/-
2.	Electrical & Utility Expenses	` 15,000/-
3.	Cost of Consultancy and installation	` 20,000/-
Total	Two Hundred thousand only/-	` 80,000/-

Total investment in the proposed technology (including equipment cost & Other cost) is ` 40.80 lakh.

4.2 Arrangements of funds

Proposed financing for the replacement of Conventional lathe with CNC Lathe is made considering a debt equity ratio of 3:1, which is normally allowed by financial institutions for financing energy efficiency projects. On the basis of debt equity ratio of 3:1 the promoter's contribution works out to 25% of the project cost and the balance would be term loan from the Bank / FIs.

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 2.74 years.

4.3.3 Net Present Value (NPV)

Net Present Value of new project would work out ` 33.24 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 24.69%. 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 21.05 %.

Table 4.4 Financial indicator of proposed technology

Particulars	Unit	Value
Simple Pay Back period	Years	2.74
IRR	%age	24.69
NPV	` in lakh	33.24
ROI	%age	21.05
DSCR	ratio	1.68

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 5%

Fuel saving decrease by 5%

Table 4.5: Sensitivity analysis

Particulars	IRR	*NPV*	ROI	DSCR
Normal	24.69%	33.24	21.05	1.68
5% increase in fuel savings	25.21%	34.39	21.15	1.71
5% decrease in fuel savings	24.17%	32.09	20.94	1.64

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

4.5 Procurement and implementation schedule

The installation of CNC lathe machine can be done in the 10 – 14 days, However the CNC lathe machine is end to end solution of CNC lathe 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

Particular	Unit	Bench Mark		
Name of cluster unit studied		**Case 1**	**Case 2**	**Value**
Specific Energy Consumption	kWh/Tonne	1358.34	11500	6429.17
Average Energy Cost	`/Tonne	6791.7	57500	32145.85
Raw material cost	`/tonne	40000	40000	40000
Other Cost (Utility)	`/tonne	10000	10000	10000
Average Production cost	`/tonne	56791.7	107500	82145.85
Annual Production	Tonne	50.4	12	31.2
Annual Production Cost	`/annum	2862301.7	1290000	2562950.5

Energy savings estimation for CNC lathe machine

S.No	Particular	Unit	Conventional Lathe machine	CNC Lathe machine
1	Specific Energy Consumption	kWh/Tonne	6429.17	4500.4
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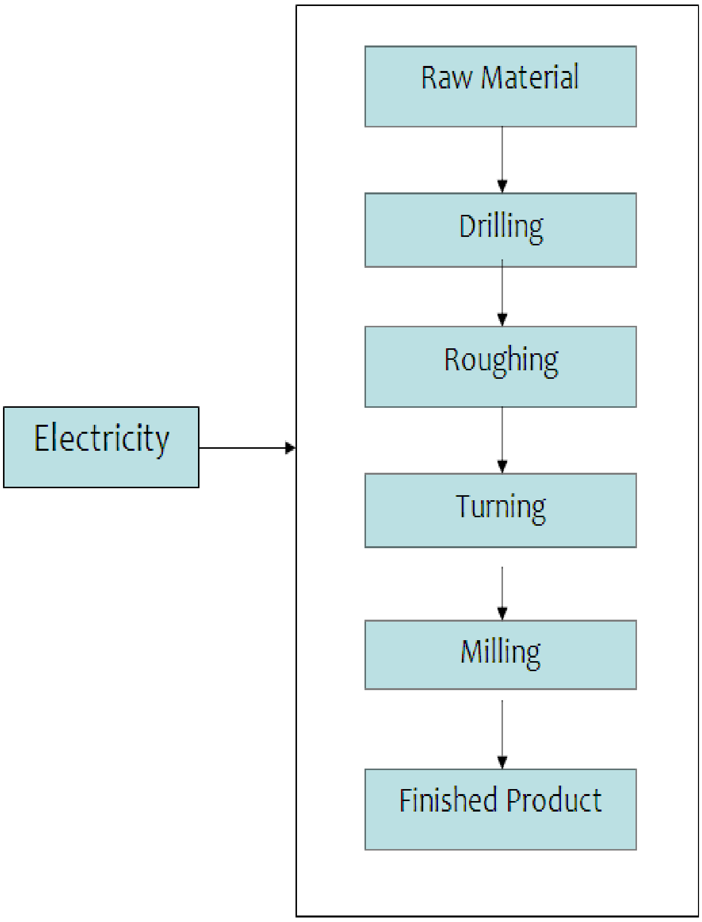
***Note:-** *As in the proposed DPR Conventional Lathe is replaced by CNC Lathe, it is assumed that it improves the overall productivity by 1.75 times i.e. 31.2 Tonnes/Annum in earlier case to 54.60 Tonnes/Annum after implementation. Accordingly, the energy saving could be achieved.Consequnetly, the O&M cost of machinery shall increase to 5 % with annual Escalation of 5 %.*

S.No	Particular	Unit	Conventional Lathe Machine	CNC Lathe Machine
1	Average Production	`/tonne	82145.85	54893
2	Annual Production	Tonne/annum	54.6	54.6
3	Annual Production Cost	`/annum	4485163	2997158
4	Annual cost reduction	`/Annum		1488006

So the saving reaches to **` *14880006*** *(27252.85*54.60 tonne)*

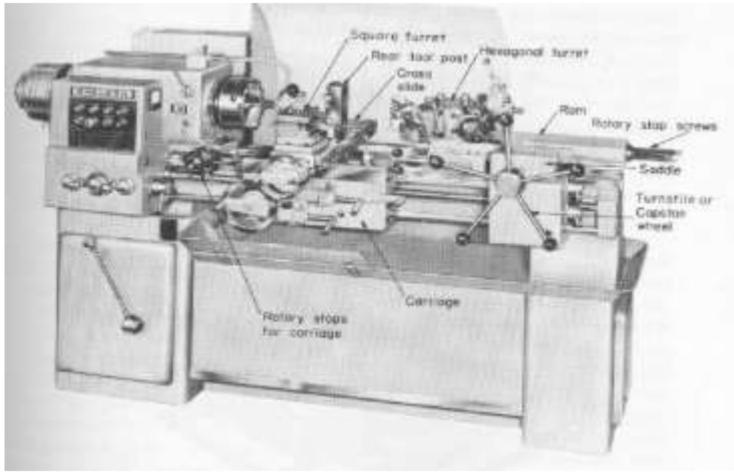
Annexure 2: Process flow diagram

CNC lathe machine is end to end solution for CNC lathe machining process in machine tools manufacturing units. Lathe machine computerized numerical control (CNC) machines have become the application of choice for complex surface machining. These machine tools are widely used in the aerospace, automotive, tool and die making and other industries requiring complex shapes.

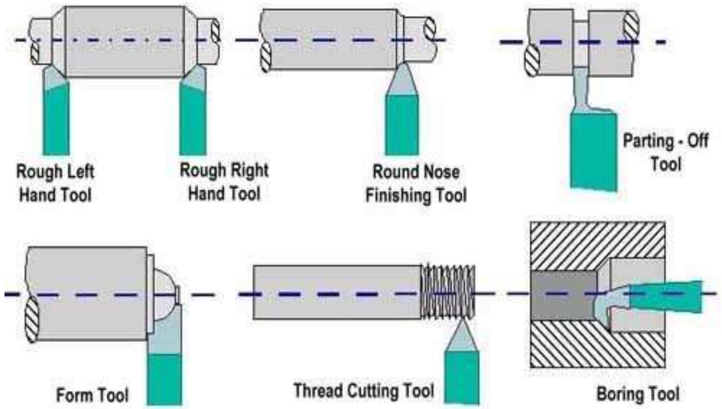


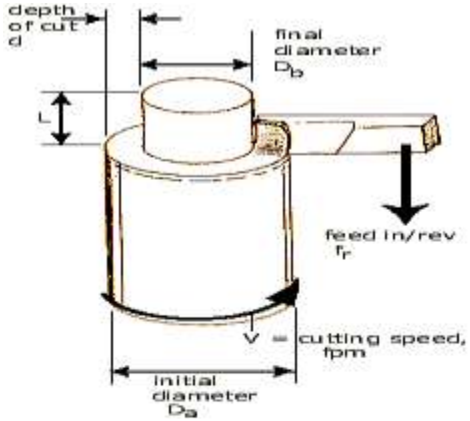
Annexure 3: Technical Drawing of CNC lathe machine

Turret lathe and capstan lathe

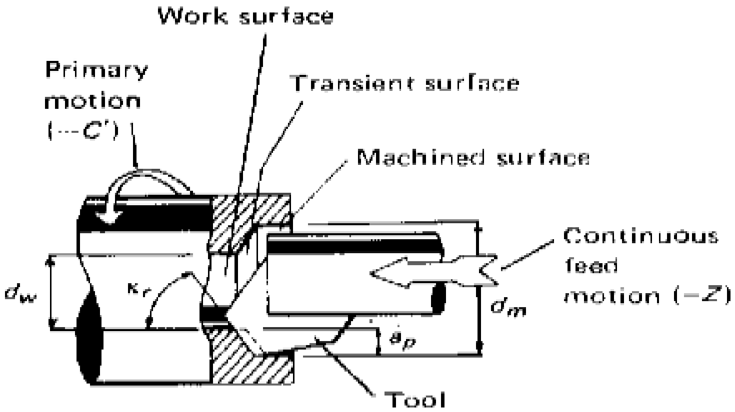


CUTTING TOOLS FOR LATHES





Facing



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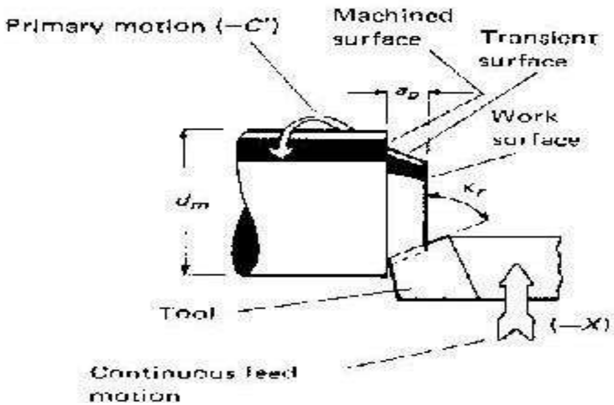
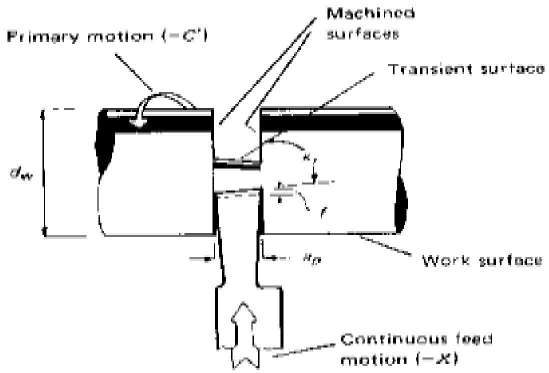
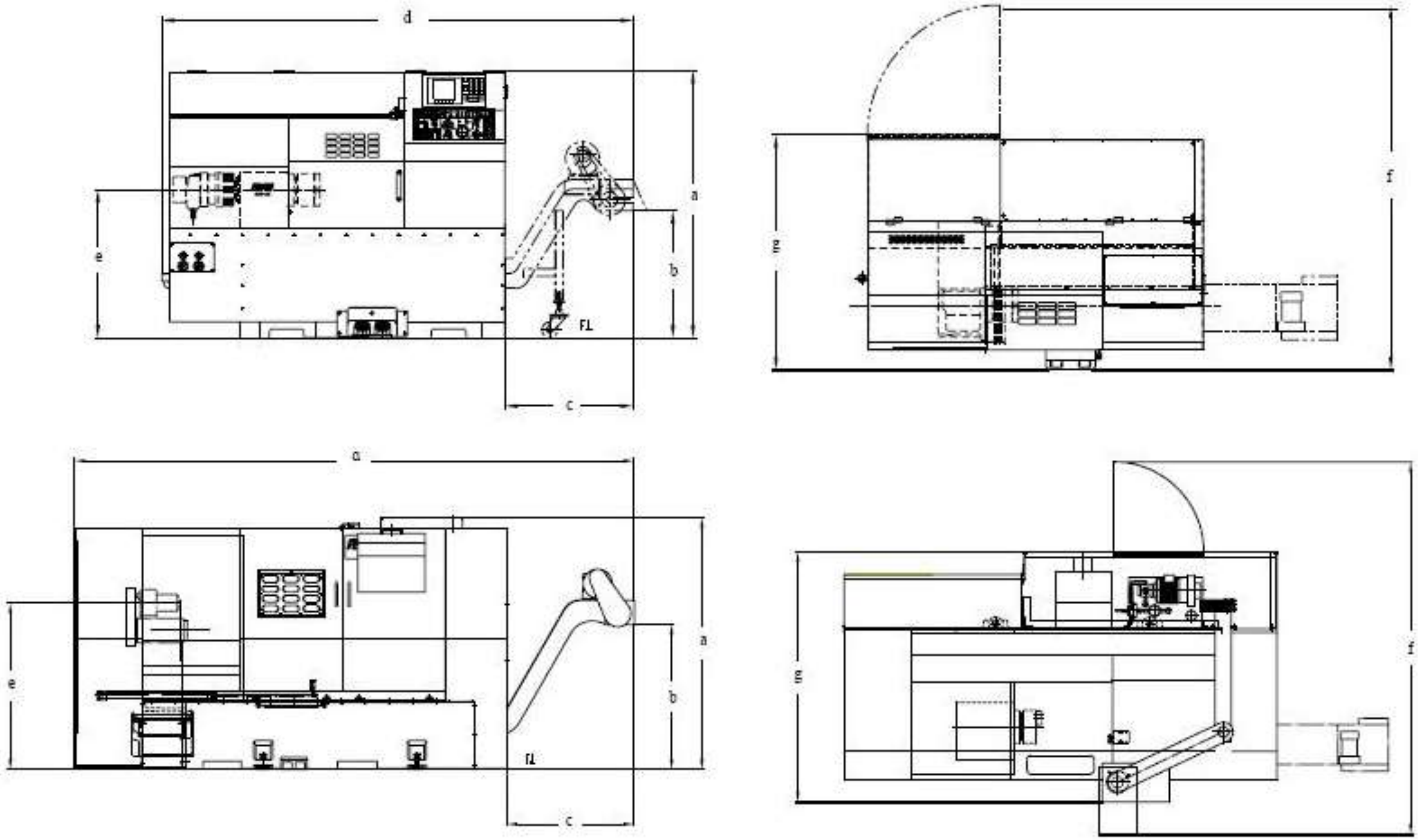
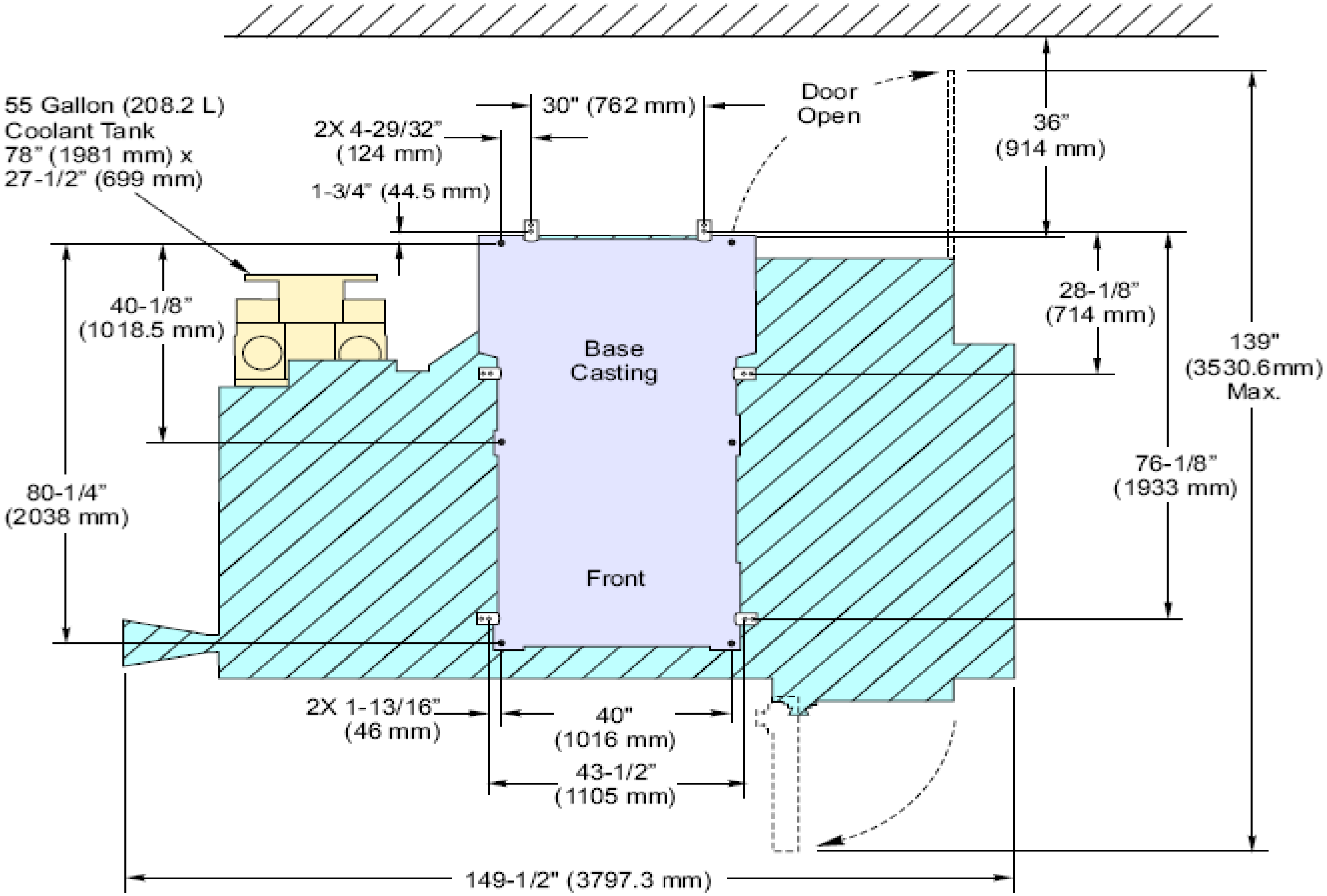


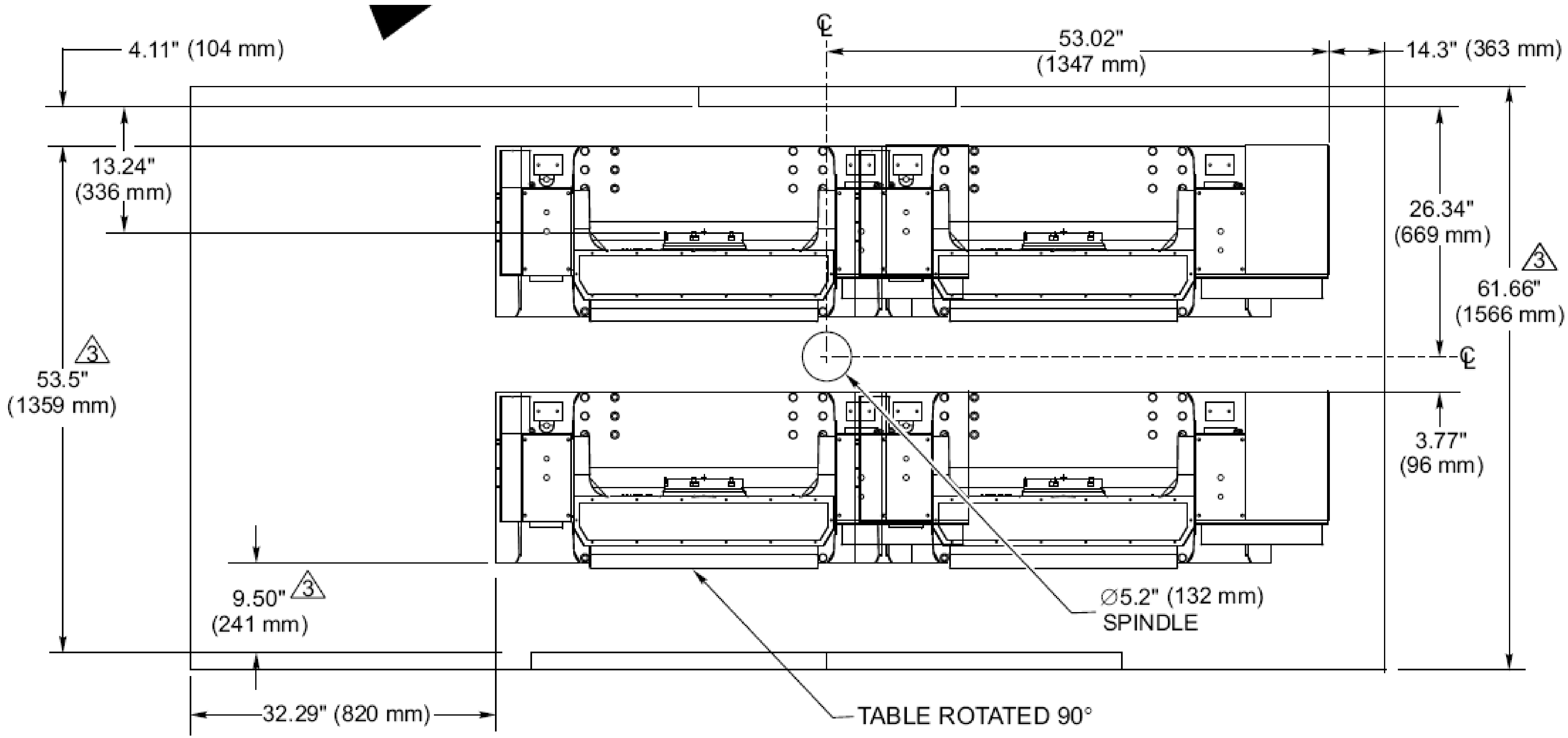
Parting

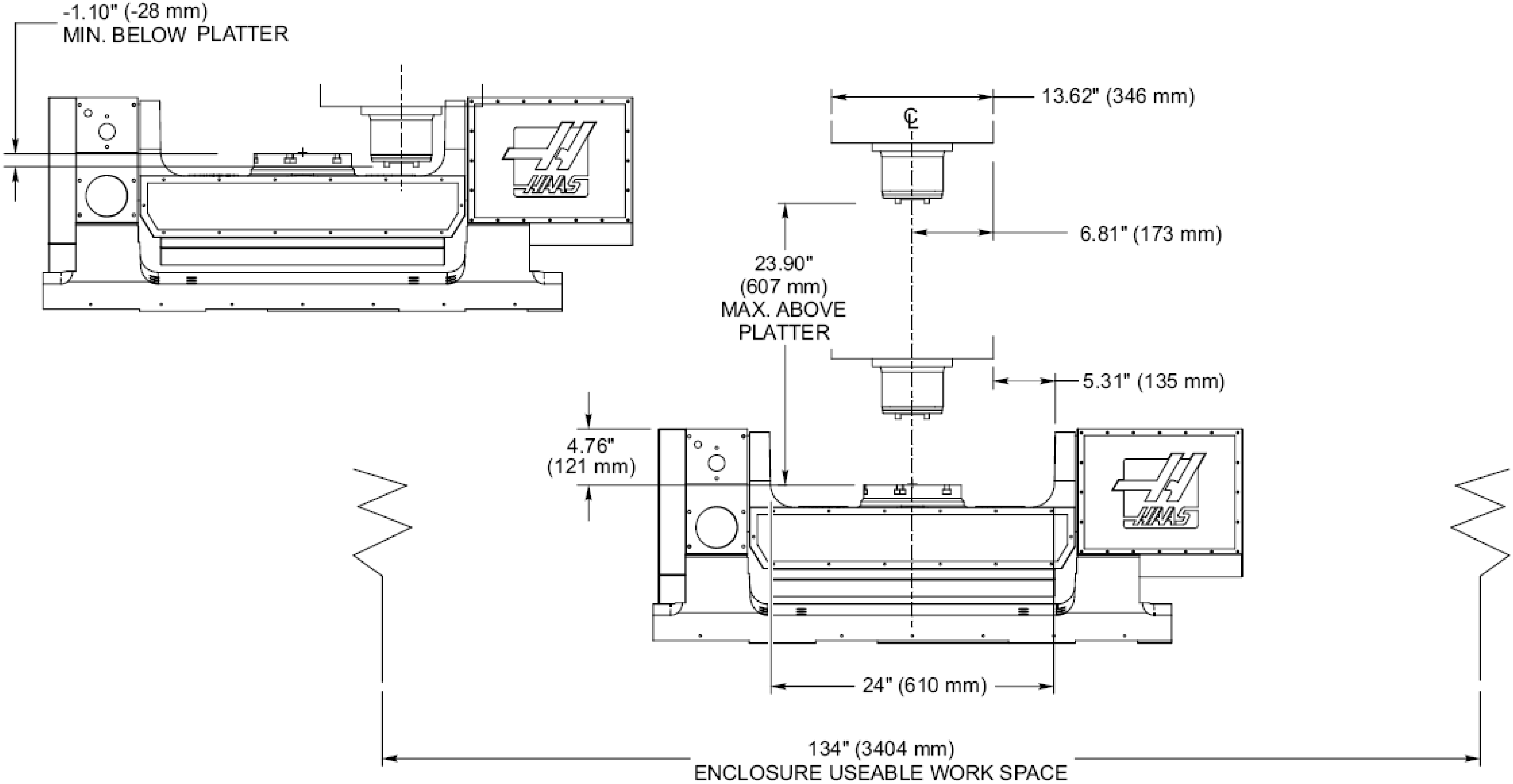




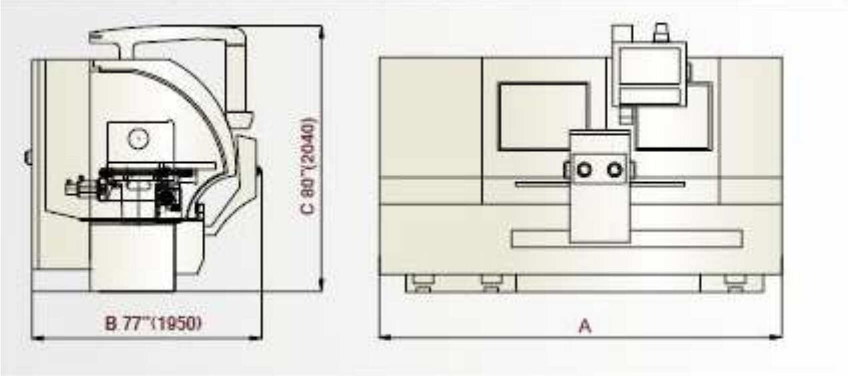
Sketch of The CNC Lathe Machine (Shipping Model)


55 Gallon (208.2 L)
Coolant Tank
78" (1981 mm) x
27-1/2" (699 mm)
30" (762 mm)
2X 4-29/32"
(124 mm)
1-3/4" (44.5 mm)
Door
Open
36"
(914 mm)
28-1/8"
(714 mm)
139"
(3530.6mm)
Max.
40-1/8"
(1018.5 mm)
Base
Casting
80-1/4"
(2038 mm)
76-1/8"
(1933 mm)
Front
2X 1-13/16"
(46 mm)
40"
(1016 mm)
43-1/2"
(1105 mm)
149-1/2" (3797.3 mm)

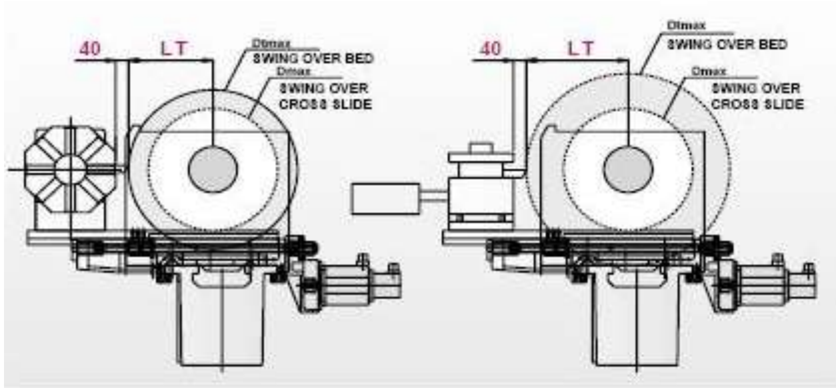

4.11" (104 mm)
53.02"
(1347 mm)
14.3" (363 mm)
13.24"
(336 mm)
26.34"
(669 mm)
61.66"
(1566 mm)
53.5"
(1359 mm)
3.77"
(96 mm)
9.50"
(241 mm)
∅5.2" (132 mm)
SPINDLE
32.29" (820 mm)
TABLE ROTATED 90°


-1.10" (-28 mm)
MIN. BELOW PLATTER
13.62" (346 mm)
6.81" (173 mm)
23.90"
(607 mm)
MAX. ABOVE
PLATTER
5.31" (135 mm)
4.76"
(121 mm)
24" (610 mm)
134" (3404 mm)
ENCLOSURE USEABLE WORK SPACE

GENERAL DIMENSIONS



MAX. TURNING DIAMETER



Annexure 4: Detailed financial calculations & analysis for financial indicators

Assumption

Name of the Technology	***CNC Lathe 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)	40.00	Feasibility Study
Cost of modification in civil construction	` (in lakh)	0.45	Feasibility Study
Cost of consultancy	` (in lakh)	0.15	Feasibility Study
IDC	` (in lakh)	0.20	Feasibility Study
Total Investment	` (in lakh)	40.80	Feasibility Study
Financing pattern			
Own Funds (Equity)	` (in lakh)	10.20	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	30.60	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	1928.77	
Annual production	Tonne/Annum	54.6	
Cost	`/kWh	5	
Other savings	`/Tonne	17609	
St. line Depn.	%age	5.28	Indian Companies Act
IT Depreciation	%age	80.00	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	30.60	1.20	29.40	3.55
2	29.40	2.40	27.00	2.83
3	27.00	3.00	24.00	2.56
4	24.00	4.20	19.80	2.21
5	19.80	5.20	14.60	1.76
6	14.60	5.50	9.10	1.21
7	9.10	6.00	3.10	0.64
8	3.10	3.10	0.00	0.09
		30.60		

WDV Depreciation

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	40.80	8.16
Depreciation	32.64	6.53
WDV	8.16	1.63

Projected Profitability

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Revenue through Savings										
Total Revenue (A)	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88
Expenses										
O & M Expenses	2.04	2.14	2.25	2.36	2.48	2.60	2.73	2.87	3.01	3.16
Total Expenses (B)	2.04	2.14	2.25	2.36	2.48	2.60	2.73	2.87	3.01	3.16
PBDIT (A)-(B)	12.84	12.74	12.63	12.52	12.40	12.28	12.15	12.01	11.87	11.72
Interest	3.55	2.83	2.56	2.21	1.76	1.21	0.64	0.09	-	-
PBDT	9.29	9.91	10.07	10.31	10.64	11.06	11.51	11.92	11.87	11.72

Depreciation	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
PBT	7.13	7.75	7.91	8.16	8.49	8.91	9.36	9.76	9.71	9.56
Income tax	-	1.15	3.42	3.50	3.62	3.76	3.91	4.05	4.03	3.98
Profit after tax (PAT)	7.13	6.60	4.49	4.65	4.87	5.15	5.44	5.71	5.68	5.58

Computation of Tax ***`(in lakh)***

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Profit before tax	7.13	7.75	7.91	8.16	8.49	8.91	9.36	9.76	9.71	9.56
Add: Book depreciation	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Less: WDV depreciation	32.64	6.53	-	-	-	-	-	-	-	-
Taxable profit	(23.35)	3.38	10.07	10.31	10.64	11.06	11.51	11.92	11.87	11.72
Income Tax	-	1.15	3.42	3.50	3.62	3.76	3.91	4.05	4.03	3.98

Projected Balance Sheet ***`(in lakh)***

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Liabilities										
Share Capital (D)	10.20	10.20	10.20	10.20	10.20	10.20	10.20	10.20	10.20	10.20
Reserves & Surplus (E)	7.13	13.74	18.23	22.88	27.75	32.90	38.34	44.05	49.73	55.31
Term Loans (F)	29.40	27.00	24.00	19.80	14.60	9.10	3.10	0.00	0.00	0.00
Total Liabilities D)+(E)+(F)	46.73	50.94	52.43	52.88	52.55	52.20	51.64	54.25	59.93	65.51
Assets										
Gross Fixed Assets	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80	40.80
Less: Accm. Depreciation	2.15	4.31	6.46	8.62	10.77	12.93	15.08	17.23	19.39	21.54
Net Fixed Assets	38.65	36.49	34.34	32.18	30.03	27.87	25.72	23.57	21.41	19.26
Cash & Bank Balance	8.09	14.44	18.09	20.69	22.52	24.32	25.92	30.69	38.52	46.25
Total Assets	46.73	50.94	52.43	52.88	52.55	52.20	51.64	54.25	59.93	65.51
Net Worth	17.33	23.94	28.43	33.08	37.95	43.10	48.54	54.25	59.93	65.51
Dept equity ratio	2.88	2.65	2.35	1.94	1.43	0.89	0.30	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	10.20	-	-	-	-	-	-	-	-	-	-
Term Loan	30.60										
Profit After tax		7.13	6.60	4.49	4.65	4.87	5.15	5.44	5.71	5.68	5.58
Depreciation		2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Total Sources	40.80	9.29	8.76	6.65	6.81	7.03	7.30	7.60	7.87	7.83	7.73
Application											
Capital Expenditure	40.80										
Repayment of Loan	-	1.20	2.40	3.00	4.20	5.20	5.50	6.00	3.10	-	-
Total Application	40.80	1.20	2.40	3.00	4.20	5.20	5.50	6.00	3.10	-	-
Net Surplus	-	8.09	6.36	3.65	2.61	1.83	1.80	1.60	4.77	7.83	7.73
Add: Opening Balance	-	-	8.09	14.44	18.09	20.69	22.52	24.32	25.92	30.69	38.52
Closing Balance	-	8.09	14.44	18.09	20.69	22.52	24.32	25.92	30.69	38.52	46.25

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

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Profit after Tax		7.13	6.60	4.49	4.65	4.87	5.15	5.44	5.71	5.68	5.58
Depreciation		2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Interest on Term Loan		3.55	2.83	2.56	2.21	1.76	1.21	0.64	0.09	-	-
Cash outflow	(40.80)	-	-	-	-	-	-	-	-	-	-
Salvage value											19.26
Net Cash flow	(40.80)	12.84	11.59	9.21	9.01	8.78	8.52	8.23	7.96	7.83	26.99
IRR	22.87%										
NPV	25.45										

Break Even Point `(in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Variable Expenses										
Operation & Maintenance Exp (75%)	1.53	1.61	1.69	1.77	1.86	1.95	2.05	2.15	2.26	2.37
Sub Total (G)	1.53	1.61	1.69	1.77	1.86	1.95	2.05	2.15	2.26	2.37
Fixed Expenses										
Operation & Maintenance Exp (25%)	0.51	0.54	0.56	0.59	0.62	0.65	0.68	0.72	0.75	0.79
Interest on Term Loan	3.55	2.83	2.56	2.21	1.76	1.21	0.64	0.09	0.00	0.00
Depreciation *(H)*	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15
Sub Total (I)	6.22	5.52	5.28	4.95	4.53	4.02	3.47	2.96	2.91	2.95
Sales (J)	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88	14.88
Contribution (K)	13.35	13.27	13.19	13.11	13.02	12.93	12.83	12.73	12.62	12.51
Break Even Point (L= G/I) (%)	46.59%	41.59%	40.02%	37.79%	34.79%	31.09%	27.08%	23.29%	23.04%	23.55%
Cash Break Even {(I)-(H)} (%)	30.45%	25.36%	23.69%	21.35%	18.24%	14.42%	10.29%	6.37%	5.97%	6.33%
Break Even Sales (J)*(L)	6.93	6.19	5.95	5.62	5.18	4.63	4.03	3.47	3.43	3.50

Return on Investment `(in lakh)

Particulars / Years		1	2	3	4	5	6	7	8	9	10	Total
Net Profit Before Taxes		7.13	7.75	7.91	8.16	8.49	8.91	9.36	9.76	9.71	9.56	86.74
Net Worth		17.33	23.94	28.43	33.08	37.95	43.10	48.54	54.25	59.93	65.51	412.06
ROI	21.05%											

Debt Service Coverage Ratio `(in lakh)

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Cash Inflow											
Profit after Tax	7.13	6.60	4.49	4.65	4.87	5.15	5.44	5.71	5.68	5.58	44.05
Depreciation	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	2.15	17.23
Interest on Term Loan	3.55	2.83	2.56	2.21	1.76	1.21	0.64	0.09	0.00	0.00	14.86

Total (M)	12.84	11.59	9.21	9.01	8.78	8.52	8.23	7.96	7.83	7.73	76.14

Debt

Interest on Term Loan	3.55	2.83	2.56	2.21	1.76	1.21	0.64	0.09	0.00	0.00	14.86
Repayment of Term Loan	1.20	2.40	3.00	4.20	5.20	5.50	6.00	3.10	0.00	0.00	30.60
Total (N)	4.75	5.23	5.56	6.41	6.96	6.71	6.64	3.19	0.00	0.00	45.46
Average DSCR (M/N)	1.68										

Note: - As the proposed machinery is CNC Lathe 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.	Activities	Weeks						
		1	2	3	4	5	6	7
1	Procurement and Delivery							
2	Civil & Electrical Work							
3	Commissioning							
4	Training							

Annexure 6: Details of technology/equipment and service providers

Name of Organization	Communication Address	Contact No.
Ace Micromatic Machine Tools Pvt.Ltd	Plot no.533, 10th main, 4th Phase, Peenya Industrial area, Bangalore-560058	
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 Lathe Machine

Specifications	HL-25	HL-35
Capacity		
Maximum Turning Length	23.62"(600mm)	26.57"(675mm)
Maximum Swing Over Bed	17.72"(450mm)	19.69"(500mm)
Maximum Turning Diameter	9.84"(250mm)	14.17"(360mm)
C-Axis Maximum Turning Diameter	11.81"(300mm)	15.75"(400mm)
Distance Between Centers	25.59"(650mm)	30"(762mm)
Spindle		
Spindle Speed	4800 rpm	4000 rpm
Spindle Nose	A2-6	A2-8
Bar Capacity	2.04"(52mm)	2.95"(75mm)
C-Axis Bar Capacity	2.05"(52mm)	2.95"(75mm)
Chuck Diameter	8"(203.2mm)	10"(254mm)
Spindle Motor Direct Drive	15/20HP(AC 11.2/14.9kW)	20/25HP(AC 14.9/18.6kW)
Spindle Diameter	3.9"(99.1mm)	5.12"(130mm)
Spindle Bore	2.4"(61mm)	3.43"(87mm)
C-Axis Maximum Live Tool Speed	3000 rpm	3000 rpm
C-Axis Live Tool Motor	3.0/5.0HP(AC 2.2/3.7kW)	5/7.0HP(AC 3.7/5.5kW)
C-Axis Spindle Bore	2.2"(55.9mm)	3.43"(110mm)
Turret		
Number of Stations	12	12
Durga	23(12 O.D. / 11 I.D.)	23(12 O.D. / 11 I.D.)
C-Axis Motorized Live Tools	11	11
Turning Tool O.D./I.D	.75" /1.25"	1" / 2"
C-Axis Turning Tool O.D./I.D	. 75" / 1.5"	1" / 1.5"

Specification X-Axis contd.		
X-Axis		
Travel	5"(127mm)	10.24"(260mm)
Rapid Traverse Rate	1180"/min (29.92m/min)	787.4"/min(20m/min)
AC Servo Motor	2.1HP(AC 1.57kW)	2.8HP(AC 2.1kW)
Ballscrew	1.26"(32mm) x P0.39"(10mm)	1.57"(40mm) x P0.39"(10mm)
Z-Axis		
Travel	24.8"(630mm)	27.17"(690mm)
Rapid Traverse Rate	1417"/min(35.99m/min)	944.88"/min(24m/min)
AC Servo Motor	2.1HP(AC 1.57kW)	5.1HP(AC 3.8kW)
Ballscrew	1.26"(32mm) x P0.47"(12mm)	1.97"(50mm) x P0.47"(12mm)
Tailstock		
Tailstock Travel	15.75"(400mm)	20.08"(510mm)
Quill Diameter	2.76"(70mm)	4.72"(120mm) *
Quill Travel	3.94"(100mm)	4.72"(120mm) *
Quill Taper	MT#4	MT#5 *
Guide way		
	Linear	Linear
Machine Weigh		
	7161 lbs (3248 kg)	13228 lbs (6000 kg)
Machine Dimensions		
LxW	85.5" x 54.33"	132.68" x 79.53"
	(2171mm x 1380mm)	(3370mm x 2020mm)
Machine Height	67.56"(1716mm)	77.36"(1965mm)
Power Requirements		
	220Volts, 3 Phase 60Hz, 20 KVA	220Volts, 3 Phase 60Hz, 30 KVA

*** Specification curtsy FEMCO CNC machine Tools @ www.femcousa.com*

HAAS BUILD-A-QUOTE

HAAS AUTOMATION INC.
2800 STURGIS ROAD
OXNARD CA 93030
USA

MY CURRENT SELECTION

Selection		Qty	Price
VF-1	VMC 20" x 16" x 20"	1	48,995.00 USD
Tooling Taper	CT-Style Tool Changer Grippers	1	**Included In Price**
Drive System	2-Speed Gearbox	1	5,095.00 USD
Through-Spindle Coolant	Through-Spindle Coolant, 300 psi (21 bar)	1	6,295.00 USD
Additional Axis	4th-Axis Drive and Wiring	1	2,095.00 USD
Options	Servo Auto Door	1	2,295.00 USD

Total Price	**64,775.00** USD

Haas Build-a-Quote is for example only. Prices, specifications,availability and specific configurations may change without notice. Despite our best efforts, a small numberof items may contain pricing, typography,or photography errors. Correct prices and configurations are valid only at the time your order is placed with your Haas Factory Outlet distributor.

Shipping, delivery, transportation and rigging charges are not included in this quote.
Haas Automation 800-331-6746. www.HaasCNC.com | CI CHENNAI
Caution: Federal, State, Local taxes are not included in the quote price.

Regardless of location, Haas Automation offers this quotation without including required taxes. Your local Haas Factory Outlet can help determine tax requirements.

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(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

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DFC Building, Plot No.37-38,
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