DETAILED PROJECT REPORT
ON
REPLACEMENT OF CONVENTIONAL HORIZONTAL M/C CENTRE WITH CNC HORIZONTAL M/C CENTRE (BANGALORE MACHINE TOOL CLUSTER)











Bureau of Energy Efficiency

Prepared By

Reviewed By

REPLACEMENT OF CONVENTIONAL HORIZONTAL MACHINE CENTER TO CNC HORIZONTAL MACHINE CENTER OR NEW CNC HORIZONTAL MACHINE CENTER

BANGALORE MACHINE TOOL CLUSTER

BEE, 2010

Detailed Project Report on Replacement Of Conventional Horizontal Machine Center To CNC Horizontal 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

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.

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

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

Contents

List of Annexure……vii

List of Tables……..vii

List of Figures……viii

List of Abbreviations……viii

Executive summary……ix

About BEE'S SME program……xi

1 INTRODUCTION 1

1.1 Brief about the SME cluster 1

1.2 Energy performance in existing situation 8

1.2.1 Fuel and electricity consumption 8

1.2.2 Average production 9

1.2.3 Specific energy consumption 9

1.3 Identification of technology/equipment 9

1.3.1 Description of technology/equipment 10

1.3.2 Role in process 11

1.4 Benchmarking for existing specific energy consumption 11

1.4.1 Design and operating parameters 12

1.4.2 Operating efficiency analysis 12

1.4.3 Specific fuel and electricity consumption 13

1.5 Barriers for adoption of proposed technology/equipments 13

1.5.1 Technological Barrier 13

1.5.2 Financial Barrier 14

1.5.3 Manpower Skill 14

1.5.4 Vendor Linkages: 14

2 TECHNOLOGY OPTION FOR ENERGY EFFICIENCY IMPROVEMENTS 15

2.1 Detailed description of technology selected 15

2.1.1 Description of technology 15

2.1.2 CNC Horizontal Machine 16
2.1.3 Technology specification..... 16
2.1.4 Suitability or integration with existing process..... 17
2.1.5 Superiority over existing technology 18
2.1.6 Availability of technology..... 19
2.1.7 Source of technology 20
2.1.8 Service/technology providers..... 20
2.1.9 Terms and condition of sales 20
2.1.10 Process down time during implementation..... 20
2.2 Life cycle assessment and risks analysis 20
2.3 Suitable unit/plant for implementation of proposed technology 20
3 ECONOMIC BENEFITS FROM NEW ENERGY EFFICIENT TECHNOLOGY 21
3.1 Technical benefits..... 21
3.1.1 Fuel saving 21
3.1.2 Improvement in product quality..... 23
3.1.3 Increase in production 23
3.1.4 Reduction in raw material consumption 23
3.1.5 Reduction in other losses..... 23
3.2 Monetary benefits 24
3.3 Social benefits 24
3.3.1 Improvement in working environment 24
3.3.2 Improvement in skill 24
3.4 Environmental benefits 24
3.4.1 Reduction in effluent generation 24
3.4.2 Reduction in GHG emission such as CO2, NOx, etc..... 24
3.4.3 Reduction in other emissions like SOx..... 25
4 IMPLEMENTATION OF NEW ENERGY EFFICIENT TECHNOLOGY 26
4.1 Cost of technology implementation 26
4.1.1 Cost of technology 26

4.1.2 Other costs 26
4.2 Arrangements of funds 26
4.3 Financial indicators 26
4.3.1 Cash flow analysis 26
4.3.2 Simple payback period 26
4.3.3 Net Present Value (NPV) 26
4.3.4 Internal rate of return (IRR) 26
4.3.5 Return on investment (ROI) 27
4.4 Sensitivity analysis 27
4.5 Procurement and implementation schedule 27

List of Annexure

Annexure – 1: Energy audit reports used for establishing 28

Annexure -2: Process flow diagram 30

Annexure – 3 Technical Drawing of CNC Horizontal machine 31

Annexure – 4 Detailed financial calculations & analysis for financial indicators 36

Annexure – 5: Details of procurement and implementation plan 41

Annexure – 6 Details of technology/equipment and service providers 42

Annexure – 7 Quotations or Techno-commercial bids for new technology/equipment 42

List of Tables

Table 1.1 Energy Consumption Pattern of Machine Tools Cluster 9

Table 1.2 Energy Consumption Pattern of Existing Technology 11

Table 2.1 Equipment Speciation 17

Table 3.1 Energy savings estimation for CNC Horizontal machine 22

Table 4.1 Cost of equipment 26

Table 4.2 Cost of civil work and consultancy 26

Table 4.4 Financial indicator of proposed technology 27

Table 4.5: Sensitivity analysis 27

List of Figures

Figure 1.1 Process flow chart of typical Machine Tools Unit 2

Figure 1.2: Share of Energy Type used in the Machine Tool Units 8

Figure 1.3 Energy auditing methodology 13

Figure 2.1 CNC Horizontal Machine operations..... 16

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
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.

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 Horizontal Machine centre with CNC Horizontal Machine Centre or new CNC Horizontal Machine centre

Products can be produced by modern technology, which uses computer software, hardware and firm ware in industries. It is needed to use CNC Horizontal 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 Horizontal machines into semi automatic control Horizontal machine. Developing and changing into semi automatic control Horizontal 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 Horizontal are analyzed in this paper. These consist of changing the tool, working the machining processes and locating the tool in turret. And under proper maintenance will serve the owner for a period of 12 to 15 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:

Sr. No.	Particular	Unit	Value
1.	Project cost	`(in lakhs)	151.00
2.	Electricity saving	kWh	105311
3.	Monetary benefit	`(in lakhs)	67.73
4.	Simple payback period	Year	2.23
5.	NPV	`(in lakhs)	148.95
6.	IRR	%age	30.18
7.	ROI	%age	22.06
8.	DSCR	Ratio	2.12
9.	CO2 reduction	Tonnes/annum	80
10.	Procurement and implementation schedule	week	12

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.

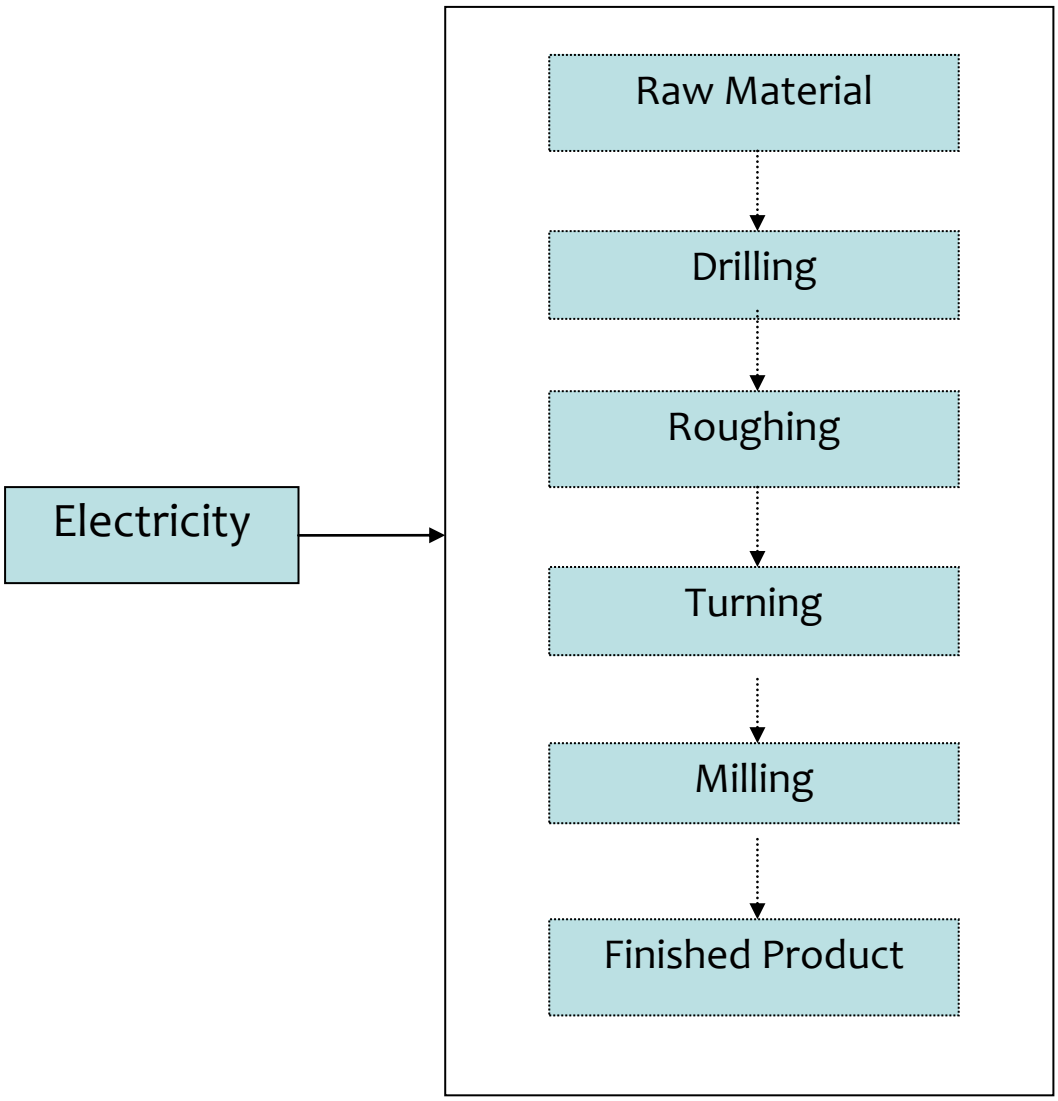


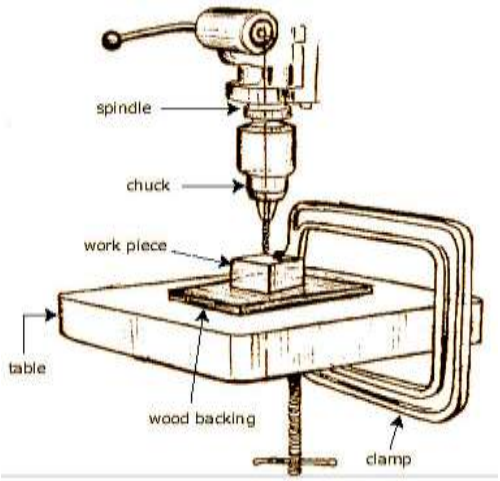
Figure 1.1 Process flow chart of typical Machine Tools Unit

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.



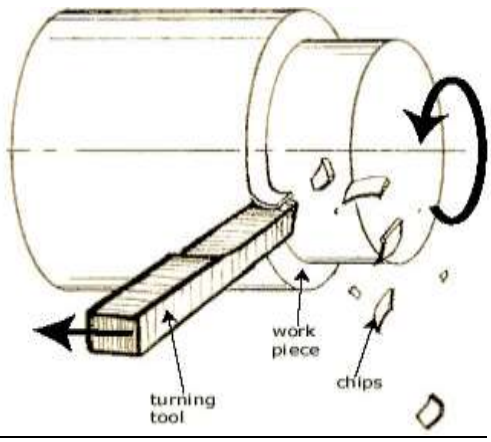
Drilling may affect the mechanical properties of the work piece by creating low residual stresses around the hole opening and a very thin layer of highly stressed and disturbed material on the newly formed surface. This causes the work piece to become more susceptible to corrosion at the stressed surface.

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.

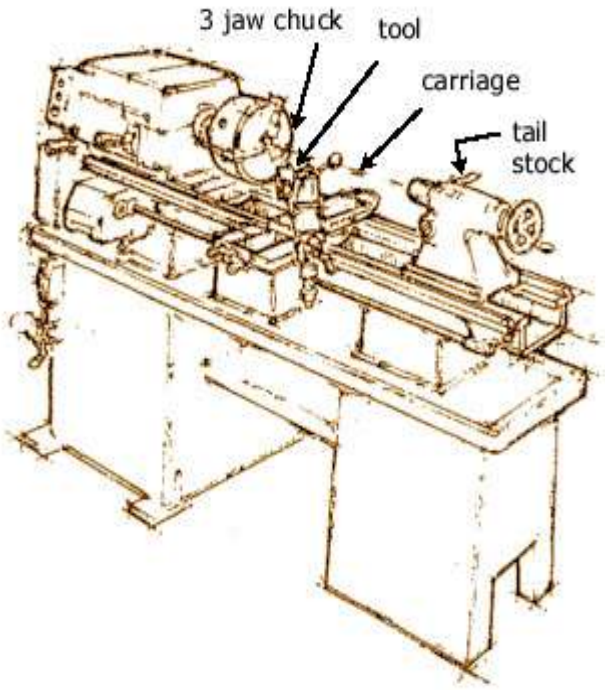
When possible drilled holes should be located perpendicular to the work piece surface. This minimizes the drill bit's tendency to "walk", that is, to be deflected, which causes the hole to be misplaced. The higher the length-to-diameter ratio of the drill bit, the higher the tendency to walk.

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

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 Horizontals 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 Horizontal is the only machine tool that can reproduce itself.

The turning processes are typically carried out on a Horizontal, 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 favourably 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 Horizontals 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.

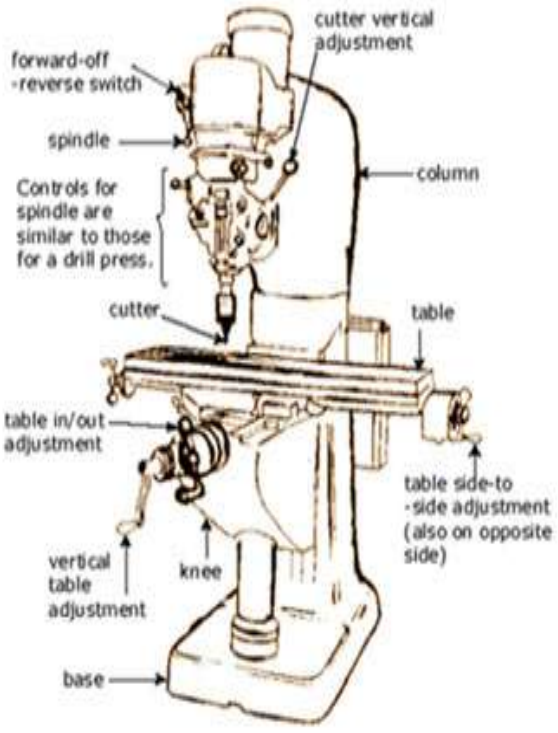
There are various types of boring. The boring bar may be supported on both ends (which only works if the existing hole is a through hole), or it may be supported at one end. Lineboring (line boring, line-boring) implies the former. Backboring (back boring, back-boring) is the process of reaching through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

- ***Knurling***

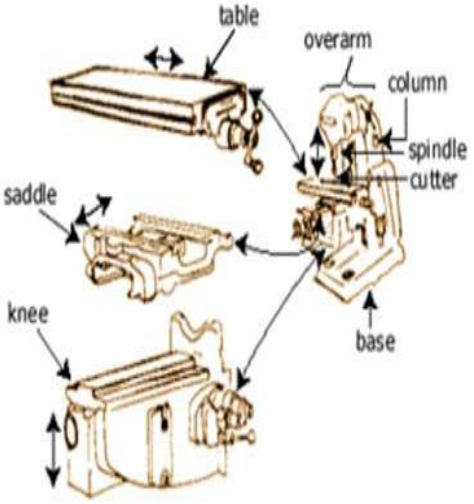
The cutting of a serrated pattern onto the surface of a part to use as a hand grip using a special purpose knurling tool. Threading both standard and non-standard screw threads can be turned on a Horizontal using an appropriate cutting tool. (Usually having a 60, or 55° nose angle) Either externally,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

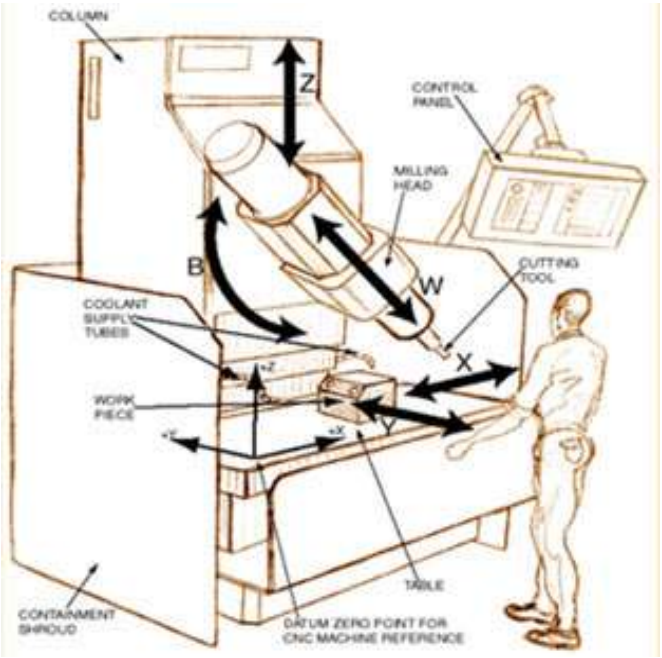


the rotating cutter, material is cut away from this work piece in the form of small chips to create the desired shape.



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.

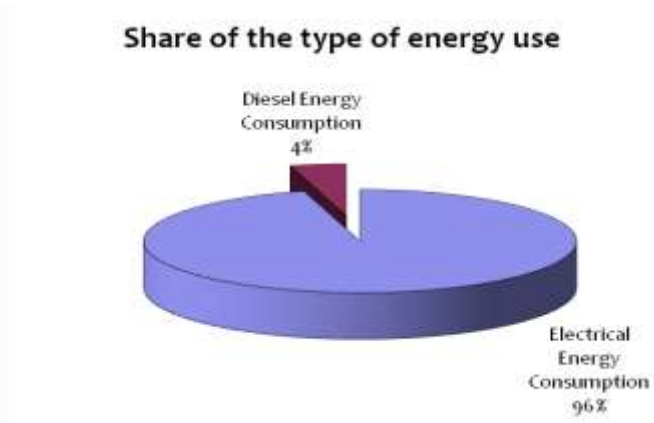


Figure 1.2: Share of Energy Type used in the Machine Tool Units

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

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

1.3.1 Description of technology/equipment

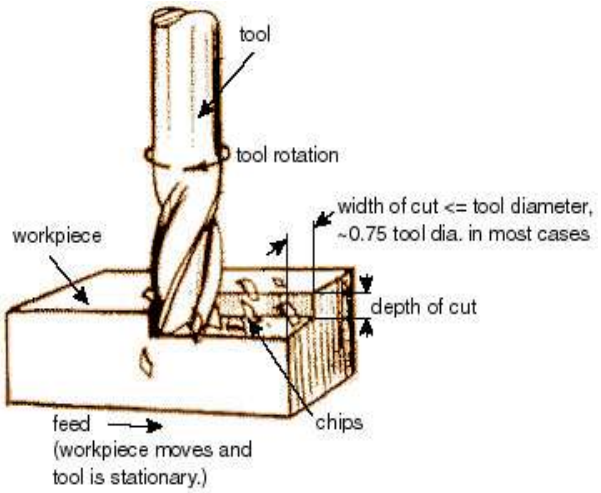
The machine tools industry can be divided into metal cutting and metal forming sectors. The metal cutting sector can be further classified into conventional and computer numerically controlled (CNC) machines, while the metal forming sector can be segregated into conventional and numerically controlled (NC) machines. Some commonly used metal cutting machines includes electrical discharge machining systems (EDMS), machining centers, Horizontals 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.

CNC systems make it possible for microprocessors and programmable logic controllers to work in parallel. This allows 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 enhance the versatility of a traditional milling machine. Moreover, by employing multiple CPU's, the versatility of the machine tools can be 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.

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 grinding 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 Horizontals, 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 manufacturing 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 30 machine units out of which 20 were preliminary audits, 10 were detailed audits,and two were assesed to will use the technology. The total production cost estimated based on the various technology dependents on cost of production of these units. It can be onserved that the total production cost is about Rs. 350145.9 per tonne. And Rs. 10924552 anually

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

Particular	Unit	Bench Mark		
Name of cluster unit studied		Case 1	Case 2	Value
Raw material cost	`/tonne	18000	18000	18000
Other Cost (Utility)	`/tonne	300000	300000	300000
Average Production cost	***`/tonne***	***324791.7***	***375500***	***350145.9***
Annual Production	Tonne	50.4	12	31.2
Annual Production Cost	`/annum	16369502	4506000	10924552

1.4.1 Design and operating parameters

In present scenario 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 loss for the investor. From economic point of view, in order to produce part at effective cost is by producing it at high volume. Machine components become expensive which requires new type of maintenance to cater to this problem.

Unit	Type of Fuel	Unit	Value	Equivalent Energy (G J)	%age Contribution
Fenwick	Electricity	kWh/year	13,200	47.5	9.6
Ravi	Electricity	kWh/year	124800	449.4	90.4

*****Based on measured actual electricity consumption by the existing technology (12 tonnes produced annually)***

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 products, 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:

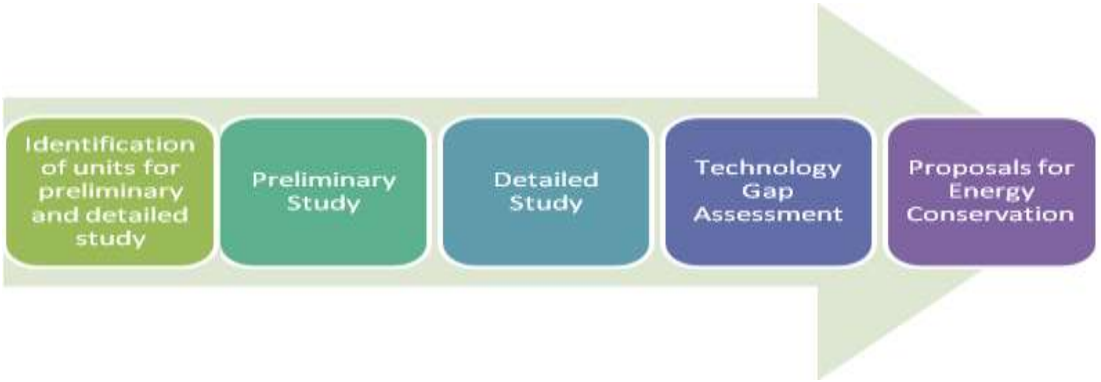


Figure 1.3 Energy auditing methodology

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 related 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 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 not 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 obsoleence 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 a need for continuous Research and Development in the 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 there is lack of awareness of productivity methodologies.

Only 65 percent of the companies uses CNC or NC machines because most of the smaller players gets 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 a company/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 requires 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 Horizontal 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 Horizontal machines into semi automatic control Horizontal machine. Developing and changing into semi automatic control Horizontal 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 Horizontal are analyzed in this paper. These consist of changing the tool, working the machining processes and locating the tool in turret. In this report, the hydraulic circuit design which can change four kinds of tools by using hydraulic motor is made and also constructed. The hydraulic circuit comprises of 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 Horizontal Machine 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 Horizontal, 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 progress has 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 Horizontal 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 Horizontal Machine

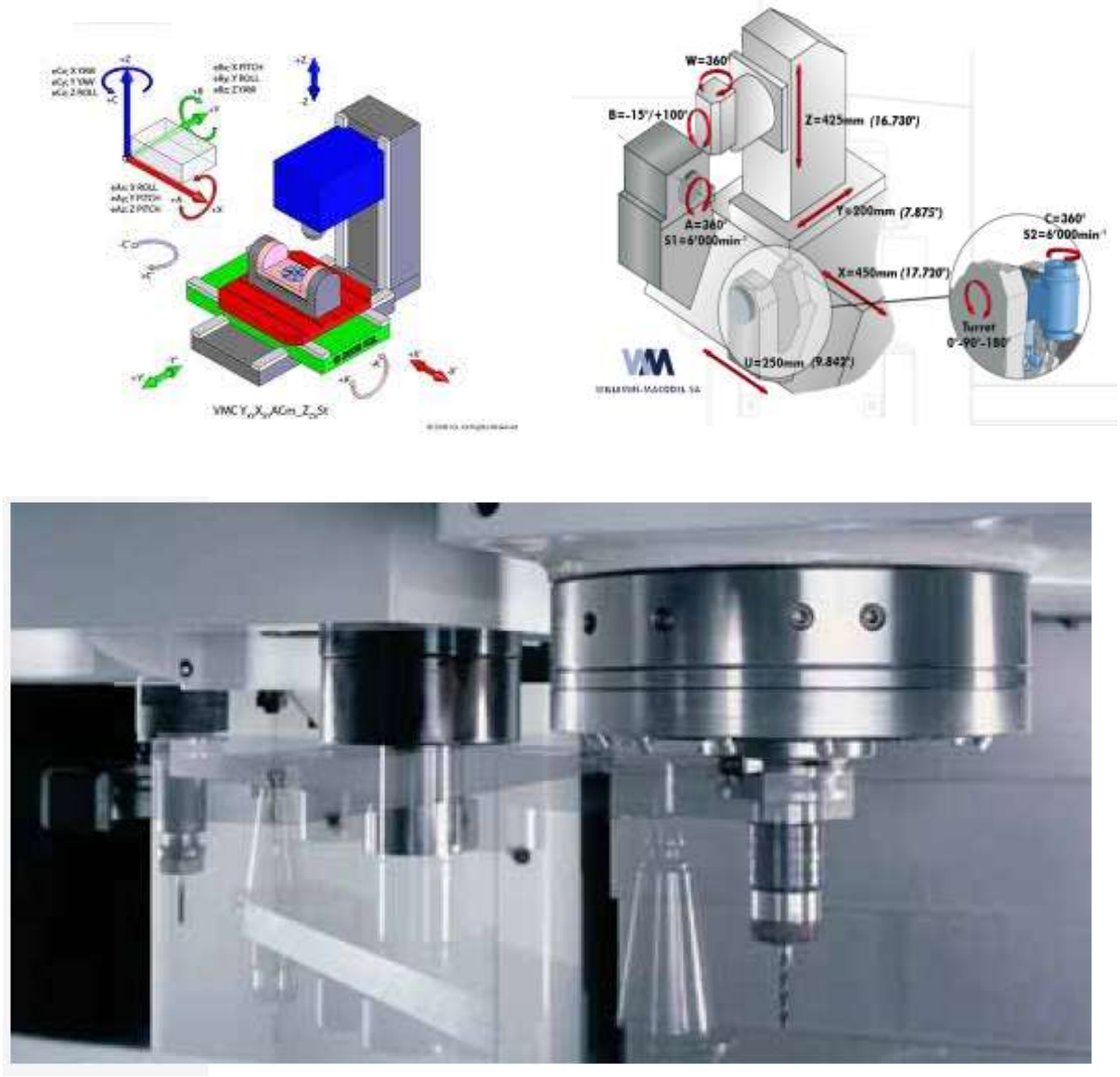


Figure 2.1 CNC operations Horizontal Machine operations

2.1.3 Technology specification

- Biggest workpiece range and stroke in its class

- Rapid feed rate and tool change time equivalent to that of small machines
- High torque spindle makes heavy cutting of difficult-to-cut material possible
- Tool change: HSK-A63
- Chip relief in deep hole drilling and cavity milling
- Multi side machining with indexer or rotary with one setup
- Milling on complex surfaces with full rotary table
- Heavy duty milling unlike rotary type pallet changers

Table 2.1 Equipment Speciation

S. No.	Particulars	Value
1.	Pallet size	49 x 49 in (1,250 x 1,250 mm)
2.	X Axis	86.5 in (2,200 mm)
2.	Y Axis	63 in (1,600 mm)
4.	Z Axis	73 in (1,850 mm)
5.	Rapid feedrate	1,654 ipm (42 m/min)
6.	Spindle speed	6,000 rpm
7.	Spindle drive motor	40 hp (30 kw) / 30 hp (22 kw)
8.	Spindle nose taper	CAT50
9.	Torque	440 ft.lb (600 Nm)
10.	Max load on pallet	11,000 lb (5,000 kg)
11.	Floorspace	244 x 390 in (6,200 x 9,900 mm)
12	Rapid feeds (m/min.):	75
13.	Rotary table positions:	360
14.	Rotary table rotation speed (rpm):	60
15.	Workpiece swing	ø94.5 x 71 in (ø2,400 x 1,800 mm)
16.	Linear axes measuring system:	pressurized Heidenhain optical scales
17.	Rotating axes measuring system:	pressurized Heidenhain optical scales

2.1.4 Suitability or integration with existing process

The NN device can be built-in into each CNC control unit of the CNC horizontal machining. The standard parallel transmission of data is used. If it is not possible to programme the

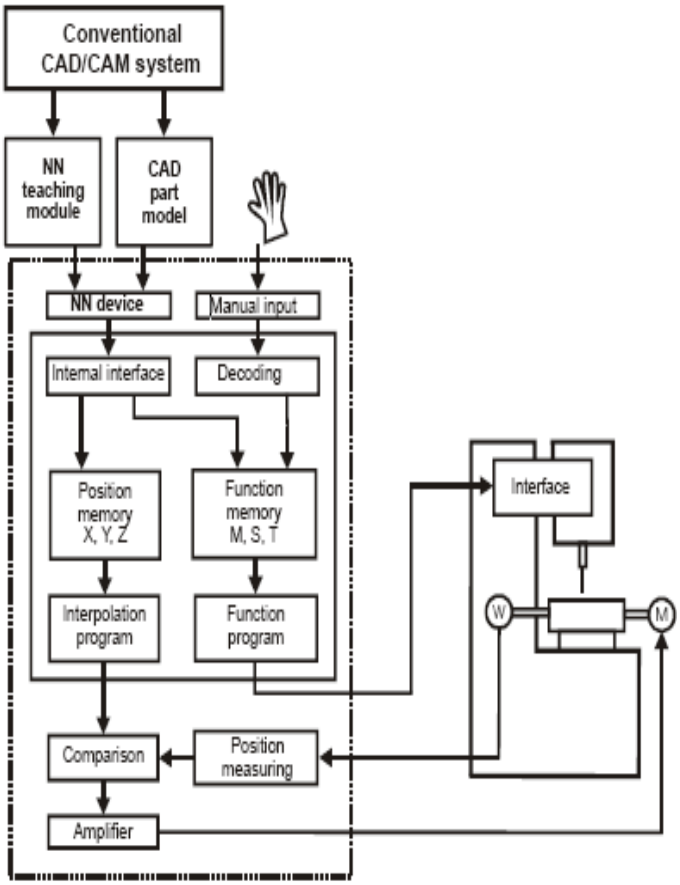
internal interface, the NN device must be connected to existing DNC interface, which each CNC control possess. The NN device for teaching is connected to NN device with standard serial interface. The CAD model of the part is send to NN device through standard communication interface.

For teaching of NN device through the module for teaching different commercial available, CAD/CAM programming systems can be used as are Unigraphics Solution, I-Deas, Catia, HyperMill etc. The new control unit solves the problem of automatic and intelligent generating of NC programs for CNC horizontal machining centres. It describes the control device of a CNC machining centre for face milling (rough), contour milling (rough), final milling after the contour and in Z-plain, final contour 3D milling, contour final milling, milling on Z-plain, final contour milling on equidistant, milling of pockets, normal drilling, deep drilling, centering, reaming, sinking and threading with the capability of teaching and automatic intelligent generating of NC part programs on the bases of neural network, which is built-in into a special NN device. The neural network for milling, drilling and operations alike can learn to generate NC part programs in module for learning**.** The device then completely runs automatically, without the intervention of the operator, only on the basis of 2D, 2,5D or 3D computer model of prismatic part**,** which has not been previously programmed, generate NC part programs. In solving the machining problems, the NN can serve as ideal tool, for helping NC programmer making the right decision, or at least serve as an orientation tool. Time saving could be also achieved, because not so many post-machining operations would be necessary.

2.1.5 Superiority over existing technology

The CNC Horizontal features a control panel that permits the Horizontal 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 Horizontal 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 Horizontal is designed for

maximum safety. A safety door provides protection during machining. Magnetic interlocks located on this door stops 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 cut off the power to the spindle motor and stops the axes. The CNC Horizontal supports low-voltage communications with robotic units. For this purpose, the CNC Horizontal 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 Horizontal 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 Horizontal Software.



- High precision, and high gripping force, high reliability and stability.
- Flimsy parts are shaped by quenching.
- Self-tighting feature automatically increase gripping force proportional to increased torque to prevent tool shank slippage.
- Positive lock mechanism prevents chucks from loosening in operational when suddenly stopped or in the reverse operation.
- The chuck is attached with a loosed key. It can be used loosen chuck When the clamping force was too strong.
- Efficient removal of chips and coolant, steeply peaked 30° telescoping guards guide material underneath the column.
- Eliminating thermal contamination of the machine's geometry.

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 supplying 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 same. 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 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. 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 Horizontal machine can be done in 14 days, However the CNC Horizontal machine is end to end solution of Horizontal 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 Horizontal machine, the technology and machine will continue to work up to 12 to 15 years under proper maintenance. No need to any further huge modification after one time installation. In case of risk analysis there is a need of proper maintenance and timely oiling.

2.3 Suitable unit/plant for implementation of proposed technology

CNC Horizontal machine is suitable for the units involved in the production of more fast machining than conventional Horizontals hence increase in productivity and Quality of the product is definitely enhanced.

3 ECONOMIC BENEFITS FROM NEW ENERGY EFFICIENT TECHNOLOGY

3.1 Technical benefits

3.1.1 Fuel saving

CNC Horizontals are rapidly replacing the older production Horizontals (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 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). And saving capacity of the producting unit is enhanced without effecting the annual production of the unit.The design of a CNC Horizontal 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 Horizontal machine is the ability to machine complex shapes in a single setup. This reduces the machinist setup time and increase the production rate. The main advantage of CNC Horizontal 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 ensures constant and reliable lubrication to the spindle bearings preventing 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 horizontal 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 Horizontal machine are tabulated below:

Table 3.1 Energy savings estimation for CNC Horizontal machine

S. No.	Particular	Unit	Conventional Horizontal machine	CNC Horizontal machine
1	Specific Energy Consumption	kWh/Tonne	6429.17	4500.42
2	Average Energy Cost	`/Tonne	32145.85	22502.1
3	Cost of Material	`./tonne	18000	13500
4	Other Cost (Man Power/Utility)	`./tonne	300000	220403.4
5	***Average Production***	***`./tonne***	***350145.9***	***256405.5***
6	Annual Production	Tonne/annum	31.2	31.2
7	Annual Production Cost	`./annum	10924552	7999851.6
8	Reduction in Production Cost	`./Tonne		93740.4
9	Annual cost reduction	`/Annum		2924700.4

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

**Note:- As in the proposed DPR Conventional Machine is replaces b CNC Horizontal Machine , 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,*

Part machined on conventional CNC control **without** Feed Forward error correction

Part machined on a Milltronics CNC control **with** Feed Forward error correction

the energy saving could be achieved. Consequnetly, the O&M cost of machinery shall

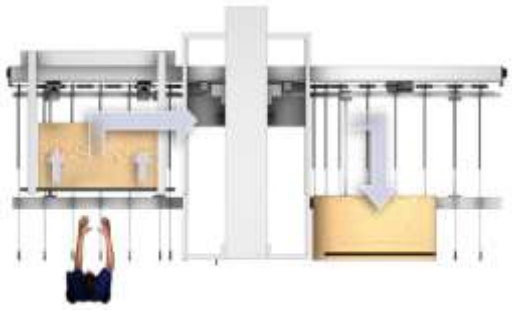
increase to 5 % with annual Escalation of 5 %.

3.1.2 Improvement in product quality

CNC Horizontal 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 totaly designed by CNC machine with comparision to the exisitng manual set up based product.The rejection of material in CNC Horizontal 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 Horizontal 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 any users of Conventional Horizontal machine machines revels that the CNC Horizontal 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 Horizontal machining is almost nil 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 Horizontal 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:-

- Easy integration with conveyor or gantry due to fixed work-piece loading table
- Optimization through multiple combinations of index table, NC rotary table, and fixed table
- 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.
- Faster acceleration/deceleration times
- Boosts spindle torque 19%.
- Improve servo system for rapid response to signals from the spark-gap monitoring circuits
- Cycle time reductions of 10% to 20%
- 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 Horizontal machine has been estimated around ` 67.73 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 Horizontal 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, hence 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 Horizontal machine in machine tools industries. Reduction in electricity consumption translates into GHG reductions is estimated to be 80 tonne of CO_2 per tons 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 Horizontal machine are provided in Table 4.1 below:

Table 4.1 Cost of equipment

S. No.	Particulars	Cost
1	Cost of CNC Horizontal machine	`15000000

**** cost of CNC machine is in Japanese Yen and converted @ Rs. 0.58 per Yen and 36% 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	`55,000/-
2.	Electrical & Utility Expenses	` 15,000/-
3.	Cost of Consultancy and installation	` 30,000/-
Total	One Hundred thousand only/-	` 100,000/-

Total investment in the proposed technology (including equipment cost & Other cost) is ` 151.00 lakh.

4.2 Arrangements of funds

Proposed financing for the replacement of conventional machine with new turn mill center 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 2.23 years.

4.3.3 Net Present Value (NPV)

Net Present Value of new project would work out ` 148.95 lakh.

4.3.4 Internal rate of return (IRR)

The after tax internal rate of return of the project works out to be 30.18%. 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 22.06 %.

Table 4.3 Financial indicator of proposed technology

Particulars	Unit	Value
Simple Pay Back period	Years	2.23
IRR	%age	30.18%
NPV	` in lakh	148.95
ROI	%age	22.06%
DSCR	ratio	2.12

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 4.4 Sensitivity analysis

Particulars	IRR	NVP in lakh	ROI	DSCR
Normal	30.18%	148.95	22.06	2.12
10% increase in fuel savings	30.49%	151.25	22.09	2.14
10% decrease in fuel savings	29.87%	146.65	22.03	2.10

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

4.5 Procurement and implementation schedule

Total time period required for implementation of proposed machine will be 11 weeks. The installation of CNC Horizontal machine can be done in the 10 – 14 days, However the CNC Horizontal machine is end to end solution of CNC Horizontal machineing production process, implementation will not affect production. Thus implementation of this technology will not affect the process. Details of procurmrentation schdules are furnished in Annexure 6.

ANNEXURE

Annexure 1: Energy audit reports used for establishing

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

Audit No. 1

S.No	Particular		Benchmarking		
		Unit	Case 1	Case 2	Value
1	Specific Energy Consumption	kWh/Tonne	1358.34	11500	6429.17
2	Average Energy Cost	`/Tonne	6791.7	57500	32145.85
3	Cost of Material	`/annum	18000	18000	18000
4	Other Cost (Man Power/Utility)	`./tonne	300000	300000	300000
5	Average Production	`/tonne	324791.7	375500	350145.9
6	Annual Production	Tonne/annum	50.4	12	31.2
7	Annual Production Cost	`/annum	16369502	4506000	10924552

Energy savings estimation for CNC Horizontal machine

S.No	Particular	Unit	Conventional Horizontal machine	CNC Horizontal machine
1	Specific Energy Consumption	kWh/Tonne	6429.17	4500.42
2	Average Energy Cost	`/Tonne	32145.85	22502.1
3	Cost of Material	`,/annum	18000	3600
4	Other Cost (Man Power/Utility)	`./tonne	300000	200000
5	Average Production	`./tonne	350145.9	226102.1
6	Annual Production	Tonne/annum	31.2	31.2
7	Annual Production Cost	`./annum	10924552	7054385.52
8	Reduction in Production Cost	`./Tonne		124043.8
9	Annual cost reduction	`./Annum		3870166.56

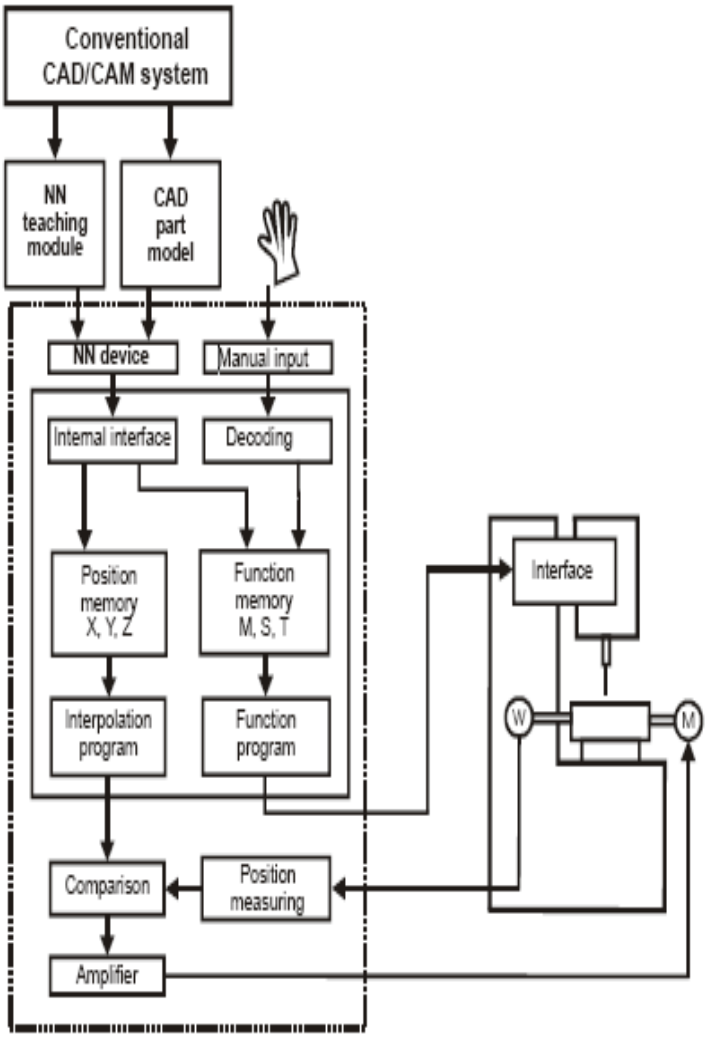
**Note:- As in the proposed DPR Conventional Machine is replaced by CNC Horizontal Machine, it is assumed that it improves the overall productivity by 1.75 times i.e. 31.2 Tonnes/Annum in earlier case to 54.6 Tonnes/Annum after implementation. Accordingly, the energy saving could be achieved. Consequnetly, the O&M cost of machinery shall increase to 5 % with annual Escalation of 5 %.*

S.No	Particular	Unit	Conventional Horizontal machine	CNC Horizontal machine
1	Average Production	`./tonne	350145.9	226102.1
2	Annual Production	Tonne/annum	31.2	54.6
3	Annual Production Cost	`./annum	10924552	12345175
4	Annual cost reduction	`./Annum		6772802

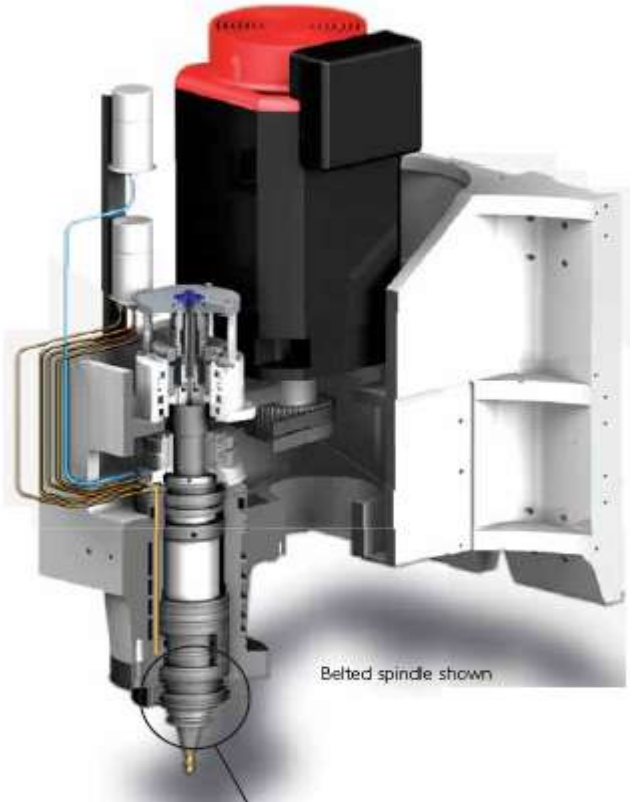
The saving accounts to `***6772802*** (` 124044*54.6 tonnes).

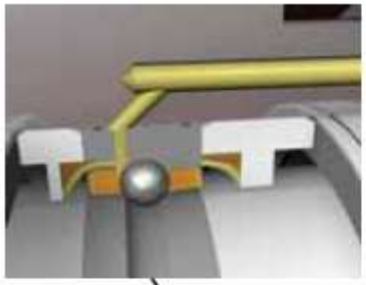
Annexure 2: Process flow diagram

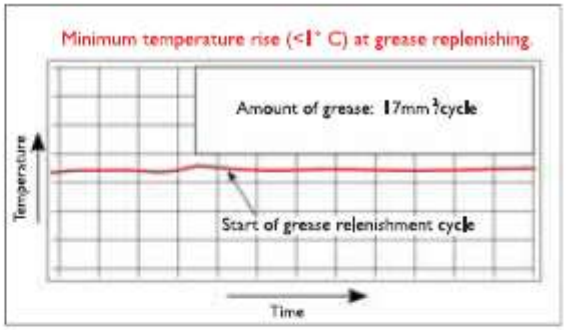
CNC Horizontal machine is end to end solution for CNC Horizontal machining process in machine tools manufacturing units. Horizontal machine computerized numerical control (CNC) machines have become the application of choice for complex surface machining. These machine tools are widely used in the aerospace,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

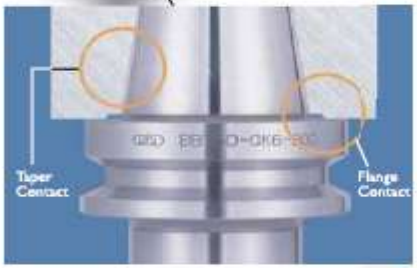


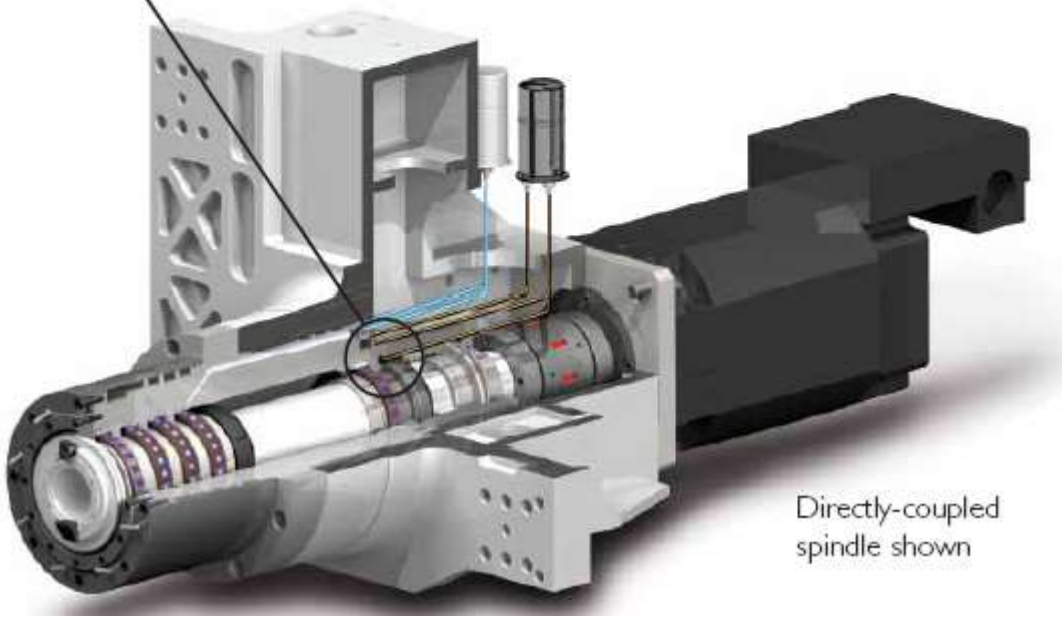
Annexure 3: Technical Drawing of CNC Horizontal machine

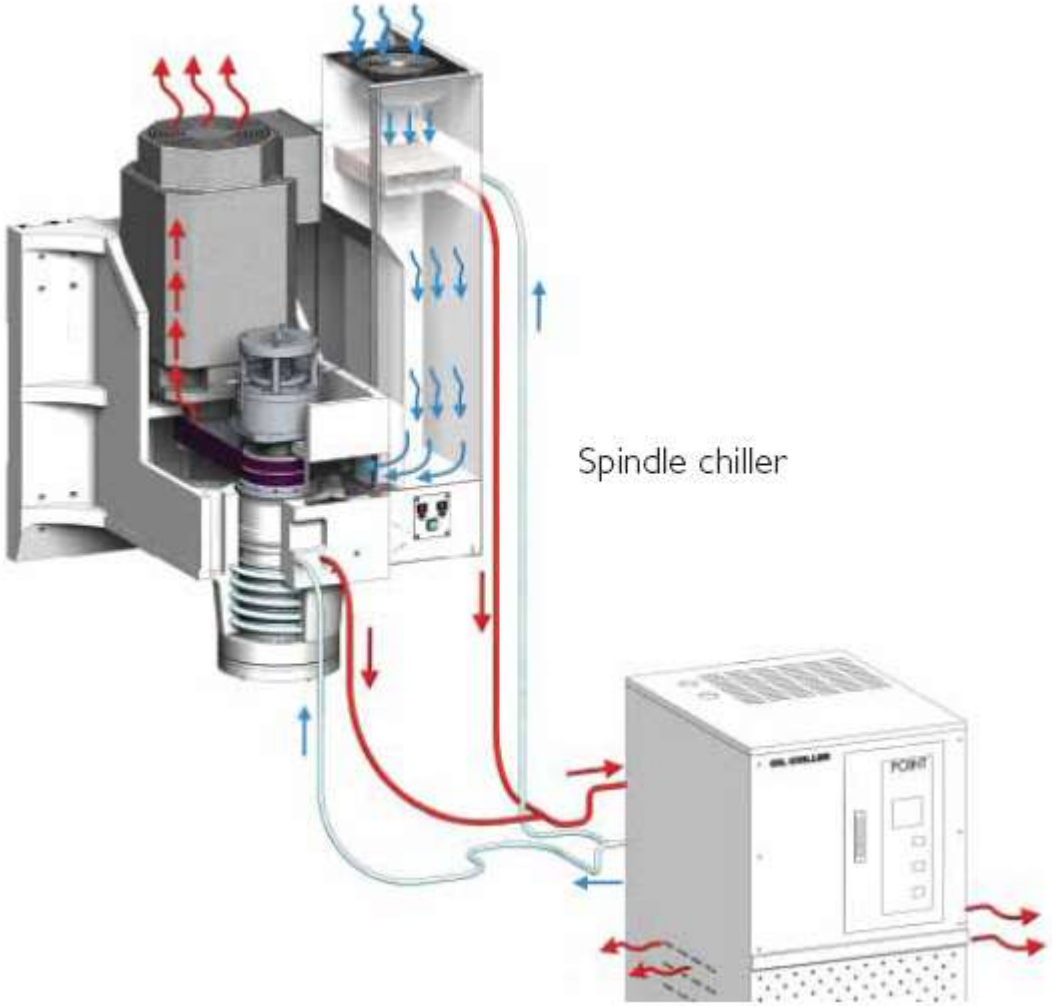








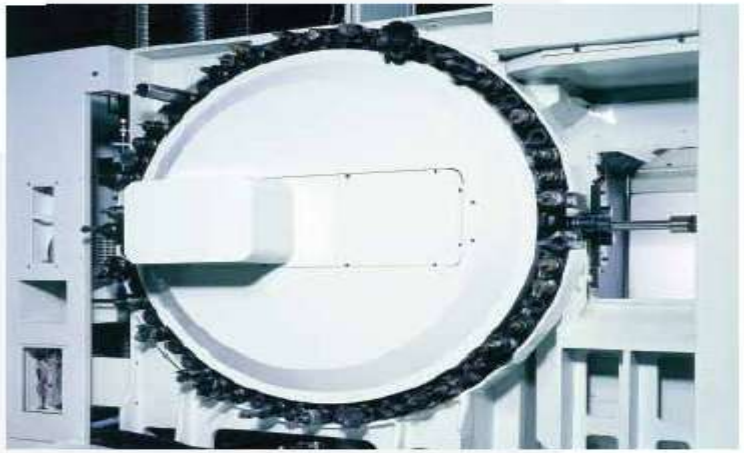




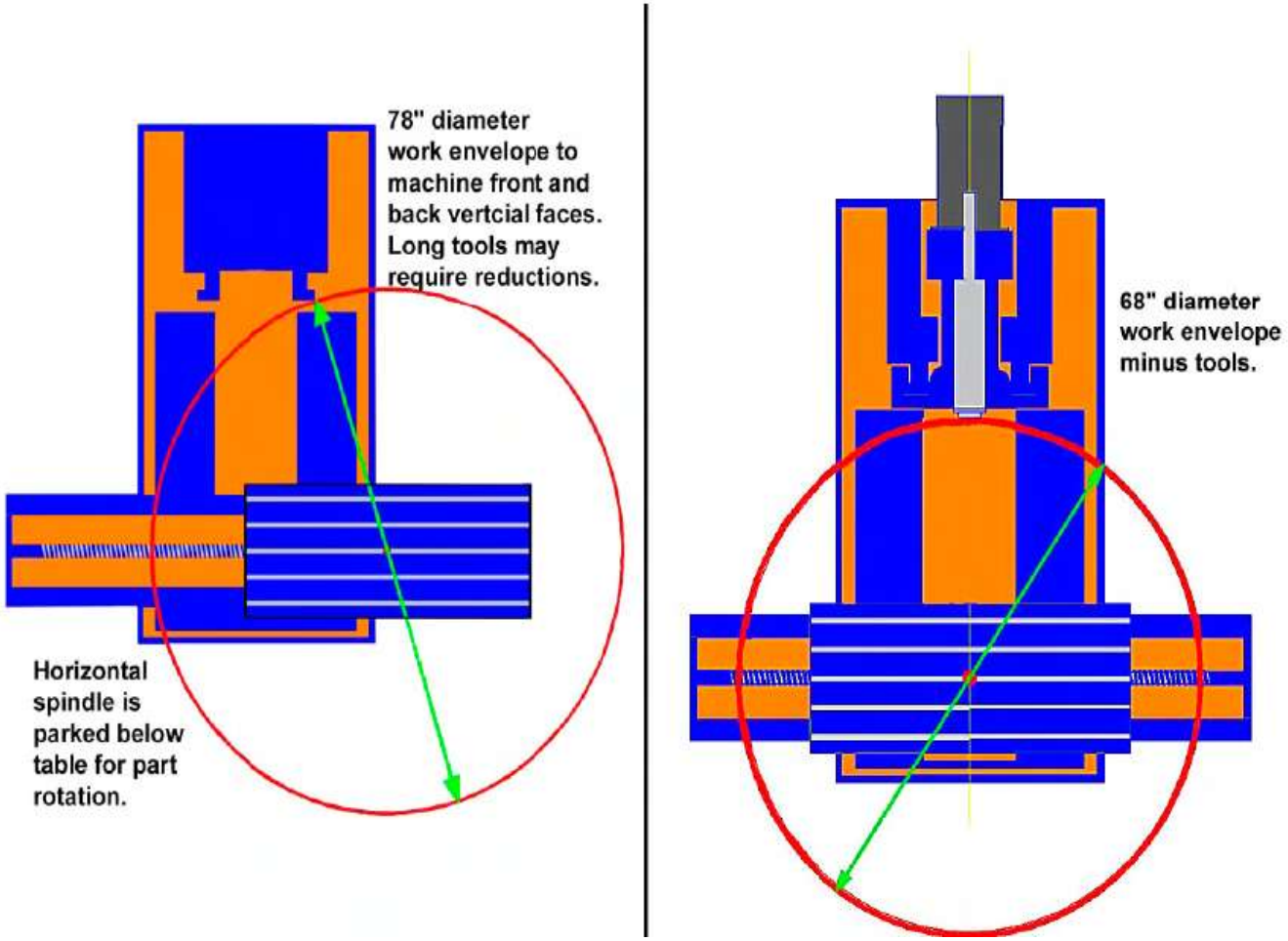
The CNC Horizontal Machine (Spindle Chiller)

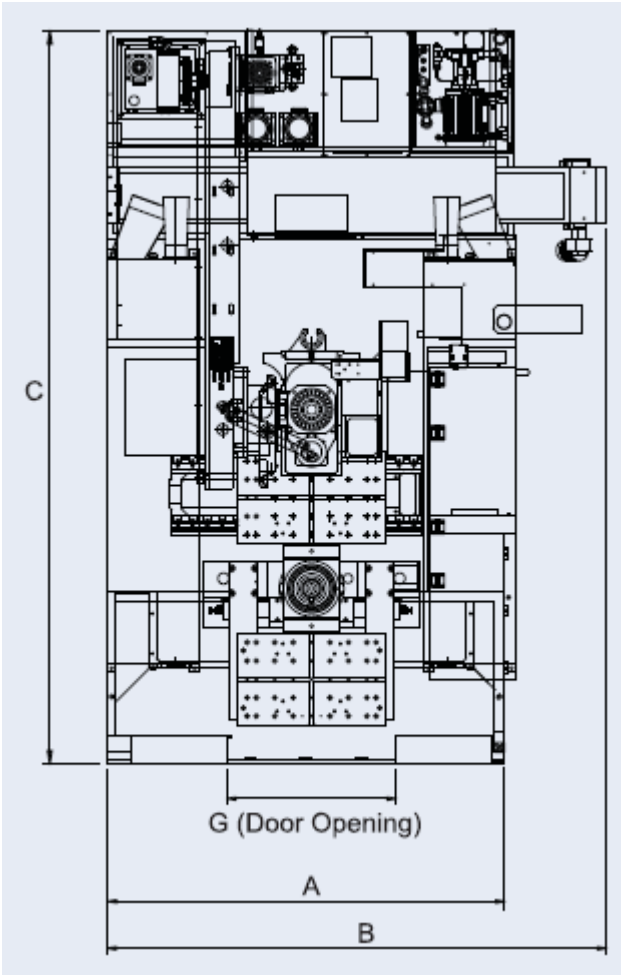
Model	ATC Tool Positions	ATC Option	Tool Shank Taper
XR 700 APC HP	32	48 or 60	40
XR 700 APC HPD	32	48 or 60	40
XR 1000 APC	32	48 or 60	40
XR 700 HMC	60	120	40
XR 700 HMC HP	60	120	40
XR 700 HMC HPD	60	120	40

ATC (Automatic Tool Changer)

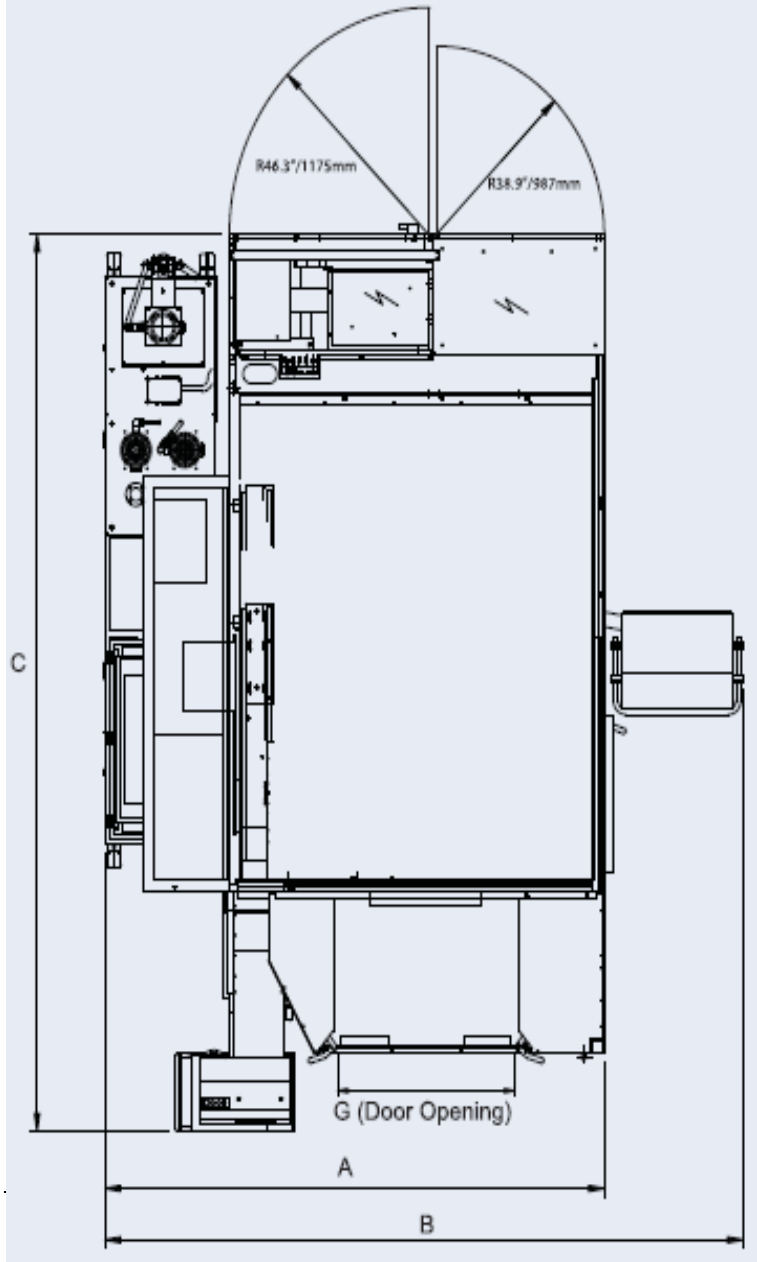


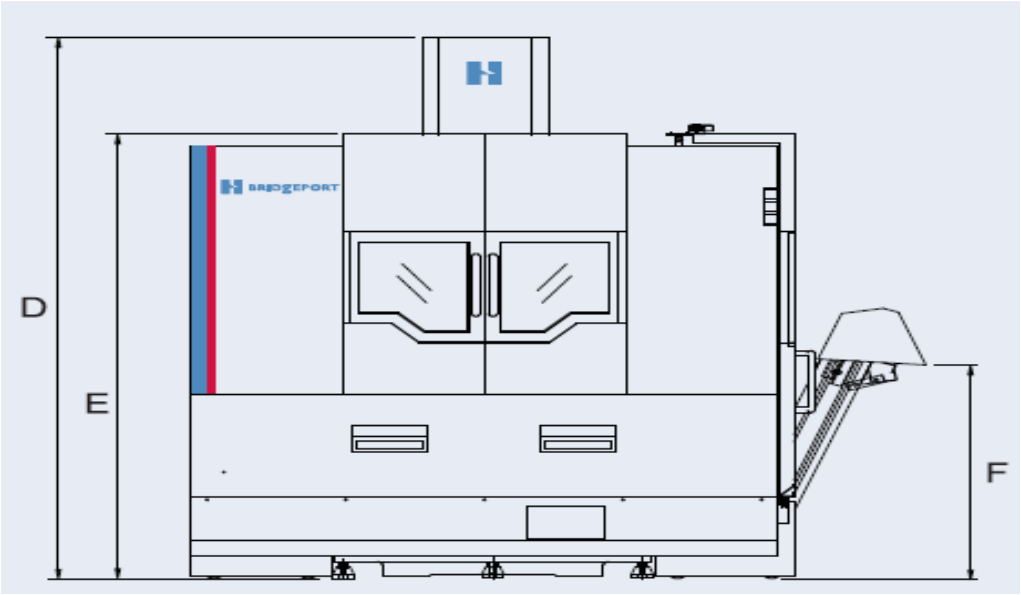
Capacities of the TW-43-HV

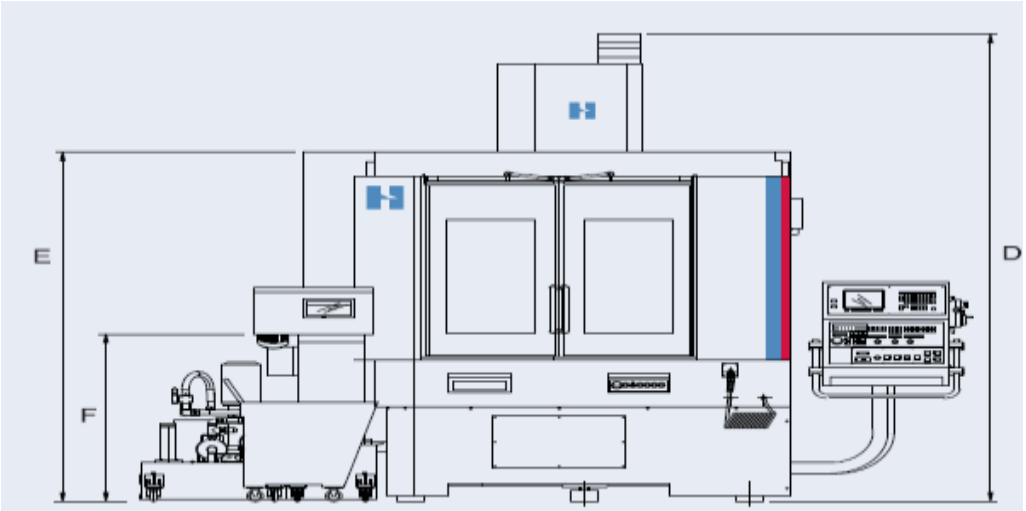




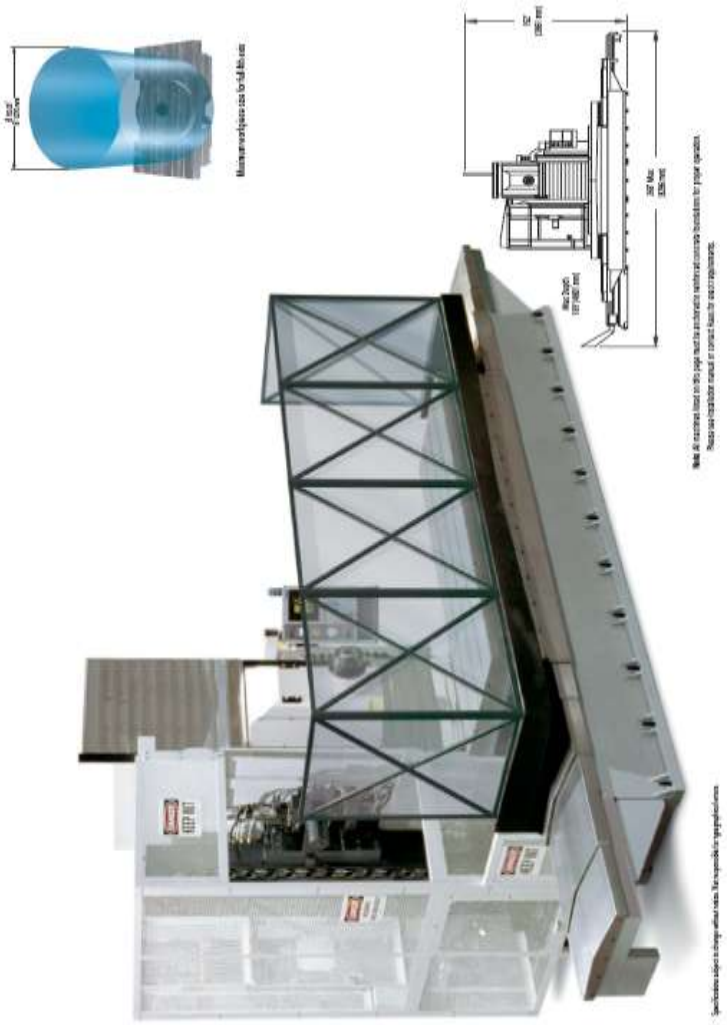
Floor Plan


R46.3"/1175mm
R38.9"/987mm
C
G (Door Opening)
A
B
CONSERVE IT


D
E
F


E
F
D


Main Spindle
Features



Annexure 4: Detailed financial calculations & analysis for financial indicators

Assumption

Name of the Technology	*CNC Horizontal Machine Centre*		
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)	150	Feasibility Study
Cost of modification in civil construction	` (in lakh)	0.55	Feasibility Study
Cost of consultancy	` (in lakh)	0.45	Feasibility Study
Total Investment	` (in lakh)	151.00	Feasibility Study
Financing pattern			
Own Funds (Equity)	` (in lakh)	37.75	Feasibility Study
Loan Funds (Term Loan)	` (in lakh)	113.25	Feasibility Study
Loan Tenure	years	7	Assumed
Moratorium Period	Months	6	Assumed
Repayment Period	Months	78	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	1928.75	
Production	Tonne/Annum	54.6	
Cost	`/kWh	5	
Other savings	`/Annum	114400	
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	113.25	6.00	107.25	13.12
2	107.25	12.00	95.25	10.18
3	95.25	14.00	81.25	8.92
4	81.25	15.00	66.25	7.44
5	66.25	16.00	50.25	5.94
6	50.25	16.50	33.75	4.31
7	33.75	18.50	15.25	2.56
8	15.25	15.25	0.00	0.45
		113.25		

WDV Depreciation ***` (in lakh)***

Particulars / years	*1*	*2*
Plant and Machinery		
Cost	151.00	30.20
Depreciation	120.80	24.16
WDV	30.20	6.04

Projected Profitability ***` (in lakh)***

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Revenue through Savings											
Fuel savings	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	677.28
Total Revenue (A)	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	677.28
Expenses											
O & M Expenses	7.55	7.93	8.32	8.74	9.18	9.64	10.12	10.62	11.15	11.71	94.96
Total Expenses (B)	7.55	7.93	8.32	8.74	9.18	9.64	10.12	10.62	11.15	11.71	94.96
PBDIT (A)-(B)	60.18	59.80	59.40	58.99	58.55	58.09	57.61	57.10	56.57	56.02	582.32
Interest	13.12	10.18	8.92	7.44	5.94	4.31	2.56	0.45	-	-	52.93
PBDT	47.05	49.62	50.48	51.55	52.61	53.78	55.06	56.65	56.57	56.02	529.39
Depreciation	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	79.73
PBT	39.08	41.65	42.51	43.57	44.63	45.81	47.08	48.68	48.60	48.04	449.66
Income tax	-	8.65	17.16	17.52	17.88	18.28	18.71	19.26	19.23	19.04	155.73
Profit after tax (PAT)	39.08	32.99	25.35	26.05	26.75	27.53	28.37	29.42	29.37	29.00	293.93

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Profit before tax	39.08	41.65	42.51	43.57	44.63	45.81	47.08	48.68	48.60	48.04
Add: Book depreciation	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97
Less: WDV depreciation	120.80	24.16	-	-	-	-	-	-	-	-
Taxable profit	(73.75)	25.46	50.48	51.55	52.61	53.78	55.06	56.65	56.57	56.02
Income Tax	-	8.65	17.16	17.52	17.88	18.28	18.71	19.26	19.23	19.04

Projected Balance Sheet

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
Liabilities										
Share Capital (D)	37.75	37.75	37.75	37.75	37.75	37.75	37.75	37.75	37.75	37.75
Reserves & Surplus (E)	39.08	72.08	97.43	123.48	150.23	177.76	206.13	235.55	264.92	293.93
Term Loans (F)	107.25	95.25	81.25	66.25	50.25	33.75	15.25	0.00	0.00	0.00
TOTAL LIABILITIES (D)+(E)+(F)	184.08	205.08	216.43	227.48	238.23	249.26	259.13	273.30	302.67	331.68
Assets										
Gross Fixed Assets	151.00	151.00	151.00	151.00	151.00	151.00	151.00	151.00	151.00	151.00
Less Accm. depreciation	7.97	15.95	23.92	31.89	39.86	47.84	55.81	63.78	71.76	79.73
Net Fixed Assets	143.03	135.05	127.08	119.11	111.14	103.16	95.19	87.22	79.24	71.27
Cash & Bank Balance	41.05	70.02	89.34	108.37	127.10	146.10	163.94	186.08	223.43	260.40
TOTAL ASSETS	184.08	205.08	216.43	227.48	238.23	249.26	259.13	273.30	302.67	331.68
Net Worth	76.83	109.83	135.18	161.23	187.98	215.51	243.88	273.30	302.67	331.68
Debt Equity Ratio	2.84	2.52	2.15	1.75	1.33	0.89	0.40	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	37.75	-	-	-	-	-	-	-	-	-	-
Term Loan	113.25										
Profit After tax		39.08	32.99	25.35	26.05	26.75	27.53	28.37	29.42	29.37	29.00
Depreciation		7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97
Total Sources	151.00	47.05	40.97	33.32	34.03	34.73	35.50	36.34	37.40	37.34	36.98
Application											
Capital Expenditure	151.00										
Repayment Of Loan	-	6.00	12.00	14.00	15.00	16.00	16.50	18.50	15.25	-	-
Total Application	151.00	6.00	12.00	14.00	15.00	16.00	16.50	18.50	15.25	-	-

Net Surplus	-	41.05	28.97	19.32	19.03	18.73	19.00	17.84	22.15	37.34	36.98
Add: Opening Balance	-	-	41.05	70.02	89.34	108.37	127.10	146.10	163.94	186.08	223.43
Closing Balance	-	41.05	70.02	89.34	108.37	127.10	146.10	163.94	186.08	223.43	260.40

IRR **` (in lakh)**

Particulars / months	***0***	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Profit after Tax		39.08	32.99	25.35	26.05	26.75	27.53	28.37	29.42	29.37	29.00
Depreciation		7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97
Interest on Term Loan		13.12	10.18	8.92	7.44	5.94	4.31	2.56	0.45	-	-
Cash outflow	(151.00)	-	-	-	-	-	-	-	-	-	-
Salvage value											71.27
Net Cash flow	(151.00)	60.18	51.15	42.24	41.47	40.67	39.81	38.90	37.85	37.34	108.25
IRR	30.18%										
NPV	148.95										

Break Even Point

Particulars / Years	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***
Variable Expenses										
Oper. & M Exp (75%)	5.66	5.95	6.24	6.56	6.88	7.23	7.59	7.97	8.37	8.78
Sub Total*(G)*	5.66	5.95	6.24	6.56	6.88	7.23	7.59	7.97	8.37	8.78
Fixed Expenses										
Oper. & Maintenance Exp (25%)	1.89	1.98	2.08	2.19	2.29	2.41	2.53	2.66	2.79	2.93
Interest on Term Loan	13.12	10.18	8.92	7.44	5.94	4.31	2.56	0.45	0.00	0.00
Depreciation *(H)*	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97
Sub Total (I)	22.98	20.13	18.97	17.60	16.21	14.69	13.06	11.08	10.76	10.90
Sales (J)	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73	67.73
Contribution (K)	62.07	61.78	61.48	61.17	60.85	60.50	60.14	59.76	59.36	58.94
Break Even Point (L= G/I)	37.03%	32.59%	30.86%	28.77%	26.64%	24.29%	21.71%	18.54%	18.13%	18.49%
Cash Break Even {(I)-(H)}	24.19%	19.68%	17.89%	15.74%	13.54%	11.11%	8.45%	5.20%	4.70%	4.97%
Break Even Sales (J)*(L)	25.08	22.07	20.90	19.49	18.04	16.45	14.70	12.56	12.28	12.53

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Net Profit Before Taxes	39.08	41.65	42.51	43.57	44.63	45.81	47.08	48.68	48.60	48.04	449.66
Net Worth	76.83	109.83	135.18	161.23	187.98	215.51	243.88	273.30	302.67	331.68	2038.08
											22.06%

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

Particulars / Years	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*Total*
Cash Inflow											
Profit after Tax	39.08	32.99	25.35	26.05	26.75	27.53	28.37	29.42	29.37	29.00	235.55
Depreciation	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	7.97	63.78
Interest on Term Loan	13.12	10.18	8.92	7.44	5.94	4.31	2.56	0.45	0.00	0.00	52.93
Total (M)	60.18	51.15	42.24	41.47	40.67	39.81	38.90	37.85	37.34	36.98	352.26

DEBT

Interest on Term Loan	13.12	10.18	8.92	7.44	5.94	4.31	2.56	0.45	0.00	0.00	52.93
Repayment of Term Loan	6.00	12.00	14.00	15.00	16.00	16.50	18.50	15.25	0.00	0.00	113.25
Total (N)	19.12	22.18	22.92	22.44	21.94	20.81	21.06	15.70	0.00	0.00	166.18
Average DSCR (M/N)	2.12										

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.	Activity	Weeks										
		1	...	4	5	6	7	8	9	10	11	12
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.*
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

intelmac

MORI SEIKI
NH6300 DCG II
HORIZONTAL MACHINING CENTER

QTN.NO.IMTPL/BLR/MORI SEIKI/133/11 FEB 08, 2011

Petroleum Conservation Research Association,
302, Kaveri Apartments, 4th Main Road,
G.M.Palya, New Thippasandra Post,
Bangalore-560 075

MANUFACTURER : MORI SEIKI CO. LTD., JAPAN

MACHINE : HORIZONTAL MACHINING CENTRE

MODEL : NH-6300 DCG II.

TECHNICAL DESCRIPTION :

Mori Seiki NH-6300DCG II is a new model High Precision Horizontal Machining Centre with the highest speed in its class, suitable for a wide range of machining, from heavy duty cutting of steel to high speed cutting of aluminum, the ultimate in dynamic characteristics and surface quality with revolutionary Driven at the Centre of Gravity (DCG^{TM})

The DCG series is developed using finite element method and a model analysis from the initial design stage.

The DCG series horizontal machining centers provide high accuracy and high rigidity due to many technological innovations such as driven at the centre of gravity and market oriented concepts. These advanced high performance machines are designed to deliver increased accuracy, unmanned operation, easy operation and maintenance, thus raising productivity.

DCG TECHNOLOGY :

The simple technology of gravity movement is incorporated in this machine effectively, thus providing greater advantages.

- DCG principal combines speed and precision, thus helping movement as instructed, accurately and with ease.
- With DCG principal object movement is through the centre of gravity point.
- With DCG principal vibration during axis movement is at minimum.
- With DCG principal, many vibration related problems get minimized, thus ensuring smooth trouble-free accurate performance of the machine.
- DCG technology even over powers linear motor drives in controlling vibrations.
- DCG technology improves surface quality due to constant speed and powerful acceleration.
- DCG technology helps to achieve reduction in machining time due to faster acceleration and deceleration.

BED & Z AXIS :

The bed is of T shape box type rigid construction in which guideways for Z axis table movement is incorporated, with high speed, high performance LM guideways. The use of Twin Drive for Z axis improves dynamic performance due to adoption of driven at the centre of gravity technology.

COLUMN, X & Y AXES :

The column is a massive box type bridge which houses X axis and saddle for Y axis spindle movement. The column is installed on the bed so as to raise the rigidity against torsion. The column carries X and Y axis slideways that resists cutting forces of the spindle head on both sides. This structure is durable even during interrupted cutting.

The X axis Twin Drive System has been employed to enable use of a gravity drive to achieve a stable machine design using box in box technology.

SPINDLE :

The machine incorporates high performance direct drive spindle, thus eliminating possible vibrations. Right combination power and torque for various machining applications is possible. Performance and accuracy of the spindle is achieved through spindle oil cooler which helps to minimize thermal distortion.

RECIRCULATING BALLSCREWS :

The machine is equipped with 5 Nos. re-circulating ballscrews, two in X axis, 2 in Z axis and 1 in Y axis. These ballscrews are cooled through coolant which flows through the support bearings, thus improving performance accuracy by minimizing thermal distortion due to very high rapids.

ECO – FRIENDLY DESIGN FOR GUIDEWAY LUBRICATION :

All the sliding ways used the lubricating oil system for the roller guides installed on both ends of the block, thus providing oil free rollers guides.

COOLANT SYSTEM :

Coolant system with shower coolant provided for effective chip cutting and disposal. Large 930 Ltr. Tank capacity is used to keep coolant temperature low.

ELECTRICAL EQUIPMENT WITH FEATURES TO REDUCE ELECTRICITY CONSUMPTION :

The electrical cabinet is placed on the front side of the machine. The electrical cabinet has easy access and door safety lock, as well as the main switch. The cabinet is slimmer thus the proximity between the maintenance person and electrical elements becomes closer during maintenance.

Automatic power off function, automatic machine light function and low speed / low acceleration control function achieves greater power saving.

Total installed power is 65.2 KVA.

GUARDING :

The machine is provided with complete guarding with safety door interlock system. Well-thought access has been provided for loading / unloading and to take care maintenance activities.

CHIP DISPOSAL :

Machine has a pocket type centre trough to use chip conveyor for effective disposal of chips.

1.0 **MAIN SPECIFICATIONS :**

1.1 **Travel** :

- Longitudinal Movement of saddle X – axis :1050 mm
- Vertical Movement of Saddle head Y – axis : 900 mm
- Cross Movement of table Z – axis : 980 mm
- Distance from pallet surface to spindle centre : 100~1000 mm
- Distance from table centre to spindle gauge plane: 100~1080 mm

1.2 **Pallet :**

- Height to the surface of the pallet : 1250 mm
- Pallet working Surface : 630 x 630 mm
- Pallet loading capacity : 1500 Kg.
- Max. workpiece swing diameter : 1050 mm.
- Max. workpiece height : 1300 mm.
- Table surface configuration : M16 Tap,24 holes, Pitch 125 mm
- Minimum Table indexing angle : 1°
- Table indexing time (90 deg.) : 2.0 Sec.

1.3 **Spindle :**

- Max. Spindle Speed : 10,000 rpm.
- No. of spindle speed ranges : 1
- Type of spindle taper hole : No. 50
- Spindle bearing inner dia : 100 mm

1.4 **Feedrate**

- Rapid traverse rate (X,Y,Z Axis) : 50000 mm/min
- Cutting feedrate : 1 – 50000 mm/min.
- Maximum rotational speed : B : 38.5 rpm
- Jog federate : 0 ~ 1260 mm/min.

1.5 **Automatic Tool Changer :**

-	Type of tool shank	: BT-50
-	Type of retention knob	: MORI SEIKI 90 deg. type
-	Tool storage capacity	: 60 tools – Chain type
-	Max. tool diameter / without adjacent tools	:110 mm / 320 mm
-	Max. tool length	:630 mm
-	Max. tool weight	: 30 Kg.
-	Max.tool mass moment	: 29.4 N-m
-	Method of tool selection	: Fixed address
-	Tool change time-tool to tool -chip to chip	: 1.7 secs. : 4.4 secs.

1.6 **Automatic Pallet Changer**

-	Number of pallets	: 2 nos.
-	Type of pallet	: Turn type
-	Pallet changing time	: 15 Secs

1.7 **Motor :**

-	Spindle drive motor (30 min/cont.)	: 40 / 30 /25 Kw
-	Feed Motor (X/Y/Z/B)	: 4.5 x 2/5.5/5.5 x 2/3.0 KW.
-	Coolant Pump Motor	: 1.2 Kw

1.8 **Power Source**

-	Electrical Power Supply	: 65.2 KVA
-	Compressed air supply	: 0.5 Mpa / 600 L/min

1.9 **Tank Capacity**

-	Coolant tank capacity	: 930 L

1.10 **Machine Size**

-	Machine height (from floor)	: 3,287 mm
-	Floor space(width x depth)	: 3,370 x 5962 mm
-	Machine weight	: 19,000 Kg.

Standard Features :

- Maximum Spindle Speed 10000 rpm with 40/30/25 Kw motor power
- Inverter controlled spindle oil Cooler
- Tool Storage Capacity – 60 Tools (chain type)
- Type of Tool Shank – BT50
- Type of retention knob – Mori Seiki 90°
- Tap Pallet
- 1° Indexing table
- 2-Station turn type APC
- Coolant System
- Shower Coolant
- Coolant float switch (lower limit detection)
- Tool Tip air blow system
- Chip Conveyor–single construction,Rear discharge,Hinge type(with drum filter)
- Automatic Power Off System
- Manual pulse generator (separate type)
- Full Cover
- Door Interlock System (incl. mechanical)
  - Front Door
  - Setup station door
  - Electrical cabinet door
- Door Interlock System
- Low air pressure detecting switch
- Low hydraulic pressure detecting switch
- Built in worklight
- Leveling block
- Hand tools
- Signal tower – 3 steps

Price in J. Yen

F.O.B.,NAGOYA,JAPAN

1.0	Mori Seiki model NH-6300 DCG II High Precision Horizontal Machining Centre with MSX-701 CNC Controller including following standard features	**19,000,000**

Above price is inclusive of optional features listed below :

-
-

(Machine built for 200 Volt, 50Hz, 3 Phase power Supply)
Suitable step down transformer not included in above price.

2.0	Supervision charges for Installation & commissioning by Mori Seiki Engineer (To & Fro Air fare and Lodging & Boarding expenses are to be borne by customer)	2,000,000

ALTERNATIVELY

Supervision charges for installation & Commissioning by Intelmac Engineers	Rs. 2,00,000

Terms & Conditions of sale enclosed.

For INTELMAC MACHINE TOOLS PVT. LTD.

Kirankumar Dixit
9343908030

TERMS AND CONDITIONS OF SALE

1. **PRICES** :

   PRICES QUOTED ARE ON F.O.B JAPAN BASIS.

2. **DELIVERY** :

   5 MONTHS EX-WORKS FROM THE DATE OF RECEIPT OF TECHNICALLY AND COMMERCIALLY CLEAR ORDER AND IRREVOCABLE CONFIRMED LETTER OF CREDIT (L/C) WHICHEVER IS LATER SUBJECT TO METI CLEARANCE FROM JAPANESE GOVERNMENT.

3. **TERMS OF PAYMENT** :

   YOU HAVE TO OPEN CONFIRMED (AT SMBC,JAPAN), IRREVOCABLE L/C FOR 100% OF F.O.B ORDER VALUE WITH A PROVISION TO DRAW 20% ADVANCE ALONGWITH THE ORDER .

   THE ORDER AND LETTER OF CREDIT IS TO BE OPENED IN THE NAME OF MORI SEIKI CO. LTD., JAPAN.

   L/C CONFIRMATION CHARGES OUT SIDE INDIA TO BE BORNE BY PURCHASER.

4. **INSURANCE** : TO BE ARRANGED BY YOU.

5. **WARRANTY** :

   A. 27 MONTHS FROM THE DATE OF SHIPMENT OR 24 MONTHS FROM THE DATE OF INSTALLATION AND COMMISSIONING, WHICHEVER IS EARLIER.

   B. DURING WARRANTY ANY PARTS THAT MAY HAVE BEEN FOUND FAULTY AND NEED REPLACEMENT WILL BE SUPPLIED FREE OF COST BY OUR PRINCIPAL. HOWEVER, THE COSTS OF CLEARANCE FROM CUSTOMS INCLUDING DUTIES, TAXES, GOVERNMENT LEVIES ETC. ARE TO BE BORNE BY THE PURCHASER.

6. **FORCE MAJEURE** :

   THE INTERNATIONAL FORCE MAJEURE CONDITION WILL APPLY TO THIS OFFER.

7. **ARBITRATION** :

   ANY DISPUTES LEADING TO ARBITRATION WILL BE REFERRED TO INTERNATIONAL ARBITRATION COURT.

8. **VALIDITY** :

   THIS OFFER IS VALID FOR 30 DAYS.

9. **ERECTION & COMMISSIONING** :

   THE QUOTED PRICES DO NOT INCLUDE CHARGES TOWARDS SUPERVISION OF ERECTION & COMMISSIONING. THESE ARE QUOTED SEPARATELY

10. **GENERAL TERMS & CONDITIONS**

    AS PER ENCLOSED TERMS & CONDITIONS OF MORI SEIKI, JAPAN.

For INTELMAC MACHINE TOOLS PVT. LTD.

Kirankumar Dixit
9343908030

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