TRAINING REPORT

OF

SIX WEEK INDUSTRIAL TRAINING, UNDERTAKEN

AT

"HINDUSTAN MACHINE TOOLS, PINJORE"

IN

"CNC DEPARTMENT"

SUBMITTED IN PARTIAL FULFILLMENT OF THE DEGREE

OF

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IN

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INTRODUCTION

The Third Machine Tool Factory of HMT limited located at Pinjore near Chandigarh went into production on 1st October 1963. It was the first HMT factory to be located away from HMT complex at Bangalore, where two machine tools factories and a watch factory had earlier been established.

These factories was designed, build and commissioned by Indian talent without any foreign assistance in a record period of 17 months of breaking the ground on May 2, 1962 at a capital investment of Rs. 750 lakhs (inclusive of the township) and was formally inaugurated by Pt. Jawaharlal Nehru, the Prime Minister of India.

Over the years HMT successfully diversified into other engineering areas to manufacture prosses and press breaks. Die casting and plastic injection molding machine watches, printing machines, lamps and lamp making machinery, Dairy machinery, tractors bearings

HMT LIMITED

Fulcrum of Indian Industrial Development

HMT synonymous with excellence in precision engineering is a multi-unit multi-product company established as a public sector enterprise in 1953. Built on a strong foundation of technical know-how acquired from world leaders in machine tools such as Oerlikon, Manurhin, Gildemeister, Liebher, and RinoBeradi. HMT's machine tools expertise has been developed to such an extent that HMT can design and develop any kind of machine. Having established as a machine tool manufacturer, HMT diversified into other product lines.

From simple lathes to multi station transfer lines, from stand-alone CNC machines to flexible manufacturing systems, leading to factory automation, HMT's board rang of machine tools cover General Purpose Machines, Special Purpose Machines, CNC Machines, meeting the application needs to every engineering services.

Pioneering the concept of CNC technology in India, HMT has the distinction of being the first company to successfully manufacture its own CNC systems, in association with Siemens.

HMT's commitment to the development of machine tools technology is clearly reflected in the fact that HMT has to many as seven exclusive machine tools unit spread across the country. Each superbly equipped to meet the most challenging demand for machine tools. These units are in Banglore, Pinjore, Kalamassery, Hyderabad, Ajmer are all ISO 9000 certified.

Today HMT is well positioned at the forefront of the precision engineering field. Its manufacturing plants employ a highly skilled workforce strongly supported by R& D. Today over 78000 machine tools manufactured by HMT, are in use in India and elsewhere.

HMT (International) Limited

HMT's wholly owned subsidiary, HMT (International) Limited is a recognized export house renowned internationally and enjoying a Mini Ratna status places HMT products and services Worldwide.

HMT (I) also has complete capabilities to undertake turnkey projects in all engineering disciplines including software engineering. It has successfully executed turnkey projects in Indonesia, Malaysia, Tanzania, Ethiopia, Algeria and Iraw.

The Pinjore Unit

After having established two machine tools factories and a watch factory in Banglore, the Pinjore Unit was established as the third machine tool factory. It went into production on 1st October 1963. This factory has been designed, built and commissioned entirely by India talent in a record period of 17 months of breaking the ground on May 2, 1962. Pandit Jawaharlal Nehur, the first Prime Minister of free India, inaugurated it on October 23, 1963. Later in June 1971, HMT's Tractor Project commenced its operation here.

Machine Tool Division

The unit was initially planned for manufacturing Milling Machines. To begin with foreign designed machines were manufactured and subsequently after acquiring designing capabilities, HMT's self-designed machines were introduced. Today, the range includes various types of knee as well as turtle ram types of milling machines. Rugged and versatile, these machines offer wide spindle speeds and feeds. With high content of mechatronics, Milling Machines with pre-defined programmed up to 40 steps have been introduced.

In 1969, manufacture of Broaching Machines was taken up as import substitution. Available in horizontal and vertical versions, these ruggedly constructed machines have infinitely variable cutting speeds with dead constant speeds ensuring optimum tool life and fine surface finish.

In tune with HMT'S commitment to usher in the latest technologies to the country's fast developing industrial base, in 1976 the Unit introduced the state-of-art computerized numerically machines offering unlimited options in the unmanned manufacturing concept.

The unit has designed a wide range of both Horizontal Vertical CNC Machining Centres to meet stringent accuracy standards, providing high flexible and productivity with enough muscle to remover large quantities of materials a low rpm for light metal alloys. High processing speed is ensured through CNC Systems that have powerful graphics an user-friendly features. The machine can be integrated with other machine tools into flexible manufacturing line. The unit also manufacturers Moving Column Type Special Purpose Machines which can perform milling, drilling, taping, boring and reaming operations with re-circulating liner motion bearing for high position accuracy's with encoder 'x', 'y' and 'z' axis.

INDEX

HMT MACHINE TOOLS, PINJORE

Pattern/Foundry Shop, Material Testing

Pattern Making Shop

Materials Used: Wood, Aluminium and Thermocol.

Wood: Used for pattern making was either of Teak or Deodar or both of them. When both of them are used, then Teak is generally on the inner sides because Teak is harder and retains its shape for longer times as compared to Deodar that secretes a resin that on solidification can affect the shape of the pattern which when used gives defective casting.

Comparison of Teak and Deodar:

1. Teak is easier to work with for milling operations.
2. Teak is harder in comparison with Deodar.
3. Teak has longer life so it's used in making of patterns of those tools which are to be manufactured in large numbers, time and again.

Thermocol: Its main advantage is that it's cheap and is lighter in weight as compared to wood or aluminium.

Aluminium: It is lighter as compared with wood and also it's rigidness and smooth finishing gives better casting. Also it retains its shape for longer times with almost no effect of water on it as compared to wood, which is very sensitive.

ALLOWANCE:-

- Shrinkage allowance.
- Machine allowance.
- Grinding allowance.

SHRINKAGE OF MATERIAL:-

Every material after cooling contracts or shrinks. This is known as Shrinkage of material.

Shrinkage of Cast iron is 1%

Shrinkage of aluminium is 2%

Shrinkage of brass is 1.5%

MACHINERY:-

Machines used in pattern shop are:-

1) Blade sharping machine.
2) Bend saw machine.
3) Wood planner.
4) Circular saw.
5) Wood milling machine.

Foundry Shop

In foundry castings are made according to design provided to them by the designing department.

Foundry is divided into following sections:-

1) Sand plant systems.
2) Core making and baking.
3) Moulding section.
4) Melting section.
5) Testing lab.
6) Core setting and metal pouring section.
7) Fettling and primary section.

The main objectives are of reusing the used products led to the installation of sand plant system. The vital task of sand preparation is performed in this system only.

Operations taking place:

Castings are made from patterns that are exact facsimile of article to be produced. The patterns are pressed into sand and when removed leave their impression in sand, only slightly smaller than exact. Foundry practice deals with the making of metal fabrics called castings directly in one operation by utilizing the hydrostatic pressure of molten metal's so as to tell the material to take the shape of a mould which has been previously been prepared, there is thus no forging, pressing rolling or welding of metal in hot state.

Moulding is that section which is concerned with the making of negatively shaped mould into which liquid metal is poured from the positive casting core within the production of these parts of the mould, which are made into a form of core box away from main mould.

Properties of moulding sand:

1. **Porosity:**Sand must be porous in order to allow the escape of any air, gases or moisture present or generated in mould when the hot metal is poured in to it.

2. **Plasticity:** Sand must be plastic so that it can be shaped to form pattern.

3. **Adhesives:** Sand must be adhesive i.e. capable of attaching itself to another body so that it will cling to the sides of the moulding box and to the flask in which it is moulded or supports provided in flask.

4. **Cohesion:** The ability of the particles to stick together is necessary to allow the pattern to be removed without breaking the mould and also to withstand the high temperatures and the flow of molten metal as it enters into the mould. Moreover, it must retain cohesion on becoming hot.

5. **Refractoriness:** The resistance to fusion by heat is an obvious requirement in moulding sand, for they have to stand up to the exceeding high temperatures and retain their stability. Moreover if the sand does not have this property than it will affect the face of the casting and will make it difficult if not impossible to make.

Terms used in Foundry:

Moulds: It is the negative shape of pattern and after pouring is called positive shape casing.

Cope: The upper part of mould and flaks is called cope.

Drag: The bottom part of a flask or mould is called drag.

Core: A body of sand used to form holes or opening through castings.

Core Sand: It is more permeable than moulding sand and is able to resist more heat.

Core Oven: An over in which cores or moulds are baked.

Painting and Primary Section:

Here the conveyer used is "Power driven overhead roller conveyer" the speed of which is set in such a way that it provides enough of the time for spray painting casting is to be unloaded. After painting the casting is ready and is stored in open for seasoning.

Material Testing

Metals are tested in two labs:

- Mechanical Lab
- Chemical

Operation in Mechanical Lab:

Universal Testing m/c-

Its components are oil pump, hydraulic press, main piston, fixed crosshead & movable cross head.

It has range according to the load applied.

- 0-1 tons
- 0-4 tons
- 0-10 tons

It is used generally to determine:

- Proportional & elastic limit
- Yield point
- Ultimate tensile strength
- Percentage reduction & reduction in area

Working:

It is generally used to perform tensile test which is widely used in the design of material for structure and other purpose. Here, test piece is pulled out at a constant rate by gradually increasing the axial pull, till the rupture takes place. Firstly the specimen is held in the jaws of m/c and the load is applied gradually by a hydraulic press, which is measured from the pressure developed inside the cylinder. The function of oil pump is supply oil under the pressure to the hydraulic cylinder. The load taken from the lod scale. The test is carried out on a specimen having uniform cross-section throughout the gauge length.

BrinellHardness Test:

Hardness measured by this m/c in HBN. In this steel diamond are used to take impression, load applied on the specimen to take impression is given by the formula $30D^2$.

Where, D=Dia of diamond ball (2.5 mm max.)

Impressions formed on the specimen are of round shape.

Rockwell Hardness Test:

Hardness measured by this m/c in HRC. Maximum load applied in this machine is 150 kg. Impressions are of pyramid shape. It is performed when quick and direct reading is desirable in this test the load for making indent are smaller and thus make smaller shallower indent. The specimen is placed on the anvil, and is raised till it comes in contact with the intender. A minor load of 100 kN applied on the specimen and the small pointer indicates set> Now the main pointer is also made to the set position. The load is then applied.

Precautions:

- The indenter and anvil should be clean properly.
- Surface should be clean, flat and dry.

Spectroscope:

These are used to check alloying element. When a ray of spark produced from specimen allowed falling on a prism it detracts in all type color Red to Violet then more is the percentage of allowing element more is the intensity of the color. A well experienced worker is needed for this operation.

Metal Testing in Chemical Lab:

In chemical lab Study takes place on:-

- Chemical composition
- Microstructure

Term observed in chemical composition:-

- Weight per liter
- Viscosity
- Solid content

Microstructure Testing:

In this testing molecular geometry of the components are studied.

Procedure:-

- Polishing by paper.
- Cloth polishing

Cloth & Paper are of special type use to make the specimen clean and uniform. Then specimen is going for image analysis, image angular give the structure of its molecule. From the image we can saw the irregularity like pumps, blade or break etc. if they are present in the geometry of the molecule.

Small Parts

Small parts manufacture those components and accessories that weigh anything below 40 Kg. The small part division is further divided into the following shops:-

1. Turrets
2. Gears
3. Accessories
4. Round
5. Non-round
6. Spindle
7. Sheet metal

The functions of each of the departments have been briefly illustrated in the following pages.

TURRETS

This division is so named because of its turret because of turret lathes. Turrets are machines, which are used for mass production. Tools are put into the index turret and number of identical components is produced in one setting. Stopper on the drum of the turret controls the cut.

Various machines in the turret section are:

- Drum turret lathe
- Centreless grinding machine
- Polygon drilling machine
- Lathe
- Radial drilling machine
- Bench drilling machine
- Vertical milling machine
- Horizontal milling machine
- Cylindrical grinder
- Surface grinder

Components manufactured in the turret section are as follows:

Screw, Special screws, Thick washer, Hard Washer, Screw plug etc.

Operations performed in this section are:

- Turning
- Surface grinding
- Internal grinding
- Cylindrical grinding
- Polygon grinding
- Drilling

Components Manufactured

Spares, Rings Studs, Nuts, Holders, Micro Nut etc.

Operation Performed

Turning Second Side Drilling, Surface Grinding, Centreless Grinding, Cylindrical Grinding & Polygon Grinding.

GEARS

All the gears that are used in machine tool division are made in this sections.

Processes involved in the manufacture of a gear are:

1. Design is prepared.
2. Design is released to foundry shop.
3. The casting is prepared and released for material cutting.
4. The job piece then undergoes turning.
5. Gear hobbing (teeth cutting) is done and followed by fitting.
6. Inspection is done.
7. The job piece is then sent for heat treatment where “carburizing” and “annealing” is done.
8. After heat treatment again turning is done.
9. Radial drilling is done.
10. Inspection is done.
11. The job piece is then sent for heat treatment plant for **hardening and sand/shot ballasting (to remove the surface dirt).**
12. Internal boring and grinding is done to make the bore.
13. Then cylindrical grinding is done.
14. Inspection is done.
15. Gear Tooth grinding is done.
16. At last gear tooth chamfering is done.
17. Inspection is done.

The different kinds of gears manufactured in this section are:-

- Worm gears
- Rack
- Bevel gears
- Spur helical gears

Machines installed in the gear section are:-

- Center Lathe
- Gear Hobbing Machine
- Combined Turning And Drilling Lathe
- Horizontal Broaching Machine
- Vertical Broaching Machine
- Radial Drilling Machine
- Rotary Grinder
- Cylindrical Grinding Machine
- High Production Gear Hobber
- Bevel Gear Shaper
- Bevel Gear Generator
- Gear Grinding
- Gear Tooth Round Machine
- Metal Washing Machine

Components/Gear Machines:

Spur Gear, Helical Gear, Work Wheel, Rack, Bevel Gears.

ACCESSORIES

It is called the accessories division because it manufactures small accessories and components that are required to make up various machines.

The following list of accessories is the ones manufactured by this division:

- Universal diving head of different sizes
- Round table (hand driven)
- Round table (power driven)
- Universal milling head
- Vertical milling head
- Rack milling attachment
- Slotting attachment
- Horizontal indexing head

- Here manufacturing & assembly of accessories of milling machines is done & also accessories of FN1, FN2 & MIT are made.

Accessories Manufactured

1. Universal Dividing Head of different sizes
2. Round table (hand driven) of various sizes & diameters
3. Round table (power driven) of various sizes & diameters
4. Universal Milling Head
5. Vertical Milling Head
6. Rack Milling Attachment
7. Slotting Attachment
8. Horizontal Indexing Head
9. Vertical Indexing Head
10. Height Adjustable Tailstock
11. Arbors

TYPES OF ACCESSORIES

- **Table Accessories**:
  Universal Dividing Head, Height Adjustable Tailstock, Vertical Indexing Head
- **Column Accessories:**

  Milling Heads

MACHINES INSTALLED

Sr. No.	Name of the Machine	No of Machines
1.	S.S. Facing	1
2.	Centre Lathe	8
3.	Drum Turret Lathe	2
4.	Vertical Turret Lathe	1
5.	Horizontal Milling Machine	4

- Linear dividing
- Thread milling
- Internal grinding
- Cylindrical grinding
- Surface grinding

Machines Installed in Round section are:

- Centerlathe machine
- Oil grooving machine
- Combined turning and drilling lathe
- Horizontal milling machine
- Vertical milling machine
- Thread milling machine
- Horizontal keyway milling machine
- Slotting machine
- Linear dividing machine
- Drum dividing machine
- Radial drilling machine
- Tool grinder
- Surface grinder
- Cylindrical grinder

NON-ROUNDS

All the non-round jobs that are to be used in machines are machined here.

Components manufactured:

Blocks, rectangular strips, Gibs, pump body, stop block, adjustable plate, shift fork, bearing blocks, arm brace, clump levers etc.

Operations performed:

- Marketing
- Vertical milling
- Drilling
- Fitting
- Grinding

Machines used in this section are:

- Horizontal milling machine
- Vertical milling machine
- Surface grinding machine

SPINDLE

Components manufactured:

Main spindles, bearing housing (spindle shot) lead screw simple shaft, spline shafts etc.

Operations performed:

- Turning
- Grinding
- Drilling
- Keyway milling

Machines Installed

- Center lathe
- Deep hole boring machine
- Auto threading machine
- Vertical milling machine
- Universal milling machine
- Vertical keyway milling
- Radial Drilling
- Cylindrical grinder
- Universal grinder machine

SHEET METAL

This section includes the cutting of sheets, bending of sheets at various angles. Varaious operations like drilling, bending, shearing etc., are completed in this section. Some of the areas where sheet metals are used are:

1. For outer body manufacture
2. For making junction boxes in CNC machines.

The machines used in this section are:

- Radial arm drilling machine
- Nibbling machine
- Bending machine
- Shearing machine (hydraulic)
- NC Shearing

CNC SECTION

This section has the CNC machines providing the main operation of setting the dimensions, finishing etc. It includes following machines:

Type of machines	**No. of machines**
Straight Tool Changer	5
High Pt. Internal Grinding m/c	1
Vertical Mulling (NC)	1
Vertical Tool Changer	2

HEAT TREATMENT SECTION

In this section, various operations like annealing, normalizing, hardening, carburizing are performed at various temperatures to improve the physical and mechanical properties of the material. This section has the furnaces, hot baths, and various types of tanks containing different salts & chemical to perform the various operations.

Type of Equipments

1. Natural Bath Tank
2. Quenching bath Tank
3. Carburising bath Tank
4. Preheated Furnaces
5. Stress reliving furnace
6. NaOH bath Tank
7. Washing Tank
8. Rust Removing Tank
9. Low temp. Blocking
10. Hot water Tank.

Regardless of the reason for the heat treating, the basic process is the same has three steps.

1. Heat the metal to a specific temperature
2. Hold the metal at that temperature for a specific amount of time
3. Cool the metal in a specific manner

GENERAL ASSEMBLY PROCESS

1. Preparation of base plate setup.
2. Column fixation on base plate.
3. Knee mounted on column guide-ways by using Cables, scraping for adjusting knee surface at required angle with Column & Saddle on knee & table on saddle.
4. Bearing & main Spindle mounting.
5. Intermediate Gears & Gear Trains mounting.
6. Mounting of Vertical & Traverse/Longitudinal feed screws with feed nuts in feed nut bracket(s).
7. Mounting of over arm & over arm brackets.
8. Motor of designed BHP is mounted.
9. Coolant motor, coolant circuit & lubrication completed.
10. Accessories mounted.
11. General mountings.
12. Testing & quality assurance.
13. Painting.

HI-TECH ASSEMBLY

INTRODUCTION

It would be incorrect to state that present manufacturing belongs to numerically controlled machines rather computer numerically controlled would be more appropriate to say. With Larger and Larger proportion of manufacturing activity becoming in job or small batch production of a variety of components.

Often complex shapes require high precision, the need for flexible Automation has always been felt. And this is the era of machine tool automation. So, flexible automation is implemented in the machine tools in the form of NC and CNC technology. Today HKT is producing a lot of Conventional Machine Tools with specialized functions and mostly CNC products.

AND FEW OF HMT MACHINES ARE:

1. HMC 600
2. HMT 630
3. HMC 500

The following four heat treatment processes are the most commonly used:

Annealing is the process for making material softer while producing uniform material properties. A material can be annealed by heating it to a specific temperature and then letting the material slowly cool to room temperature in an over. This process is expensive because the oven is unusable during the cool down process.

Normalizingis also a process for making material softer but does not produce the uniform material properties of annealing. A material can be normalized by heating it to a specific temperature and then letting the material cool to room temperature outside of the oven. This process is less expensive than annealing.

Stress Relieving is also a process for making material softer. However, stress relieving does not change the material properties as does annealing and normalizing. A material can be stress relieved by heating it to a specific temperature that is lower than that of annealing or normalizing and letting it cool to room temperature inside or outside of the oven. This heat treatment is typically used on parts that have been severely stressed during fabrication.

It is worth noting that many heat treatments and welding processes cause stresses in the material that can lead to warpage either after the heat treating process or during

subsequent machining operations. Of specific concern is the stress induced by welding. If a weldment is to be machined it should almost always be stress relieved or normalized before the machining process. This is because machining chunks of material from a stressed weldment redistributes the internal stresses and can cause the part to warp. If the stresses are first relaxed then abrupt changes in geometry after machining are reduced.

Quench Tempering is the process for making material harder. This method has been known for hundreds of years but was only perfected in the last century. The metal is heated to a specific temperature and rapidly cooled (quenched) in a bath of water, brine, oil or air to increase its hardness.

One drawback of using this method by itself is that the metal becomes brittle. This treatment is therefore typically followed by a tempering process which is a heating process at another lower specific temperature to stress relieve the material and -------problem.

LOCATION

In design of fixtures, the component is very important aspect as correct location influences the accuracies of the finished products particularly in reference to the relationship with other surface on the component.

Part locator for restricting the movement of the part & its proper positioning requires skill & planning.

BASIC RULES FOR LOCATING

- **3-2-1 PRINCIPLES**- Location of the fixture is always done according to 3-2-1 principle which states that to locate a piece fully, it has to be placed and held against three points in a base plane two points in the vertical plane and one point in the plane with square of first two.

- **LEAST POINT PRINCIPLE-** According to this principle no more points than necessary should be used to secure the location on any one plane.

- **EXTREME POINT POSITION**- According to this principle the location point should be chosen as far as possible on any one surface, this ensure minimum misalignment for certain displacement of any point w.r.t. another.

- **Locator should be placed to** avoid interference with chips or dust.

HEAVY PARTS & TOOL ROOM

HEAVY PARTS

It is the shop which gives the shape to the castings which come from the foundry in this shop after being painted rough. In this section various operations are performed by the help of planners, milling and Plano milling machines. In it first of all the jobs are marked, checked so that machining time is saved if the casting size is oversized.

Different type of operations is done by using different machines including various machines devices.

This section also includes in itself a high technology section in which HTC-600 type machines are placed by the machine crucial parts generally guide way etc.

This section is generally divided into two sections basically

1. PLANNING
2. BORING

PLANNING

This section consists essentially of planners mounted on one side of the section. In this section the job planning is one of the basic operations done for machining to large process it is the primarily intended for machining to large flat surfaces. Their surface may be flat or vertical.

DOUBLE HOUSING PLANAR

This is the heavy type of planar it consists of two column one on each side of bed. The cross rail is fitted between the two housings having one or two total heads on the columns according to the specifications.

OPEN SIDE PLANAR

This type of planar consist of one housing situated vertically on one side of the bed and other side is left open without any obstruction. The cross rail is of cauli-lever type and is wholly supported on the single columns only three tool heads can be located as one column is missing rest of the technical features are same as of the double housing planar.

BORING SECTION

Boring section consist of enlarging an already drilled hole. The holes are pre drilled as in castings only the operations of boring can also be done on small scale on lathe whether it may be ----lathe or----type when the operation of boring machines are used according to requirements.

TYPES OF BORING MACHINES

1. ROTARY TYPE
2. NON ROTATING TYPE
3. VERTICAL TYPE
4. HORIZONTAL TYPE

There are about twenty machines (boring) in this section.

WOTANis the horizontal type boring machines made in West Germany. It is very precise boring machines they are 5 in number.

HORIZONTAL BORING MACHINE

In the horizontal boring machine operations are performed in which relatively large pieces which cannot be rotated and require operations on its many surfaces. The worktable can be transverses along and across the machine bed. It is possible to machine a flat surface with the based hole by mountings a facing head over the spindle.

VERTICAL BORING MACHINE

This type of machine is large in size and vertical. They are used to machine work pieces like steam turbines etc. the size of such a machines is given by the diameter of largest work pieces which can be mounted on it.

MACHINING TIME IN BORING OPERATION

Machining time is the time required to complete the work pieces in a request period of time.

$$\text{Time period} = \frac{\text{Length of cut}}{\text{RPM} * \text{feed per meter}}$$

The main parts of the boring machines are head stock, column, column base, end support column RAM ways, table and saddle, bed floor, cross rail rolls.

GRINDING

INTRODUCTION

It is a process of removing material in form of small chips by the abrasive action of revolving wheel on the surface of work piece the wheel used for performing the grinding action is called grinding wheel. It is basically a finishing process used for producing close dimensional and smooth surface finish.

GRINDING WHEEL

In machine tools generally wheel containing SIC as abrasive is used. But Aluminium Oxide can also be used.

GRINDING MACHINES

1. CNC GRINDING MACHINE (made by STIDER)

It is a universal grinding machine. It is used for cylindrical grinding and internal grinding. As the machine is CNC so it produces high accuracy. In this machine grinding up to accuracy of N6 tolerance level can be done. It has another advantage over other machines that it can perform internal grinding. In this machine separate motor for driving wheel and job are there. The jobs came to this machine after all machining process are done and job is hardened.

2. SURFACE GRINDING MACHINE

These machines are used to produce and finish flat surfaces. In addition to this the cylindrical type CNC grinder is used for obtaining finish up to microns by grinding the different types of jobs e.g.- spindles, arbores etc.

- Aluminium Silicate grinding wheels are used for grinding HSS (High Speed Steel).
- Carbide tools are grinded by Diamond cutters.

3. CYLINDER GRINDING MACHINE

In these machines piece is held between the dead centre and rotated by a dog and diver on the face plate. There are movements in cylindrical centre type grinding.

Work must revolve.

Wheel must revolve.

Work must pass the wheel.

Wheel must pass the work.

4. THREAD GRINDING MACHINE

It is one of its unique kinds of machine. There are only three to four in IMDIA. In this machine threads in steel parts are formed by grinding unlike in any other machine where threads are produce by cutting. This machine produces threads of better quality with no pitch to pitch variation. In this machine even taps can be generated, both wheel and job moves and both have their driving motor.

5. MILLING

Milling is the process of removing metal by feeding the work against a rotating multipoint cutter. In milling operation the rate of metal is rapid as cutter rotates at a high speed and has many cutting edges.

TYPES OF MILLING MACHINE

In machine shop milling is done with following machines:

- JIG BORING MACHINE (made by VOLTAS)
- HORIZONTAL BORING MACHINE
- CNC MACHINES (made by HMT)
- VERTICAL UNIVERSAL MILLING MACHINE

TOOLS USED

The milling cutter is a multipoint cutter revolving tools. The teeth of milling cutter may be parallel to the axis or at an angle known as helix angle. Helix may be right or left. Various types of cutter used in this machine are:-

1. Plain milling cutter: These cutters have straight or helical teeth. They are used to machine flat surfaces.
2. Face mulling cutter: It is also used for machining flat surfaces.
3. Plain sitting saw: It resembles plain milling cutter but has small width. It is used for cutting-off and slotting operations.
4. Side milling cutter: They have teeth on their periphery and also one of its sides it may have plain, helical or staggered teeth.
5. Angle milling cutter: The cutters have their cutting teeth at an angle. Single angular cutter is used for cutting dovetail.
6. T-slot cutter
7. End mill cutter: They have teeth on end as well as periphery the peripheral teeth may be straight or helical these are used for light milling operations like cutting slots, machining accurate holes and for profile milling operations.

TYPES OF CUTTERS:

1. Profile relieved cutters
2. Form relived cutters

The profile relieved cutters are obtained by sharpening a narrow land behind the cutting edge.

This narrow land is re-sharpened by grinding when the cutting edge becomes dull. Form relieved cutters have a curved relief behind the cutting edge and these cutters have a curved relief behind the cutting edge and these cutters are sharpened by grinding the tool face.

GPM ASSEMBLY/CNC ASSEMBLY

GPM ASSEMBLY

SCARPING

Introduction:

Scraping is very useful and significant process of removing metal in very small quantity, which is used in assemble process.

Why Is Scarping Done?

By scraping we get number of bearing points. So load is uniformly distributed.

Scraping provided oil pockets, which hold lubricating oil between the two surfaces in contact.

For alignment with greater accuracy

For having good appearance.

Tools Used

Scrapper

Spirit level

Surface plat

Angle gauge

About Scrappers

It is of two types:

Hand Scrapper

Machine Scrapper

Scrapper is a HSS blade brazed to M.S. body.

Carbide tipped blade with 90-degree angle is also used.

QUALITY CLASSES OF SCRAPPING

Quality	**Description**	**Bearing**
Points/inc		
Quality 1	Super precision Scrapping	More than 22
Quality 2	Precision scrapping	10 - 18
Quality 3	General scrapping	6 – 10
Quality 4	Rough scrapping	3 – 5
Quality 5	Dressing or shaping	1 - 2

CNC ASSEMBLY

INTRODUCTION

This is one of the most important and lucrative shop for the plant where CNC is assembled. The products prepared at other shops, purchased and imported items form the various countries are combined here and the output is known as 'CNC'. As far discussed about design lab, the o/p of that lab is used here. The design of CNC machine according to application and as per demand is taken and the operation starts. The parts are prepared in Hi-tech Small Parts shops. Then they are combined to from Head, column, bed, ATC Assembly etc. electrical wiring is then made. Electric cabinet of machine is taken from the concern shop and then attached to the machine.

After attaching the operating system and computer hardware then the next job refers to Electronics lab.The concern deptt.Examines the exact circuitry and wiring of the machine. If the machine is working well then the last mode is to check the accuracy of the operation and the minimum time of various operations. After all of these activities it's time to decorate and surround it for its good looking and for safety purposes. Now the machine is ready for SALE.

A CNC MACHINE

- CNC system
- Axes/spindle controller/drive
- Motor
- Speed control feedback device
- Position control feedback device

CNC MACHINE

Horizontal Machine	**Vertical Machine**
HMC 630-100	VMC 1200
HMC 520	VMC 800
HMC 400	VMC 500
HMC 500S	VMS 55, 55M
HMC 320	FMM 25V
FMM 25H	SNC 25V
HSM 400	
HSM 800	

MAIN PARTS OF CNC MACHINE

MECHANICAL ITEMS

- DUCTS
- STABL FLEX
- CRT (continuous rotary table, B-axis)
- PALLET CHANGER
- SPINDLE
- HEAD (spindle motor, Y limit switch)
- COLUMN (including Y motor)
- Bed
- Ball screw road
- Guide way (THK-JAPAN)
- MAGZINE

Various shapes and size:

- Right angle ----40 tools
- Circular-----24 tools.
- Square----44 tools

    - HAUDROLIC PACK
    - ATC & ARM

HYDRAULIC ITEMS USED IN CNC

- SINGLE SOLENOID SPRING OFFSET DIRECTIONAL CONTROL VALVE.
- DOUBLE SOLENOID SPRING CENTERED DIRECTIONAL CONTROL VALVE.
- PRESSURE OPERATED CHECK MODULE
- NON PRESSURE COMKPENSATED FLOW CONTROL VALVE
- NON COMPENSATED DUAL CONSTRUCTION FLOW CONTROL VALVE
- PRESSURE AND TEMPERATURE COMPENSATED FLOW CONTROL VALVE
- PRESSURE RELIEF VALVE
- PRESSURE REDUCING VALVE
- HYDRAULIC MOTOR
- ACCUMALATOR
- PRESSURE SWITCH

ELECTRICAL ITEMS

- PRS (24 V DC)
- 14 (24V DC)
- SOLENOIDS (110 ac)
- CONTROL TRANSFORMER (I/P 415 V)
- SERVO DRIVES AND MOTORS
- CRT SCREEN
- PARTS DISCUSSED IN ELECTRICAL LAB

MISCELLANEOUS

- OPERATING SYSTEM
- MACHINE OPERATOR PANNEL
- INDICATING LIGHT
- EMERGENCY PUSH BUTTON
- NIZZLES
- SUPPLY (230 V)
- 24 V RECTIFIER CONDENSER
- BRIDGE RECTIFIER (90 V FOR FANUC 24 V FOR SIEMAN0
- SURROUNDING CABINE

GENERAL INTRODUCTION TO ELECTRICAL & ELECTRONICS ITEMS

- PROXIMITY SWITCH
- LIMIT SWITCH
- CIRCUIT BREAKER
- OVERLOAD RELAYS
- CONTRACTORS
- FUSE PRESSURE SWITCH
- INTRODUCTION TO NC
- FEED BACK DEVICE

PROXIMITY SWITCH

These are solid state switching device which required no physical contact to actuate them. These are used for control and positioning signals because of long life, high switching speeds, no touch, zero operation force, wear & maintenance free operation, bounce free signals, reliable switching under extreme conditions. It comprises of three principle parts:

1. Oscillator
2. Trigger
3. Amplifier

To obtain a switching signal at a given voltage and temperature, sensing distance is the main factor. Sensing distance is the maximum. Distance between target and sensing face. Sensing face is the surface from which the electromagnetic field radiates sensing distance depends on material, thickness & area of taget.

LIMIT SWITCH

These are used to make or break the control circuit when mechanically actuated by a moving member. Moving member may be a component or may be a dog mounted on a moving component.

Or maybe the plunger actuated type as in case of filter clogged limit switch contacts may be of the normally open type (N) which will close when switch is actuated or normally close type (NC) which will open when switch is actuated.

CIRCUIT BREAKER

A device designed to open and close by no automatic means and to open the circuit automatically on a predetermined overload of current, when properly, applied with in its railing.

THERE ARE TWO TYPES

1. Thermal
2. Hydraulic

Thermal circuit breaker responds only to temperature. Changes in bimetallic elements. Heat is generated in element. The element bends or deforms to unlatch mechanism & open the contacts. Mainly used MCB (miniature circuit breaker) offer duel protection i.e. protection against overload and short circuit.

OVERLOAD RELAYS

It can be defined as a device which is operative by variations in the conditions of one electric circuit to affect the conditions of the other devices in the same or other electric circuit. Relays provide overload protection to control circuits when used with contractors and motor control equipment's, they provide accurate and reliable protections to motor against overload. They also offer protection against severe unbalanced voltages. Tripping characteristics of the relays are such that relays trips before damage is caused due to overload.

CONTRACTORS

Devices used for repeatedly establishing & interrupting an electric power circuit. The contactors are reliable for controlling electrical circuits of all kinds e.g. capacitor, lighting, heating, switching AC and DC circuits. It is also suitable for use in control panel for machine

tool, motor control centers& other application where high frequency of operation is required. Contractors of both AC & DC type double break contacts have silver cadmium oxide contacts to provide:

1. Low contact resistance
2. Improved resistance to arc rupturing
3. Anti-welding characteristics

FUSE

Fuses are a device for the protection of equipment. A wide range of fuses are available for protection of transformer, cables, capacitors & motors for applications in air or oil.

'HRC' FUSEare used for the interruption of fault current in indoor and outdoor high velocity system & also for protection of distribution power equipment.

PRESSURE SWITCH

The function of pressure switch is to break or make the control circuit whenever the pressure actuates the switch contacts. The switch contacts may be of normally open type which close on increasing pressure or of normally closed type which open on increasing pressure. Pressure switches uses single pole double throw(SPDT) micro switches as switching element. Some pressure switches are suitable for application where frequent alteration of pressure setting is required. Adjustment is made by means of a screw driver slot in the top of the switch, switches are suitable for use with water oil, air, nitrogen, inert gases, steam, mineral oil, natural gas.

TOOL ROOM

INTRODUCTION

This is one of the necessary sections in any industry which deals with the requirement of tool of its other section. In HMT the tool room has been divided into two sections one in HIGH-TECH and NEOLOGY section and other is traditional one. In the high technology section the more complex machinery imported one like Jig boring machines and CNC cylindrical grinding machine. As both type of machine provide the better accurate finishing this is up to microns.

JIG BORING MACHINE

A metal-cutting machine for finishing holes, planes and slots with a highly precise location of centres or surfaces without the use of special attachments for toll alignment.

Jig-boring machines are used for boring, drilling, counter-sinking, reaming, milling, and other types of finishing in individual and small-scale production during the manufacturer of cutting and measuring tools, jigs, dies, and key components of machines and instruments. Devices with stable and adjustable end gauges and indicator sensing units are used on jig-boring machines for precise measurements; also used are lead screws with dials and a Vernier, which are equipped with error-elimination compensators, and graduated shafts with optical measuring instruments. There are two types of these machine tools: double-sided (gantry) machines with a one-movement table and open-sided (single-sided, overhanging) machines with a two-movement table. In open-sided machines the spindle head moves only vertically; in the double-sided machines it moves horizontally along the crosspiece, which can travel in a vertical direction. The manufactured article and the cutting tool on the jig-boring machine are moved relative to one another along orthogonal coordinates (with linear displacement accuracy to 2 microns) and polar coordinates (with angular displacement accuracy to 4 seconds of arc). Sturdy construction is a feature of jig-boring machines, which have smooth drive motions and accurate balancing of fast-rotating parts (to reduce vibration). The machines are installed in insulated areas in which a constant temperature of 20 degree C is maintained. Jig-boring machines are operated by highly skilled workers.

Its mains pars are:

1. Heavy base
2. Two vertical columns

    - A spindle head which slide over vertical columns
    - A spindle which is mounted on the horizontal which can be move vertically
    - A saddle is mounted on the horizontal ways which provide cross fed to the job
    - A table is mounted on saddle which can move across the saddle along the horizontal ways.

General Assembly Process:

- First of all the best is set and its grinded face is scrapped to make it flat.
- The bottom surface of the column is scrapped to make it perpendicular to bed. The dove tails are made parallel to each other by scrapping. After the column is mounted on the base.
- The gear trains are mounted in the bearings in the column.
- The leaves for changing the gear are placed.
- The main motor is mounted on the back of the column.
- In the horizontal milling machine, the spindle is mounted in the column.
- Coolant motor and lubricant pump are mounted in the column. The lubricants pipes are arranged with the progress of assembly.
- Dove tails of the knee are also scrapped to make them parallel to each other and perpendicular to the base. The upper surface is also scrapped to make it perpendicular to the column.
- Knee is mounted and supported on the thrust bearing. Its feed screw is also mounted.
- Gibb is inserted between the dove tail; then the dove tails are checked for the perpendicular motion of the knee. Any error removed by the scrapping of the gab.
- The gear train and feed box containing gear train also mounted at the knee.

- Feed motor is mounted on the feedbox of the knee. In horizontal milling machine, the derive box containing the splinted rod is also mounted.
- The electric cabinet is mounted to the knee.
- The feed screw for the movement of the saddle is also placed in the feed nut blocks of the knee.
- The saddle is mounted at the knee. The dove tail and the gab are already being scrapped for parallelism and even sliding. Gibb is inserted and its screws are tightened.
- In case of universal horizontal milling machine, the swivel is mounted on the saddle.
- Feed screw for the table is mounted on the table or the swivel.
- The table is then mounted. Same treatment is given to the dove tail and to the gab.
- In horizontal milling machine the over arm is mounted on the column. Its parallelism to the saddle's movement and the spindle is made highly accurate by scrapping.
- In horizontal milling machine the arbour and the over arm bracket are mounted.
- In case of the vertical milling machine the head is mounted. Its perpendicularity to the table is checked.
- Electric connections are made. Hand wheels, leavers and the limit switches are attached and the pins are inserted. Coolant pipes are led.
- Testing and quality assurance of the machine is done.
- Machine is sent for paining.
- Remaining electrical and hydraulically connections are made.
- The machine is packed in wooden case along with necessary accessories.
- The machine is ready to dispatch.

CNC ASSEMBLY SECTION

Input Unit: It receive all the command from operator interface (operation station containing all the switches, push button displays etc. required to operate and monitor machine activates) and feedback and status of machine in the form of AC, DC and analog signals. All input signals are made compatible (by unit input) to be understood by control unit like conversion of signal to digital form by A/D converter etc. Software is input by means of paper tape or magnetic devices stored in memory till they are needed by control unit.

Control Unit: It takes instruction from the memory unit and interprets them one at a time. It process information received from the operator and machine interface via the input unit. This information is interpreted and manipulated with hardware logic and computer programs. It then sends appropriate instruction to other unit to cause instruction execution.

Memory Unit: It stores instruction and data received from the input. It also stores the result of arithmetic operations supplies information to the output unit through control unit.

Arithmetic Unit: It performs calculations and makes decision. It results are stores in memory unit.

Output Unit: It receives data from memory at the command of control unit. The signals are made compatible with output devices so that command issued by output unit can be obeyed by them.

Operator Interface:

Various units which comprise operator interface are follows. Pouched tape is the most commonly used input system for NC system. The instruction for a given operation is contained in several rows of digits 0 to 9 which can be coded from words.

Machine Interface:

It consist of all devices used to monitor and control machine tool, like extreme limit switches, miscellaneous position location, solenoids for hydraulic and air control, control valves, servo mechanism etc.

CNC System: The CNC concepts employs a mini computer specially a programmable logic controller for line control of the machine tool and eliminate additional hardware circuits in the control cabinet.

PROJECT STUDY OF INDEXING

Indexing Fixture

The indexing fixture is an indispensable accessory for the milling machine. Basically, it is a device for mounting work pieces and rotating them a specified amount around the work piece's axis, as from one tooth space to another on a gear or cutter.

The index fixture consists of an index head, also called a dividing head, and a footstock, similar to the tailstock of a lathe. The index head and the footstock are attached to the worktable of the milling machine by T slot bolts. An index plate containing graduations is used to control the rotation of the index head spindle. The plate is fixed to the index head, and an index crank, connected to the index head spindle by a worm gear and shaft, is moved about the index plate. Work pieces are held between centres by the index head spindle and footstock.

Indexing The Work Pieces

(1) General: Indexing equipment is used to hold the work piece, and to provide a means of turning it so that a number of accurately located speed cuts can be made, such as those required in cutting tooth spaces on gears, milling grooves in reamers and taps, and forming teeth on milling cutters. The work piece is held in a chuck, attached to a indexing head spindle, or mounted in between a live center in the indexing head and dead center in the footstock. The center rest can be used to support long slender work. The center of the footstock can be raised or lowered for setting up tapered work pieces that require machining.

(2) Index Head: The bead of the indexing fixture contains an indexing mechanism, used to control the rotation of the index head spindle in order to space or divide a work piece accurately. It consists of a 40-tooth worm wheel fastened to the index head spindle, a single-cut worm, a crank for turning the worm shaft, and an index plate and sector. Since there are 40 teeth in the work wheel, one turn of the index crank causes the worm wheel, and consequently the index head spindle to, make one-fortieth of a turn; so 40 turns of the index crank revolves the spindle one full turn.

(3) Plain Indexing: The following principle applies to basic indexing of work pieces:

(a) Suppose it is desired to mill a spur gear with 8 equally spaced teeth. Since 40 turns of the index crank will turn the spindle one full turn, one-eighth of 40, or 5 turns of the crank after each cut, will space.

(4) **Index Plate:** The index plate is a round metal plate with a series of six or more circles or equally spaced holes; the index pin on a crank can be inserted in any hole in any circle. With the interchangeable plates regularly furnished with most index heads, the spacing necessary for most gears, bolt heads, milling cutters, splines, and so forth, can be obtained. The following stes of plates are standard equipment:

(a) Brown and Sharpe type, 3 plates of 6 circles, each drilled as follows:

Plate 1-15, 16, 17, 18, 19, 20 holes.

Plate 2-21, 23, 27, 29, 31, 33 holes.

Plate 3-37, 39, 41, 43, 47, 49 holes.

(b) Cincinnati type, one plate drilled on both sides with circles divided as follows:

First side- 24,25, 28, 30, 34, 37, 38, 39, 41, 42, 43 holes

Second side- 46, 47, 49,, 51, 53, 54, 57, 58, 59, 62, 66 holes.

(5) **Sector:** The sector indicates the next hole in which the pin is to be inserted and makes it unnecessary to count the holes when moving the index crank after each cut. It consists of two radial, bevelled arms which can be set at any angle to each other and then moved together around the center of the index plate.

TYPES OF INDEXING:

a) Direct Indexing: The construction of some index heads permits the work to be disengaged from the work wheel, making possible a quicker method of indexing, called direct indexing. The index head is provided with a knob which, when turned through part of a revolution, operates an eccentric and disengages the worm. Direct indexing is accomplished by an additional index plate fastened to the index head spindle. A stationary plunger in the index head fits the holes in the index plate. By moving the plate by hand to index directly, the spindle and the work piece rotate an

equal distance. Direct index plates usually have 24 holes and offer a quick means of milling squares, hexagons, taps etc. Any number of divisions which is a factor of 24 can be indexed quickly and conveniently by the direct indexing method.

b) **Differential Indexing:** Sometimes a number of divisions are required which cannot be obtained by simple indexing with the index plates regularly supplied. to obtain these divisions a differential index head is used. The index crank is connected to the worm shaft by a train of gears instead of by a direct coupling and with simple indexing. The selection of these gears involves calculations similar to those used in calculating change gear ratio for cutting threads on a lathe.

c) **Angular Indexing:** When you must divide work into degrees or fractions of degrees by plain indexing, remember that one turn of the index crank will rotate a point on the circumference of the work 1/40 of a revolution. Since there are 360 degree in a circle, one turn of the index crank will revolve the circumference of the work 1/40 of 360 degrees, or 9 degrees.