Cnc milling machines

CONTENTS

3. INTRODUCTION TO NC AND CNC Numerical control (NC) refers to the automation of machine tools that are operated by programmed commands encoded on a storage medium, controlled manually via hand

wheels or levers, or mechanically automated via cams alone. The first NC machines were built in the 1940s and 1950s. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern computer numerical control (CNC) machine tools that have revolutionized the machining processes.

The program is translated into the appropriate electrical signals for input to motors that run the machine. A CNC machine is an numerical control machine with the added feature of an on board computer. The computer is referred to as the machine control unit (MCU). In modern CNC systems, component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing (CAM) programs. The programs produce a computer file that extracts the commands needed to operate a particular machine, and then loaded into the CNC machines for production.

Since any component might require the use of a number of different tools-drills, saws, etc. , modern machines often combine multiple tools into a single " cell". The Evolution of NC It was in 1947 when numerical control was born. It began when John C. Parsons of the Parsons Corporation, Traverse City, Michigan, a manufacturer of helicopter rotor blades, could not make his templates fast enough. So, he invented a way of coupling computer equipment with a jig borer. Mr. Parsons used punched cards to operate his digit Ron system. 1949 was the year of another “ Urgent need”. The U. S.

Air Material command realized that parts for its planes and missiles were becoming more complex. Also, as the designs were constantly being improved, changes in the drawing were frequently made. Thus, in their search for methods of faster production, an Air Force study contract was awarded to the Parsons Corporation. The servo mechanisms laboratory of the Massachusetts Institute ofTechnology(MIT) was the subcontractor. In 1951, MIT took over the complete job, and in 1952, the prototype of today's NC machine, a modified Cincinnati Hydrotel Milling Machine, was successfully demonstrated.

The numerical control was originated at MIT. Fig: 1 Fig: 2 CNC MACHINES CNC stands for Computer Numerically Controlled. CNC refers to how a machine operates, that is, its basic method of controlling movement, e. g. , a CNC machine uses a stream of digital information (code) from a computer to move motors and other positioning systems in order to guide a spindle or other tooling over raw material. A CNC machine usesmathematicsand coordinate systems to understand and process information about what to move, to where, and how fast.

Most CNC machines are able to move in three controlled directions at once. These directions are called axes and are given simple names such as X, Y and Z (based on the Cartesian Co-ordinate System). The X axis is always the longest distance a machine or a part of a machine must travel. X may be the movement from front to back, Y the movement from left to right, and the Z is almost always vertical movement (normally the spindle's positioning movement up and down). Superior Machinery sells many types of CNC Machines, from CNC Horizontals, CNC Verticals to CNC Lathes; they have over 182 CNC Machines to choose from.

A CNC machine must be able to communicate with itself to operate. A computer numeric control unit sends position commands to motors. The motors must talk back to the control that, indeed, they have acted correctly to move the machine a given distance. The ability of CNC machines to move in three (or more) directions at once allows them to create almost any desired pattern or shape. All of this processing happens very fast, accurately and consistently. 4. HISTORY Fig: 3 In 1775, John Wilkinson- cannon boring machine (lathe). In 1881, Eli Whitney- milling machine. In 1947, Mr.

John Parsons began experimenting for using 3-axis curvature data to control the machine tool motion for the production for aircraft components. In 1949, parsons- first NC machine. In 1951, MIT was involved in the project. In 1955, after refinements NC became available in industry . Today, modern machineries are CNC milling machines and lathes. CNC technology was developed in the United States in the 1950? s for the US Air Force by metalworking machine tool builders. It was a major advance in the ability of machines to faithfully reproduce complex part machining steps more accurately without human intervention or variability.

Numerical control (NC) refers to the automation of machine tools that are operated by abstractly programmed commands encoded on a storage medium, as opposed to manually controlled via handwheels or levers, or mechanically automated via cams alone. The first NC machines were built in the 1940s and 1950s, based on existing tools that were modified with motors that moved the controls to follow points fed into the system on punched tape. These early servomechanisms were rapidly augmented with analog and digital computers, creating the modern computer numerical control (CNC) machine tools that have revolutionized the machining processes.

In modern CNC systems, end-to-end component design is highly automated using computer-aided design (CAD) and computer-aided manufacturing

(CAM) programs. The programs produce a computer file that is interpreted to extract the commands needed to operate a particular machine via a postprocessor, and then loaded into the CNC machines for production. Since any particular component might require the use of a number of different tools-drills, saws, etc. , modern machines often combine multiple tools into a single “ cell”.

In other cases, a number of different machines are used with an external controller and human or robotic operators that move the component from machine to machine. In either case, the complex series of steps needed to produce any part is highly automated and produces a part that closely matches the original CAD design. Proliferation of CNC The price of computer cycles fell drastically during the 1960s with the widespread introduction of useful minicomputers. Eventually it became less expensive to handle the motor control and feedback with a computer program than it was with dedicated servo systems.

Small computers were dedicated to a single mill, placing the entire process in a small box. PDP-8? s and Data General Nova computers were common in these roles. The introduction of the microprocessor in the 1970s further reduced the cost of implementation, and today almost all CNC machines use some form of microprocessor to handle all operations. The introduction of lower-cost CNC machines radically changed the manufacturing industry. Curves are as easy to cut as straight lines, complex 3-D structures are relatively easy to produce, and the number f machining steps that required human action have been dramatically reduced. With the increased automation of manufacturing processes with CNC machining, considerable improvements in consistency and quality have been achieved with no strain on the operator. CNC automation reduced the frequency of errors and provided CNC operators with time to perform additional tasks. CNC automation also allows for more flexibility in the way parts are held in the manufacturing process and the time required to change the machine to produce different components.

During the early 1970s the Western economies were mired in slow economic growth and rising employment costs, and NC machines started to become more attractive. The major U. S. vendors were slow to respond to the demand for machines suitable for lower-cost NC systems, and into this void stepped the Germans. In 1979, sales of German machines surpassed the U. S. designs for the first time. This cycle quickly repeated itself, and by 1980 Japan had taken aleadershipposition, U. S. sales dropping all the time. Once sitting in the #1 position in terms of sales on a top-ten chart consisting entirely of U. S. ompanies in 1971, by 1987 Cincinnati Milacron was in 8th place on a chart heavily dominated by Japanese firms. Many researchers have commented that the U. S. focus on high-end applications left them in an uncompetitive situation when the economic downturn in the early 1970s led to greatly increased demand for low-cost NC systems. Unlike the U. S. companies, who had focused on the highly profitable aerospace market, German and Japanese manufacturers targeted lower-profit segments from the start and were able to enter the low-cost markets much more easily. As computing and networking evolved, so did direct numerical control (DNC).

Its long-term coexistence with less networked variants of NC and CNC is explained by the fact that individual firms tend to stick with whatever is profitable and their time andmoneyfor trying out alternatives is limited. This explains why machine tool models and tape storage media persist in grandfathered fashion even as the state of the art advances. 5. CNC SYSTEM ELEMENTS A typical CNC system consists of the following six elements. 1 Part program 2 Program input device 3 Machine control unit 4 Drive system 5 Machine tool 6 Feedback system Fig: 4 6. WORKING OF CNC MACHINES:

CNC machines are Controlled by G and M codes. These are number values and co-ordinates. Each number or code is assigned to a particular operation. Typed in manually to CAD by machine operators. G&M codes are automatically generated by the computer software. The tool or material moves. Tools can operate in 1-5 axes. Larger machines have a machine control unit (MCU) which manages operations. Movement is controlled by a motor (actuators). Feedback is provided by sensors (transducers) Closed loop. Tool magazines are used to change tools automatically. Tool Paths and Cutting Motions:

Tool paths describe the route the cutting tool takes. Motion can be described as point to point, or contouring. Speeds are the rate at which the tool operates e. g. rpm. Feeds are the rate at which the cutting tool and work piece move in relation to each other. Expressed in IPM (inches per minute) Feeds and speeds are determined by cutting depth, material and quality of finish needed. e. g . harder materials need slower feeds and speeds. Rouging cuts remove larger amounts of material than finishing cuts. Rapid traversing allows the tool or work piece to move rapidly when no machining is taking place.

Fig: 6 Point to Point Tool path Fig: 5Contour ToolPath 1. Point to Point tool paths cut following lines 2. Contour tool paths cut follow surfaces Linear Interpolation: (Point to Point) Linear interpolation consist of a programmed point linked together by straight line Fig: 7 Circular Interpolation: (Contour) Circular interpolation is the process of programming arcs and circles. Circular interpolation requires endpoints, a feed rate, a center, a radius, and a direction of movement. Block of Information: When running, a part program is interpreted one command line at a time until all lines are completed.

Fig: 8 N001 G01 X1. 2345 Y. 06789 MO3 N001: Represents the sequence number of the operation G01: Represents linear operation (tool movement) X12345: Will move the tool or table 1. 2345 in. a positive direction along the X axis Y6789: Will move the tool or table 0. 6789 in. along the Y axis M03: Turns spindle on clockwise Commands, which are also referred to as blocks, are made up of words which each begin with a letter address and end with a numerical value. Each letter address relates to a specific machine function. " G" and " M" letter addresses O-Program number (Used for program identification)

N-Sequence number (Used for line identification) G-Preparatory function X-X axis designation Y-Y axis designation Z-Z axis designation R-Radius designation F-Feed rate designation S-Spindle speed designation H-Tool length offset designation D-Tool radius offset designation T-Tool Designation M-Miscellaneous function G- CODES (Preparatory Functions) which cause some movement of the machine table or head. G00 - Rapid Movement G01- Linear Interpolation (movement) G02- Circular Interpolation, CW G03-

Circular Interpolation, CCW G17 -XY Plane, G18- XZ Plane, G19 -YZ Plane G20/G70 -Inch units

G21/G71 -Metric Units G40- Cutter compensation cancel G41 -Cutter compensation right G43- Tool length compensation (plus) G43- Tool length compensation (plus) G44- Tool length compensation (minus) G49-Tool length compensation cancel G80-Cancel canned cycles G81-Drilling cycle G82-Counter boring cycle G83-Deep hole drilling cycle G90-Absolute positioning G91- Incremental positioning M-CODES (Miscellaneous) which turn ON or OFF different functions M00 -Program stop M01 -Optional program stop M02 -Program end M03- Spindle on clockwise M04 -Spindle on counterclockwise M05- Spindle stop M06- Tool change . BASIC CONCEPTS OF PART PROGRAMMING Part programming contains geometric data about the part and motion information to move the cutting tool withrespectto the worpiece. Basically, the machine receives instructions as a sequence of blocks containing commands to set machine parameters; speed, feed and other relevant information. A block is equivalent to a line of codes in a part program. N135 G01 X1. 0 Y1. 0 Z0. 125 T01 F5. 0 These define: N135-Block number G01-G codes X1. 0, Y1. 0, Z0. 125-Coordinates T01-Tool number F5. 0-Special function Programming Methods Automatically Programmed Tools (APT):

A text based system in which a programmer defines a series of lines, arcs, and points which define the overall part geometry locations. These features are then used to generate a cutter location (CL) file. Computer Aided Machining (CAM) Systems-Computer Aided Design (CAD) Systems: CAD/CAM systems allow for rapid development and modifying of designs and documentation. The 3D geometric model produced becomes a common element for engineering analysis (FEA), machining process planning (including CNC part programming, documentation (including engineering drawings), quality control, and so on.

Drives of CNC machine tool Hydraulic actuator - high power machine tool Stepping motor - small machine due to limited power and torque DC motor - excellent speed regulation, high torque, most widely used. 8. PROPERTIES OF CNC MACHINES Based on Motion Type: Motion control - the heart of CNC: Point-to-Point or Continuous path Based on Control Loops: Open loop or Closed loop Based on Power Supply: Electric or Hydraulic or Pneumatic Based on Positioning System: Incremental or Absolute Point-to-Point Tool Movements: Point-to-point control systems cause the tool to that point only.

The tool is not in continuous contact with the part while it is moving. Examples: drilling, reaming, punching, boring and tapping. Fig: 9 Continuous-Path Tool Movements : Continuous-path controllers cause the tool to maintain continuous contact with the part as the tool cuts a contour shape. These operations include milling along any lines at any angle, milling Fig: 10 Arcs and lathe turning. Loop Systems for Controlling Tool Movement: Schematic illustration of the components of (a) an open-loop and (b) a closed-loop control system for a CNC machine. 9. TYPES OF CNC MACHINES * Lathe Machine * Milling Machine Drilling Machine -The bench drill -The pillar drill * Boring Machine * Grinding Machine CNC Mills: These machining centers use computer controls to cut different materials. They are able to translate programs consisting of specific number and letters to move the spindle to various locations and depths. Used to make 3D prototypes, moulds, cutting dies, printing plates and sights. CNC Lathes: They cut metal that is often turning at fast speeds. CNC lathes are able to make fast , precision cuts using Indexable tools and drills with complicated programs. Normally, they cannot be cut on manual lathes.

They often include 12 tool holder sand coolant pumps to cut down on tool wear. Fig: 11 CNC Grinders: Grinding metal process uses a coated wheel that slowly removes metal to create a part. Through the years, grinding was done on a manual machine, but with the advent of CNC technology, the grinding process has advanced . Fig: 12 CNC DRILLING: Drilling is commonly used for mass production. The drilling machine (drilling press) is used to create or enlarge holes. The bench drill: For drilling holes through raw materials such as wood, plastic and metal The pillar drill: A larger version that stands upright on the floor.

As the bench drill, it can be used to drill larger pieces of materials and produce bigger holes. Fig: 13 CNC Boring: Process of enlarging an existing hole or internal cylindirical surface. This can be accomplished on a lathe or a machine tool specifically designed for the process, such as a horizontal boring machine. Fig: 14 Electrical Discharge Machines (EDM): Wire EDM machines utilize a very thin wire (. 0008 to . 012in.) as an electrode. The wire is stretched between diamond guides and carbide that conduct current to the wire and cuts the part like a band saw.

Material is removed by the erosion caused by a spark that moves horizontally with the wire. Fig: 15 Laser Cutting Machines: The machine utilizes an intense beam of focused laser light to cut the part. Material under the beam experiences a rapid rise in temperature and is vaporized. Laser cuts with a minimum of distortion, no mechanical cutting forces. Specific tools to perform different Operations: Fig: 16Fig: 17 CNC lathe machine tool turret is part of the CNC machine where all tooling is mounted. CNC lathe tool turret has an integral Disk like part (Tool turret disk) on which all the tools are mounted.

CNC lathe tool turret is mounted on the x-axis carriage. Fig: 18 Slant Bed CNC Lathe / Flat Bed CNC Lathe On some CNC lathe machines x-axis carriage with the tool turret is located behind the spindle (such cnc lathe machines are called slant bed cnc lathe machines) and on other cnc lathe it is located at the front (as normal lathe machines) such cnc lathe machines are called flat bed cnc lathe machine. The below is a Slant Bed CNC Lathe Machine. Fig: 19 Fig: 20 CNC Lathe Tool Turret Tool Capacity: Tool capacity for cnc lathe machines varies machine to machine.

Small CNC lathe machines normally comes with a tool turret capacity of 4 or 8 tools stations. Bigger and heavy CNC lathe machines tool turrets are big and heavy and accordingly will hold more tools such as 12 or more. Fig: 21 Tool Holder: Tool holder is the actual part which fastens the tool to the cnc lathe tool turret Disk. Tool holder size also depends upon the cnc lathe tool turret size, heavy CNC late machine tool turret comes with with big bore for tool holders such as 50 mm diameter. For the small tool turret this might be 40 mm diameter or, less to suit the tool to hold.

Fig: 22 CNC Lathe Tool Turret Rotation CNC lathe tool turret rotates with the cnc program commands. Normally a letter “ T” is used to call a tool in the working position. The tool rotation is dependent on cnc lathe machine. Some cnc lathe tool turret rotate in one direction (CW or CCW). Some cnc lathe tool turret rotates both directions, such tool turret direction is optimized for the nearest tool station. Some cnc lathe give full control over tool call up, you can call by optimized direction or you can call tool by rotating tool turret by CW direction or CCW.

Tool Offset in CNC Lathe with Fanuc Control Fig: 23 There are variety of cnc machines in the market, and almost every cnc machine in a cnc workshop has different kind of cnc machine controls if controls are not different they might have different versions of the same cnc machine control. As the operating of different cnc machines controls is very much different from one another the same way Tool Offsetting is very much different. Here I will discuss the cnc tool measurement on Fanuc. Tool Offset Setting on Fanuc TC

Some cnc machines has some kind of built-in mechanism of tool-offsetting, this built-in mechanisn of tool-offsetting makes adding new tools are changing existing tools a breeze, because you just tie-up the tool in the tool-post on the cnc machine tool-turret and just perform the procedure the cnc machine manufacture has given in the cnc machine operating and setting manual. The Fanuc controls such as Fanuc TC has this capability, Just tie up tool in the tool turret and perform a simple procedure and everything is done. The tool offsetting procedure might be different from version to version, But on Fanuc TC this procedure is simple as under.

For tool offsetting of a new tool just tie up the tool in the tool post and in MDI (Manual Data Input) Mode call up the tool in the working position by entering the command T1, the T is for tool call up and 1 is tool number if you have your tool on another position you might change that with that tool number.

Now change the cnc machine to Jog Mode and touch the tool cutting point to the finished component (already gripped in cnc machine jaws) face and bring the Tool-Geometry page and enter under the tool number the command MZ0 this command will clear any previous values and will measure the current tool's tool-offset in Z-axis.

Now touch the tool to a known-diameter on the component and again in the tool-geometry page enter the command MX50 you can enter the measured diameter value instead of 50. This way now we have calculated the tool-measurement on the Fanuc TC cnc machine control. CNC Dry Run Invaluable Tool for CNC Setter: Fig: 24 It shows the power and the flexibility the cnc machine manufacturers and cnc control manufacturers give a cnc machine setter by integrating the Dry Run on cnc machines. On some cnc machines the Dry Run is added as a CNC Machine Mode like Fanuc.

On Fanuc cnc control you just select the Dry Run mode and cnc machine is now in Dry Run Mode. Introduction of Dry Run for CNC Machines Setting a new component on a cnc machine is not an easy job. You have to go through many important tasks like cnc machine zero offsetting (cnc machine shift value setting), tool offsetting of tools used on cnc machine etc. Now if you have completed these all tasks, now comes the time to run the cnc program for the first time, A really crucial and time consuming cnc task. A small negligence might be cause of an accident on cnc machine (tool breakage etc. . To make the first run easy and safe the cnc machine manufacturers and cnc control manufacturers provide us a way by which we can easily control the tools feed with feed override. So now the cnc setter is a bit easy because he can now run all the tools with a Safe Feed. Now cnc setter easily can lower the tool feed when he feels the tool is entering a bit danger zone, and easily can increase the tool feed (to a rapid feed) when the tool is away from the component (so the time not go wasted with lower feed when tool is away from component).

In Dry Run all the cnc blocks whether those are starting with G00 or G01 and other G-code like G02/G03 run with the same feed, which is controlled through Feed Override. On Fanuc the feed override is controlled through Handwheel after feed override button press, and there also exists a Rapid Feed Button which if pressed during Dry Run Mode the cnc machine program block will run with Rapid Feed. One point must be cleared for Fanuc control is that feed override also works in Auto Mode and Single Block Mode but in such modes the feed override only controls G01/G02/G03 like G-code.

But feed override will not control the G00 (Rapid Traverse). But in Dry Run Mode all the cnc program will run with the feed which is controlled through Feed Override. An introduction to cnc machine speed override and feed override controls and safety instructions which must be adhere to while working with cnc machine feed and speed override. CNC Machine Speed Override / Feed Override Introduction Normally you program the speed and feed this way, N10 G97 S1000 G95 F0. 3 Fig: 25

Now for one reason or other you want to increase or decrease the speed or feed of the cnc machine for some time, you definitely have a way to just alter the cnc machine program, but there is one more suitable solution the Feed Override and Speed Override Controls. The feed override and speed override are the most suitable and handy way to control the cnc machine feed and speed through cnc control panel. You control the speed and feed in percentage. When the feed override is 100% the actually feed which is programmed will be active.

But if the feed override is 50% then the feed will decrease by that ratio, now the machine tools will run with 50% of feed. So if you have programmed 0. 5 mm/rev feed then with 100% the 0. 5 will be active, but for 50% feed override the actually tool feed will be 0. 25 mm/rev. The same rule applies for speed override, for 100% the actual programmed speed will be active and spindle will revolve with the actual programmed speed. But at 50% speed override the spindle speed will drop by 50%. Feed Override Speed Override Minimum Maximum Values: Normally you can control speed override and feed override from 0% to 120%.

At 0% speed override the spindle will stop rotating, and at 0% feed override the tool will stop working (the tool will be stationary). No doubt 120% feed override and speed override is just safe. But some cnc machines give even more flexibility I have worked on a cnc machine which has its feed override 0% to 200%. Normal cnc machine has just 0% to 120% feed override and speed override. Speed Override and Feed Override Safety Precautions Whenever handling the speed override and feed override always think about safety, safety of yourself, tool, machine, component and your surroundings.

Never try to use the speed override and feed override if you don’t need it. Because when cnc programs are made the speed and feed is properly set for the machined component. The increase in feed or speed might break insert or even tool. CNC Backlash CNC Troubleshooting, In this category we will see the cnc machine from a different view (cnc machine maintenance), your feedback will really matter, and I hope you will share you knowledge and experience. I will talk about the CNC Backlash which is found in cnc machine axis. * what is cnc backlash, * cnc backlash causes, * when to worry about cnc backlash, how to measure backlash, * How to resolve and compensate cnc backlash through hardware and cnc control software. Fig: 26 *What is CNC Backlash? CNC Backlash is any kind of play which is found in cnc machine axis. or you might say, CNC Backlash is non-movement of the cnc axis which occurs on axis reversal. *Causes of CNC Backlash? This play (backlash) might be due to * Clearance which is kept in mechanical parts to reduce friction. * As mechanical parts get loose with time. * As with time mechanical parts keep moving and rubbing each other and after long time they lose their actual shape and size. CNC Backlash Is already there A cnc machine axis move due to their Lead Screw and Lead Screw Nut. There is always kept a very minor backlash in the lead screw and lead screw nut to reduce damage and wear. *CNC Backlash When to Worry It is good if your cnc machine axis backlash is near 0. 0001? but not always possible, so 0. 0003? to 0. 0004? is acceptable. But if the amount of play in the lead screw and nut crosses this limit then there is the time to worry, and call up you mechanical maintenance guys. CNC Backlash How to Measure?

CNC machine backlash can be measure with a Dial Indicator attached to an Adjustable Stand. Put the stand on the cnc bed and direct the needle (plunger) of the dial indicator towards the axis which you want to measure. 1. Set the dial needle to 0. 0mm (zero). 2. Now move the axis in one direction 0. 5mm. Dial indicator should show 0. 5mm travel. 3. Now reverse the same axis 0. 5mm. If your dial indicator now goes back to 0. 0mm, then everything is okay. But otherwise, if on reversal the dial lags behind, then the amount the dial lags behind is the backlash.

CNC Backlash How to Resolve? (Backlash Compensation) Now you have two choices the hardware way and software way to resolve cnc backlash. You first better choose the hardware way, because normally backlash is due to lead screw or lead screw nut wear, so better resolve the issue by tightening them a bit if they are loose than required, there are plenty of other hardware ways to cope with backlash. CNC controls also give us the ability to control (compensate) cnc backlash through their parameters. CNC Backlash Compensation through CNC Control Parameters How Much Successful?

The better advice is that you resolve the issue by changing the lead screw (if possible) or lead screw nut, or just tightening them if they are loose might work, but otherwise CNC control parameters can be changed to compensate backlash, the cnc lathe machine I work on with fanuc control has the 0. 012mm set in its parameters as the backlash compensation for x-axis and z-axis. So such values can be changed to resolve the backlash issue. 10. DRILLING AND TAPPING ON CNC MACHINES Drilling is the operation of producing circular hole in the work-piece by using a rotating cutter called DRILL.

The machine used for drilling is called drilling machine. The drilling operation can also be accomplished in lathe, in which the drill is held in tailstock and the work is held by the chuck. The most common drill used is the twist drill. Drilling Machine It is the simplest and accurate machine used in production shop. The work piece is held stationary ie. Clamped in position and the drill rotates to make a hole. Types 1) Based on construction: Portable, Sensitive, Radial, up-right, Gang, Multi-spindle 2) Based on Feed: Hand driven , Power driven Components of drilling machine:

Spindle The spindle holds the drill or cutting tools and revolves in a fixed position in a sleeve. Sleeve The sleeve or quill assembly does not revolve but may slide in its bearing in a direction parallel to its axis. When the sleeve carrying the spindle with a cutting tool is lowered, the cutting tool is fed into the work: and when it's moved upward, the cutting tool is withdrawn from the work. Feed pressure applied to the sleeve by hand or power causes the revolving drill to cut its way into the work a fraction of an mm per revolution. Column

The column is cylindrical in shape and built rugged and solid. The column supports the head and the sleeve or quill assembly. Head The head of the drilling machine is composed of the sleeve, a spindle, an electric motor and feed mechanism. The head is bolted to the column. Worktable The worktable is supported on an arm mounted to the column. The worktable can be adjusted vertically to accommodate different heights of work or it can be swung completely out of the way. It may be tilted up to 90 degree in either direction, to allow long pieces to be end or angle drilled. Base

The base of the drilling machine supports the entire machine and when bolted to the floor, provides for vibration-free operation and best machining accuracy. The top of the base is similar to the worktable and may be equipped with t- slot for mounting work too larger for the table. Hand Feed The hand- feed drilling machines are the simplest and most common type of drilling machines in use today. These are light duty machine that are operated by the operator, using a feed handled, so that the operator is able to “ feel” the action of the cutting tool as it cuts through the work piece. These drilling machines can be bench or floor mounted.

Power feed The power feed drilling machine are usually larger and heavier than the hand feed ones they are equipped with the ability to feed the cutting tool in to the work automatically, at preset depth of cut per revolution of the spindle these machines are used in maintenance for medium duty work or the work that uses large drills that require power feed larger work pieces are usually clamped directly to the table or base using t – bolts and clamps by a small work places are held in a vise. A depth –stop mechanism is located on the head, near the spindle, to aid in drilling to a precise depth.

Sensitive or Bench Drilling Machine * This type of drill machine is used for very light works. Fig. 1 illustrates the sketch of sensitive drilling machine. * The vertical column carries a swiveling table the height of which can be adjusted according to the work piece height. * The table can also be swung to any desired position. * At the top of the column there are two pulleys connected by a belt, one pulley is mounted on the motor shaft and other on the machine spindle. * Vertical movement to the spindle is given by the feed handle by the operator. * Operator senses the cutting action so sensitive drilling machine.

Fig: 27 Up-Right Drilling Machine * These are medium heavy duty machines. * It specifically differs from sensitive drill in its weight, rigidity, application of power feed and wider range of spindle speed. Fig. 2 shows the line sketch of up-right drilling machine. * This machine usually has a gear driven mechanism for different spindle speed and an automatic or power feed device. * Table can move vertically and radially. * Drill holes up to 50mm Fig: 28 Radial Drilling Machine * It the largest and most versatile used for drilling medium to large and heavy work pieces. Radial drilling machine belong to power feed type. * The column and radial drilling machine supports the radial arm, drill head and motor. Fig. 3 shows the line sketch of radial drilling machine. * The radial arm slides up and down on the column with the help of elevating screw provided on the side of the column, which is driven by a motor. * The drill head is mounted on the radial arm and moves on the guide ways provided the radial arm can also be swiveled around the column. * The drill head is equipped with a separate motor to drive the spindle, which carries the drill bit.

A drill head may be moved on the arm manually or by power. * Feed can be either manual or automatic with reversal mechanism. Drill Materials The two most common types are 1. HSS drill- Low cost 2. Carbide- tipped drills - high production and in CNC machines Other types are: Solid Carbide drill, TiN coated drills, carbide coated masonry drills, parabolic drills, split point drill. Fig. 4 shows various types of drills. Drill fixed to the spindle Fig: 30 Tool Nomenclature: Fig. 31 Nomenclature of twist drill Tool holding devices Fig. 7 and Fig. 8 shows the different work holding and drill drift device.

The different methods used for holding drill in a drill spindle are * By directly fitting in the spindle hole. * By using drill sleeve * By using drill socket * By using drill chuck Fig: 32 Drilling operations: Operations that can be performed in a drilling machine are * Drilling * Reaming * Boring * Counter boring * Countersinking * Tapping Drilling: It is an operation by which holes are produced in solid metal by means of revolving tool called ‘ Drill’. Fig. 9 shows the various operations on drilling machine. Reaming: Reaming is accurate way of sizing and finishing the pre-existing hole.

Multi tooth cutting tool. Accuracy of 0. 005mm can be achieved. Boring: Boring is a process of enlarging an existing hole by a single point cutting tool. Boring operation is often preferred because we can correct hole size, or alignment and can produce smooth finish. Boring tool is held in the boring bar which has the shank. Accuracy of 0. 005mm can be achieved. Fig. 33 Various operations on drilling machine Counter Bore :- This operation uses a pilot to guide the cutting action to accommodate the heads of bolts. Fig. 10 illustrates the counter boring, countersunk and spot facing processes. Countersink:-

Special angled cone shaped enlargement at the end of the hole to accommodate the screws. Cone angles of 60°, 82°, 90°, 100°, 110°, 120° Fig. 34 Counter boring, countersunk and spot facing Drilling machines are tools that have a rotating, cutting component at one end that bores holes into different materials. There are several types of drilling machines that may be used for a wide variety of purposes, including woodworking, construction, masonry, metalworking, medicine, oil drilling, and many other fields. Common drills include the hand drill, push drill, pistol-grip drill, hammer drill, and drill press.

In addition to making holes, drills are often used to push screws into wood, metal, plastic, rock, or composites. The hand drill and push drill are both manually operated drilling machines that have been largely replaced by power drills. A hand drill works by turning a crank that rotates gears, which cause the chuck to turn. The chuck is the component of the drilling machine that holds the bit, or the end cutting piece. The push drill is a skinny tool resembling a screwdriver with a handle that can be pushed down on a threaded shaft, or a pole with helical ridging.

As the handle is pushed down along threading, the shaft, chuck, and bit spins downward, much like pumping a toy metal top. Pistol-grip drills are the most commonly used drilling machines. These are corded electric drills that are typically shaped roughly like a pistol, with a trigger switch that starts a motor inside the drill. The motor causes the chuck and bit to spin in continuous revolutions. These drilling machines may be used to make holes for bolts or other purposes, to push screws into wood, plastic, or other materials, and to bore countersinks.

A countersink is a screw-shaped hole that is made before the screw is drilled in, preventing splintering or pulling of the plastic or wood around the head of the screw. A pistol-grip drill is also available in a battery-powered, cordless version, though they are usually more expensive. There are many different types of this drill and several indications for use. It is also possible to adapt the drill with an attachment, such as sanding or sawing components. A hammer drill, also called a rotary hammer, is similar to a pistol-grip drill, but also applies a punching motion to complement the rotational action of the bit.

This hammering, forward force makes it useful for tougher materials, such as concrete or stone, that standard electric drills cannot cut through. For softer materials, however, the hammer drill may apply excessive force and a standard drill may be a better choice. A drill press is a type of drill that may stand on the floor or be mounted on a workbench. The base of the machine is bolted to the table or floor and a column rises up from the base to support the back of the head of the drill. The column also supports a table that can be adjusted in height between the head and the base.

The spindle, a metal component that holds the chuck and drill bit, extends downward from the front of the head, parallel to the column. A larger distance between the spindle and column allows wood with a larger width to be drilled. An " on" switch triggers the spindle to spin and levers attached to the head of the drill press move the spindle and chuck to move up or down. These drilling machines are suited for accurate drilling, because the bit is fixed and the work can be secured to the table with clamps or a vise. -- Types Of Drill Bits

Drill bits are tools used in making cylindrical holes. Various types of drill bits are designed for different uses. Drill bits are equipments or tools that are used in making cylindrical holes. Drill bits can also be referred to as a drilling machine. Drill bits are available in various drill types such as metal drills, gun drills, screw machine drills, core drills, step drills, spade drills, forstner drills, masonry drills, dental or surgical drills, wood bits, twist drills, drill blank taper drills and much more. They are designed to cut while doing a clockwise rotating motion. Several drill bits are coolant fed.

They contain a channel or hole for directing the coolant fed near to the cutting edges. The split point drill heads of drill bits are used for chip clearance and for excellent centering. Drill bits can also be used in cutting aluminum, general-purpose metals, brass, copper, bronze, ceramic, and plastic, stainless steel, steel, wood, titanium and hardened materials. Various types of drill bits are designed for different uses. Listed below are some types of Drill Bits. Twist Drill: It drills holes in plastic, metal and wood. This drill is currently produced with a width covering a range from 0. 5 millimeters to 100 millimeters while its length is around 1000 millimeters. The most usual twist drill has a tip angle of 118 degrees. This is a proper angle for an extensive array of job. It also has a long series drill for extended length twist drills. It is not advisable to drill deep holes using this twist drill. Diamond Drill Bit: This particular drill is used in the bathroom for updating or remodeling. It is also used in redesigning your kitchen decoration. Furthermore, it is used on ceramic, glass, tile, limestone, stained glass, marble, fiberglass, porcelain, stone, slate and porcelain tile.

When using this drill, the main concern is to obtain water at the edge of the drill bit. Drilling fiberglass may be done with or without water but make sure that the fiberglass has ample amount of water just to get the drill wet. Indexable Drill Bit: This provides an excellent performance in making short-hole drillings. Stainless steel is drilled 3x in diameter and only a short-hole must be done. Listed below are some other types of drill bits Adjustable Bit: This is built with a changeable cutter blade to bore holes of various sizes. It is also used for drilling gaps for wiring or piping.

Around-the-corner bit: It is used to cut arched holes that are stretched in corners with a diagonal cutting surface. Auger Bits: This drill creates drill holes in wooden materials. The drill ends have a screw head so that the bits may be self fed. Brad-point drill: This drill looks almost the same as the usual bits but it has sharpened point to make wood drilling a lot easier. This drill has cleaner holes other than spade bits. Counterbore: The drill allows a screw to be driven under the wood outside. The holes that are drilled may be filled with a plug or wire.

Drill Saw Bit: It is used to cut holes such as wood and metal and can enlarge current holes. Countersink: A drill that has an angled tip design that forms a “ slump” in the screw head. Fly cutter: This one is often used to cut circles in wood and other soft metals. The diameter of circles may be adjusted by changing the cutter blade setting. Hole saw: It cut holes from one to six centimeters in diameter and has a center bit for directing the cutting blade edge of the saw. Reamer bit: The tapered bit of reamer may be used on existing holes rather than to enlarge holes.

Screw pilot bit: This beautiful bit is used for drilling body holes. A pilot hole is used along with the countersink. Wire Brushes: It use to remove rust and to clean up metal and is available either as a wheel or a cup with wire brush. Plastic bit: This is designed with a tip so as to prevent splintering when drilling plastic. It is important to reduce the speed and slowly drill the other side of the plastic. Plug cutter: Use this to remove cylindrical shapes from the wood. It covers the screw using a small cylindrical plate. Tapping:- Tapping is the process by which internal threads are formed.

It is performed either by hand or by machine. Minor diameter of the thread is drilled and then tapping is done. Fig. 11 show the tapping processes. Fig. 35 Hand taps and tapping process using tap wrench Fig. 36 Various operations performed on drilling machine Work Holding Devices 1. Machine Table Vice: The machine vice is equipped with jaws which clamps the work piece. The vice can be bolted to the drilling table or the tail can be swung around swung around. Fig. 13 shows the standard and swivel vice. The swivel vice is a machine wise that can be swivel through 360° on a horizontal plane. Fig: 37 1.

Step Blocks These are built to allow height adjustment for mounting the drilling jobs and are used with strap clamps and long T-slot bolts. 2. Clamps These are small, portable vises , which bears against the work piece and holding devices. Common types of clamps are C-clamp, Parallel clamp, machine strap clamp, U-clamp etc.. Fig. 14 shows the correct and incorrect methods of mounting the work piece. Fig: 38 11. APPLICATION OF CNC MACHINES ? cutting ? drilling ? milling ? welding ? boring ? bending ? spinning ? pinning ? gluing ? sewing ? routing Its application in some industries like -Automotive Industry Aerospace Industry -Machinery Industry -Electrical Industry -Instrumentation Industry Automotive Industry Different Products Fig: 39 Aerospace Industry Aircraft Turbine Machined by 5-Axis CNC Milling Machine Fig: 40 12. ADVANTAGES AND DISADVANTAGES OF CNC -Ease of Use ? CNC machines are easier for beginners ? Operation of several CNC machines at same time ? Some CNC machines don't need any operator indeed call their operator in case of the emergencies. High Efficiency ? operate almost continuously 24 hours a day, 365 days a year. Expanding Options ? Expand the machine's capabilities with Software

Changes and updates. No Prototyping ? new programmers provide elimination build a prototype, save time and money. Precision ? Parts are identical to each other. Reduce Waste ? Reduce waste as errors allows minimize wasted Material. Disadvantage of CNC Machines Cost CNC machinery: ? costs quite a lot more than conventional machinery. ? Does not eliminate the need for expensive tools. ? Expensive to repair. 13.

CONCLUSION CNC machines which are applicable any type of processing. manufacturing anything is identical in shorter time. CNC machines provide many advantages. Many industries prefer using CNC machines.