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CNC Part Programming of Axisymmetric Components

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INTRODUCTION TO CNC

1.1 Introduction to CNC

Electronics and computer technologies have had a significant influence on the control function in manufacturing. Programmable automations of manufacturing systems are able to accommodate variations in product configuration with reduced set up times. Numerical control (NC), one of the applications of programmable automation is widely undertaken by manufacturing firms.Computer numerical control is a NC system that utilizes a dedicated, stored program computer to perform some or all of the basic numerical control functions. Here punched tape and tape reader are used once to enter the program. Once it is entered, it is stored in the computer. New system options can be incorporated in to the NC controller simply by re-programming the unit. Because of their capabilities CNC is often referred to as “soft wired NC”.

Fundamentals of programming:

There are mainly two important types of codes that are very useful in the program development for a product which has to be manufactured .They are:-

1) Geometric Codes

2) Miscellaneous Code

Geometric Codes:

G – Codes are preparatory functions which involves actual tool moves for example, control of the achine). These include rapid moves, feed moves, radial feed moves, dwells, and roughing and profiling cycles.

Here are some of the codes listed below.

a) G 00 Rapid positioning
b) G 01 Linear interpolation
c) G 02 Circular interpolation clockwise
d) G 03 Circular interpolation counter clockwise
e) G 17 XY plane selection
f) G 18 XZ plane selection
g) G 19 YZ plane selection

Miscellaneous Codes:

M- codes are miscellaneous functions, which include actions necessary for machining but not those that are actual tool movements. That is, they are auxiliary functions, such as, spindle on and 0ff tool changes, coolant on and off, program stops, and other similar related functions.

Some of the codes are listed below.

a) M00 program stop
b) M01 optional program stop
c) M02 program end
d) M03 spindle on clockwise
e) M04spindleoncounter clockwise
f) M05 spindle stop
g) M06 tool change
h) M07 coolant on
i) M08 coolant off
j) M09 subroutine end
k) M30 program end

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1.2 ABSTRACT

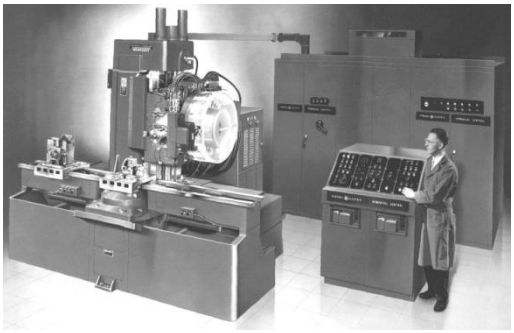
A part program is a set of instructions given to Computerized Numerical Control (CNC) machine. CNC is automation to machine tools such as a lathe controlled by program rather than manually i.e. by hand. Thus a CNC has three main components such as:

A part program
Machine Controller Unit

Processing unit

1.3 Brief History:

The first commercial NC machines were built in the 1950's, and ran from punched tape. By the end of 50's, NC was starting to catch on, though there were still a number of issues. A number of key developments brought CNC rapidly along during the 1960's



The above fig is the Milwaukee-Matic-II was the first machine with tool changer. More recently, microprocessors have made CNC controls even cheaper, culminating with the availability of CNC for the hobby and personal CNC market. The Enhanced Machine Controller project, or EMC2, was a project to implement an Open Source CNC controller that was started by NIST, the National Institute of Standards and Technology as a demonstration. Some time in 2000, the project was taken into the public domain and Open Source, and EMC2 appeared a short time later in 2003.

2.0 Kinds of CNC Machines:

The most common types of CNC machines are as follows

CNC Machine Lathes

Some view Lathes as the only universal machine tool because a lathe can make all of the parts needed for another lathe. A lathe spins the work piece in a spindle while a fixed cutting tool approaches the work piece to slice chips off of it. Because of this geometry, lathes are ideal for parts that have symmetry around some axis that could be chucked up in the spindle.CNC Lathes have at the very least the ability to drive the cutting tool under g-code control over 2 axes, referred to as X and Z. They may have a considerable amount of other functionality as well, and there are many variations on lathes such as Swiss Lathes.The act of cutting a work piece on a lathe is called "Turning".

CNC Milling Machines

In a mill, the cutter is placed in the spindle where it rotates. The work piece then moves past the cutter so that chips may be sliced off. The act of cutting a work piece on a mill is called "Milling".CNC Mills have at the very least the ability to drive cut in 3 dimensions (some older machines may be limited to 2 or 2 1/2 if there are limitations on when that 3rd dimension may be used) which are referred to as the X, Y, and Z axes.

The above illustrated figure is a template milling machine which are used for making templates of a particular dimension as required by the user. This machine is of 2 ½ axis machine.

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CNC Routers

A CNC Router is actually a type of CNC Mill, typically one that uses what's called a "gantry" configuration. Typically they're called CNC Routers instead of CNC Gantry Mills when they're used to cut wood, but this need not exclusively be the case. Many think of CNC machines as being focused on cutting metal, but there is a huge market for CNC woodworking machines of which the CNC Router is the principle example.There are many more types of CNC machine than just these three most common types including CNC presses of various kinds and so on.

2.1Types of CNC Machines

a) Based on Motion Type:

Point-to-Point & Continuous path

b) Based on Control Loops:

Open loop & Closed loop

c) Based on Power Supply:

Electric , Hydraulic & Pneumatic

d) Based on Positioning System

Incremental & Absolute

2.2 How CNC Machine works

- 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.

3.1Features of CNC Machinery

- 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 motors (actuators).
- Feedback is provided by sensors (transducers)
- Tool magazines are used to change tools automatically.

3.2 Tools

- Most are made from
  high speed steel (HSS),
  tungsten carbide or ceramics.
- Tools are designed to direct waste away from the material.
- Some tools need coolant such as oil to protect the tool and work.

Some of the tools used for CNC Template Milling Machine are illustrated below.

ENDMILL FITTED IN COLLET

SPINDLE WITH DRILL BIT

3.3Advantages of CNC Machines

1) Reduced Lead Time
2) Elimination of Operator errors
3) Use of Part Program and Tape Recorder only once
4) Greater Flexibility

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5) Longer Tool Life
6) Less Scrap
7) Accurate cost and scheduling
8)Lower Labour cost and less operator intervention

4.1 Flow of CNC processing:

- Develop the part drawing
- Decide which machine will produce the part
- Choose the tooling required
- Decide on the machining sequence
- Do math conclusions for the program coordinates
- Calculate the speeds and feed required for the tooling and part material
- Write the NC program
- Prepare setup sheets and tool lists
- Send program to machine
- Verify the program
- Run the program if no changes are required

4.2 Major Phases of CNC Program

The following are the three major phases of a CNC program. They are:-

1) Program setup
2) Material Removal
3) System shutdown

Program Setup:

- The program setup phase is virtually identical in every program. It always with the program starts flag (%sign). Line two always has a program number (up to four digits, 0000 to 9999).
- Line three is the first that is actually numbered. It begins with N5 (N for sequence number, 5 for block number 5). We can use and number incrementing upward. We use increments of 5 in example. Incrementing in this way enables you to insert up to 4 new lines between lines when we are editing program.
- Block 5 tells the controller that all distances (X and Z coordinates) are absolute, that is, measured form the origin point. It also instructs the controller that all coordinates are measured in inch units.

The program set up contains all the instructions that prepare the machine for operation. The setup phase may also include such commands as coolant on, cutter compensation cancel, or stop for tool change.

Material Removal:

- The material removal phase dealer exclusively with the actual cutting feed. It contains all the commands that designate linear or circular feed moves, rapid moves, canned cycles such as grooving of profiling, or any other function required for that particular part.

System Shutdown:

- The system shutdown phase contains all those G- and M- codes that turn off all the options that were turned on in the setup phase. Functions such as coolant and spindle rotation must be shutoff prior to removal of the part from the machine. The shutdown phase also is virtually identical in every program.

4.3 Sample Program

%9999

N5 G90 G70

N10 MO6 T2

N15 MO3 S1200

N20 G00 X1Y1

N25 Z0.125

N30 G01 Z-0.125F5

N35 G01 X2 Y2

N40 G00 Z1

N45 X0Y0

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N50 MO5

N55 M30

1) Program setup

% Program start

9999 program address number

N5 G90 G70 use absolute units, and inch programming

N10 M06 T2 Stop for tool change, use tool#2

N15 MO3 S1200 Turn the spindle on CW to 1200rpm

2) Material Removal

N20 G00 X1 Y1 Rapid to (X1,Y1) from origin point

N25 Z0.125 Rapid down to Z0.125

N30 G01 Z-0. 125 F5 Feed down to z-0.125 at 5 ipm

N35 G01 X2 Y2 Feed diagonally to (X2, Y2)

N40 G00 X1 Rapid up to Z1

N45 X0 Y0 Rapid to X0, Y0

3) System shutdown

N50 M05 Turn the spindle off

N55 M30 End of program

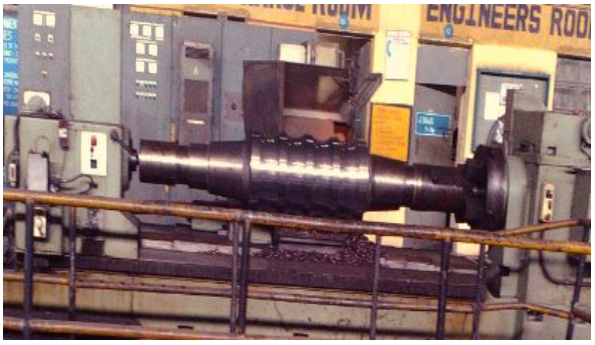
Three phases of a CNC Program are mentioned above by taking a sample program.

4.4 Selection of CNC Machines

CNC machines are selected according to the use or particular job to be done by the user. If the user needs a turning operation to be done he uses CNC Lathe Machine. If the user needs a milling operation he uses milling machine with particular axis which he needs to machine.

In this Project we are using Both CNC LATHE and TEMPLATE MILLING MACHINES for designing of a roller. The templates are here used as gauge for the rollers to be manufactured. The templates is cut using CNC TEMPLATE MILLING Machine on a mild steel plate. This plate is kept in between the grooves for easy inspection procedure. This Template is designed according to the customer desire or need in CAD software. The rollers are manufactured in the roll design section and with the help of the CAD model we create a program for the CNC LATHE MACHINE. Here is the template that we made on the CNC TEMPLATE MACHINE .

Here is the Roller Design that we have manufactured using CNC LATHE MACHINE



5.0 FUTURE SCOPE

Beyond next-generation computer numerical controls (CNC), there may be virtual reality for CNC programming, advanced CNC intelligence, and advanced automation and programming for additive manufacturing and robotic assembly of microstructures. Each article below is linked to more information and images. This leads to increase of Flexible Manufacturing System Productivity and decreases the cost of labor. For Preparing the Template recently introduced program is R-Parameter Programming. This includes in preparation of many no. of similar templates with different sizes at a time.

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This programming includes in just changing the dimensions required as per the user or designer.

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KEYPONITS

5.1 CONCLUSION

Activities of roll shop & repair shop, roll turning process, developments on roll turning technology, features of NC machines and programming fundamentals are briefly discussed.

This project can be further enhanced in FMS cell (FMS system). In FMS system the various components are CNC Machine tools, Robots, Automated Guided Vehicles. This Will be the basic step for integration of CAD/CAM. This integration further leads to Flexible Manufacturing System.