

COMPUTER AIDED MANUFACTURING (CAM)

UNIT 2 (NC PART PROGRAMING)

NC Part Programming

Part Program is the program required to machine a specific part or component.

Require intimate knowledge about the processes.

NC part programmer should be a skill operator and good part programmer for maximum utilization of machine capabilities and available resources like jigs and fixtures, cutting tools, without violating the machine constraints.

Assumed that it is the tool that undergoes the primary motion, for writing NC part program.

Absolute positioning mode: Target position of the tool is given relative to the origin point of the program.

Incremental positioning mode: Target position for the tool is given relative to the current tool position

Structure of an NC part program

1. Fixed sequential format: Each statement consists of exactly the same number of words entered in a specified sequence.
2. Each word consists of a fixed number of data characters.
3. Characters cannot be omitted and no extra characters can be included

```
0050 00 +0025400 +0012500 +0000000 0000 00  
0060 01 +0025400 +0012500 -0010000 0500 08  
0070 01 +0025400 +0012500 +0000000 0500 09
```

Tab sequential format

1. It is essential the same as fixed sequential format
2. The difference is that each word within a statement is preceded by a TAB character
3. The sequence of the words remains significant
4. The spaces should not be used in the actual program.

```
0050 TAB 00 TAB +0025400 TAB +0012500 TAB TAB TAB  
0060 TAB 01 TAB TAB TAB -0010000 TAB 0500 TAB 08  
0070 TAB 00 TAB TAB TAB +0000000 TAB 0000 TAB 09
```

Word address format

1. A method of coding machine motion using ANSI format letter system.
2. Ease to use.
3. Does not require all the words.
4. Ignores spaces.

<i>Address</i>	<i>Meaning</i>
F	Feed rate command
G	Preparatory function
I	Circular interpolation: x-axis offset
J	Circular interpolation: y-axis offset
K	Circular interpolation: z-axis offset
M	Miscellaneous commands
N	Sequence number
R	Arc radius
S	Spindle speed
T	Tool number
X	x-axis data
Y	y-axis data
Z	z-axis data

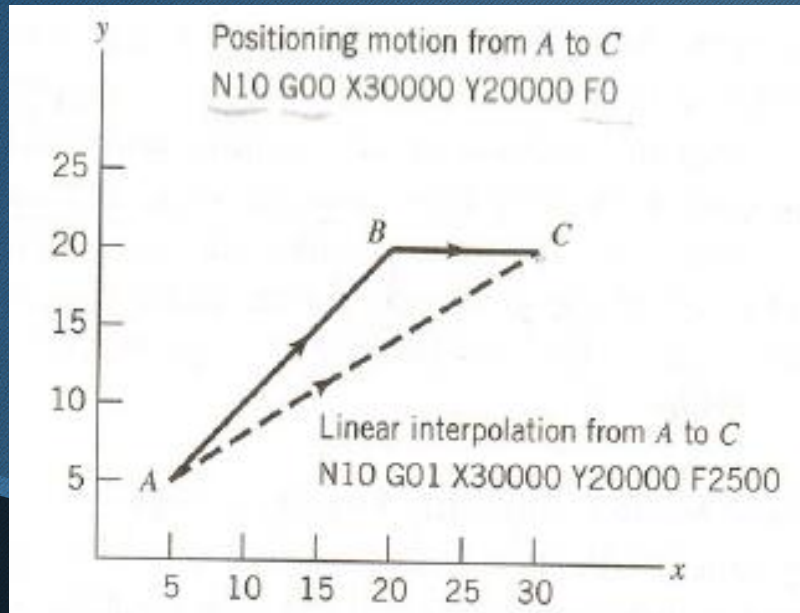
```
N50 G00 X25400 Y12500 Z0 F0  
N60 G01 Z-10000 F500 M08  
N70 Z0 M09
```

Fundamentals of NC Programming:

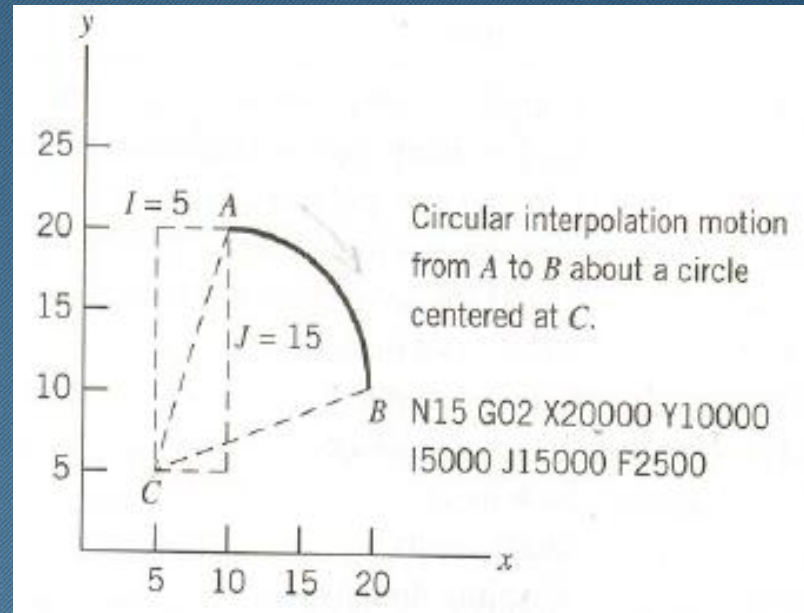
- Preparatory function:
Necessary operation conditions
- Axis motion commands:
Control the amount of relative motion
- Feed and speed commands:
Control the cutting conditions
- Identification commands:
To identify specific entities in the program, such as cutting tools used
- Miscellaneous commands:
Controls various aspects of the machine's operation such as turning the spindle on and off and changing tools

```
N50 G00 X25400 Y12500 Z0 F0  
N60 G01 Z-10000 F500 M08  
N70 Z0 M09
```

PREPARATORY FUNCTION

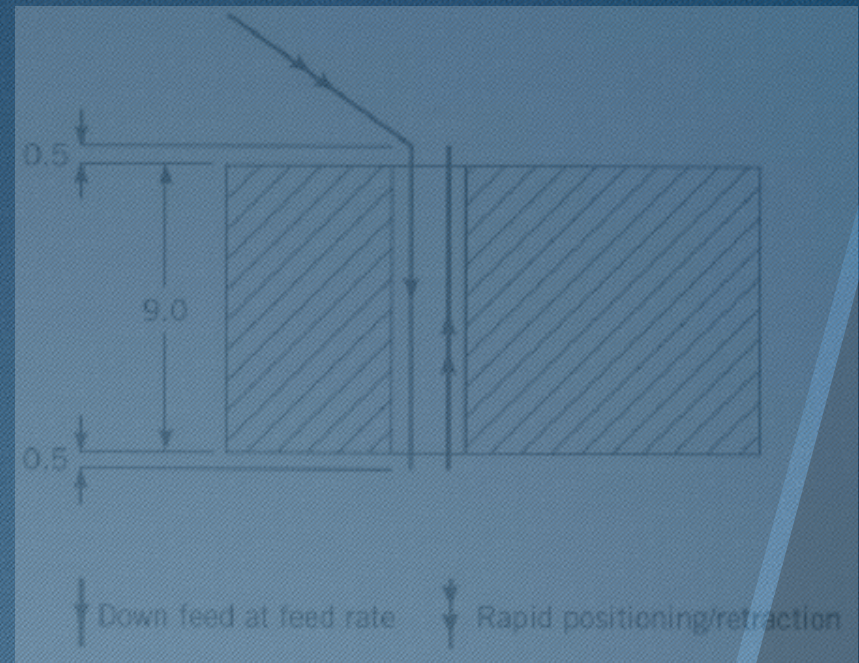


Positioning and linear interpolation for NC.



Circular interpolation for NC.

PREPARATORY FUNCTION

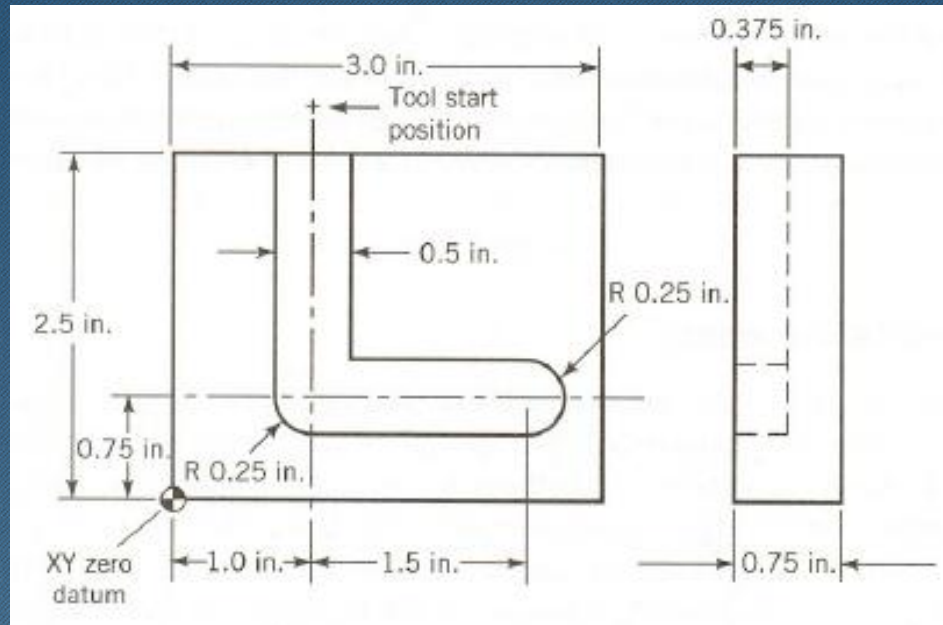


Drilling motion for Exhibits

<i>Code</i>	<i>Function</i>	<i>Down Feed</i>	<i>At Bottom</i>	<i>Retraction</i>
G81	Drilling	Continuous feed	No action	Rapid
G82	Spot face, counterbore	Continuous feed	Dwell	Rapid
G83	Deep hole drilling	Peck	No action	Rapid
G84	Tapping	Continuous feed	Reverse spindle	Feed rate
G85	Through boring (in and out)	Continuous feed	No action	Feed rate
G86	Through boring (in only)	Continuous feed	Stop spindle	Rapid
G87	Chip breaker drilling	Intermittent	No action	Rapid
G88	Chip breaker drilling	Intermittent	Dwell	Rapid
G89	Through boring with dwell	Continuous feed	Dwell	Feed rate

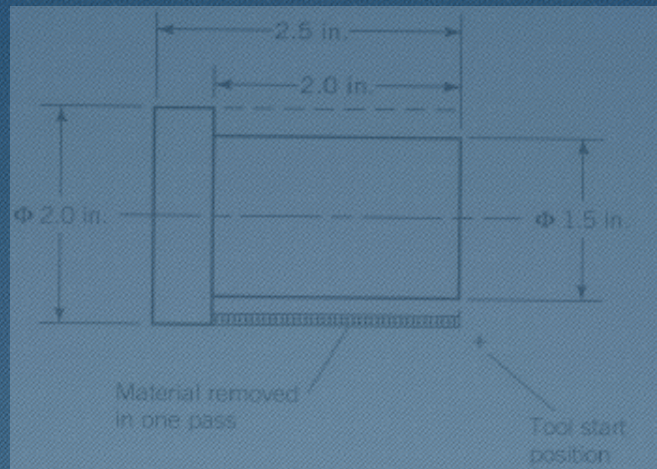
Commonly Used Canned Cycles

EXAMPLE 1



A slot milling example.

<code>%</code>	Indicates start of program
<code>N005 G90 G70</code>	Specifies absolute dimensions, inch units
<code>N010 G97 G94 T01</code>	Specifies units for speed and feed rate; loads first tool
<code>N015 G00 X1.000 Y3.000 Z2.500 F0</code>	Rapid positioning of tool to start point
<code>N020 G01 Z-.375 M03 S500 F10</code>	Turns on spindle, feeds tool to required depth
<code>N025 Y7.50</code>	Machines the vertical portion of the L
<code>N030 X2.500</code>	Machines the horizontal portion of the L
<code>N035 Z2.50</code>	Retracts tool to 0.25 in above part surface
<code>N040 X-1.000 Y-1.000 F0</code>	Moves to safe location at rapid rate
<code>N045 M30</code>	Turns off all machine functions



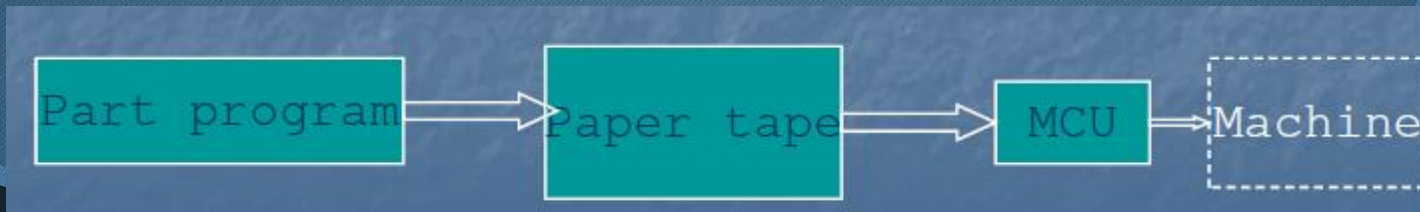
A simple turning example.

<code>%</code>	Indicates start of program
<code>N005 G90 G70</code>	Specifies absolute programming, inch units
<code>N010 G98 G92 T01</code>	Specifies units for speed and feed rate, loads 1st tool
<code>N015 G00 X2200 Z2600 F0</code>	Rapid positioning of tool to tool start position
<code>N020 X1800 M03 S1200 F0</code>	Position tool to remove 0.1 in. off part diameter, start spindle
<code>N025 G01 Z500 F12</code>	Feed tool into workpiece
<code>N030 X1900</code>	Retract tool (overlap previous cut)
<code>N035 G00 Z2600 F0</code>	Move tool clear of workpiece
<code>N040 X1600 F0</code>	Position tool to remove 0.1 in. off part diameter
<code>N045 G01 Z500 F12</code>	Feed tool into workpiece
<code>N050 X1700</code>	Retract tool (overlap previous cut)
<code>N050 G00 Z2600 F0</code>	Move tool clear of workpiece
<code>N060 X1500 F0</code>	Position tool to take finish cut
<code>N065 G01 Z500 F12</code>	Feed tool into workpiece
<code>N070 X2200</code>	Retract tool clear of the workpiece
<code>N075 G00 X5000 Z5000 F0</code>	Move to safe position
<code>N080 M30</code>	Turn off all machining functions

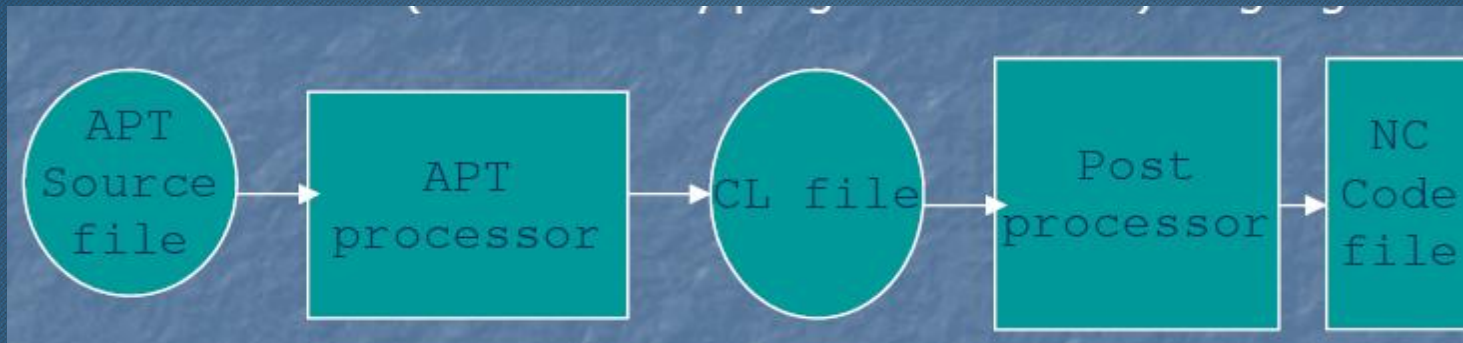
Loading the program

Conventional NC:

- 1-in.-wide punched paper tape: for program storage and input to NC machines
- A binary-based representation code
- Two standard coding schemes: EIA & ASCII



Standard APT (Automatically programmed tools) language:



APT source file: written by user

APT processor checks the source file for errors in defined geometry, errors in required tool motions

CL file means cutter location file Post processor converts CL data into final NC codes.

Post processing

- Convert the CL data into m/c tool coordinates.
- Check for speed, feed, movement limitations.
- Develop motion command using M&G codes.
- Computer-Aided Part Programming:
 - Process machine specific functions.
 - Select acceleration, deceleration, etc.