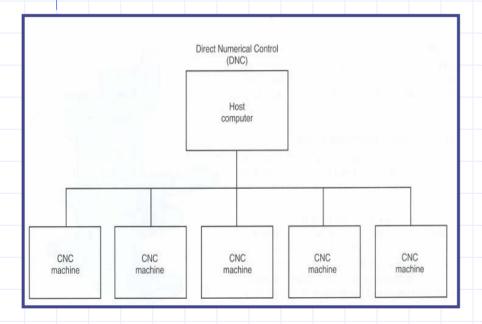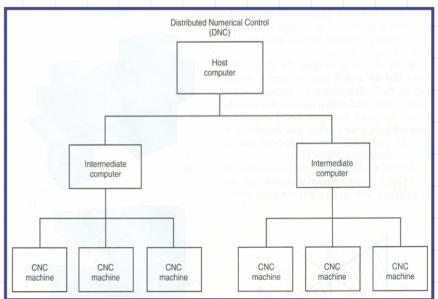# ETEC 223

NC/CNC

NC (Numerical Control)

- NC is not a machining process.
- NC is the operation of the machine tool by a series of coded instructions.
- The code consists of alphanumeric data that are translated into pulses of electric current.
- NC Program….
  - Instruct servos when to start, in what direction to move, and how far to move.
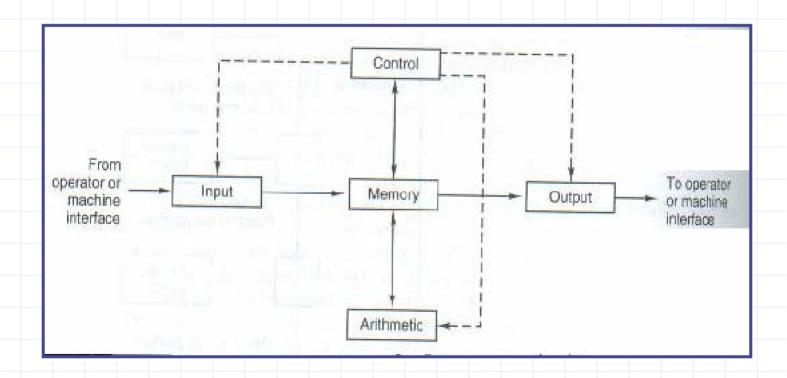 - Control feed rate, cutter speed, coolant flow and tool changes.

DNC & CNC

- ◆ DNC
  - Used to identify two different NC methods
    - ◆ **Direct Numerical Control**
    - ◆ **Distributed Numerical Control**
  - For large mfg. Situation
- ◆ Two DNCs

Direct Numerical Control
(DNC)

Host computer

CNC machine | CNC machine | CNC machine | CNC machine | CNC machine

Distributed Numerical Control
(DNC)

Host computer

Intermediate computer | Intermediate computer

CNC machine | CNC machine | CNC machine | CNC machine | CNC machine | CNC machine

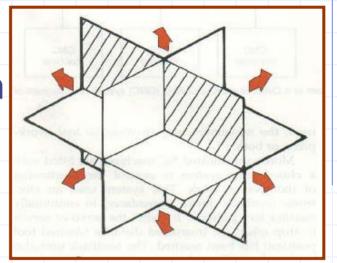# ◆CNC (Computer Numerical Control)

■Five units of a CNC
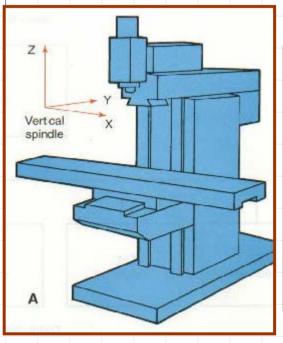
HAAS VF-4 CNC Mill

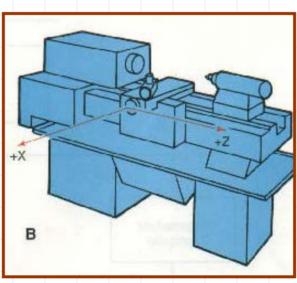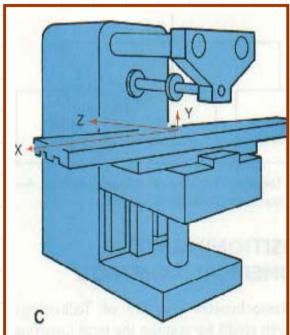# Positioning with CNC

◆ Cartesian Coordinate System
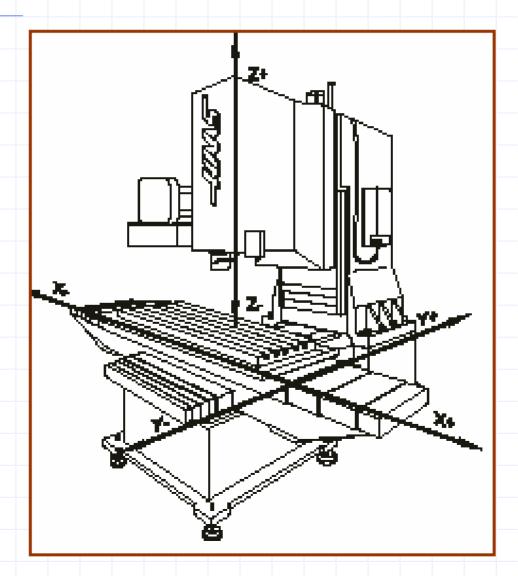
Z axis is assigned to the spindle motion
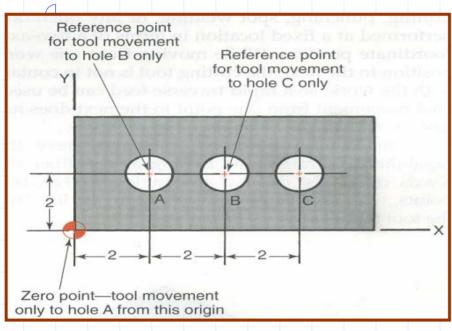
X, Y & Z Coordinates
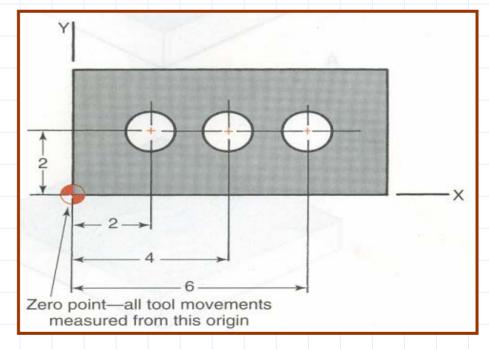
Tool positioning methods

- Incremental & Absolute positioning

Reference point for tool movement to hole B only

Reference point for tool movement to hole C only

A   B   C

2

2   2   2

Zero point—tool movement only to hole A from this origin
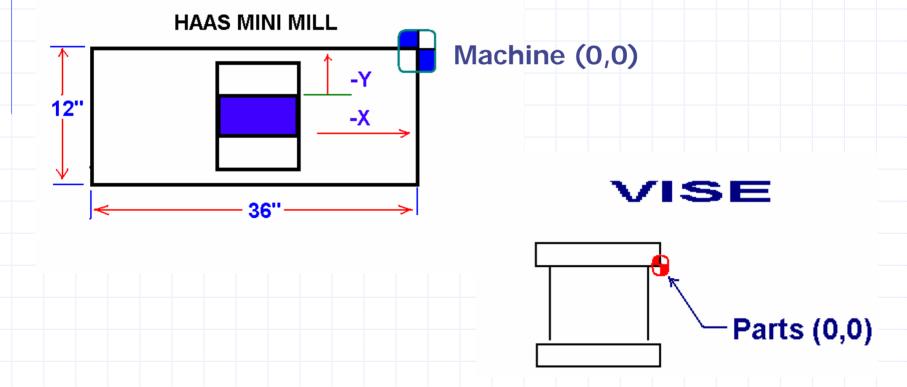
Incremental (G91)

Absolute (G90)

2

2

4

6

Zero point—all tool movements measured from this origin

Work Coordinate System (Zero Part Set)

- ◆ G54 – G59 & G110 – G129
  - Allow us to set a (0,0) for work piece.
  - Temporary move of machine (0,0) points.

HAAS MINI MILL

12"

-Y

-X

Machine (0,0)

36"

VISE

Parts (0,0)

Programming with G & M Codes

- ◆ G & M Codes
  - ■ G-Codes
    - ◆ Preparatory Codes
    - ◆ Tool & Table movements
  - ■ M-Codes
    - ◆ Miscellaneous Codes
    - ◆ Control of spindle, direction, coolant,....

Modal & Non-Modal Commands

- ◆ Modal
  - Call it out once, stay active until another code from its group appears.
- ◆ Non-Modal
  - Use only once.
  - Have to call out every time you want to use it.
  - If group # on a G & M code sheet is 00, then it is a non-modal command.

CNC Programming I
(Word Address Programming)

Programming Language Terminology

- **Character**
  - Alphanumeric or Punctuation mark
  - **N, G, ;, 1, 9**
- **Addresses**
  - Letter that describes the meaning of the numerical value following address
  - **X, Y, Z, G, M,....**
    - **G00, X -3.75,...**
      - G & X; addresses
      - 00 & -3.75; characters
- **Words**
  - Address + Number(s)
    - **G90** (=absolute positioning)
- **Block/Line**
  - One or more Words

Block: Contains one or more words

- **N20 G90 G00 X-2.5 Y3.75 S1000** ;
  - ◆ **O** ; Program Number
  - ◆ **N** ; Sequence or Line Number
  - ◆ **G** ; Prep. Code. Relates to movement of machine
  - ◆ **M** ; Miscellaneous Code. Relates to control of machine
  - ◆ **X, Y, Z, I, J, K, P, Q, R** ; Movement of axis.
    - ■ Must contain DECIMAL point
  - ◆ **F** ; Feed rate (IPM)
    - ■ Must contain DECIMAL point
  - ◆ **S** ; Spindle speed (RPM)
  - ◆ **T** ; Tool number (1 to 10 for HAAS Mini Mill)
  - ◆ **D** ; Tool diameter offset (use with G code)
  - ◆ **H** ; Tool height offset (use with G code)

Program

- A sequence of blocks
  - %
  - **O0001**
  - **(Tool list)**
  - **(T10-Dowel pin)**
  - **(T1-2.5 Face cutter)**
  - **(T2-1.0 End mill)**
  - **N001 G0 G90 G80 G40 G17**
  - **N002 G91 G28 Z0.**
  - **N003 G28 Y0.**
  - **N004 T10 M06 (Dowel pin)**
  - **N005 G00 G90 G54 X.1875 Y-1.5**
  - **N006 G43 H10 Z2.**
  - **N007 Z.2**
  - **N008 G1 Z-.5 F20.**
  - **N009 M00**
  - ......
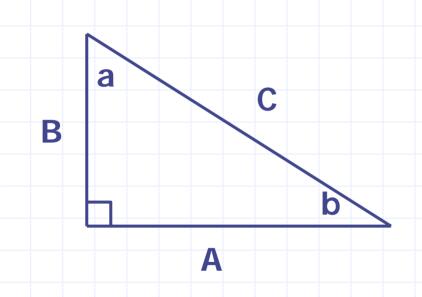 - **N090 M30**
  - %

Start-up Block

S & F

- To find S (=rpm) value:
  - Rpm = (CS * 4) /Dia.
- To find F (=ipm) value:
  - For Milling;
    - IPM = Rpm * IPT * N
      - IPT is table value (Table 10A, p. 786)
      - N is number of teeth or inserts
  - For Drilling;
    - IPM = Rpm * IPR
      - IPR is table value (Table H-3, p. 373)
  - For Tapping;
    - IPM = Rpm * IPR
      - Select numbers between 200 and 1000 for Rpm.
      - IPR is the value of pitch

Locate X & Y (Math. for CNC prog.)

To determine the Sides

Known Angle a:

$A/C = Sin\ a$

$B/C = Cos\ a$

$A/B = Tan\ a$

Known Angle b:

$B/C = Sin\ a$

$A/C = Cos\ a$

$B/A = Tan\ a$

a

c

B

b

A

Locate X & Y (Math. for CNC prog.)

To determine the Angles

Known Sides A, C;

$$a = Sin^{-1}(A/C)$$

Known Sides B, C;

$$a = Cos^{-1}(B/C)$$

Known Sides A, B;

$$a = Tan^{-1}(A/B)$$

Known Sides B, C;

$$b = Sin^{-1}(B/C)$$

Known Sides A, C;

$$b = Cos^{-1}(A/C)$$

Known Sides B, A;

$$b = Tan^{-1}(B/A)$$

a

C

B

b

A