CNC & CAM 101

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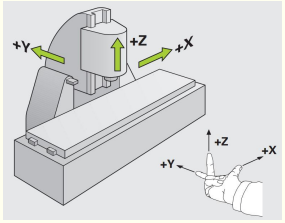
- Fundamentals of CNC
- Methods of CNC Programming
- CAM & Interpolation

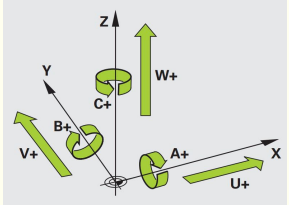
Fundamentals of CNC

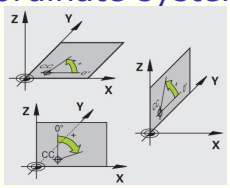
- Improved automation:
  - Unattended operation of CNC macines
  - Operator intervention can be reduced or eliminated.
    - Reduced operator fatigue
    - Fewer mistakes caused by human error
    - Consistent and predictable machining time
    - Fast change-overs
- Heart of CNC:
  - Automatic, precise, and consistent motion control

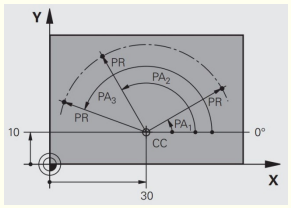
Fundamentals of CNC

- Coordinate system:
  - Rectangular or "Cartesian" coordinate system
  - Polar coordinate system





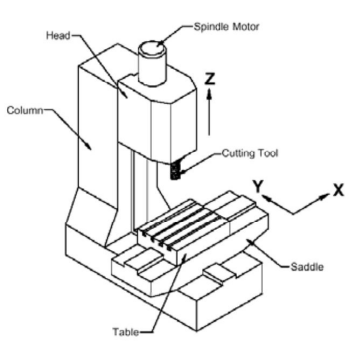


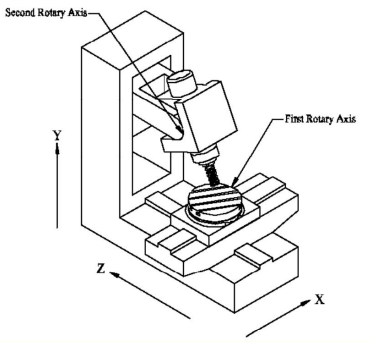


  - Program zero-point, also called work zero, part zero, or program origin

Fundamentals of CNC

- Two or more directions of motions, i.e. axes
  - Linear or Rotary

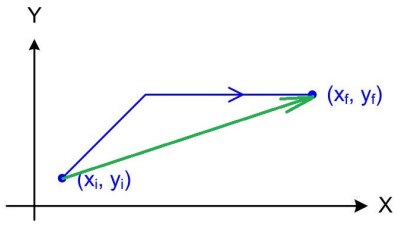




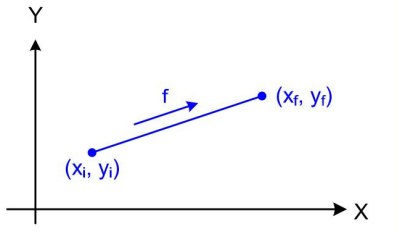
Fundamentals of CNC

- Motion type:
  - Rapid, Linear

G0 Xx_f Yy_f Zz_f

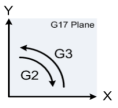


G1 Xx_f Yy_f Zz_f Ff



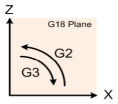
Fundamentals of CNC

- Motion type:
  - Circular



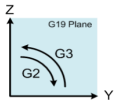
XY Plane:

G17 G{2 3} Xx Yy {Rr Ii Jj} Ff



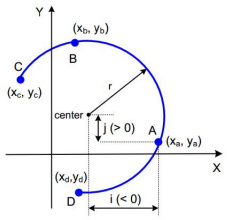
ZX Plane:

G18 G{2 3} Xx Zz {Rr Ii Kk} Ff



YZ Plane:

G19 G{2 3} Yy Zz {Rr Jj Kk} Ff



A→B:

G90 G17 G3 Xx_b Yy_b Ii Jj Ff

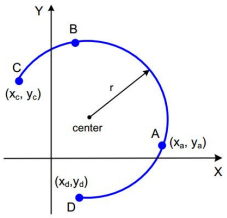
abs CCW - +

G91 G17 G3 Xx'_b Yy'_b Rr Ff

incr CCW

where $x'_b = x_b - x_a$

$y'_b = y_b - y_a$



A→C (angle > 180°):

G90 G17 G3 Xx_c Yy_c R-r Ff

abs CCW

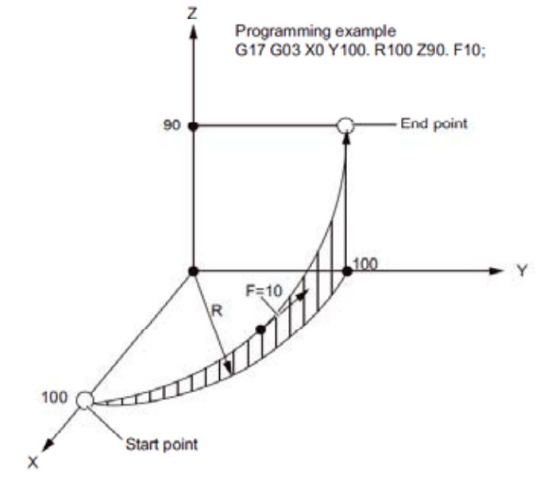
A→D:

G90 G17 G2 Xx_d Yy_d Rr Ff

abs CW

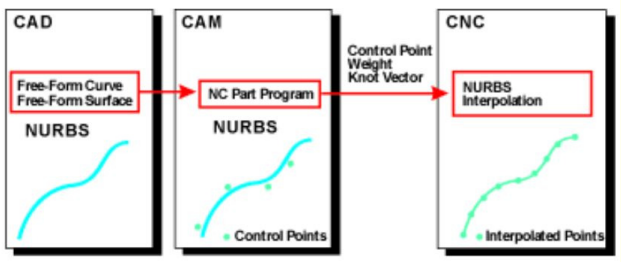
Fundamentals of CNC

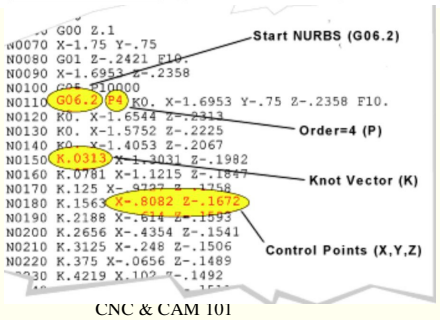
- Motion type:
  - Helical
  - Superimposed 2 motions:
    - Plane circular
    - Vertical linear



Fundamentals of CNC

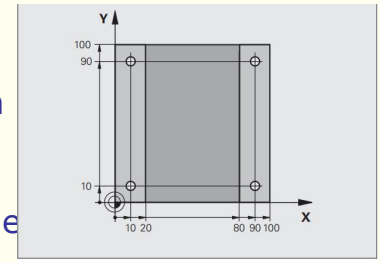
- Motion type:
  - NURBS



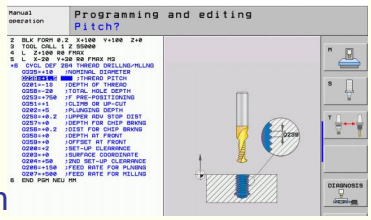


Methods of CNC Programming

- Manual programming:
  - Arithmetic calculations longhand as opposed to on an electronic calculator
  - Simple, repetitive jobs
  - Editing of NC file (at G-code level) to correct mistakes



- Conversational (Shopfloor) Programming:
  - Created at the CNC machine
  - Single-purpose CAM system



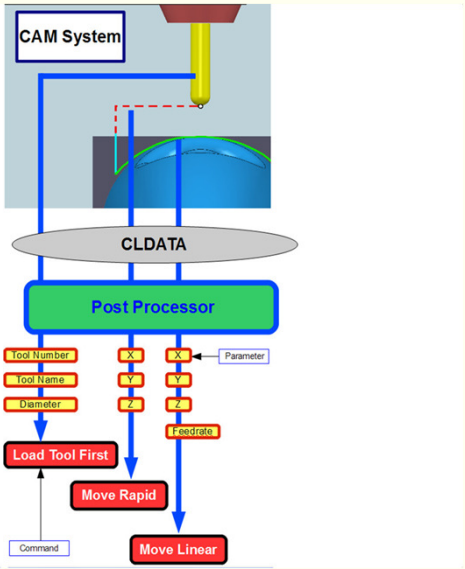
Methods of CNC Programming

- CAM programming:
  - Keeps the programmer from having to do math calculations
  - Easy to program different kinds of machines with the same CAM software
  - General steps:
    - Import CAD model
    - Stock definition
    - Tool definition
    - Toolpath strategies and cutting parameters
    - Simulation and verification
    - Post processing
    - Setup sheet generation

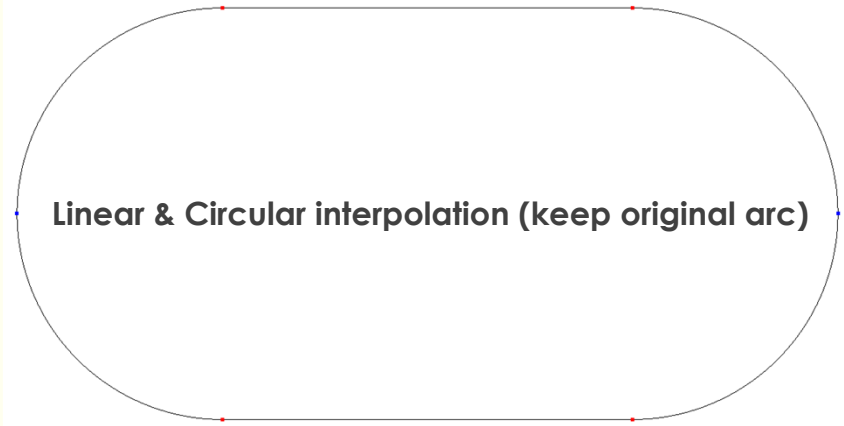
DESIGN & MANUFACTURING SERVICES FACILITY

Methods of CNC Programming

- CAM programming:

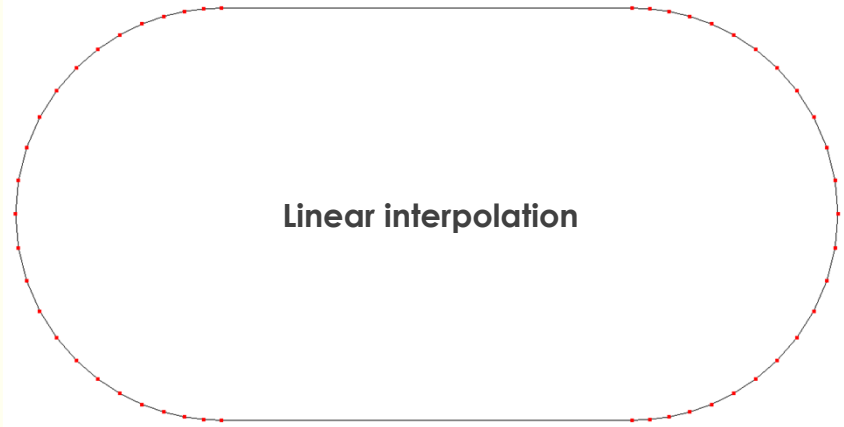


CAM & Interpolation



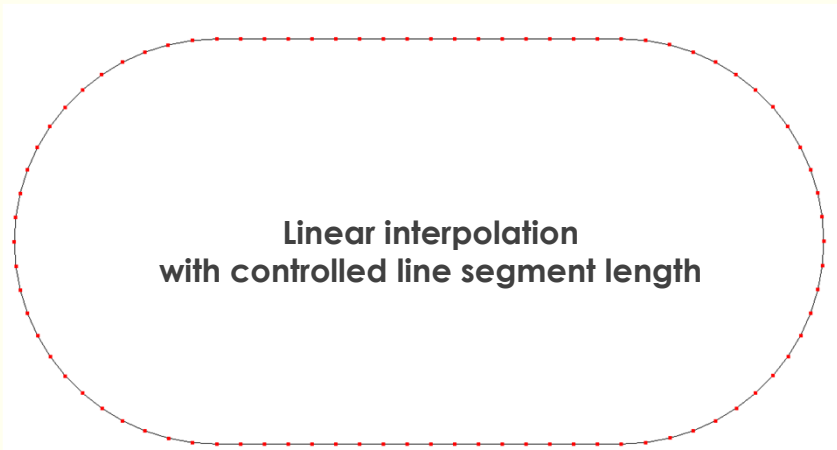
Feedrate = 10000mm/min

CAM & Interpolation



Feedrate = 10000mm/min

CAM & Interpolation



Feedrate = 10000mm/min

CAM & Interpolation

Toolpath Length = 2.80m
Radius of arc = 4mm
Estimated cutting time = 16s

Toolpath Length = 3.51m
Radius of arc = 8mm
Estimated cutting time = 21s

Toolpath Length = 3.94m
Radius of arc = 12.84mm
Estimated cutting time = 22s

Actual Machining = 25s

Feedrate = 10000mm/min