

Introduction to CNC & Digital Fabrication — Technical Handout

This reference handout accompanies the CNC & Digital Fabrication Introduction. It details technical fundamentals, coordinate geometry, workflow stages, and detailed machine specs.

1 WHAT IS CNC & DIGITAL FABRICATION?

CNC stands for Computer Numerical Control. Unlike traditional manual tools requiring hand physical control, CNC machines use digital software commands to drive high-precision stepper/servo motors across programmed multi-axis toolpaths with micron-level accuracy.

THE DIGITAL FABRICATION WORKFLOW:

- CAD (Computer-Aided Design):** Creating the digital model/drawing in vector software (e.g. Fusion 360, Illustrator, Inkscape).
- CAM (Computer-Aided Manufacturing) / Slicing:** Converting geometry into toolpaths, feed rates, speeds, and machine command code (G-Code).
- Machine Execution:** The machine processor executes physical motion commands along defined X, Y, and Z coordinate axes.

2 UNDERSTANDING COORDINATE AXES & GEOMETRY

- **X-Axis:** Horizontal Cartesian movement (Left / Right motion).
- **Y-Axis:** Depth Cartesian movement (Forward / Backward motion).
- **Z-Axis:** Vertical Cartesian movement (Up / Down depth passes).
- **Origin (0,0,0) / Machine Home:** The reference point from which all G-code toolpaths are calculated.

3 DETAILED MACHINE SPECIFICATIONS & FUNDAMENTALS

Digital Tool Technology	Technical Fundamentals & Operating Rules
CO2 Laser Cutter (Thermal Light Subtractive)	• How It Works: Concentrates a focused infrared laser beam via optics to vaporize material. • Modes: Vector Cutting (high power, slow speed to penetrate) vs. Raster Engraving (high speed, pulsed scan to burn graphics). • Key Parameters: Power (%), Speed (mm/s), Frequency (Hz), Focal Length. • DANGEROUS MATERIALS WARNING: NEVER cut PVC, Vinyl, or chlorine materials. Heating generates deadly chlorine gas and hydrochloric acid which destroys optics and lungs.

Digital Tool Technology	Technical Fundamentals & Operating Rules
3D Printer (FDM) (Additive Manufacturing)	• How It Works: Melts thermoplastic filament through a heated nozzle, depositing successive layers onto a build bed. • Key Parameters: Layer Height (resolution, 0.1–0.3mm), Infill Density (% internal grid strength), Nozzle & Bed Temp. • Best Uses: Complex 3D organic geometry, hollow enclosures, rapid prototyping.
CNC Router (Rotary Milling Subtractive)	• How It Works: High-speed electric spindle spins cutting end mills to physically carve material away in controlled depth passes. • Key Parameters: Spindle RPM, Feed Rate (mm/min), Stepdown / Depth of Cut, Tool Geometry. • Workholding: Material MUST be rigidly clamped, screwed, or vacuum-held to spoilboard.
Vinyl Cutter (Drag-Knife Plotter)	• How It Works: High-precision drag blade slices top film layer while stock is driven along Y-axis rollers. • Key Parameters: Blade Downforce (grams), Blade Depth/Extension. • Post-Processing: Manual 'weeding' of negative space followed by transfer tape application.

Note: Keep this handout as an educational reference guide. All physical machine access must be booked and supervised through CSL staff.