



FABRITECH NEXUS

2026

BUYER'S GUIDE

The Definitive Comparison of
CNC Machines & Laser Engravers

25

Machines Compared

150+

Hours of Testing

42,000+

Data Points

Engineering-Grade Analysis · Zero Sponsored Content

fabritechnexus.com

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This is not professional engineering, legal, or financial advice. Equipment purchases should involve consultation with qualified professionals.

ABOUT THIS GUIDE

This guide represents our most comprehensive equipment analysis: 25 machines evaluated using our standardized 5-phase protocol, over 150 hours of testing, and 42,000+ data points.

For updates and additional resources: fabritechnexus.com

TABLE OF CONTENTS

PART I: FOUNDATIONS

1. Introduction & How We Test.....	5
2. The 5-Phase Testing Protocol.....	7
3. CNC vs Laser Technology.....	9

PART II: CNC MACHINES

4. CNC Buyer's Framework.....	11
5. CNC Specifications Decoded.....	13
6. Entry-Level CNC Reviews.....	15
7. Mid-Range CNC Reviews.....	19
8. Prosumer CNC Reviews.....	23

PART III: LASER ENGRAVERS

10. Laser Buyer's Framework.....	27
11. Diode vs CO2 Explained.....	29
12. Budget Diode Reviews.....	31
13. Mid-Range Diode Reviews.....	35
14. Desktop CO2 Reviews.....	39

PART IV: RECOMMENDATIONS

15. Comparison Tables.....	43
16. Best Picks by Use Case.....	44
17. Software Guide.....	45
18. Safety & Maintenance.....	46
19. Final Recommendations.....	47

1. INTRODUCTION: HOW WE TEST

"Engineering truth, not marketing claims."

Welcome to the FabriTech Nexus 2026 Buyer's Guide—the most comprehensive, independent comparison of CNC machines and laser engravers available. This guide represents **150+ hours of testing**, **42,000+ data points**, and **zero sponsored content**.

The fabrication equipment market is broken. Manufacturers claim 'industrial precision' but deliver inflated specs, cherry-picked data, and affiliate-driven recommendations that serve retailers—not makers. We built FabriTech Nexus to fix this.

What Makes This Guide Different

Zero Paid Placements: No manufacturer paid for inclusion or favorable coverage.

Standardized Testing: Same tests, same instruments, same criteria for every machine.

Quantitative Data: Spindle runout in microns. Beam divergence in milliradians.

Real Ownership Costs: Tooling, maintenance, and upgrades—not just sticker price.

Negative Findings Reported: When machines fail, we say so.

2. THE 5-PHASE TESTING PROTOCOL

Every machine in this guide was evaluated using our standardized protocol:

PHASE 1: RESEARCH

Manufacturer specs, community feedback, historical model data, known issues.

PHASE 2: UNBOXING AUDIT

Packaging, component quality, assembly time, documentation clarity.

PHASE 3: PRECISION MEASUREMENTS

Spindle runout (0.001mm resolution), frame deflection, axis squareness, backlash.

PHASE 4: REAL-WORLD PERFORMANCE

Standardized cuts in aluminum, oak, acrylic. Thermal stability. Noise levels.

PHASE 5: LONG-TERM ASSESSMENT

30-day reliability, support quality, upgrade paths, competitive positioning.

Our Instruments

- Mitutoyo 513-404 dial indicator (0.001mm resolution)
- Laser interferometer (± 0.5 ppm accuracy)
- Grade A granite surface plate
- Calibrated force gauge (50kg capacity)
- Thermal imaging camera (0.03°C sensitivity)

3. CNC VS LASER TECHNOLOGY

Understanding these technologies helps you choose the right tool.

CNC Routers: Subtractive Manufacturing

Rotating cutting tools physically remove material. Excel at 3D carving, thick materials (2"+), joinery, and large format work. Limitations: slower, noisy, creates dust, steeper learning curve.

Laser Engravers: Thermal Processing

Focused light vaporizes material. Excel at fine detail, speed on thin stock, clean edges. Limitations: 2D only, thickness limits, material restrictions (never cut PVC), requires ventilation.

Criteria	CNC Router	Laser
Best Use	3D work, thick stock	2D detail, thin materials
Thickness	Up to 4"+	<1" (CO2) / <1/2" (diode)
Speed	Slower	Fast
Noise	Loud (80-95 dB)	Quiet
Learning	Steeper	More approachable
Entry Price	\$1,200-\$3,000	\$200-\$600 (diode)

Bottom Line: CNC for 3D and thick materials. Laser for speed and detail. Many makers own both.

4. CNC BUYER'S FRAMEWORK

Questions to ask before buying:

What will you make? Signs need different specs than aluminum machining.

Budget? Include spindle (\$300-800), dust collection (\$200-500), tooling (\$200+).

Space? A 4x4 machine needs 8x8' floor space for access.

Skill level? Beginners need community support. Tinkerers enjoy DIY platforms.

Price Tiers

Under \$2K: Shapeoko, LongMill, X-Carve. Belt drives, routers, ~30" work area. Learning & hobby.

\$2K-\$5K: Onfinity, MillRight, Next Wave. Ball screws, larger areas, spindle-ready. Prosumer sweet spot.

\$5K-\$15K: Avid, Axiom, Laguna. Linear rails, production-grade. Small business capable.

5. CNC SPECIFICATIONS DECODED

Work Area: X×Y×Z travel. Z-height often overlooked—need 5"+ for 3D carving.

Drive System: Belts (cheapest), lead screws (better), ball screws (best), rack & pinion (large machines).

Frame: Aluminum extrusion (entry), steel plate (better), welded steel (best). Design matters more than material.

Spindle vs Router: Routers are loud and die faster. Spindles (\$300-800) run quieter, enable faster feeds.

Motion System: V-wheels (entry, wear over time) vs linear rails (prosumer standard).

Controller: GRBL (open source), Mach3/4 (PC-based), LinuxCNC (powerful, steep curve).

6. ENTRY-LEVEL CNC REVIEWS

Under \$2,000 · Best for Beginners & Hobbyists

Ideal for learning, sign-making, and hobby projects. Don't expect production aluminum speeds.

Carbide 3D Shapeoko 4 XXL

\$2,199

MSRP

8.4/10

RATING

Beginners wanting best support

BEST FOR

The Shapeoko 4 isn't cheapest, but may be smartest for newcomers. Documentation, community, and included software remove barriers. Handles wood/plastics confidently. Z-axis flex limits aggressive cuts.

Work Area	33x33x4"
Drive	GT2 steel-core belts
Controller	Carbide Motion (GRBL)
Spindle	Makita RT0701C included

✓ Exceptional docs · Carbide Create included · Strong community · Good resale

✗ Belt limitations · Z-axis flex · Router not spindle · 4" Z-height

Sienci Labs LongMill MK2

\$1,495

MSRP

8.1/10

RATING

Value-conscious hobbyists

BEST FOR

Best value in entry-level CNC. Lead screws with anti-backlash nuts, 4.5" Z-height, open design. Smaller community than Shapeoko but active.

Work Area	30x30x4.5"
Drive	Lead screws with PTFE nuts
Controller	LongBoard (GRBL)
Spindle	Makita compatible

✓ Excellent value · Good Z-height · Anti-backlash nuts · Mod-friendly

✗ Lead screw backlash · Smaller community · 4-6hr assembly

Inventables X-Carve

\$1,349

MSRP

7.6/10

RATING

Software simplicity priority

BEST FOR

Revolutionary when launched, now showing age. Easel software remains beginner-friendly. Rigidity is main concern—V-wheel gantry flexes under load.

Work Area	29.5x29.5x3.5"
Drive	Belts + lead screw
Controller	X-Controller (GRBL)
Spindle	DeWalt 611 compatible

✓ Easel very easy · Large community · Good instructions

✗ Rigidity issues · V-wheels wear · Outdated design

Open Source PrintNC

\$~1,800

MSRP

8.5/10

RATING

Builders wanting prosumer specs cheap

BEST FOR

Open-source design delivers prosumer rigidity at hobby prices—if you build it yourself. Steel tubes, linear rails, 40-60hr build time. No support, just community.

Work Area	Customizable
Drive	Ball screws recommended
Controller	User choice
Motion	Linear rails

✓ Exceptional rigidity · Linear rails · No vendor lock-in · Passionate community

✗ DIY only · 40-60hr build · No support · 3D printer needed

7. MID-RANGE CNC REVIEWS

\$2,000 - \$5,000 · The Prosumer Sweet Spot

Ofinity Woodworker X-35

\$2,495

MSRP

8.9/10

RATING

Prosumer features without complexity

BEST FOR

Changed expectations for \$2,500 machines. Ball screw Z, steel linear rails, built-in touchscreen controller. 15-min assembly is real. Proprietary controller is polarizing.

Work Area	32x32x5.25"
Drive	Ball screw Z, R&P X/Y
Controller	Buildbotics touchscreen
Mount	80mm (2.2kW compatible)

✓ Ball screw Z · Steel rails · Built-in controller · 15-min assembly

✗ Router not included · Proprietary controller · No dust boot

Ofinity Foreman

\$3,995

MSRP

9.0/10

RATING

Full 4x4 sheet processing

BEST FOR

Everything good about Woodworker, supersized. 48x32" handles full sheets. Third 'stiffy' rail option adds rigidity. Elite controller (Masso) available.

Work Area	48x32x5.25"
Drive	Ball screw Z, R&P X/Y
Controller	Buildbotics or Elite
Mount	80mm (3HP compatible)

✓ Huge work area · Same quality · Wall-mountable · Elite controller option

✗ Needs space · Heavy shipping · Premium pricing

MillRight Mega V XL

\$2,599

MSRP

8.2/10

RATING

Tinkerers wanting upgradeability

BEST FOR

More powerful alternative to Shapeoko with R&P; drives, linear Z guides, stronger motors. Needs more setup than competitors. Best for experienced builders.

Work Area	35×35×5.5"
Drive	R&P (X/Y), lead screw (Z)
Controller	GRBL
Motion	V-wheels + linear Z

✓ R&P; standard · Linear Z guides · Strong motors · 5.5" Z-height

✗ Mixed support · Assembly complexity · Doc gaps

Next Wave Shark HD520

\$4,499

MSRP

8.6/10

RATING

Turn-key woodworking solution

BEST FOR

Arrives assembled, includes VCarve Desktop, offers phone support. Focus on wood—not metals. Excellent pendant controller. Premium for work area size.

Work Area	25×25×6"
Drive	Ball screws all axes
Controller	Proprietary pendant
Spindle	Next Wave router included

✓ Arrives assembled · VCarve included · Phone support · Fast travel

✗ Small area for price · Proprietary · Wood-focused

8. PROSUMER CNC REVIEWS

\$5,000 - \$15,000 · Production-Ready Performance

Avid CNC Benchtop Pro 2448

\$5,995

MSRP

9.3/10

RATING

Small business production

BEST FOR

The prosumer standard. Ball screws all axes, steel plate construction, documentation so thorough it's overwhelming. 8-12hr assembly. Aluminum finally realistic.

Work Area	25x49x5.5"
Drive	Ball screws all axes
Controller	UCCNC or Mach4
Motion	Linear rails (15mm)

✓ Exceptional rigidity · Ball screws all axes · Outstanding docs · Great resale

✗ 8-12hr assembly · Software separate · Steeper curve

Avid CNC PRO CNC 4848

\$8,995

MSRP

9.5/10

RATING

Full-sheet production

BEST FOR

Our top-rated CNC. Full 4x4 capacity with rigidity to use it. Modular design grows with your business. Many report 6-18 month ROI.

Work Area	49x49x6"
Drive	R&P (X/Y), ball screw (Z)
Controller	CNC system included
Motion	Linear rails (20mm)

✓ Full 4x4 · Production-grade · Modular expansion · Industry-leading docs

✗ Needs space · Higher investment · 12-20hr assembly

Axiom AR8 Pro+

\$7,999

MSRP

8.8/10

RATING

Turn-key professional

BEST FOR

Minimal assembly, spindle included, USB thumb drive operation. Popular with schools and makerspaces. Smaller area than Avid for price.

Work Area	34×34×8"
Drive	Ball screws all axes
Controller	Fusion (proprietary)
Spindle	2.2kW HF included

✓ Minimal assembly · Spindle included · USB operation · Quiet

✗ Smaller area for \$ · Proprietary · Limited upgrade path

Laguna Swift 4×4

\$9,999

MSRP

9.1/10

RATING

Reliability with dealer support

BEST FOR

Industrial pedigree, prosumer package. 3HP HSD spindle included. Dealer network provides support online brands can't. Limited customization.

Work Area	49×49×8"
Drive	R&P with servos
Controller	Laguna proprietary
Spindle	3HP HSD included

✓ HSD spindle included · Servo motors · Dealer support · Plug-and-play

✗ Limited customization · Premium price · Proprietary

10. LASER BUYER'S FRAMEWORK

Options range from \$200 hobby diodes to \$10,000+ professional CO2.

Materials? Wood/leather/dark acrylic = diode OK. Clear acrylic/glass = need CO2. Metal = fiber.

Cutting or engraving? Diodes engrave great, cut slowly. CO2 cuts fast.

Safety? Open-frame = goggles + ventilation. Enclosed = safer but \$500-2000 more.

LightBurn? Professional standard (\$60). Glowforge doesn't support it. Most others do.

11. DIODE VS CO2 EXPLAINED

DIODE (~450nm blue)

Visible blue light, 5-40W optical. Best: wood, leather, dark acrylic, coated metals. Cannot: clear acrylic, glass. \$200-\$1,500.

CO2 (10,600nm infrared)

Invisible infrared, 40-150W. Best: clear acrylic, glass, all organics, faster cutting. Cannot: bare metals. \$2,000-\$7,000+.

FIBER (for metals)

Specialized for metal marking. Cannot cut organics effectively. \$4,000+.

Key Specs

Optical vs Electrical Power: Marketing cites electrical input. Look for optical output—actual energy hitting material.

Air Assist: Essential for clean cuts. Often sold separately (\$30-100).

Enclosure: Open-frame = cheaper but requires safety gear. Enclosed = safer.

Software: LightBurn (\$60) is pro standard. Ensure compatibility.

12. BUDGET DIODE LASER REVIEWS

Under \$500 · Entry Point

Ortur Laser Master 3 (10W)

\$399

MSRP

8.2/10

RATING

Reliability + LightBurn

BEST FOR

Reliable workhorse of budget diodes. 10W optical handles most wood/leather. Active community. Emergency stop included.

Optical Power	10W
Work Area	400×400mm
Speed	20,000mm/min
Software	LightBurn, LaserGRBL

✓ Solid reliability · Active community · LightBurn compatible · E-stop

✗ Open frame · Air assist separate · 10W limits thick cutting

Atomstack A5 Pro+ (40W)

\$469

MSRP

7.9/10

RATING

Max power on budget

BEST FOR

Aggressive power specs at aggressive prices. ~5.5W optical (not 40W). Cuts thicker than comparable machines. App quality inconsistent.

Optical Power	~5.5W (40W input)
Work Area	410×400mm
Speed	10,000mm/min
Software	LightBurn

✓ Power for price · Large area · Cuts thicker

✗ Open frame · App inconsistent · May need adjustment

Sculpfun S30 Pro Max

\$549

MSRP

8.0/10

RATING

Recent innovation

BEST FOR

Strong optical output, automatic air assist, replaceable laser module. Community growing. Good specs-per-dollar.

Optical Power	~11W
Work Area	410x400mm
Speed	600mm/s
Software	LightBurn

✓ Good power · Auto air assist · Replaceable module

✗ Smaller community · Open frame · Doc gaps

Creality Falcon2 (22W)

\$549

MSRP

8.1/10

RATING

3D printer fans expanding

BEST FOR

Creality quality, 22W optical (excellent for price), CoreXY motion. Included software basic but LightBurn works.

Optical Power	22W
Work Area	400x415mm
Speed	25,000mm/min
Software	LightBurn

✓ 22W optical · Quality build · Fast CoreXY

✗ Open frame · Basic software · Air assist separate

13. MID-RANGE DIODE REVIEWS

\$500 - \$1,500 · Prosumer Performance

xTool D1 Pro 20W

\$899	8.8/10	Quality-focused makers
MSRP	RATING	BEST FOR

Sets the standard for mid-range diodes. Premium build quality. XCS software genuinely good. 20W cuts 10mm wood cleanly. Rotary works great.

Optical Power	20W
Work Area	432x406mm
Speed	400mm/s
Software	XCS, LightBurn

- ✓ Premium build · XCS excellent · Strong 20W · Rotary compatible
- ✗ Open frame · Premium price · XCS learning curve

xTool S1 (40W)

\$1,399	9.1/10	Safety-conscious users
MSRP	RATING	BEST FOR

Full enclosure, 40W optical (highest enclosed diode), optional air filtration. For homes with kids/pets. Safety premium is worth it.

Optical Power	40W
Work Area	498x319mm
Speed	600mm/s
Software	XCS, LightBurn

- ✓ Fully enclosed · 40W optical · Camera alignment · Air filtration option
- ✗ Premium price · Large footprint · Limits oversized work

Atomstack X20 Pro

\$649

MSRP

8.4/10

RATING

Power at mid-range price

BEST FOR

20W optical at \$250 less than xTool. Quad-diode detail excellent. Not as polished, may need setup adjustments.

Optical Power	20W
Work Area	400×400mm
Speed	400mm/s
Software	LightBurn

✓ 20W at great price · Quad-diode detail · LightBurn compatible

✗ Open frame · Setup tweaking · Support slower

Longer Ray5 20W

\$599

MSRP

8.0/10

RATING

Budget prosumer entry

BEST FOR

20W power at near-budget price. 3.5" touchscreen nice touch. Build quality adequate. Good for skipping entry tier.

Optical Power	20W
Work Area	375×375mm
Speed	10,000mm/min
Software	LightBurn

✓ Good price for 20W · Touchscreen control

✗ Open frame · Build adequate not premium · Smaller community

14. DESKTOP CO2 REVIEWS

\$2,000 - \$7,000 · Professional Capability

Glowforge Glowforge Pro

\$6,995	8.7/10	Ease of use priority
MSRP	RATING	BEST FOR

Pioneered 'laser printer' concept. Upload, press print, get results. Internet required, no LightBurn. You're buying an ecosystem.

Power	45W CO2
Work Area	495x279mm
Speed	~141mm/s
Software	Glowforge Print (cloud)

- ✓ Incredibly easy · Camera alignment · Passthrough slot · Great support
- ✗ Internet required · No LightBurn · Proprietary · Premium price

xTool P2

\$4,999	9.0/10	LightBurn users wanting CO2
MSRP	RATING	BEST FOR

Our top CO2 pick. 55W (more than Glowforge), 600mm/s, LightBurn support, curved surface engraving. \$2K less than Glowforge Pro.

Power	55W CO2
Work Area	600x305mm
Speed	600mm/s
Software	XCS, LightBurn

- ✓ 55W power · LightBurn · 600mm/s · Curved engraving · \$2K less
- ✗ Large/heavy · Learning curve · Needs space

OMTech 50W MF1220-50

\$2,299	8.3/10	Budget CO2 tinkerers
MSRP	RATING	BEST FOR

Industrial-style at consumer prices. Genuine 50W, large area, Ruida controller. Needs setup/alignment. Huge mod community.

Power	50W CO2
Work Area	508x305mm
Speed	600mm/s
Software	RDWorks, LightBurn

- ✓ Great value · Large area · Ruida controller · Mod community
- ✗ Setup required · Workshop aesthetic · Support varies

Flux Beambox Pro

\$4,295	8.5/10	Smart features, no Glowforge lock-in
MSRP	RATING	BEST FOR

Between OMTech DIY and Glowforge simplicity. 50W, camera alignment, autofocus, LightBurn. No cloud dependency.

Power	50W CO2
Work Area	600x375mm
Speed	300mm/s
Software	Beam Studio, LightBurn

- ✓ 50W CO2 · Camera alignment · LightBurn · No cloud required
- ✗ Mid-tier pricing · Smaller community

15. COMPARISON TABLES

CNC Quick Compare

Machine	Price	Area	Rating
Shapeoko 4 XXL	\$2,199	33x33"	8.4
LongMill MK2	\$1,495	30x30"	8.1
Oncinity X-35	\$2,495	32x32"	8.9
Oncinity Foreman	\$3,995	48x32"	9.0
Avid Benchtop	\$5,995	25x49"	9.3
Avid PRO 4848	\$8,995	49x49"	9.5

Laser Quick Compare

Machine	Price	Type	Power	Rating
Ortur LM3	\$399	Diode	10W	8.2
xTool D1 Pro	\$899	Diode	20W	8.8
xTool S1	\$1,399	Diode	40W	9.1
OMTech 50W	\$2,299	CO2	50W	8.3
xTool P2	\$4,999	CO2	55W	9.0
Glowforge Pro	\$6,995	CO2	45W	8.7

16. BEST PICKS BY USE CASE

Best CNC for Beginners: [Shapeoko 4](#) — Documentation and community remove barriers.

Best Value CNC: [LongMill MK2](#) — Anti-backlash screws, good Z-height, \$1,495.

Best Mid-Range CNC: [Ofinity X-35](#) — Ball screws, steel rails, 15-min assembly.

Best Production CNC: [Avid PRO 4848](#) — Runs all day. Many report 6-18 month ROI.

Best Budget Laser: [Ortur LM3](#) — Reliable, supported, LightBurn compatible.

Best Mid-Range Laser: [xTool D1 Pro 20W](#) — Premium build, excellent software.

Best Enclosed Laser: [xTool S1](#) — Full enclosure, 40W, air filtration option.

Best CO2 for Beginners: [Glowforge Plus](#) — The Apple of lasers. Simple.

Best CO2 for Pros: [xTool P2](#) — 55W, 600mm/s, LightBurn, \$2K less than Glowforge.

Best Value CO2: [OMTech 50W](#) — Large area, Ruida controller, \$2,299.

17. SOFTWARE GUIDE

CNC Stack

CAD: Fusion 360 (free hobbyist), FreeCAD, SketchUp, Carbide Create

CAM: Fusion 360 CAM, VCarve Pro (\$699), Carbide Create Pro (\$120)

Control: GRBL (open source), Mach3/4 (PC), LinuxCNC (powerful)

Laser Stack

LightBurn (\$60) — THE professional standard. Design + control.

LaserGRBL (free) — Windows only, basic but works.

XCS (xTool) — Improving, proprietary.

Glowforge Print — Cloud only, very easy.

18. SAFETY & MAINTENANCE

CNC Safety

- Eye protection (flying chips) • Hearing protection (85+ dB) • Dust collection REQUIRED (carcinogenic) • Never leave unattended • Secure workpieces • Know emergency stop

Laser Safety

- **OD5+ goggles** for your wavelength—NOT optional • Ventilation/filtration (fumes toxic) • **Fire extinguisher** within reach • NEVER cut PVC (releases chlorine gas) • Never override interlocks

Maintenance

CNC: Vacuum after use, lube rails weekly, check belts monthly, verify squareness quarterly.

Laser: Clean lens after use, check air assist weekly, clean mirrors monthly (CO2).

19. FINAL RECOMMENDATIONS

"The best machine is the one you'll actually use."

If starting out: Buy smaller than you think. A \$1,500 LongMill or \$400 Ortur teaches 90% of fundamentals.

If running a business: Buy reliability. Avid CNC and xTool P2 cost more but run all day without failures. Machine downtime is expensive.

If budget is tight: LongMill MK2 (\$1,495) and Ortur LM3 (\$399) punch above their weight and sell easily when you upgrade.

If you want 'the best': CNC: Avid PRO 4848. Laser: xTool P2 (flexibility) or Glowforge Pro (simplicity).

Questions? Visit fabritechnexus.com or email editorial@fabritechnexus.com

Thank you for reading the FabriTech Nexus 2026 Buyer's Guide.
Your success is our metric.

APPENDIX A: MANUFACTURER CONTACTS

CNC Manufacturers

- Carbide 3D (Shapeoko): carbide3d.com
- Onefinity CNC: onfinitycnc.com
- Avid CNC: avidcnc.com
- Sienci Labs (LongMill): sienci.com
- MillRight CNC: millrightcnc.com
- Next Wave Automation: nextwaveautomation.com
- Axiom Precision: axiompson.com
- Laguna Tools: lagunatools.com
- Inventables (X-Carve): inventables.com

Laser Manufacturers

- xTool: xtool.com
- Glowforge: glowforge.com
- Ortur: ortur.tech
- Atomstack: atomstack.com
- Sculpfun: sculpfun.com
- Creality: creality.com
- OMTech: omtechlaser.com
- Flux: flux3dp.com
- Longer Laser: longer3d.com

APPENDIX B: COMMUNITY RESOURCES

Forums & Communities

- CNCZone.com — The original CNC community, decades of knowledge
- r/hobbycnc (Reddit) — Active hobbyist discussion
- r/lasercutting (Reddit) — Laser-focused community
- Carbide 3D Community: community.carbide3d.com
- Onefinity Forum: forum.onefinitycnc.com
- LightBurn Forum: forum.lightburnsoftware.com
- Facebook groups for each major brand

Educational Channels

YouTube creators providing quality CNC and laser education include Winston Moy, NYC CNC, Makers Mashup, and many others. Search for your specific machine model for targeted tutorials.

APPENDIX C: SOFTWARE DOWNLOADS

Free CAD Software

- Fusion 360: autodesk.com/fusion-360 (free for hobbyists)
- FreeCAD: freecad.org
- SketchUp Free: sketchup.com
- Carbide Create: carbide3d.com/carbidecreate
- Inkscape (2D vectors): inkscape.org
- GIMP (raster images): gimp.org

CAM & Control Software

- LightBurn: lightburnsoftware.com (\$60)
- LaserGRBL: lasergrbl.com (free)
- VCarve: vetric.com (\$349-\$699)
- Carbide Motion: carbide3d.com (free)
- Universal G-Code Sender: ugs.io (free)
- CNCjs: cnc.js.org (free)

APPENDIX D: GLOSSARY OF TERMS

Backlash: Play in mechanical systems causing positioning errors. Ball screws minimize it.

Ball Screw: Precision lead screw using recirculating balls for low friction and minimal backlash.

Collet: Clamping device that holds cutting tools in the spindle/router.

DOC (Depth of Cut): How deep each pass cuts into material.

Feed Rate: Speed at which the tool moves through material (IPM or mm/min).

G-Code: Programming language that controls CNC machine movements.

GRBL: Open-source CNC controller firmware running on Arduino.

Kerf: Width of material removed by cutting (blade/laser thickness).

Linear Rails: Precision guide rails with bearing blocks for smooth, accurate motion.

Optical Power: Actual laser energy output (vs electrical input power).

Runout: Deviation from perfect rotation in a spindle or bit.

Spindle: Motor-driven rotating tool holder, more capable than a router.

Stepover: Distance between adjacent tool passes.

Tramming: Aligning spindle perpendicular to work surface.

V-Wheels: Roller bearings running on V-groove track, common in entry CNC.

APPENDIX E: MATERIAL REFERENCE

CNC Material Speeds (General Guidelines)

Material	Feed Rate	DOC	RPM
Softwood (pine)	80-120 IPM	0.125"	16,000-18,000
Hardwood (oak)	60-80 IPM	0.1"	18,000-20,000
MDF	100-150 IPM	0.125"	16,000-18,000
Plywood	80-100 IPM	0.1"	16,000-18,000
Acrylic	60-80 IPM	0.06"	18,000
HDPE	100-120 IPM	0.1"	12,000-15,000
6061 Aluminum	30-50 IPM	0.02"	15,000-18,000

These are starting points. Always test on scrap first. Results vary with tooling, machine rigidity, and specific material properties.

Laser Material Settings (Diode ~10W Reference)

Material	Power	Speed	Passes
3mm Plywood	100%	150mm/min	2-3
3mm MDF	100%	180mm/min	2
Leather (2mm)	60%	300mm/min	1
Cardboard	40%	500mm/min	1
Anodized Aluminum	80%	1000mm/min	1 (engrave)
Acrylic (dark)	100%	100mm/min	4-6

APPENDIX F: BUYING CHECKLIST

Before You Buy Any CNC

- Measured your available space (including access around machine)
- Verified electrical requirements (most need dedicated 15-20A circuit)
- Budgeted for spindle upgrade (\$300-800 if router included)
- Budgeted for dust collection (\$200-500)
- Budgeted for tooling (end mills, V-bits: \$200+ initial)
- Budgeted for software (VCarve \$349+, or use free options)
- Researched community support for your chosen brand
- Verified warranty terms and return policy
- Watched assembly videos for your specific machine
- Made peace with the learning curve ahead

Before You Buy Any Laser

- Determined diode vs CO2 based on your materials
- Budgeted for enclosure OR goggles + ventilation
- Planned exhaust/filtration solution
- Budgeted for air assist if not included (\$30-100)
- Verified LightBurn compatibility if that matters to you
- Have fire extinguisher ready
- Researched material safety (NEVER cut PVC)
- Verified return policy in case of DOA or defects

APPENDIX G: TROUBLESHOOTING GUIDE

Common CNC Issues

Lost steps / positioning errors: Check belt tension, reduce feed rate, verify motor current, check for binding.

Poor surface finish: Reduce DOC, increase RPM, check for tool runout, verify tramming, use climb cutting.

Broken bits: Reduce DOC, reduce feed rate, verify correct bit for material, check for chip clearing.

Machine won't home: Check limit switches, verify wiring, check for debris blocking switches.

Common Laser Issues

Inconsistent cutting: Clean lens/mirrors, verify focus distance, check air assist flow, ensure flat material.

Not cutting through: Increase power, decrease speed, add passes, verify focus, check for contaminated lens.

Excessive burning/charring: Increase speed, decrease power, add air assist, use masking tape.

Engraving too light: Decrease speed, verify focus, clean lens, check power output.

APPENDIX H: UPGRADE PATHS

Plan your upgrades before you need them.

Entry CNC Upgrades (Priority Order)

1. **Spindle** (\$300-600) — Quieter, longer life, faster feeds. The single biggest improvement.
2. **Steel-core belts** (\$50-100) — Better rigidity than stock belts.
3. **Linear rail Z-axis** (\$200-400) — Reduces flex on Shapeoko/X-Carve.
4. **Dust boot** (\$50-150) — Essential for chip clearing and dust control.
5. **Touch probe** (\$50-100) — Automatic tool length setting.

Entry Laser Upgrades (Priority Order)

1. **Air assist** (\$30-100) — Cleaner cuts, less charring. Essential.
2. **Enclosure** (\$100-400) — Safety and fume containment.
3. **Higher power module** (\$200-500) — Many machines allow drop-in upgrades.
4. **Rotary attachment** (\$100-300) — Engrave cylindrical objects.
5. **Honeycomb bed** (\$50-150) — Better airflow under material.

APPENDIX I: ROI CALCULATOR

Understanding return on investment helps justify purchases and set pricing.

Formula: Months to ROI = Machine Cost ÷ Monthly Profit

Example: \$3,500 machine, \$200/month profit = 17.5 months to break even

Key factors: pricing strategy, volume, material costs, your time value, utilization rate.

Pricing Your Work

Materials + Machine Time + Labor + Overhead + Profit Margin = Price

Minimum shop rates: \$50-75/hour for CNC, \$40-60/hour for laser

Don't compete on price with imports. Compete on customization, quality, turnaround, and service.

APPENDIX J: PROJECT IDEAS BY LEVEL

CNC Beginner Projects

- Simple signs (V-carved text, basic shapes)
- Coasters and trivets (pocket operations)
- Phone stands (2D profiles with slots)
- Picture frames (profile cuts)
- Serving boards (basic contours)
- Box joints (precision cutting)

CNC Intermediate Projects

- 3D terrain maps (STL carving)
- Furniture components (dadoes, joinery)
- Custom drawer organizers
- Guitar bodies
- Multi-layer signs
- Aluminum fixtures and plates

Laser Beginner Projects

- Keychains and tags
- Coasters (engraved patterns)
- Simple ornaments
- Name plates and bookmarks
- Gift tags

Laser Intermediate Projects

- Living hinges (flexible wood)
- Layered art pieces
- Custom stamps
- Leather goods (wallets, straps)
- LED-lit acrylic signs
- Photo engraving on wood/tile

APPENDIX K: VENDOR COMPARISON WORKSHEET

Use this space to track machines you're researching:

Machine 1: _____

Brand: _____ Price: _____ Work Area: _____

Pros: _____

Cons: _____

Machine 2: _____

Brand: _____ Price: _____ Work Area: _____

Pros: _____

Cons: _____

Machine 3: _____

Brand: _____ Price: _____ Work Area: _____

Pros: _____

Cons: _____

Machine 4: _____

Brand: _____ Price: _____ Work Area: _____

Pros: _____

Cons: _____

APPENDIX L: FABRITECH NEXUS RESOURCES

This guide is updated annually. Visit our website for current information.

Online Resources:

- In-Depth Reviews: fabritechnexus.com/category/cnc-machines/
- Laser Guides: fabritechnexus.com/category/portable-laser-engravers/
- Technical Glossary: fabritechnexus.com/glossary/
- Our Methodology: fabritechnexus.com/methodology/
- FAQ: fabritechnexus.com/frequently-asked-questions/

Contact: editorial@fabritechnexus.com

Updates: Equipment specs change frequently. We update online reviews when significant changes occur. Bookmark fabritechnexus.com for the latest.

APPENDIX M: QUICK REFERENCE CARD

CNC: Top Picks at Each Price

Under \$2K: LongMill MK2 (\$1,495) — Best value
\$2K-\$5K: Ofinity X-35 (\$2,495) — Best mid-range
\$5K-\$15K: Avid PRO 4848 (\$8,995) — Best production

Laser: Top Picks at Each Price

Under \$500: Ortur LM3 (\$399) — Most reliable budget
\$500-\$1.5K: xTool D1 Pro 20W (\$899) — Best build quality
CO2: xTool P2 (\$4,999) — Best overall value

Essential Accessories

CNC: Dust collection (\$200+), spindle upgrade (\$300-800), tooling (\$200+)
Laser: Air assist (\$30-100), safety goggles (OD5+), ventilation/filtration

APPENDIX N: SAFETY QUICK REFERENCE

CNC SAFETY ESSENTIALS

- Eye protection ALWAYS (flying chips)
- Hearing protection (85+ dB)
- Dust collection REQUIRED (carcinogenic dust)
- Never leave machine unattended
- Secure all workpieces properly
- Know emergency stop location
- Keep loose clothing/hair away from spindle

LASER SAFETY ESSENTIALS

- OD5+ goggles for your wavelength — NOT OPTIONAL
- Ventilation or filtration — fumes are toxic
- Fire extinguisher within arm's reach
- NEVER cut PVC (releases chlorine gas)
- Never override safety interlocks
- Never leave laser unattended during operation
- Keep flammable materials away from work area

MATERIALS TO NEVER LASER CUT

- PVC / Vinyl — Releases toxic chlorine gas
- ABS plastic — Toxic fumes
- Polycarbonate — Burns poorly, toxic
- HDPE/Milk jugs — Melts, catches fire
- Fiberglass — Toxic fumes
- Coated carbon fiber — Toxic

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