

# CNC Machining vs. Other Processes: What Makes It the Right Choice?

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# I. Introduction

In today's fast-paced manufacturing environment, product designers and engineers are presented with a wide range of production methods—from traditional casting to cutting-edge 3D printing. Each process has its strengths, and choosing the right one depends on factors like geometry, material, lead time, and cost.

**CNC machining** stands out as a versatile, precise, and reliable manufacturing method. But how does it compare to alternatives like injection molding, 3D printing, or die casting? This article provides a comprehensive comparison to help you understand when CNC machining is the best fit for your product development and production needs.



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# **II. What Is CNC Machining?**

CNC (Computer Numerical Control) machining is a **subtractive manufacturing process** that uses computercontrolled tools to remove material from a solid block (metal or plastic) to create custom parts. It includes operations like **milling**, **turning**, **drilling**, and **grinding**.

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### Why CNC Machining?

- Delivers tight tolerances (±0.001 mm possible)
- Compatible with metals and engineering plastics
- Excellent repeatability and dimensional accuracy
- Ideal for functional prototypes and low-to-medium volume production

CNC is often the go-to process when material strength, surface finish, and precision are non-negotiable.

### **III. Key Alternatives to CNC Machining**

Before determining when CNC is the best option, it's helpful to understand its main competitors:

### 1. Injection Molding

- Best for: Mass production of plastic parts
- Involves injecting molten plastic into a steel mold
- High upfront cost (tooling), but low cost per part at scale

### 2. 3D Printing (Additive Manufacturing)

- Best for: Rapid prototyping and complex geometries
- Builds parts layer-by-layer with minimal waste
- Lower strength and surface quality compared to CNC
- 3. Die Casting
  - Best for: High-volume production of metal parts
  - Molten metal is injected into a mold cavity
  - Excellent for lightweight and intricate metal parts

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### 4. Sheet Metal Fabrication

- Best for: Enclosures, brackets, panels
- Includes laser cutting, bending, punching
- Limited in thickness and 3D geometry

### 5. Vacuum Casting

- Best for: Low-volume plastic parts with production-like appearance
- Uses silicone molds and polyurethane resins
- Mimics injection-molded parts without the tooling cost

# **IV. Comparison Table: CNC Machining vs. Other Processes**

Feature / Process	CNC Machining	Injection Molding	3D Printing	Die Casting	Vacuum Casting
Setup Cost	Low	High (due to steel molds)	Very Low	High (due to metal tooling)	Medium (silicone molds)
Lead Time	Short	Long (tooling stage required)	Very Short	Medium	Medium
Tooling Requirement	None	Required	None	Required	Required
Unit Cost (Low Volume)	Moderate	High	Low	High	Moderate
Unit Cost (High Volume)	High	Very Low	Moderate	Very Low	High
Tolerances	Very Tight (±0.01mm)	Moderate to Tight	Moderate	Moderate	Moderate

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Feature / Process	CNC Machining	Injection Molding	3D Printing	Die Casting	Vacuum Casting
Material Variety	Wide (metals, plastics)	Limited to thermoplastics	Moderate (plastics, resins)	Limited to castable metals	Limited to casting resins
Surface Finish	Excellent (Ra 0.8– 1.6 μm)	Excellent (mold- dependent)	Fair (layer lines visible)	Very Good	Good
Post-Processing	Often required (deburring, polishing, coating)	Minimal	Often required (sanding, curing)	Optional (machining, plating)	Optional (trimming, painting)
Material Waste	High (subtractive)	Low	Very Low	Medium	Medium
Design Flexibility	Moderate (tool- access limits)	Moderate (depends on mold parting)	Very High (complex internal geometries)	Moderate (tool design constraints)	Moderate (mold- dependent)
Part Complexity	High (with accessible geometries)	Moderate	Very High	High	Moderate
Scalability	Good for low- medium runs	Excellent for mass production	Limited	Excellent for mass production	Limited to low volume
Environmental Impact	Higher (due to waste)	Medium	Low	Medium	Medium

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# V. When CNC Machining Is the Best Fit

CNC machining excels in several scenarios that other methods struggle with:

- **Tight Tolerances and Precision**: Ideal for aerospace, medical, and automotive components
- **Functional Prototypes**: Simulates real-world performance with production-grade materials
- **Low to Medium Volume Production**: Cost-effective without the need for expensive tooling

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- High-Strength Materials: Works with aluminum, stainless steel, titanium, and more
- Fast Turnaround: Rapid production for urgent design iterations or bridge manufacturing

# VI. When to Consider Other Manufacturing Processes

While CNC is versatile, it's not always the best option:

- A High-volume plastic parts → Injection molding offers better economies of scale
- **A** Extremely complex internal geometries  $\rightarrow$  3D printing enables designs CNC can't reach
- <u>A</u> Thin-walled metal parts in large quantities → Die casting is more efficient
- Appearance models or silicone-like plastics  $\rightarrow$  Vacuum casting is more cost-effective

Making the right decision often means balancing cost, lead time, and design requirements.

### VII. Industry Use Cases & Decision Factors

Different industries have varying needs that influence their choice of manufacturing process:

### 1. Aerospace & Defense

- Prioritize precision, strength, and certified materials  $\rightarrow$  CNC preferred
- 2. Medical Devices
  - Require biocompatibility, cleanliness, tight tolerances  $\rightarrow$  CNC or injection molding
- 3. Consumer Electronics
  - Balance of aesthetics and cost  $\rightarrow$  Injection molding, CNC for housings
- 4. **Robotics & Automation** 
  - Low-volume, custom metal components  $\rightarrow$  CNC machining is optimal
- 5. Automotive
  - Die casting for high-volume metal parts; CNC for prototyping and tooling



# **VIII. CNC Machining as a Strategic Choice**

CNC machining remains one of the most robust, reliable, and versatile manufacturing technologies in product development today. Whether you're engineering a prototype, validating a concept, or delivering low-volume production parts, CNC machining offers unmatched precision, material versatility, and speed.

### 1. CNC Machining Is Ideal When:

- Vou need tight tolerances and excellent dimensional accuracy
- Vou require parts made from metals or high-performance plastics
- You want to test mechanical functionality with production-grade materials
- You have low to medium volume needs without investing in tooling
- **V**ou're iterating quickly and need **flexibility in design changes**
- **Vou need end-use parts** with strong mechanical properties and clean finishes

#### 2. Before You Choose CNC Machining, Consider:

- A Your budget for each part—CNC can be costlier than molding in high volumes
- A The complexity of internal geometries—some shapes may require rethinking
- A The material waste—CNC is subtractive, not ideal for sustainability-driven programs

# **IX. Future-Proofing Your Product Development**

#### Highlights of different manufacturing processes:

- **CNC Machining** offers unbeatable precision, rapid setup, and wide material compatibility, making it ideal for functional parts and complex prototypes—even with higher waste.
- Injection Molding shines when it comes to mass production of plastics at the lowest per-part cost, but only after expensive tooling is completed.
- **3D Printing** enables unmatched design freedom, particularly for intricate or internal geometries, although it falls short in strength and finish.
- **Die Casting** is highly effective for **high-volume metal parts**, delivering consistent results with excellent surface quality.



• Vacuum Casting bridges the gap between prototyping and production-quality plastic parts—especially useful for short runs of aesthetic or elastomeric parts.

# X. Conclusion

In a product development world where speed, precision, and adaptability are key, CNC machining continues to be a smart choice. It bridges the gap between rapid prototyping and scalable production, making it invaluable in fields from medical devices and aerospace to consumer electronics and robotics. By understanding when and how to deploy CNC machining, you can reduce development cycles, minimize risks, and move your ideas from concept to creation faster than ever.

**Ready to bring your design to life with precision and speed?** Partner with a trusted CNC machining expert to accelerate your product development. <u>GEMS-MFG</u> is the comprehensive solution provider here for you. As a one-stop custom manufacturer, we provide a wide range of services, including rapid prototyping, mold making, injection molding, CNC machining, die casting, and more. Whether your requirements involve intricate prototypes or precision parts, GEMS-MFG is committed to delivering an efficient and cost-effective solution tailored to your needs.

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