

EDU[**CAD**]TION **STUDY GUIDE**

How to Design Around Cutting Processes

Chapter 5, Lesson 1

SendCutSend

The Cutting Process

- All cutting methods remove material along a defined path to separate your part from the surrounding stock.
- In fiber laser cutting, two primary elements work together:
 1. A focused laser beam that melts or vaporizes material.
 2. A high-pressure assist gas (typically nitrogen or oxygen) that blows molten material away from the cut. This process works only on conductive materials such as metals. The assist gas also acts as a shielding gas to protect the cut edge.

Key Terms to Know

- **Kerf:** The width of material removed during the cutting process. It forms the gap between your finished part and the scrap (see Figure 1.1).
- **Kerf Offset:** Half the kerf width, used to offset the toolpath so that the final part dimension matches your CAD design (see Figure 1.1).
- **Lead-In:** The small path from the pierce point into the actual cut line. It ensures a clean transition into the geometry (see Figure 1.2).
- **Pierce:** The initial point where the cutting tool first penetrates the material. It creates a small crater before the main cut begins (see Figure 1.2).

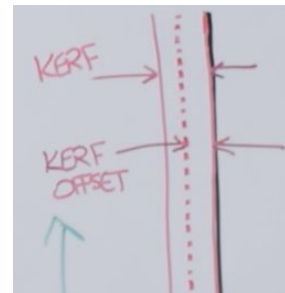


Figure 1.1

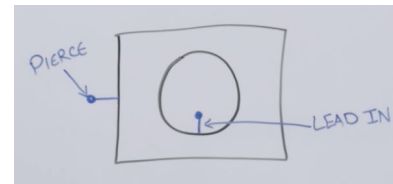


Figure 1.2

Key Terms Continued

- **Burr:** A small raised edge or rough surface left on the bottom of a part after cutting. Burr formation depends on material type, thickness, and cut quality, and it is most commonly caused by softer metals, thicker materials, or a slower cut speed (see Figure 1.3).

Note: SendCutSend offers Deburring services: <https://sendcutsend.com/services/deburring-services/>

- **Taper:** Because the laser spends more time cutting at the top of the material than the bottom, cut edges aren't perfectly vertical, they taper slightly inward.
- **Heat-Affected Zone (HAZ):** The area surrounding a cut that becomes heated but does not melt. Depending on the cutting method, this region may harden or slightly alter the material's properties. Because our fiber lasers operate at high speeds, the HAZ is minimal (see Figure 1.3).

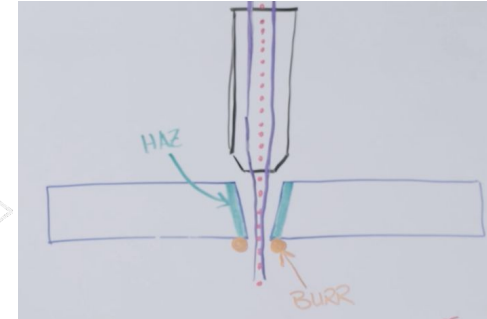


Figure 1.3

Cutting Process Comparison

- Different machines are going to have different versions of those terms:
- **Fiber Laser Cutting** (see Figure 1.4):
 - Uses heat to melt material.
 - Requires conductive materials (metals only).
 - Very fast and precise.
 - Slight taper and small burrs possible.
 - Minimal heat-affected zone.
- **CNC Router** (see Figure 1.5):
 - Removes material mechanically with a spinning end mill.
 - Generates a kerf equal to the tool diameter.
 - Kerf offset = tool radius ($\frac{1}{2}$ diameter).
 - Produces perpendicular edges (no taper).
 - Can ramp, plunge, or helical pierce for smooth entry.



Figure 1.4



Figure 1.5

Cutting Process Comparison Continued

- **Waterjet** (see Figure 1.6):
 - Uses high-pressure water and abrasive garnet.
 - Works on metals, composites, and plastics.
 - No heat or HAZ.
 - Larger kerf than laser due to abrasive width.
 - Burrs are rare, but slight edge roll-over can occur.



Figure 1.6

Design Considerations

Each cutting method behaves differently, so it's important to account for their limitations:

- **Laser and Waterjet:** May produce angled edges on thicker materials.
- **CNC Router:** Always cuts perpendicular but may leave small tool marks.
- **Material Choice:** Softer materials (like aluminum) produce larger burrs.
- **Thickness:** Thicker sheets mean slower cuts, more burr, and more kerf taper.

Designing with these realities in mind improves fit, assembly, and part consistency.

Summary

Understanding these terms prepares you to design with manufacturing realities in mind. By knowing how lasers, waterjets, and CNC routers interact with materials, you can predict part outcomes and ensure accurate, clean cuts every time.

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