

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

How to Design with Different Material Forms

Chapter 3, Lesson 3

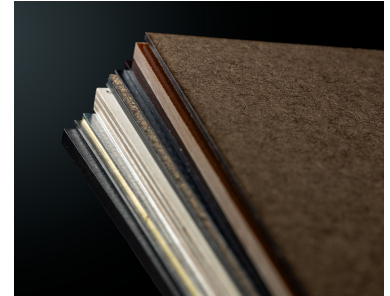
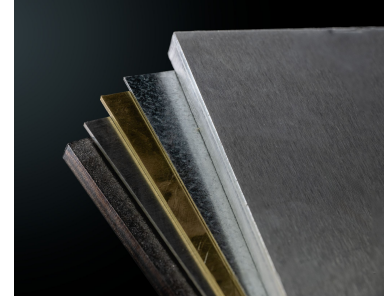
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Material + Machine = Reality

- In the previous lessons, we explored how combining material selection with manufacturing processes defines what's possible in the real world.
- Now, we focus on the raw material side, specifically, how raw stock forms such as **sheet**, **plate**, **bar**, **billet**, and **tube** determine design feasibility.

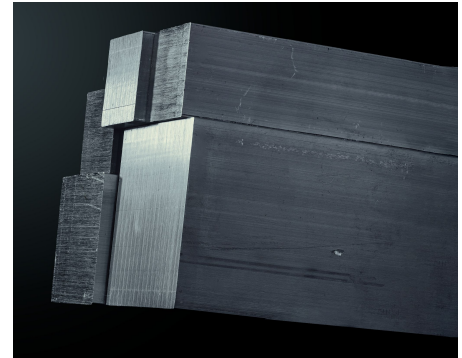
1. Sheet and Plate

- Sheet and plate materials are characterized by being much thinner in thickness compared to their width and length. These materials are typically used for 2D cutting operations such as laser cutting, water jet cutting, or plasma cutting.
- **Common Sizes:** Sheets can range from 12×12 inches to large industrial sizes like 5×10 feet.
- **Thickness:** Sheets are manufactured in fixed thicknesses and cannot be customized. For example, if your design calls for 0.125" mild steel material, you must choose the nearest available size such as 0.119" or 0.135".
- **Sheet vs. Plate:** The dividing line is typically around 0.25" (¼ inch). Thinner materials are called sheet, thicker ones plate.
- **Secondary Operations:** Sheet and plate parts often undergo additional processes such as bending, tapping, hardware installation, and surface finishing (e.g., zinc plating or anodizing).



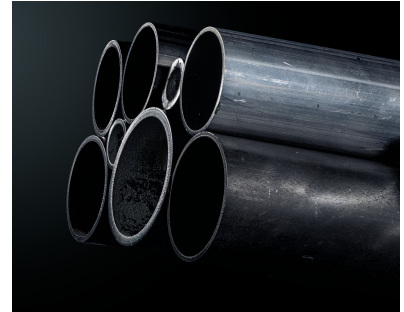
2. Bar and Billet

- Bar and billet materials are thicker, more proportional forms used primarily for 3D machining. These are solid materials that come in a variety of shapes and sizes.
- **Shapes Available:** Rectangular bar, square bar, round rod, U-channel, and L-channel are common.
- **Manufacturing Process:** These are produced via extrusion and then cut to specific lengths using a bandsaw.
- **Design Considerations:** When machining billet parts, always oversize your stock slightly to allow for a machining allowance. This ensures clean surfaces and accurate tolerances on all faces.
- **Use Case:** Ideal for components that require significant material removal or complex 3D geometries.



3. Tube

- Tube stock is a hollow form that provides strength while minimizing weight. Like billet, tube comes in various profiles:
- **Shapes:** Round, square, rectangular, and even triangular tubes are common.
- **Dimensions:** Defined by outer dimensions (OD or width/height) and wall thickness.
- **Thickness Availability:** Just like sheet, wall thicknesses are manufacturer-defined. Designers must use standard thicknesses available in the market.
- **Applications:** Tubes are used when strength-to-weight ratio is critical for example, structural frames, roll cages, or lightweight assemblies



Design Impact of Stock Forms

- The raw stock form you choose determines how you'll design and manufacture a part.
- Sheet and plate are ideal for 2D cutting and bending.
- Bar and billet allow for subtractive CNC operations and sculpted shapes.
- Tube enables lightweight, high-strength frameworks.
- Understanding each form helps you make realistic, efficient CAD decisions.

Summary

Choosing the right raw material form bridges the gap between concept and manufacturable design. By aligning CAD models with available stock profiles, you reduce cost, waste, and production complexity, ensuring that what you design can actually be built efficiently.

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