

LEARN-IT: Material selection

Which material should I use?

What other materials should I consider?

Wood
Metal
Plastic

	Machining properties				Practical properties					Mechanical properties		
Wood	Ease of Cutting	Ease of Welding	Ease of Adhering	Non-splitting	Food-safe	Anti-corrosive	Scratch-resistant	UV-resistant	Water-resistant	Strength	Stiffness	Thermally conductive
Metal	Ease of Cutting	Ease of Welding	Ease of Adhering	Non-splitting	Food-safe	Anti-corrosive	Scratch-resistant	UV-resistant	Water-resistant	Strength	Stiffness	Thermally conductive
Plastic	Ease of Cutting	Ease of Welding	Ease of Adhering	Non-splitting	Food-safe	Anti-corrosive	Scratch-resistant	UV-resistant	Water-resistant	Strength	Stiffness	Thermally conductive

Concrete / Brick	Plaster	Ceramic	Paper / Cardboard
Available everywhere	Not available everywhere	Widely available	Does not require special tools to handle
Resilient to weather	Can be very smooth, so is usually used for molds	Can be very smooth	Very pliable
Heavy		Brittle	Adheres very well
Hard, but brittle		Food-safe	

Glass / Plexiglass	Canvas / Leather	Rubber
Transparent	Very pliable	High friction
UV-resistant	Very resilient to weather and use	Somewhat resilient
Brittle		

Strength (Yield point)

Describes the stress a material can handle before it starts to permanently deform.

Stiffness/Rigidity (Elastic modulus, λ)

Describes the stress a material can handle before it moves.

Thermal conductivity (k or U-value)

Describes how easily heat travels through the material.

Wood

Metal

Plastic

	Soft	Hard	Plywood	Other plant-based materials	Mild steel	Stainless steel	Alloy/Tool steel	Aluminum	PET	HDPE	PVC	PP
	I weigh less than hard wood	I am usually denser – try to dig your fingernail into me	I have a granular end-grain	I easily split into strips	I'm dark and magnets stick to me	I'm light-colored	I look like mild steel, but am really hard	I'm light-colored and not heavy	I'm crunchy, strong, and split easily	I'm pliable, soft, and sometimes stretchy	I'm hard and brittle, usually white or grey	I'm hard and strong
	\$0.50 - \$2 / foot	\$5 - \$20 / foot	\$0.50 - \$2 / square foot	\$0.08 - \$1 / foot	\$0.50 / foot	\$6 / foot	\$1 / foot	\$1 / foot	\$0.03 / bottle	\$4 / bucket	\$0.30 / foot	\$0.03 / bottle
Common applications	House frames Simple furniture	Expensive furniture Piers Flooring	Foundation for flooring	Outdoor furniture Temporary bridges Shacks	Rebar Appliances Car frames	Cutlery Blades Water bottles	Pipelines Electric motors Cutting/drilling equipment	Water bottles Soft drink cans Food cans	Soft drink bottles	5-gallon buckets Detergent containers Trash cans	Pipes and fittings	Food containers
Specific characteristics	Low cost The cheapest industrial lumber Easy to work with Softer fibers make it easier to cut	Very durable Some are oily, so are water-friendly	Flat compressed wood Can be composed of soft or hard wood Difficult to split Each ply's grain is laid perpendicular to the next Not food-safe May contain toxic adhesives	Lowest cost Often found in people's backyards Splits easily into strips Stiff, but brittle	Low cost Easy to work with while remaining structural Corrodes easily if ungalvanized Must be painted or galvanized to protect against rust and treated with fire retardant Easy to weld	Corrosion-resistant Even under high-salinity, poor-circulation, low-oxygen conditions More difficult to weld Specific welding electrodes, equipment, and technique is required	Very tough, wear-resistant, holds a cutting edge To achieve some of these improved properties the metal may require heat treating	Soft and very light Ideal for machining Some cannot be welded even those that can be welded are difficult	Strong but brittle Good gas barrier Fair moisture barrier Resistant to acids Susceptible to bases	Low cost Good chemical resistance Great impact resistance	Low cost Great weather and chemical resistance Susceptible to organic solvents Strong but brittle Slippery	Low cost Good chemical resistance
Typical geometry	Boards and planks 1" x 3" board 2" x 4" board 1" x 6" plank 1" x 12" plank	Boards and planks 1" x 3" board 2" x 4" board 1" x 6" plank 1 x 12" plank	Sheets typical is 4' x 8' ¼"-¾" thick	Tubes Usually ¼" – 3" Twines and strips	Flat, angle, round, square stock Wires Sheets	Flat, angle, round, square stock Wires Sheets	Flat, angle, round, square stock Wires Sheets	Flat, angle, round, square stock Sheets	Soda bottles	Milk/Water bottles (HDPE) Shampoo bottles (HDPE) Grocery bags (LDPE)	Pipes, tubes, and rods	Yogurt cups Take-out containers Butter containers
Standard types	Pine, Cedar, Spruce, Fir	Ash, Mahogany, Maple, Oak, Ipe	3-ply and 5-ply plywood, Medium Density Fiberboard (MDF), Particle board	Bamboo, Rattan, Jute, Rope	A36 hot roll Hot roll steel has looser specifications on carbon content and dimensions 1018 cold roll Cold roll steel has a nicer finish, but is 2x more expensive than hot roll and may have residual stresses	303/304 Most common stainless steel, but not as corrosion-resistant – 18/8 (18% chromium, 8% nickel) 316 More corrosion-resistant, marine-grade – 18/10 composition (18% chromium, 10% nickel)	O1, A2, D2	6061 – T6 structural channel				

Protip

Wet wood will shrink and warp over time as it dries.
Most wood processed abroad is sold wet – it is not kiln-dried

Wood can be bent with steam in a semi-sealed container

Protip

General notation
Specific composition Treatment process Shape Cross-sectional dimensions
A36 – hot roll angle 0.5" x 0.5" x 0.125"

Carbon steel

Iron, 0-2% carbon, other metals

Cast iron

Iron, >2% carbon, other metals

Stainless steel

Iron, 10-20% chromium, other metals

The alloying metals are added at different temperatures and amounts throughout the process.

Protip

Thermoplastics (PET, HDPE/LDPE, PVC, PP) can be remolded or melted, but should not be mixed together.

Thermoset plastics (epoxy, polyurethane) CANNOT be remolded with heat.

Typically, products made from recycled plastics are not recyclable.