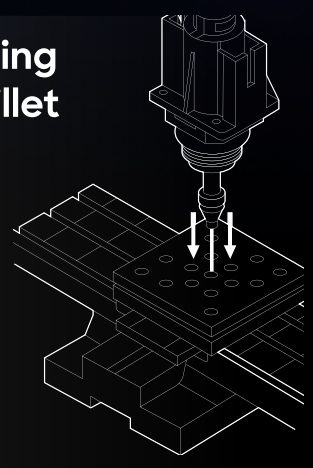
Selecting the right manufacturing process for solid metal parts

Make the right call for cost, strength, volume, and design freedom.

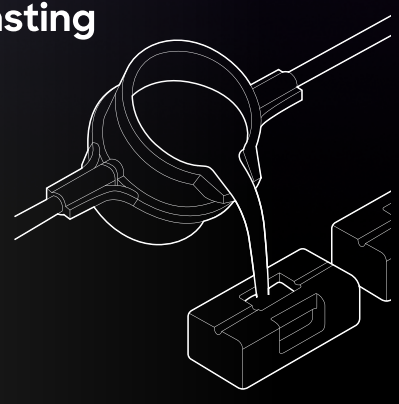
Machining from Billet



BEST WHEN

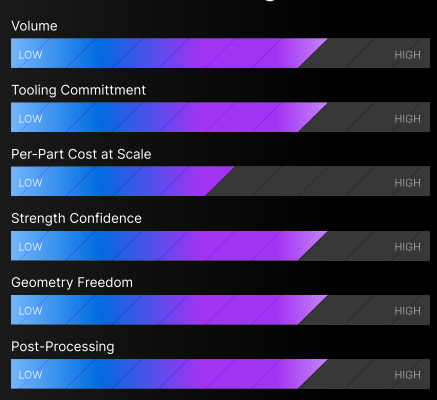
- Design is evolving
- Strength is critical
- Tooling risk needs to be minimized

Casting

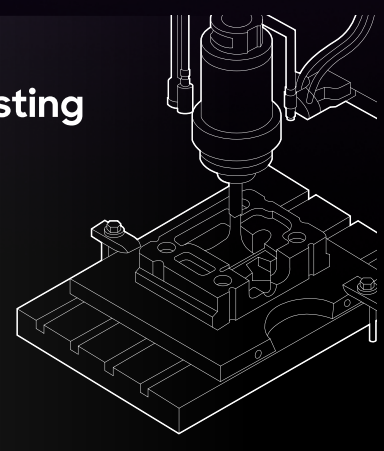


BEST WHEN

- Production volume is moving beyond prototyping
- Per-part cost must be reduced
- Design is stable enough to introduce tooling



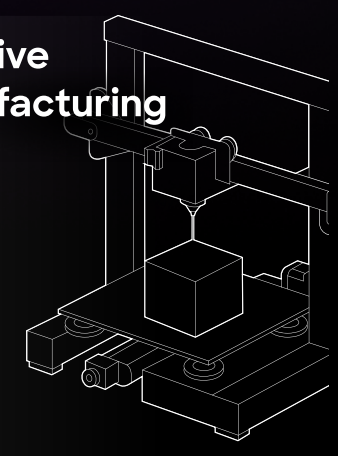
Die Casting



BEST WHEN

- Demand is stable and high
- Design is finalized
- Maximum production efficiency is a priority

Additive Manufacturing



BEST WHEN

- Geometry is highly complex
- Internal channels or lightweight structures are required
- Low-volume or specialty production

A Closer Look at Each Manufacturing Process

MACHINING FROM BILLET

- No tooling and the most flexibility early in the design process. Best for prototyping and low volumes.
- Tight tolerances, consistent material properties, and the highest structural confidence – ideal for load-bearing parts.
- Handles complex geometry, sharp internal corners, and variable wall thickness. Often requires no additional processes.
- **TRADEOFF** longer cycle times, higher material waste, and higher per-part cost as volume increases.

CASTING

- Introduces tooling and reduces per-part cost once volume increases. Best for moderate production.
- Near-net shape but requires secondary machining. Design constraints include wall thickness, draft angles, and ribbing.
- Porosity risk depends on geometry and process control. Evaluate carefully for load-bearing parts.
- Often the first step away from machining as volume grows and the design stabilizes.

DIE CASTING

- High upfront tooling investment. Best for high-volume production with stable, finalized designs.
- Most common with aluminum and zinc alloys – steel is not typically die cast.
- Requires draft angles, controlled wall thickness, and ribbing. Tighter tolerances than casting but still needs post-processing (flash trimming, machining).
- High-pressure injection reduces porosity for higher strength confidence and repeatability.
- Least flexibility – design changes are costly once the tool is cut.

ADDITIVE MANUFACTURING

- No tooling, low upfront commitment. Ideal for low volumes and specialty variants.
- Supports highly complex geometries, internal channels, and lightweight structures.
- Great for rapid iteration and design exploration.
- **TRADEOFF** slower build times, higher per-part cost, and potential for lower strength in some orientations.

Manufacturing Process Selection For Real-World Applications

Motorcycle Sump

VOLUME-DRIVEN PROCESS CHANGE

At low production volumes, this sump would be machined from billet aluminum to avoid tooling cost while preserving flexibility during early development. As volume increases, investing in tooling for casting reduces cycle time and material waste, lowering per-part cost. The design is adjusted to meet casting requirements.

DECISION

Volume drives the decision.
Once demand justifies tooling investment, casting becomes the appropriate choice.

Rear Footrest Bracket

WHEN STRENGTH OVERRIDES COST

The rear footrest bracket operates in a high-vibration, load-bearing environment. In testing, the part cracked under tip-over simulation. Stress concentrated in areas that could not tolerate material variability – and casting porosity introduced a weakness that wouldn't exist in a fully dense machined part.

DECISION

Machine from billet. For components in critical load paths, the structural confidence and consistent material properties outweigh the cost savings.