

Impro



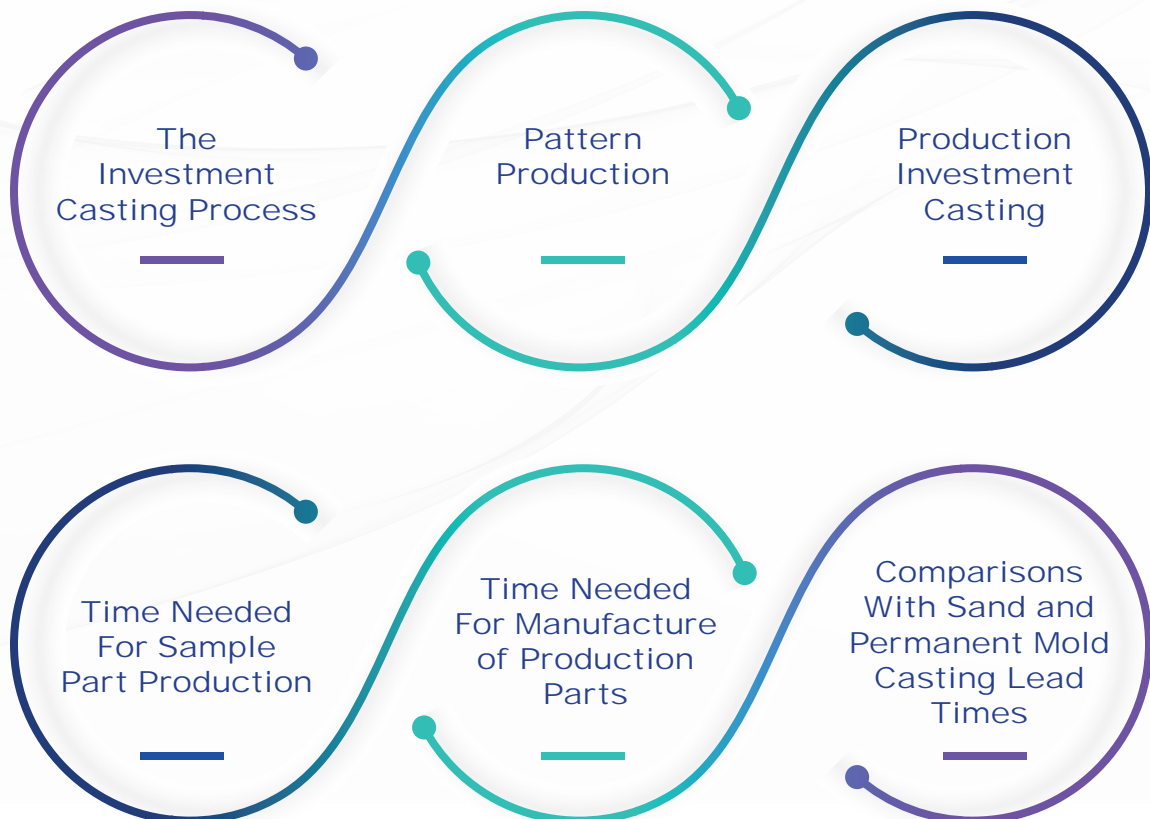
How Long Does Investment Casting Take?

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Lead time is a critical aspect of the procurement process. When a part has been in production for a while this becomes well-established. However, when launching a new product that incorporates parts that must be made to order, buyers and project managers are sometimes surprised by how long it takes to get samples and the initial production quantities.

This guide addresses the question of how long it will take to receive parts produced by the investment casting process. It looks at what's involved in sample production, the casting process itself, and any additional considerations. Individual sections address:



The Investment Casting Process

To understand how long it takes to receive an investment cast part it's first necessary to know what's involved in the production process.

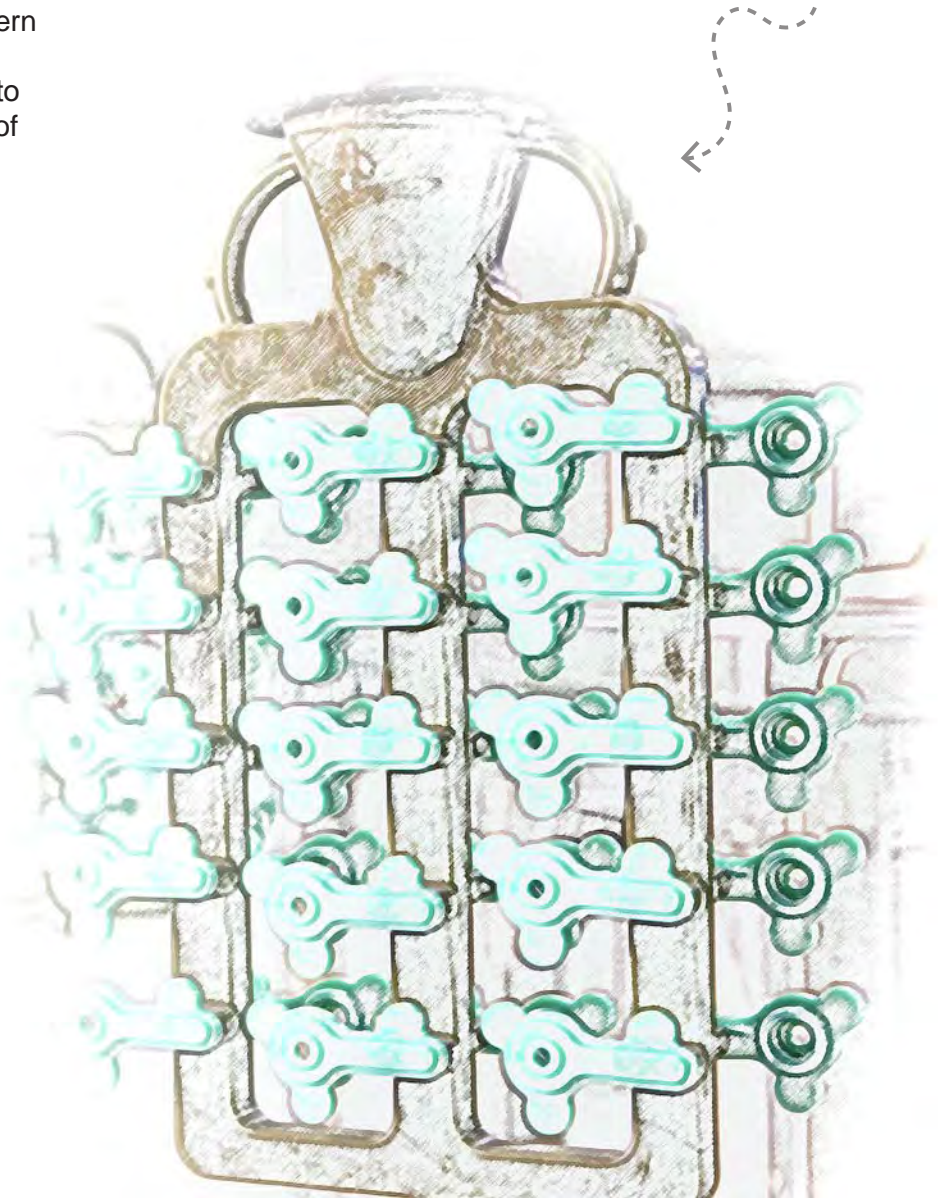


Investment casting needs a pattern to form the mold cavity. This pattern is a replica of the part to be cast, with additions and modifications to accommodate the requirements of the casting process.

The additions comprise the gating system and any necessary cores. The gating system forms the channels for metal to flow in at a controlled speed and for air to leave the cavity.

Cores are inserts that will remain in the mold cavity after the pattern is removed. Their purpose is to create internal passages and features in the cast parts.

Modifications are shrinkage allowances, radii, stiffening webs or ribs, and in the case of deep core pulls (metal) in the wax tooling, draft angles are required.

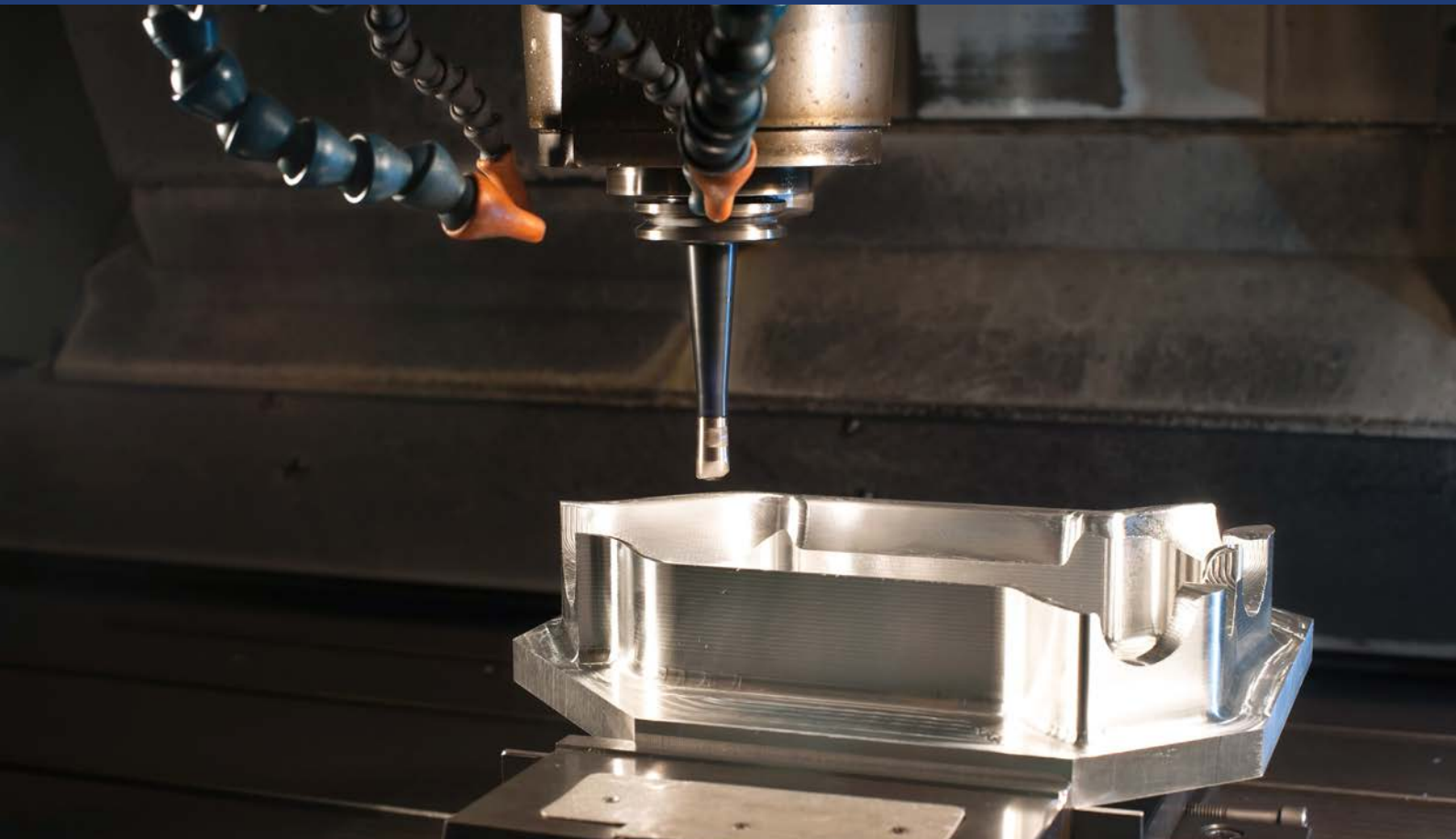


Investment casting uses a wax pattern. This is coated in a ceramic slurry that dries to form a hard shell. The wax is then melted out of the shell to leave the mold cavity. Thus a new pattern is needed for every casting cycle and part.

Investment Casting Tooling Production



For wax patterns for investment casting are injection molded. The injection molding dies take time to produce. These are machined in aluminum or hardened steel and assembled before being proven out by test molding some pieces. These are inspected dimensionally to ensure conformance to the specified dimensions and features. The wax pattern tooling provides high repeatability and short cycle times, which makes the process economic.



Initial Patterns

Initial patterns produced by the tooling will be inspected to validate the tooling.

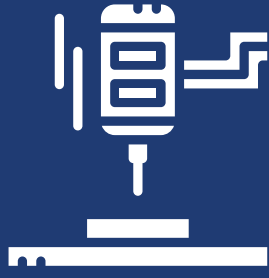
Wax Patterns

Wax patterns are then used to investment cast the part required, in the chosen metal. This again is measured to verify conformance to print.

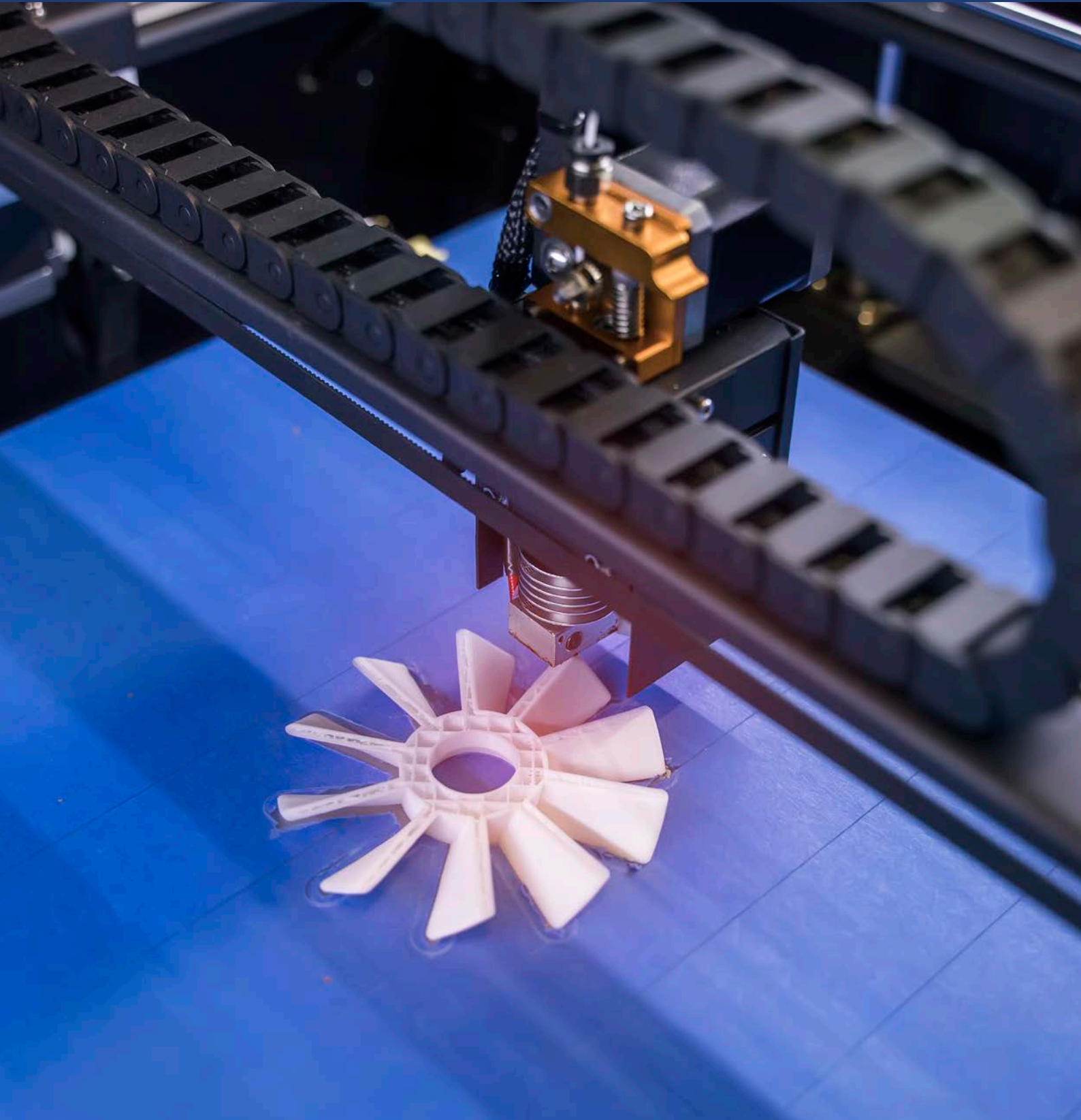
As metal shrinks during cooling it's not uncommon for the injection molding tool to need modification. In the case of very complex parts, multiple cycles of prove-out and modification are sometimes needed.



At Impro, typically, it takes **4-6 weeks to design**, manufacture and validate the tooling, (for more basic parts). Tooling validation means, at this point, doing a dimensional inspection of the newly constructed wax die and injecting a few initial wax patterns to ensure functionality of the die, core pulls, inserts and successful pattern removal.



A recent addition to the pattern production techniques is 3D printing. This complements investment casting in that it can produce complex pattern within hours with proper programming to the printer. The limitation is that 3D printing requires same cycle time for each pattern and won't gain efficiency for subsequent production.



Investment Casting Production

Once patterns are available, investment casting consists of:

“Tree” Assembly

Ceramic Coating

Ceramic Drying

Wax Melt-out

Filling and Solidification

Break-out

Clean Up

“Tree” assembly refers to joining multiple patterns and their associated gating components, to a central metal feeding channel. This allows multiple cavities to be filled simultaneously, which improves process speed and economics.

The “tree” is then coated in a ceramic slurry. Typically, **6-8 layers** are applied to build up a shell some **10 – 15 mm (0.400 – 0.600”) thick**.



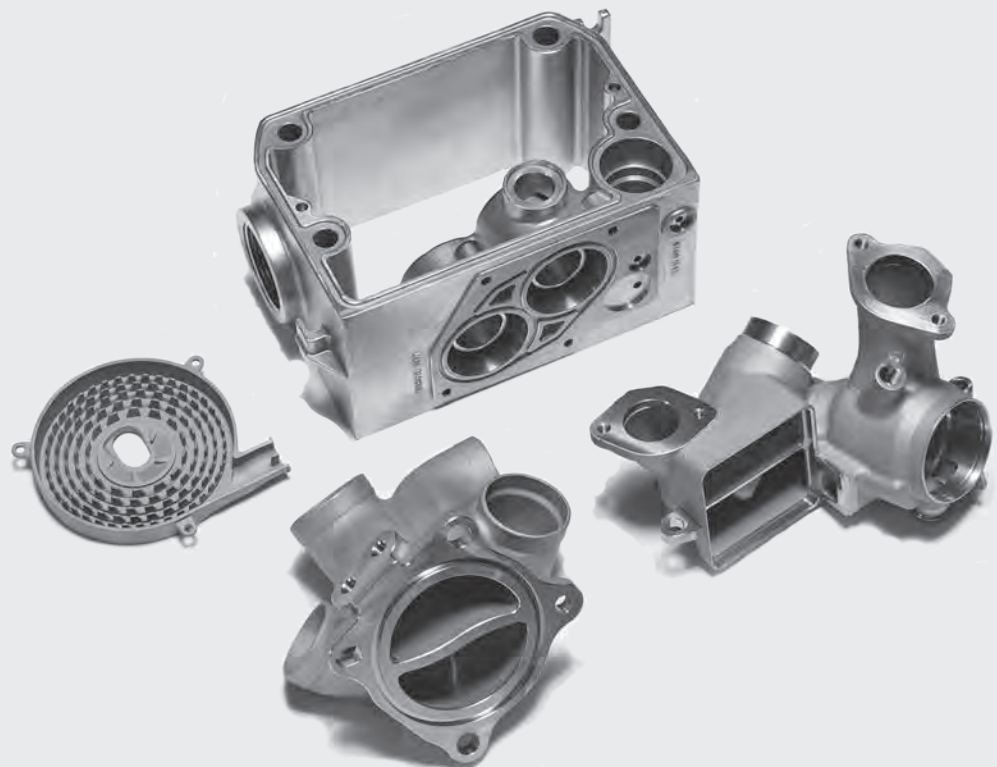
A pause between the application of each layer allows curing, after which the completed shell is left to dry thoroughly. Any remaining moisture could cause cracking when the wax is melted out.



The wax patterns are melted out of the shell by inverting the “tree” and heating it with steam in an autoclave. The shell is placed in a furnace to burn out any remaining wax.

Mold filling is a quick operation, but the “tree” must then be left for the metal to cool and solidify. Cooling rate is a critical factor in the resulting metallurgical properties and cannot be rushed. Only when cooling is complete can the parts be broken out of the shell.

Some break out processes remove the gating system from the parts. In other cases, and it depends on the size and location of the gates, they need cutting away by sawing or grinding. Once this is done the parts go for whatever machining and other finishing operations are needed.







Stainless Steel
Investment
Casting


Time Needed For Sample Part Production






The time to get sample parts depends on the method of pattern production. Assuming these will be injection molded, for parts of moderate complexity and size the following times are typical:



 **4 - 6 weeks**  **From start of pattern design to having patterns available for casting (for simple to medium complexity parts)**
(this includes machine programming and inspection).

 **1 - 2 weeks**  **Mold and inspect wax patterns.**
(If inspection reveals that tool modifications are needed, this could add 2 – 4 weeks.)

 **1 - 2 weeks**  **To cast sample parts from these patterns**
(most of this is drying and cooling time)

 **1 week**  **Part clean up and inspection**

 **3 - 6 weeks**  **If it's subsequently found that the mold tool needs modifying, the cycle will need to be repeated. This could be an additional 3 – 6 weeks.**

 **8 - 12 weeks**  **Including order processing and shipping, the total elapsed time needed to produce sample investment cast parts is in the region of 8 to 12 weeks. If parts are very complex, more time might be needed. Using 3D printing to make patterns will reduce the pattern production time.**

Time Needed For Manufacture of Production Parts



For a first production order the lead time will include pattern production. Lead times will be 4 – 6 weeks less than for sample part production because the design work has been done.



Thus parts will be shipped some 3 – 4 weeks after receipt of order (providing all necessary materials and casting capacity are available.)

In the case of scheduled deliveries, production will be geared to the rate of shipment and delivery. In this case lead time is constrained primarily by the shell manufacture, drying and cooling/metal solidification steps.

Comparisons With Sand and Permanent Mold Casting Lead Times



For sand casting the sample production process is very similar and takes a comparable length of time. Where it differs is in the amount of machining needed, with sand cast parts needing more machining to add the equivalent features. *This total time to get samples of sand cast parts could be 5 – 13 weeks.*



Permanent mold dies are usually very complex with multiple pieces and are machined from high hardness steels. This extends the initial time to produce samples this way. There may also be more machining needed. *Total time to obtain samples could be 10 – 16 weeks.*



For regular production sand casting avoids the pattern production step. However, additional machining means this process route usually has a longer lead time than investment casting: *4 – 8 weeks would be typical.*

Talk to Casting Experts When Lead Time is Critical

Introducing a new part, or converting an existing part to investment casting, usually requires the production of samples for evaluation. When these are confirmed as satisfactory the investment casting operator can then switch over to production tooling.

Lead times for both sample production and production quantities depend largely on pattern production lead time and part complexity. While many weeks may be needed to make and validate the pattern tooling, once it has been approved production patterns can be molded quickly and inexpensively.



Where samples are needed quickly, patterns can be produced by 3D printing. It offers substantial lead time savings over waiting for pattern tooling.

The best way to determine lead times is to discuss the specific project with an investment casting expert. The specialists at Impro are always happy to recommend how to meet your lead time goals for investment cast parts.

Contact us to learn more.

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