CASE STUDY

inkbit

Innovative 3D Printing Solution for Custom Gas Diaphragm Pump Head

PROBLEM STATEMENT:

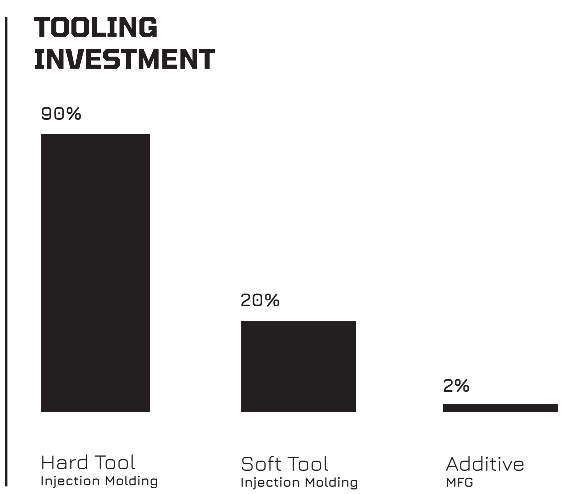
Thomas an Ingersoll Rand business, had a client that required a bespoke head for a gas diaphragm pump, tailored to fit within a novel device they were engineering. The complexity of the design aimed to minimize the product's footprint, which rendered traditional injection molding a challenging option. The client also sought a rapid market entry, targeting less than a year, with initial production volumes estimated at several hundred units, increasing to approximately 2000 units annually.

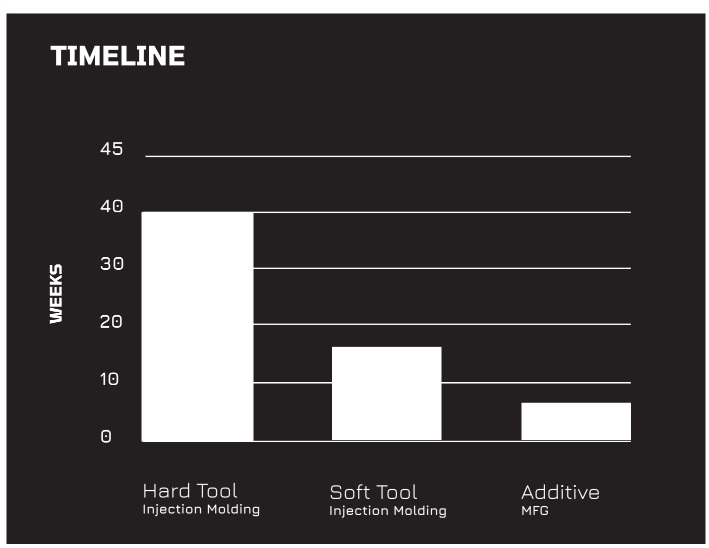
MANUFACTURING OPTIONS:

Standard Solution: Thomas's engineering team typically adopts a two-phased approach for custom projects, starting with prototyping and followed by a production ramp-up. Initially, they utilize an in-house SLS (Selective Laser Sintering) system for low-volume prototyping. The subsequent phase involves transitioning to injection molding, which, despite a high initial tooling cost and a lengthy preparation period (6 months to a year), is cost-effective for large-scale production. However, given the time-sensitive and cost-constrained nature of this project, the standard injection molding route was deemed unsuitable.

Soft Tooling Manufacturing Solution: An alternative was the creation of a low-cost soft tool, which offered reduced initial investment and shorter lead times. However, the per-unit cost remained prohibitively high, failing to offer a significant advantage over the standard process.

Additive Manufacturing Solution: Considering the part's complexity, tight timeline, and cost constraints, the team identified 3D printing as a viable production method. This approach promised the quickest time-to-market and appeared to be the most cost-effective among the options considered.





ADDITIVE MANUFACTURING SECTION:

For the selection of the most suitable additive manufacturing technology, the team prioritized technical capability while also being mindful of costs. Key technical requirements included:

- **Temperature Stability:** Capability to withstand temperatures above 80°C due to pump head heat.
- **Durability:** Strength to prevent cracking when fitting rubber tubing onto barbs.
- **Rigidity:** Ensuring part flatness to prevent leakage when clamped to the pump assembly.
- **Surface Finish:** Must support sealing with a gasket and provide a dynamic seal for the check valve.
- **Resolution and Tolerance:** Ability to achieve fine details with specific height and tolerance requirements.

Cost Comparison and Inkbit Selection: Upon evaluating various 3D printing technologies, Inkbit's platform emerged as the optimal solution, particularly as production volumes scaled up. Inkbit leverages a unique jetting technology that permits densely packed part printing and streamlined, automated post-processing. This contrasts with other technologies like SLS, SLA (Stereolithography), and FDM (Fused Deposition Modeling), which don't scale as efficiently due to their more labor-intensive post-processing requirements.

Trade-Offs with the Inkbit Solution: Despite its advantages, Inkbit's evolving materials and technology meant accepting certain trade-offs compared to injection molding, such as:

- **Aesthetic Limitations:** Restricted color options meant the parts couldn't match the black plastic appearance of the pump's other components.
- **Surface Finish and Detail Resolution:** The Inkbit process did not match the quality of traditional methods, leading to higher than usual leak rates, which were nonetheless acceptable for this application.

Lessons Learned:

- **Temperature Requirements:** The project initially overlooked the component's thermal requirements, leading to the selection of less resistant material and subsequent part failures.
- **Surface Finish:** Additional post-processing was required to achieve an acceptable finish, resulting in project delays.
- **Design for Strength:** The switch to a more temperature-resistant but brittle material necessitated design modifications to reinforce the part.

OUTCOME:

The parts manufactured using Inkbit's technology with the Chem Epoxy material ultimately satisfied all requirements for the final product. They are presently undergoing endurance testing, having already surpassed 2000 operational hours without performance degradation. This testing phase continues to ensure the parts' reliability over extended use.

ABOUT THE COMPANY:

Thomas is a leading manufacturer of systems, compressors, vacuum, and liquid pumps for Original Equipment Manufactures (OEMs) in the medical, laboratory, environmental and industrial sectors. Visit https://www.thomaspumps.com/en/ for more information.