

# 3D Printed Case-Hardened Industrial Die using BLDRmetal™ L-40

**CASE STUDY** | Laser Powder Bed Fusion

## Challenge

### Tooling for Threading Bolts that Resist Self-Loosening

Fasteners that release when used in high vibration environments, such as found in heavy equipment engine compartments or bridge structures, increase maintenance costs, jeopardize safety, and increase risk liability. Perfect Lock Bolt America, Inc. has designed new structural bolts with an intricate thread design that would alleviate these concerns by resisting self-loosening.

In order to cost effectively produce these high-tech bolts, the material and the process for making the dies used to forge the threads had to be completely reinvented. The previous solution, CNC machined D2 or M2 tool steel was unsuccessful in manufacturing – the complex die surface

profile was extremely difficult to machine and had a very short production run life due to severe die chipping.

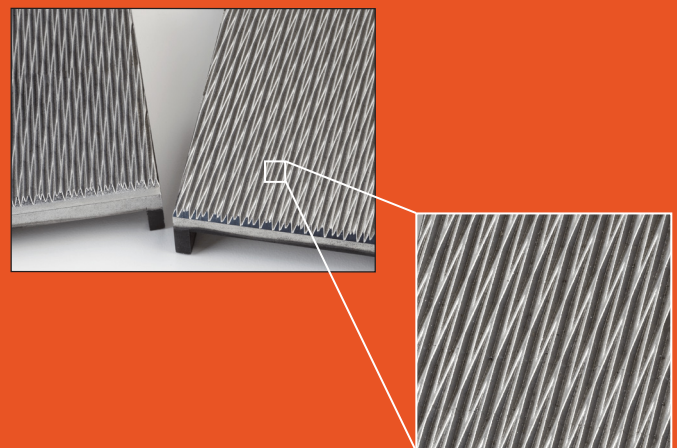
The team recognized the need to look at additive manufacturing as an alternate solution. However, their concerns were two fold: 1) Were there any materials available hard enough to create the thread profiles but resilient enough to accommodate serial bolt production and 2) Could those materials be demonstrated to work in 3D printing in the application?

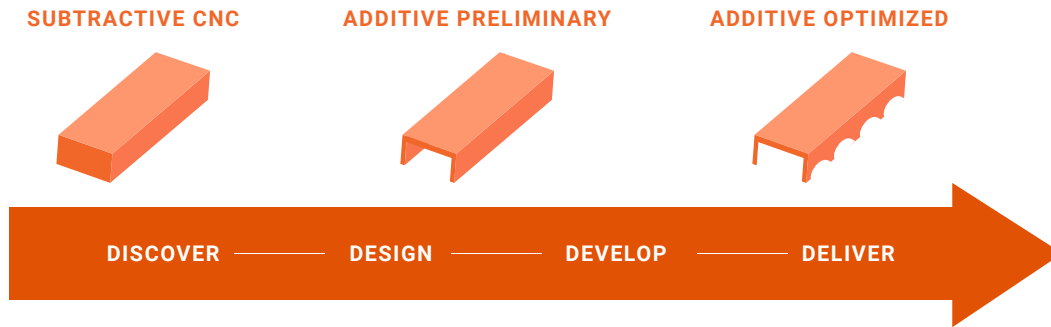
## Solution

### NanoSteel Powder Bed Fusion 3D Printed Dies

Perfect Lock Bolt partnered with NanoSteel from the conception of the problem through to the final solution. In the alloy selection phase, NanoSteel's BLDRmetal™ L-40 steel powder was proven to demonstrate the needed performance in hardness and durability. In cooperation with production partner CFK GmbH of Kriftel, Germany, and others, the team optimized the printing process and parameters to meet dimensional and surface tolerances. Concurrently, the roll thread dies, measuring approximately 20 cm (~8in), were optimized in several iterations. In addition, NanoSteel identified the post-production process to raise the surface hardness to ~70 HRC and provide a surface finish with Ra of approximately 2-3 micron.

### High Hardness Forging Die for Bolt Threading





## Results

### Successful Testing in a Production Environment

NanoSteel recognized the opportunity to create what may be the first-of-its-kind 3D printed production die. The resulting die set outperformed dies machined from D2 and M2 tool steels, successfully producing the fasteners.

“We tried nearly every combination of material and conventional CNC machining process to create our dual-thread die sets, none of which could cut or grind the complicated dual-thread geometry of our thread form,” said Mark Doll, President and CEO of Perfect Lock Bolt America Inc. “The NanoSteel solution delivers exactly what we are looking for, including excellent surface finish, flexibility, as well as strength and hardness for maximum die life. This is a welcomed technological innovation to the fastener industry. We have been pleased with our testing and are slated to start production in 2017.”

### Benefits of 3D Printing:

#### Design and Manufacturing Freedom

- Economical high complexity surface pattern
- Full customization capability
- Rapid design iteration
- Just-in-time production

### Benefits of BLDRmetal™ L-40:

#### Combines High Hardness with Ductility

- Case Hardening: Up to 74 HRC
- High Core Properties:
  - Hard: >50 HRC
  - Ductile: >10% Elongation
  - Tough: 65J (v-notch, as built)
- Easy to Print (RT to 200°C)



Optimized Die Set After Printing



Dual-Thread Bolt From Validation Trial

**Disclaimer** | Information is subject to change, please contact NanoSteel for the latest information.