Case Study

R·I·T
Center of Excellence in
ADVANCED & SUSTAINABLE
MANUFACTURING

3D-Printing for Legacy Component Repair with Hansford Parts & Products

Client:
Hansford Parts and Products

Industry:
Precision Machining

Objective
Remanufacture obsolete 1960s milling machine parts in need of repair after 50 years of use.

Outcome
Employ a hybrid laser engineered net shaping (LENS) process that additively deposits material onto the surface of a steel gear shaft with five broken teeth.

About the Client

Hansford Parts and Products is a precision machining company located in Macedon, just outside of Rochester, New York. Hansford uses and produces a large repertoire of machining infrastructure to solve manufacturing challenges, working to reduce cycle time and cost while continuously improving quality.

The Challenge

Although the machines used in manufacturing can often last for decades, the high speeds and innumerable cycles of a long service life can create wear and damage on key internal components. When machines do break down, the impacts on manufacturing business can be significant. Not only are production operations interrupted, but finding a replacement part or a service technician that knows the ins and outs of a legacy machine can be a logistical and costly challenge in itself.

Hansford recently ran into this problem when some teeth on a gear inside one of their machines failed. The device was a rack mill that Hansford used to make cutting tools for broaching machines—another manufacturing process.

> “We would have had to identify more time-consuming and costlier ways to make our custom cutters. The 3D printing project with GIS was a complete success! Our machine is working great and is back to making our cutters.”
>
> Bob Krochmalech

The broken gear was part of the mill’s drive shaft, meaning that without it, the machine itself was useless.

Prior to this gear failure, the machine was productive and produced quality parts. But after more than 50 years of service, replacement parts simply weren’t available from the supplier. In fact, the company that made it, KNAPP AG of Germany, no longer even produces cutting machines. Rather, their focus since about the 1990s has been on material handling automation hardware and software.

Without a source of replacement parts , Hansford needed an innovative approach to repair that would be cost-effective, customizable, quick, and sustainable. As a result, Hansford reached out to COE-ASM to explore the possibility of repair through additive manufacturing.

Broken teeth on the machine's drive gear; a total of five (5) teeth were damaged after more than 50 years of use.

COE-ASM Work Performed

Hansford Parts and Products was interested in exploring the capability of additive manufacturing (AM) processes for remanufacturing, and this broken gear shaft provided an opportunity for studying a real- life example. The COE-ASM first assessed whether this gear was a viable candidate for repair via AM. This required an assessment of the existing part's material and geometric properties in relation to the performance characteristics of the available additive manufacturing technologies. Due to the close proximity of undamaged teeth to the repair area, COE-ASM determined that any additive process for repair must allow for precise control. Similarly, the geometric complexity of the part (with multiple diameters across the repair area) meant that the additive process must be capable of working with non-flat and somewhat variable base surfaces. Finally, in this type of application, strength of the repair is critical to the function of the part. COE-ASM performed X-Ray analysis to determine the part's material composition and micro-hardness tests to determine the required strength.

Based on these assessments, COE-ASM engineers determined that it may be possible to restore gear tooth material using a 3D fabrication process called Laser Engineered Net Shaping (LENS). With LENS technology, a feedstock of metal powder is melted by a high-powered laser and deposited onto an X-Y plane on a target surface. After each layer is completed, the deposition plane is raised vertically, and another layer of material built on top of the previous. This process is repeated until the net shape of a target design is achieved, whereafter the material may be machine finished in order to achieve more minute specifications.

After determing the potential for tooth repair with LENS technology, COE-ASM engineers worked with Hansford's own machining specialists to prepare the part for additive repair. This required machining away the broken teeth to create a uniform groove upon which a new tooth could be built, and building a 3D computer model of the gear based on GIS' optical scan of the good teeth to facilitate additive restoration. After this was completed, the part was sent back to COE-ASM for repair. A two step process was developed, first building up the material to the root of the tooth, and then building up material from which the tooth profile could be machined. A stainless steel material (Grade 420) was used for the repair.

Preparations for LENS repair required machining away the old teeth

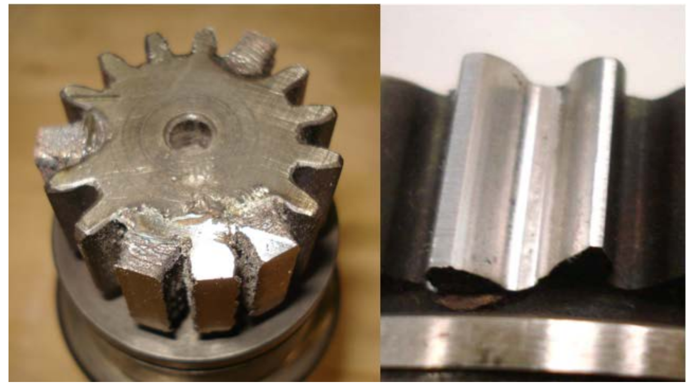
Results

After multiple tests and process refinements, COE-ASM developed a set of parameters that yielded positive results for this challenging repair. Applying specific material and gas flow rates and deposition head spacing to account for the particularities of this task, COE-ASM was able to LENS print new teeth onto the Hansford gear, restoring it to nearly final form. Hardness tests revealed that the additively-repaired gear teeth exhibited Rockwell hardness scores between 52 and 59 HRC in comparison to the base material's 60 HRC. Although not identical, Hansford and COE-ASM engineers agreed that this would likely be adequate for the gear's given application.

After validating hardness and expected performance, COE-ASM returned the repaired part to Hansford, where the company employed its own skilled machinists to finish the additively-repaired teeth into their final form

Through application of the LENS technology, COE-ASM and Hansford demonstrated how a new additive manufacturing technology can be used to extend the service life of high value machining equipment, allowing Hansford to delay a potential costly machine replacement. While it would also have been possible to reverse engineer and build the part from scratch, this would have taken significantly longer, resulting in more equipment down time, and the replacement part would have been significantly more expensive.

Full photo of final form achieved by machine finishing at Hansford.



(Left) *Teeth repaired with metal deposition into net shape.* ***(Right)*** *Final form achieved by machine finishing at Hansford.*

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