What makes Daimler's 3D printing a disruptive technology?

Daimler's latest development of a super laser melting machine sets a new precedent for larger-scale additive manufacturing, or 3D printing, and for lower cost and waste than casting or drilling in automotive manufacturing.

Daimler AG's (Daimler) recently publicized use of generative laser melting technology underscores the fact that additive manufacturing (often called 3D printing) is becoming more important in the automotive sector. Daimler, the parent company of Mercedes Benz, has been working with the Aachen, Germany-based Fraunhofer Institute for Laser Technology (ILT) and Stuttgart, Germany-based laser fusing technology specialist Concept Laser in developing a super laser melting machine line with the world's largest build chamber. Designed specifically for special requirements for Daimler's automotive applications, the machine was built with the goal of replacing expensive sand- and die-casting applications in the development process.

Such investment should not be surprising. Interest and investment in additive techniques have grown dramatically as applications have progressed from rapid prototyping to the production of end products. Today's additive manufacturing equipment uses an ever-increasing range of materials (e.g., metals, polymers, composites, powders) to create a range of functional components, layer by layer, including complex structures that cannot be viably manufactured by other methods.

While additive manufacturing has garnered interest across a wide range of industrial sectors, none have funded the technology more generously than the automotive industry. According to a report by Wohlers Associates at the decade's outset, the automotive industry accounted for 17.5 percent of the total additive manufacturing market—approximately $190 million.[1] This figure established the sector as the largest user of additive manufacturing, accounting for the largest market volume of all industrial sectors.

Compelling Promise

By enabling automakers to immediately create items from designs (without the cost and waste of casting or drilling), additive manufacturing promises an economical and highly efficient means of producing single items, limited batches, and ultimately (it is hoped), high-volume manufacturing. The game-changing potential of this technology is why it is considered disruptive, and why significant capital continues to support it.

A report from the U.S. Department of Energy notes, “additive manufacturing has the potential to vastly accelerate innovation, compress supply chains, minimize materials and energy usage, and reduce waste.”[2] Consider some of the benefits automakers may gain via use of the technology:

- **Energy savings**. By eliminating production steps, using less material, enabling reuse of products, and realizing lighter parts, additive manufacturing saves significant energy usage and costs.
- **Waste reduction.** The layered building approach of additive manufacturing can drive down material needs and costs by up to 90 percent when compared to traditional casting or drilling processes.[3]
- **Faster time to market.** By enabling immediate parts creation directly from digital design files, additive manufacturing eliminates the considerable time required for parts tooling.

Further, additive manufacturing facilitates innovation by driving down barriers to process design. Designs once considered too intricate for production are now doable, and this can speed new product development. The ability to respond more rapidly to customer demands helps make automakers more agile.[4] In a market where intense competition constantly ratchets up the need for speed-to-innovation, these attributes are key.

Growing Application

Additive manufacturing technology has already made its breakthrough in the area of prototype construction. Now, it’s attempting to conquer the production floors. “This is a paradigm shift for manufacturing technology,” says Adrian Keppler, CEO of EOS GmbH in Krailling (Germany), a world leader in integrated

e-manufacturing solutions for industrial applications. Keppler is a specialist in laser sintering; since 1989, he has been preaching the need for engineers to move away from conventional thinking, with design and construction still focused on established production methods. “We are casting off those bonds and in the future will be able to make innovative, functionally integrated parts,” Keppler promises.

More efficient structures are increasingly possible through advanced additive techniques. Such structures offer as much as 70 percent in weight reductions in lightweight construction. Professional applications are also able to handle materials that can’t be cast, and additive manufacturing equipment can also work with weldable alloys such as titanium and cobalt.

The Direct Manufacturing Research Center (DMRC) at the University of Paderborn’s Heinz Nixdorf Institute also finds that additive manufacturing is widely spread within the automotive industry. It is being used for a variety of applications, including concept modeling, functional testing, rapid manufacturing, and production planning.[5] A growing group in the sector, including BMW, Mitsubishi, Caterpillar, Lamborghini, and Jaguar, have leveraged the technology for applications that include:

- Testing part design to verify completeness and correctness of parts
- Creating parts for racing vehicles (e.g., aerodynamic skins, electrical boxes, cooling ducts)
- Developing components such as intake manifolds and cylinder heads
- Producing replacements for legacy parts[6]

The *Wall Street Journal* recently reported that Ford engineers are using additive manufacturing machines to produce prototypes of cylinder heads, brake rotors, and rear axles in less time than traditional manufacturing methods. For example, Ford saves an average of one month of production time to create a casting for a prototype cylinder head for its EcoBoost family of engines, designed for better fuel efficiency. This complex part includes numerous ports, ducts, passages, and valves to manage fuel and air flow.[7]

Daimler's role in the development of the super laser melting machine line is indicative of how the needs of the automotive market are moving additive manufacturing technologies forward. In this case, Daimler's requirements entailed a significant increase in build-up rates, an improvement in the quality of the surface finish, reproducibility and reliability of the machine as a result of appropriate process monitoring, as well as the qualification of further aluminum series alloys for a range of applications.[8]

An Economic Imperative

The critical role additive manufacturing is likely to play in manufacturing's future has been recognized by the U.S. government to the tune of $30 million invested to establish the National Additive Manufacturing Innovation Institute (NAMII). NAMII is a public-private partnership with member organizations from industry, academia, government, and workforce development resources all collaborating with a singular, shared vision: to transition additive manufacturing technology to the mainstream U.S. manufacturing sector and create an adaptive workforce capable of not only meeting industry needs, but also increasing domestic manufacturing competitiveness.

Based in Youngstown, Ohio, NAMII is built on an extensive network of additive manufacturing technical expertise surrounding a regional manufacturing cluster within the Eastern Ohio/Western Pennsylvania/West Virginia "Tech Belt" region. NAMII was founded in August 2012 as the pilot institute for up to 15 National Network for Manufacturing Innovation (NNMI) institutes across the country.

"Additive manufacturing will be an additional tool in the manufacturer's tool kit," says Ed Morris, director of NAMII. "It won't cause CNC to go away; it will still be used in combination with other techniques. In some areas, injection molding is the best choice. For products that are too complex to be done with traditional manufacturing, additive manufacturing will be the way to go."

For the automotive sector, this is not news; they have been forging that way for some time as they lead manufacturing down this promising path.

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NOTES

1. Wohlers, T., “Wohlers Report 2010 – Additive Manufacturing State of the Industry,” Wohlers Associates Inc., United States of America, 2010.
2. U.S. Department of Energy, “Additive Manufacturing: Pursuing the Promise,” DOD/EE-0776, August 2012.
3. *The Economist*, “The Printed World: Three-Dimensional Printing from Digital Designs,” 10 February 2011. www.economist.com.
4. *Ibid,* U.S. Department of Energy.
5. Direct Manufacturing Research Center, “Thinking Ahead: The Future of Additive Manufacturing,” 2011.
6. *Ibid,* DMRC.
7. *Wall Street Journal, CIO Journal,* “3D Printing Moves Deeper into the Mainstream,” June 5, 2013, http://blogs.wsj.com/cio/2013/06/05/3-d-printing-moves-deeper-into-the-mainstream.
8. *Engineer Live*, “Additive Manufacturing with Metals in Automotive,” 2013, http://www.engineerlive.com/content/additive-manufacturing-metals-automotives.