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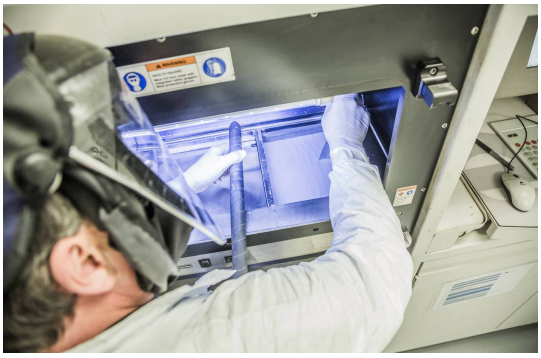
BUSINESS

3-D Printing Expands to Metals, Showing Industrial Promise

Aerospace companies turn to additive manufacturing to make lighter, more complex engine parts



General Electric's Additive Development Center in Cincinnati. *PHOTO: GE*

By **TED MANN**
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Gregory Hayes, the chief executive of United Technologies Corp., was hit with an unexpected question after explaining manufacturing problems with the aluminum fan blades on the company's latest jet engine.

"Why can't you print out these fan blades?" asked Nigel Coe, a Morgan Stanley analyst, at an investor conference in September.

Mr. Hayes responded with a laugh and waved off the suggestion, saying the company could be more than a decade away from using printers to create critical parts like fan blades. But while Mr. Hayes's chuckle might have been a typical reaction a few years ago —when a wave of hype about 3-D printing's promise had yielded little but a niche market of prototypes, toys and novelty items mostly for consumers—it is no longer the case in industrial manufacturing.

The application of the technology to industrial parts—using metal instead of polymer—has shifted 3-D printing from the theoretical into the practical in high-tech fields like aerospace.

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General Electric Co. in September agreed to buy two European 3-D printing-machine manufacturers, Sweden's Arcam AB and Germany's SLM Solutions Group AG, for more than $1 billion combined. When GE's offer for SLM was scuttled by shareholders last month, the conglomerate agreed to pay $599 million for another one, Germany's Concept Laser GmbH, the next day. GE's Arcam offer has been extended through Thursday to garner enough shareholder support.

GE sees 3-D printing with metal alloys, which it commonly refers to as "additive manufacturing," as an important part of its future, especially for its $25 billion jet-engine business. Greg Morris, who co-founded an additive manufacturing company that GE bought in 2012, said skepticism within the conglomerate has faded over the past couple of years. "Convincing people is no longer what I do," said Mr. Morris, who is now the additive technology leader at GE's aviation business.

Engineers at GE's Ohio-based jet engine business initially hoped to use additive machines to create a portion of the fuel nozzle for its new commercial jet engines, said Anthony Dean, who managed the team that developed the part for GE Aviation.

"Then we started to get greedy and said, 'Can we print the whole thing?'" Mr. Dean said.

As a result, the interior of the engine's fuel nozzle is being made entirely through printing, and the company built a $50 million 3-D printing factory in Auburn, Ala., to make the parts in bulk for the new engines.

GE has 28 of the machines in use at the Auburn facility and eventually plans to have more than 50, a spokesman said. GE says it will produce 6,000 fuel nozzle injectors at the facility this year, and double output next year. The company says it can make a set of nine of the fuel nozzle interiors in five days, rather than the weeks it takes using conventional techniques.

GE's Additive Development Center in Cincinnati. *PHOTO: GE*

GE says 35% of the company's new advanced turboprop engine will be made using 3-D printing, a technique that has allowed the company to eliminate more than 800 parts from the engine, cutting 5% of the engine's weight.

Those who didn't anticipate the rise of 3-D printing of metals may have missed it because of disappointment in the polymer-based products made by consumer-oriented companies like MakerBot, said Cathie Wood, CEO of investment manager ARK Invest.

"The industrial part of this is really heating up," said Ms. Wood, who earlier this year started a fund that only invests in 3-D printing companies.

GE's pending acquisitions could push other companies to act, whether by snapping up other additive-machinery or metal-powder makers, or just by pushing competitors to experiment with additive processes to build components they currently make through traditional means, analysts said.

The technology also is in use at United Technologies' Pratt & Whitney unit, primarily for making quick prototypes. Mr. Hayes, the CEO, said he thought additive technology could soon create some of the company's aerospace components, but was unlikely to be embraced soon for the most safety-critical components within jet engines, like the finely machined rotating parts.

Early 3-D printing adopters, like the aerospace and medical implant industries, have been joined over the past year by many companies that manufacture metal parts, said Jack Beuth, a professor of mechanical engineering at Carnegie Mellon University who runs the university's NextManufacturing Center.

Printing metal parts makes it easier to build complex structures inside the walls of a part and eliminates multiple stages of casting and welding. The process can reduce weight and complexity, but it is slow. Lasers need to lay down layer after layer of metal dust to build a part up in a process that harks back to the old dot-matrix office printers.

Despite its relative slowness, additive manufacturing has an edge over traditional processes: GE says it takes five days to print a set of nine fuel nozzle injectors at its Auburn facility, and that a similar design would take several weeks to build using traditional methods.

Prof. Beuth said manufacturers will need additive machines that can produce more parts at once, rather than building one at a time, in order to fully supplant existing stages of the manufacturing process.

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