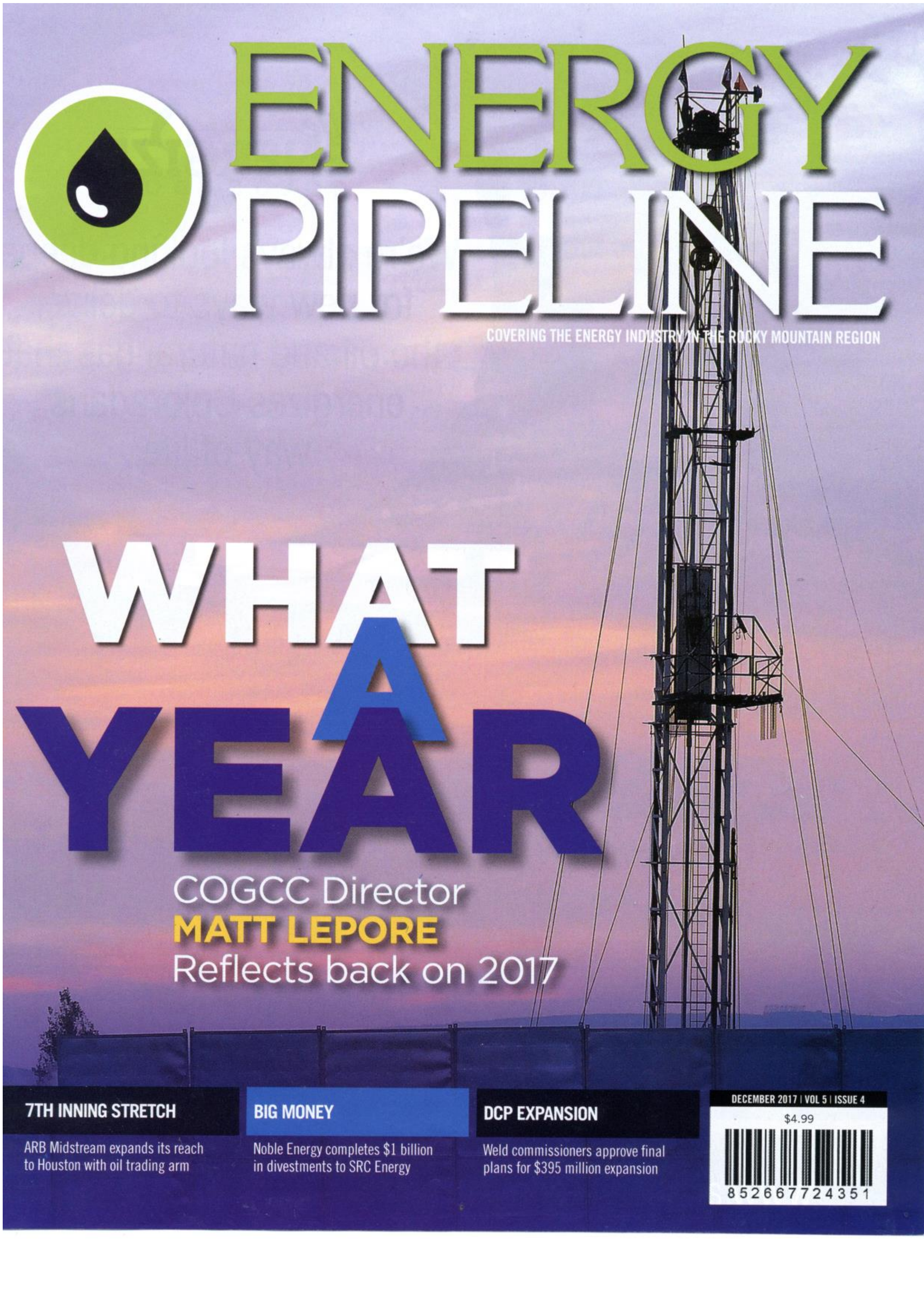

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TECH TALK

3D printing will contribute to significant efficiencies in oil company operations

BY GARY BEERS • FOR ENERGY PIPELINE

Disruptive technology can be a common label tagged to a new exciting technology, but often the new technology is innovative, not disruptive. According to C. M Christensen, a Harvard Business school professor, a disruptive technology is a new emerging technology that unexpected displaces an established one (The Innovators' Dilemma, Management of Innovation and Change, 1997).

A time-worn example is the automobile. Reportedly, the Henry Ford said – "If I had asked people what they wanted, they would have said faster horses". Obviously, his disruptive technology did not rely on a horse.

One of the most distinctive — yet underappreciated — disruptor today is 3D printing, which emerged about three decades ago. This new technology was not a "faster horse" in the manufacturing world, but a genuine disruptor – known as additive manufacturing. Three-dimensional objects are created by layering materials in a pattern under computer control. Any digital model created in a computer can be created using a variety of materials in a limited space with a few people. The complexities of milling and assembling metal components into a piece of equipment are rendered obsolete.

HIGH-QUALITY PRINTING OF PARTS WITH DIRECT METAL LASER SINTERING

The main difference in 3D printing technologies is how layers are built to create an object.

When most people hear 3D printing, they visualize an inkjet printer moving back-and-forth above a platform and continuously depositing a thin thread of binder material layer-by-layer until the object is formed. This pioneering technology is commonly called Fused Deposition Modeling (FDM).

During the past two years, the break-out 3D printing technology has been metal 3D printing, which is making many inroads into the industrial market. Technically named Direct Metal Laser Sintering (DMLS), this process involves several main steps:

» CAD model of object in computer is sliced tissue thin and traced on top of a bed of fine metal powder (i.e., Titanium, Aluminum).

» A laser passes and sinters the powder over the trace. The applied heat fuses the powder particles together without melting them to the point of liquefaction. This is the shaping process.

» The process is repeated over each new slice of the CAD model.

» Excess powder is removed and the formed, porous object is baked at low heat.

» In the final step, the object is placed in a sand filled container with a metal additive and heated at very high temperature. The object absorbs the metal and hardens. Finally, the excess powder is removed from the object before it is polished.

The aerospace and aviation industries is rapidly expanding use of this printing technology to manufacture precision parts. An example of hard-to-fabricate part for the aerospace industry created by GE Aviation utilizing the DMLS process is shown in Figure 1. The traditional manufacturing time of 12 weeks is reduced to 12 hours with this printing technology. An expected 100,000 fuel nozzles will be printed by 2020 (New industry Report: Metal 3D printing is Now the Fastest Growing Segment of the 3D Printing Industry, 3D Printing Industry, November 2017). In 2016, NASA announced plans to print much of the next-generation rocket engines, with a goal of 80 percent to 100 percent within the coming years.

Currently, the volume of a DMLS manufactured part is limited to less than a cubic meter (GE Announces Development of Atlas World Largest Powder Bed Metal 3D Printer, 3D Printing Industry, June 2017).

Figure 1. Fuel Injection Nozzle Printed with DMLS (Source: GE Aviation, 2017). An example of hard-to-fabricate part for the aerospace industry created by GE Aviation utilizing the DMLS process.

For over 50 years **GARY BEERS** has worked in numerous fields of environmental science as a consultant, regulator and educator. This career included senior management position with major consulting, nonprofit and public organizations. He has founded several successful firms to capture emerging resource management markets. One of his latest ventures, EnviroScienceINFO, provides content for public media.

3D PRINTING WILL DISRUPT HOW PARTS AND TOOLS ARE MADE FOR AND BY THE OIL/GAS COMPANIES

Last year, a major research report predicted that the next big adopter of advanced printing technologies will be the oil and gas industry (Additive Manufacturing Opportunities in Oil and Gas Markets 2016: A Ten-year Forecast, SmarTech Publishing, June 2016). They forecast:

» Printing technology will radically alter the cost structure of oil exploration and drilling operations,

» By 2019, 10 percent of oil and gas companies will be printing parts and equipment, and » By 2025, printing revenues for this industrial market will reach approximately $1.4 billion.

The following examples describe existing and planned uses of printing technologies in oil and gas operations (Oil Drillers Use Additive Manufacturing to Create Drilling Parts. Make Parts Fast, March 2016; Direct Metal printing at Offshore Technology Conference, 3D Systems, May 2016; and 3D Printing is Making Its Way into the Oil and Gas Industry, Type A Machine, March 20178).

Printing technologies manufactured three versions of a downhole drill bit (Figure 2). Direct metal printing (DMP) produced a high-quality titanium drill bit is 6.5 inches tall and weigh 7 pounds. Colorjet Printing (CJP) provided engineers with a drill bit that displayed stress and heat patterns. Multijet Printing (MJP) manufactures a rapid form for fit and function testing. While three months or longer would be needed to traditionally manufacture the titanium drill bit, less than 40 hours were needed to prep, print, and post-process the titanium version.

Other applications (i.e., down-hole operations) reveal the emerging advantages of this disruptive technology, especially metal printing, include:

» One advantage is the ability to manufacture parts with gently sloped surface and curved holes. With traditional milling methods, problems would exist since the part would have sharp internal edges which would chafe wiring, cause inefficient flow and/or encourage erosion caused by sharp turns.

» A persistent problem, during the harsh down-hole environment of drilling, is the erosion of expensive, precision-machined steel components. Printing these components in stainless steel, nickel-chromium super alloys, or other metals, results in parts that persist longer under these harsh conditions.

» Some down-hole tools consist of several parts, including electric wiring, and cannot be traditionally manufactured as a single unit. There are definite space constraints when these tools have to fit inside a drill collar. Printing provides the opportunity to manufacture a tool that could not be traditionally built. First, strong and thin honeycomb lattice structures can be printed to provide more space for internal components. Second, the tool can be manufactured as a unit when the component parts are designed into the digital model which serves as a template for the metal printing.

» Some small turbines contain some complicated end-housing and five sets of stators and rotors, which have to be manufactured separately and then assembled into single unit. Now these components can be printed in place as the turbine is printed.

In additional to these technological improvements, the availability of 3D printing supports significant cost savings. Historically, components were made of cast materials and required long lead times (i.e., several months). With printing, this time can be reduced to less than a few weeks and, expectedly, in many instances, the part locally manufactured. Obviously, cost savings are realized when down times are shortened.

These merging printing technologies offer the practical and cost-effective manufacture of parts with improved materials, of all-in-one parts, and of needed parts that previously could not be manufactured.

It is only a matter of time before the oil/gas companies integrate 3D printing into their design and operations, with an outcome of improved production efficiency and cost savings. ♠

Figure 2. Printed drill bits : Colorjet Printing, Multijet Printing, and Direct Metal Printing (Titanium). 3D printing technologies manufactured three versions of this downhole drill bit.
(Source: 3rd Dimension Industrial Printing).