Additive Manufacturing and 3D Printing for Oil and Gas -
Transformative Potential and Technology Constraints

Joseph A. Camisa, Vinit Verma
ExxonMobil Technical Computing Company, Research and Engineering IT
David O. Marler
ExxonMobil Research and Engineering, Corporate Strategic Research
Adam Madlinger
ExxonMobil Research and Engineering, Process Technology
Annandale, NJ, USA

ABSTRACT

Additive Manufacturing (AM) and 3D printing (3DP) are digital parts fabrication technologies that have very high, and potentially disruptive, value for the oil and gas industries. These technologies are rapidly evolving from their beginnings as component rapid prototyping techniques to include the manufacture of operational parts. The ability to create metal alloy components with complex geometries not feasible using traditional manufacturing is already being exploited by the aerospace industry. This paper describes the latest developments in AM and 3DP with an emphasis on those developments with the potential to result in future Oil and Gas applications.

KEY WORDS: additive manufacturing; 3D printing; digital fabrication; rapid prototyping

INTRODUCTION

Additive Manufacturing (AM) and 3D Printing (3DP) are digital parts fabrication technologies that have very high, and potentially disruptive, value for the oil and gas industries. These technologies are rapidly evolving from their start as component rapid prototyping techniques to include the manufacture of operational parts. The ability to create metal alloy components with complex geometries not feasible using traditional manufacturing is already being exploited by the aerospace industry. Active research and development by U.S. national laboratories, in academia and by AM machine vendors is quickly advancing the state of the art. Multiple U. S. agencies are funding AM research including NASA, DOE, and DOD. In September 2013 the National Institute of Standards and Technology (NIST) awarded grants totaling $7.4 million to fund research projects aimed at improving measurement and standards for the “rapidly developing field of additive manufacturing”. Early 3D printing patents expiring in 2014 are anticipated to further spur growth of AM machine availability and innovation. This paper describes the latest developments in AM and 3DP with an emphasis on those developments with the potential to result in future Oil and Gas applications.

Today the oil and gas industry uses 3DP and AM primarily as rapid prototyping tools. Potential near term oil and gas applications of AM and 3DP include major process equipment innovation for improved heat exchanger, reaction vessel, valve and machine part design. Longer term, AM may lead to improved catalyst manufacture and support refinery and chemical plant process intensification initiatives.

Technology constraints will need to be overcome to enable AM to live up to its disruptive potential for oil and gas applications. Tomorrow’s AM machines will need to be faster, process a wider range of alloys and produce parts with higher resolution. They will also need to create larger metallic parts than current technology permits. These constraints are viewed as speed bumps and not insurmountable roadblocks.

OVERVIEW OF AM TECHNOLOGIES

Additive Manufacturing consists of a broad set of technologies with a common process definition – a process in which three-dimensional models are transferred to a machine that creates multiple layers of material fused together to form a three-dimensional object representing the three-dimensional model. A list of the major categories of AM technologies is provided in Table 1.