Additive Manufacturing Challenges

Dr. Suman Das
Dr. Ben Wang
Dr. Chip White

Georgia Institute of Technology

Point of View Paper – January 28, 2013

Reaching Additive Manufacturing’s Transformative Potential

Additive manufacturing, also known as direct digital manufacturing or 3D printing, continues to receive much attention and interest within industry, government and academia for its potential to produce, on demand, highly customized and complex products with minimum energy and material waste. The true transformational aspects of additive manufacturing are the decoupling of unit product cost from lot size and the enablement of innovative product features that are not possible with today’s manufacturing processes, resulting in superior performance capabilities.

Much of the attention and the resultant funding has been directed towards the investigation of new materials and expanded process capabilities that are essential for additive manufacturing’s usefulness.

In order for additive manufacturing to reach its transformative potential, however, we strongly argue that two challenges must be immediately and quickly addressed: 1) rapid certification, and 2) supply chain realignment.

Rapid Certification

Additive manufacturing has the potential for greatly shortening procurement lead times, as several time-consuming manufacturing steps can feasibly be eliminated from each process. For example, according to Frazier (NAVAIR), the production lead time of certain key Navy parts can be reduced from 8-28 months to as few as 2-7 weeks. Many other similar predictions of time and cost savings in the acquisition of mission-critical components for both commercial and defense uses can be made as well.
Just because a mission-critical part is quickly produced, it does not necessarily follow that the production or repair problem can be solved quickly unless the part is rapidly certified. In fact, if the certification process and regulations remain as they are now, we would certainly not see many of the time saving benefits of additive manufacturing. Part certifications are sure to become choke points in massive implementations of additive manufacturing unless there is a drastic and rapid reform of the certification and qualification of mission-critical parts. The ultimate goal should be to implement “on-machine acceptance and qualification” of parts as they are built. For this to happen, much work is needed to: 1) validate and verify a wide range of different processes, processing conditions and materials; 2) quantify uncertainties associated with materials, processes and human operators; 3) develop new certification methods based on, for instance, “similarity” of material, process, or part geometry; and 4) augment physical experimentations with powerful computational models, data and tools to shorten the time to market.

**Retooling and Realigning the Global Supply Chains**

Additive manufacturing will eliminate time-consuming and expensive manufacturing steps, such as casting, forging and machining, and significantly simplify goods transport. By eliminating or reducing these supply chain tiers, the domestic supply base and the U.S. manufacturing landscape will be dramatically impacted.

More specifically, 3D printers are cost-effective and portable, and are highly versatile in that they can manufacture a large set of products with virtually no change-over time. The digital designs required by 3D printers can be transmitted electronically. The required feedstock is also as versatile as the 3D printers and is dense, much less prone to damage compared to forged, cast or machined components, and has a different set of transport and handling requirements. A component manufactured by a 3D printer can be manufactured directly at the point of consumption or closer to where and when it is needed than if it were manufactured by a traditional manufacturing process. The future supply chain will assemble both traditionally and additively manufactured components, will be more agile and better enable build-to-order, and will result in: 1) an increase in information transmitted; 2) an increase in feedstock transported; 3) a decrease in work-in-progress, finished goods, and total weight transported; and 4) a decrease in stock outs and obsolescent parts. Realizing this vision, and hence an expansion of the additive manufacturing industry as an integral part of rebuilding U.S. manufacturing competitiveness will require new standards for digital designs and supply chains that manufacture requisite quantities of 3D printers and concomitant feedstock.
What is not as certain is to what extent and how soon this transformation of supply chains and manufacturing will or can happen. To provide an impetus for this transformative agenda, we are advocating a system-wide (end-to-end), investigational process to quantify the impact of additive manufacturing on the U.S. and global supply bases; in turn, re-aligning and positioning U.S. suppliers and freight transportation and logistics providers as the new world leaders in the resulting transformed global marketplace.

###

**The Georgia Tech Manufacturing Institute**

Taking a holistic approach to re-energizing U.S. manufacturing and shepherding new technologies across the valley of death, the Georgia Tech Manufacturing Institute (GTMI) catalyzes collaborations of industry/government with many units across the Georgia Tech campus - from engineering to science to business to policy. In addition to working closely with academic faculty and students, GTMI personnel collaborate with the Georgia Tech Research Institute, Georgia Manufacturing Extension Partnership and Georgia Tech’s technology transfer functionaries and business incubators on additive processes, materials, rapid certification and supply chain realignment.

For more information on additive manufacturing challenges, contact the authors below. For more information on GTMI, visit http://www.manufacturing.gatech.edu

**Dr. Suman Das** is Morris M. Bryan, Jr. Chair in Mechanical Engineering for Advanced Manufacturing Systems and Director of the Direct Digital Manufacturing Laboratory in the George W. Woodruff School of Mechanical Engineering; and Professor in the School of Materials Science and Engineering. Contact: sumandas@gatech.edu

**Dr. Ben Wang** is Executive Director of the Georgia Tech Manufacturing Institute; Chief Manufacturing Officer for Georgia Tech; Gwaltney Chair in Manufacturing Systems in the H. Milton Stewart School of Industrial & Systems Engineering; and Professor in the School of Materials Science and Engineering. Contact: ben.wang@gatech.edu
Dr. Chip White is Schneider National Chair in Transportation and Logistics in the H. Milton Stewart School of Industrial & Systems Engineering. Contact: cwhite@isye.gatech.edu

GTMI Point of View Paper #1-2013