

# Science in the Age of Experience Additive Manufacturing Symposium: An Assembly of AM Thought Leaders

## *CIMdata Commentary*

### *Key takeaways:*

- *Like a TED conference with an Additive Manufacturing (AM) theme, speakers came from government agencies, industrial companies, academia, and tech startups, hosted by Dassault Systèmes, to deliver the current state and future vision of an end-to-end AM design to manufacturing lifecycle.*
- *Problems such as repeatability, warpage, cost, time, and lack of education all present barriers to adopting AM to make production parts. Fortunately, the solution providers, material makers, standards and academic institutes which spoke at the event are rallying to help customers make AM parts for end use.*
- *Dassault Systèmes demonstrated their 3DEXPERIENCE® suite of connected AM applications: BIOVIA, CATIA, SIMULIA, and DELMIA which illustrated what's available today to help customers design and make AM parts. Customers can choose whether to adopt incrementally, as point solutions, or holistically to provide an end-to-end platform for designing, simulating, and making AM production ready parts.*

Dassault Systèmes' Additive Manufacturing Symposium, held May 15<sup>th</sup>, 2017 at The McCormick Place Convention Center in Chicago, Il., preceded their Science in the Age of Experience conference featuring customer presentations and the latest technology advancements from their SIMULIA, BIOVIA, and GEOVIA brands. By combining additive manufacturing (AM) with SIMULIA, BIOVIA, and GEOVIA brands at the same conference, Dassault Systèmes has signaled a new approach to design, leveraging biological, chemical, and material innovations combined in the physical environment, with the ability to fully simulate, design, and make the contemplated product. It doesn't seem too long ago that Dassault Systèmes' customer conferences were a series of discrete events grouped under their separate brands and industries. Under the manufacturing stream, CATIA was at the core; the big news was new add-ons to the core mechanical 3D CAD solution. My how times have changed!

In conjunction with the Additive Manufacturing Symposium, Dassault Systèmes hosted an AM Hackathon. That event started in the afternoon session of the Symposium and continued throughout the entire Science in the Age of Experience conference. The AM Hackathon posed challenges to participants based on real-world problems proposed by industry experts. Teams were assembled based on areas of interest and attendee expertise, and comprised industry and academia. Adding a hackathon next door to the speaking gallery, established a linkage between presentations by experts to everyday people facing design challenges. This validated that, with the right tools, AM can help solve practical design problems facing engineers today.

The symposium speakers came from diverse backgrounds within the AM community. Represented were AM machine makers, AM materials makers, academic institutes, standards and certification authorities, government agencies, tech. startups, research institutes, and finally Dassault Systèmes to wrap it up. Even the on-stage hosts for most presentations were not Dassault Systèmes employees. The open forum offered a fertile

environment for people to share ideas and experiences about how AM is changing the way we make things. Dassault Systèmes as host, rather than software sales company, showed confidence, credibility, and vision with their mixed thought leader and software solution provider role; a combination which is essential to guide and support customers in their journey toward making AM production products.

## **Key Addresses & Messages**

There were 19 presentations throughout the symposium. What follows is a summary of several of these insightful presentations.

Mr. Derek Luther, Adidas Group, presented “Evolution of AM at Adidas”. Mr. Luther, based at Adidas’ Portland Oregon North American Headquarters, shared Adidas’ impressive AM vision and current advances in shoe production using AM. Incidentally, Adidas world headquarters is a small Bavarian German town called Herzogenaurach, is a difficult location to which to attract young talent with skills in digital design and advanced manufacturing such as AM. But hip Portland, the home of NIKE, makes a logical choice for pioneering AM in shoe production. Mr. Luther described their design process for the FUTURECRAFT 4D athletic shoe where using latticing techniques, a unique pair of shoes can be made for a specific athlete. Using AM specific design tools, lattice structures of the sole are controlled to the cell level. Not only that, each shoe (i.e. left and right) is unique, and conforms exactly to the athlete’s foot shape and weight, to optimize for movement, cushioning, stability, and comfort performance. Mr. Luther emphasized the new, much shorter design to manufacture process compared to traditionally molded parts: research collaboration, Design for Additive Manufacturing (DfAM) including topology optimization (TopOpt), FEA, then finally PRINT. Although Adidas’ website states the FUTURECRAFT 4D will be available fall 2017, some 300 shoes have already been made with a target to scale to 5,000 by the end of the year. Scaling AM production to that volume will surely pose some challenges considering the custom design process, manufacturing quality and repeatability need, and often underestimated, Product Lifecycle Management (PLM) to manage change, design and manufacturing process settings, security of AM digital assets, and repeat orders. Knowing Adidas, we expect they have a plan.

Mr. John Vickers, NASA, presented “NASA’s Additive Manufacturing Development Materials Science to Technology Infusion—Connecting the Digital Dot.” Mr. Vickers, principal technologist in advanced materials and manufacturing at NASA, shared some insights into how AM is needed for space exploration. The obvious case highlighted was spare parts. You can’t store inventory of all spare parts for the International Space Station (ISS) or Mars Curiosity (Rover) in space; it’s simply not practical given the cost and time of space travel (e.g., 8 months to Mars). Clearly there’s a business case to use AM parts produced locally in space where and when needed. Mr. Vickers highlighted that ISS has a functioning AM printer on board now.

Mr. Jerry Feldmiller, Orbital ATK, made a presentation entitled, “The Importance of Industry Participation with AM Companies in Shaping Future Hardware, Software, and Materials Development.” Orbital ATK is a global leader in aerospace and defense technologies, especially launch vehicles. Mr. Feldmiller emphasized that AM user groups are critical to disseminating valuable knowledge, lessons learned, and maximizing AM machine utilization. He encouraged the formation of user groups organized by industry work streams. He also emphasized how essential it is to connect all AM digital assets and processes using a Digital Thread. After his presentation, he was asked how Orbital ATK manages change and maintains the final product master record of the entire AM design. He commented that Orbital

ATK creates a master PDF, like a container, which has a complete record of materials, machine settings, quality standards, etc. Orbital ATK, using a master PDF, has found a way to protect corporate AM IP from being lost. Although a PDF may not manage all lifecycle events that preceded the result, or the changes along the journey, it does help maintain a master source of truth to refer to whenever they need to make the same or similar AM parts in the future.

Dr. Tim Simpson, Penn. State University (PSU), presented “Design for Additive Manufacturing: Challenges and Research Opportunities” emphasizing the urgent need to improve DfAM practices and tools by drawing attention to the wide range of issues still confronting industry as AM transitions from prototyping into production. Dr. Simpson, a professor in mechanical and nuclear engineering, and industrial and manufacturing engineering departments, at PSU is a prolific author with more than 300 papers to his name, and has been a TED™ speaker. He lamented that “...we lay it down in  $\eta$ m but it warps in mm,” referring to warpage issues when printing titanium. He also spoke about the commercial issue of buying a printer saying that “...customers seek an apples-for-apples comparison (to what they know) when justifying an AM printer.” What he was referring to is the problem of overlooking the hidden justification of AM because customers compare how they make a part today, say an injection molded part, to how they can make the same part in an AM machine (i.e., customers want to know how much faster/better/cheaper can I make the same part using AM). He correctly identified the flawed logic by not considering the re-design opportunity that AM provides. An injection molded part may be lightened by 90% by using DfAM methods and tools to redesign the part for an AM machine. Essentially, he was highlighting the urgent need for education about DfAM and AM production technologies, more than improvements needed to tools and machines. Additionally, he made a good point that CAD design tool user interface paradigms rely on lines and arcs as conventional engineering input techniques. He encouraged the audience to emulate the game Minecraft™ to approach design. To do this, engineers need to un-learn much about how they approach design today, because AM frees us from many manufacturing conventions downstream. He also made a significant point about security risk for AM digital assets by showing a chart titled “US Reported Cyber Incidents by Critical Infrastructure Sector” (Source: Department of Homeland Security, 2015), which highlighted how cyber-attacks on Manufacturing companies were far higher than any other industry such as Defense and Finance. This was both a surprise and a wakeup call to the audience, because, although it’s not possible to steal an injection mold needed to make a part through the public internet, it is possible to steal AM digital assets, allowing someone to immediately make parts in multiple locations around the world.

Mr. Jacob Rome, The Aerospace Corporation, spoke on “Process Simulation for Developing and Qualifying AM Parts for Space Applications.” Mr. Rome started by making an interesting statement, “GE doesn’t look at individual parts, they look at subsystems.” We have all heard of GE’s advances with AM production parts, but this insight is significant because it applies broadly to any company considering AM in production. The real opportunity to make significant gains from AM is to look at redesigning subsystems not just individual parts, because AM allows us to escape many traditional manufacturing conventions (e.g., the way we build two-piece enclosures that contain individual components, and then secure them with fixing devices such as screws, bolts, and adhesives. Mr. Rome then lead through a series of slides titled “Guidelines for Design for Additive Manufacturing (DfAM)” to offer a very pragmatic process overview of each stage of DfAM. The initial design slide depicted how requirements and standards flow into functional requirements, acceptance test requirements, qualification requirements, loads and environments, and finally, mating interfaces. After

requirements comes design iteration, which brings in materials development. The initial design overview was followed by material variability, manufacturing baseline, production, and finally process simulation using physics-based modeling. Mr. Rome, correctly, highlighted the need to design whole processes not only part geometry. Clearly there's more to DfAM than outputting a CAD STL file to an AM machine.

Dassault Systèmes closed off the day with a **3DEXPERIENCE** demonstration highlighting CATIA, SIMULIA, and DELMIA applications supporting the complete AM product lifecycle, from design and development to simulation and part fabrication. CATIA Generative Shape Design using a dynamic slider to alter design variables such as design space, load, mass etc., showed how a part could be made four-times stiffer with 40% weight reduction, perfectly highlighting advantages of DfAM. DELMIA powder bed fabrication demo showed thermal interaction between parts within the build tray, to highlight machine level simulation but right up in the design stage. Dassault Systèmes' **3DEXPERIENCE** end-to-end solution demonstration book-ended the day by showing they offer a flexible AM framework for design, optimization, stress analysis, and manufacturing process simulation. This helps customers understand consequences of their AM design choices throughout the lifecycle, before committing to manufacture, which enables engineers to make better designs, save time, reduce material wastage, and save cost.

## Concluding Remarks

Dassault Systèmes' Additive Manufacturing Symposium, comprised 19 short presentations, and was both innovative and insightful. It felt like a TED conference dedicated to AM, yet was hosted by a leading PLM solution provider, Dassault Systèmes, whose presence was subtle throughout. The various speakers highlighted both groundbreaking advances, and frustrating impediments to adoption of AM into production, yet confidence is obvious that AM is here to stay. Drawing from a conversation CIMdata had with Mr. Scott Berkey, CEO SIMULIA, Mr. Berkey said "By bringing together leading experts and thought leaders in additive manufacturing from academic institutes and industrial companies, Dassault Systèmes is helping our customers learn about the latest advances and practical challenges related to making production ready AM parts. The **3DEXPERIENCE** platform addresses the end-to-end AM process from material design to manufacturing processes and testing. It provides a single source of design, engineering, and manufacturing parameters including; material science, functional specification, generative design, optimization, production, and certification."

Although AM has been around for decades, there is a lot of work still to do—especially in DfAM education, production quality, repeatability, cyber security, material science, and lifecycle management. Dassault Systèmes is committed to reinventing how we think about, design, and make all the things we use in our lives. Their question: "If we simulate down to the infinitely small, can we harmonize the infinitely big?" alludes to this new, innovative approach to making products, and hints of more to come. Dassault Systèmes' **3DEXPERIENCE** suite of connected AM applications—BIOVIA, CATIA, SIMULIA, and DELMIA—might look initially like a collection of disparate brands, yet makes complete sense in the context of this question. CIMdata looks forward to observing, researching, and influencing the continuing AM journey.

## About CIMdata

CIMdata, an independent worldwide firm, provides strategic management consulting to maximize an enterprise's ability to design and deliver innovative products and services

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