DIGITIZE or DIE?

New Brain Bank Dedicated to Coaching U.S. Manufacturing into Digital Age

Jack McGuinn, Senior Editor

In a capitalist society, the way things usually work is that government and academia focus on research and development, while industry focuses on commercialization. The result is an increasingly wide disconnect in the applied research sector, which deals primarily with technology development and demonstration. Meanwhile, there exists — especially in the manufacturing and technological sectors — a decided lack of both able and want-to candidates to replace their rapidly retiring elders. To give it a number — there are approximately 600,000 unfilled manufacturing positions around the country — a sure sign that Baby Boomers are seemingly retiring as soon as their IRAs and Social Security will allow. Accordingly, their former employers cannot find sufficiently skilled workers to replace them.

None of this is news. Yet the fact remains today that while 81% of U.S. manufacturers agree digital manufacturing is key to their future competitiveness, only *14%* said they were adequately equipped with today's available digital technologies and related expertise. While many majors — Siemens, John Deere and General Electric, etc. — are true believers in digital manufacturing and all that that entails, others — especially small to mid-size companies — are understandably of a "show me more" mindset.

Nevertheless there is clear, general consensus on how difficult it is to compete with foreign manufacturers able to pay poverty-level wages and get away with it.

What *is* new is UI LABs' Digital Manufacturing and Design Innovation Institute (DMDII) — a "public/private partnership of American companies, academia, and government agencies that are benefiting from early advances in digital manufacturing and design." UI LABS is, citing its Website, "a first-of-its-kind innovation accelerator" that tackles problems too large-scale or complex for any one organization to handle. The challenges being addressed in manufacturing "are at the intersection of digital convergence."

Located in Chicago's West Loop corridor, UI LABS in spring of 2015 was granted $70 million from the U.S. Department of Defense (DoD) to fund the DMDII. The DoD funds were complemented by commitments of approximately $250 million from a consortium of industry, academic, government and community partners. With this blend of industry, academia, the nonprofit sector and government, DMDII sponsors research "projects" in digital manufacturing and design; disseminates lessons learned; and helps educate the workforce of tomorrow.

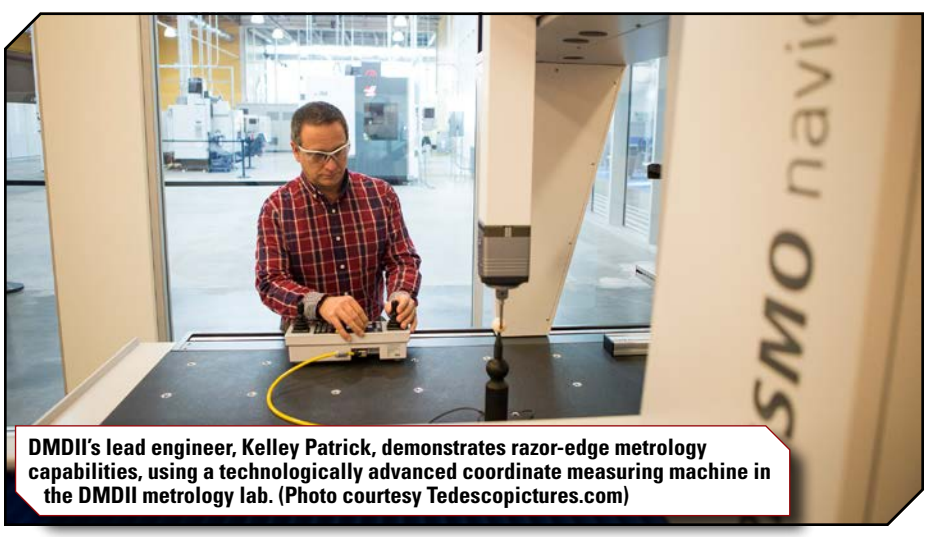
Among its (over 500) member supporters are such heavyweights as Lockheed Martin, General Electric, Siemens, Rolls-Royce, Boeing, John Deere, Caterpillar and Illinois Tool Works. Also on board from Academia are the University of Illinois; Northwestern University; the University of Chicago (*University of Chicago??*); Purdue University; the University of Texas-Austin; the University of Louisville; the University of Iowa; and the Rochester Institute of Technology. Remaining essential DMDII members are among the country's small and mid-size manufacturers — otherwise known as the bedrock and benchmark of U.S. manufacturing and its economic stability.

And so it is that DMDII is charged with aiding "U.S. manufacturers (in the capturing of data) to make their products better, faster, and more cost-competitive," while also zeroing in on "helping U.S. manufacturers to increase their return on investment (ROI) by making their production processes more efficient and agile."

Perhaps it was to underscore the significant and urgent need for U.S. entities such as DMDII that the $70 MM came from the coffers of the DoD — although Homeland Security might be even more appropriate. Of most importance perhaps is the backing of the previously mentioned consortium and its $250MM in monetary commitments.

In return, other important assets readily available to members include downloadable manufacturing software collaboration tools; opportunities to exchange product information; advertise manufacturing capability, and transmit detailed design information in a secure, neutral and intellectual property-secure digital environment.

And there's more; highest



DMDII's lead engineer, Kelley Patrick, demonstrates razor-edge metrology capabilities, using a technologically advanced coordinate measuring machine in the DMDII metrology lab. (Photo courtesy Tedescopictures.com)

(investment)-level members receive rights to intellectual property produced via DMDII collaborative research projects, and gain access to a group of digital manufacturing and design experts that can help form strategic partnerships between corporations and universities. And all members, at any level, can take advantage of:

- Coordinated support to prepare and align your workforce to digital manufacturing and design outcomes and trends
- Access to live demonstrations of the latest digital manufacturing and design technologies
- Collecting and analyzing data drawn from various types of manufacturing equipment, including:
  - Standard machining
  - Multi-access machining
  - Metrology
  - Welding & fabrication
  - Micro manufacturing
  - Additive manufacturing
  - Circuit assembly

U.S. manufacturing employment has decreased from 18 million jobs in 1970 to less than 12 million jobs today. In 2016 it remains difficult to compete with foreign manufacturers ready and able to pay poverty-level wages — and get away with it. But with game-changing digital manufacturing and design technologies/processes to help speed product design and production processes, the playing field levels dramatically.

And in the near future, according to the DMDII site, will be the ability to:

- Reduce or eliminate prototyping with advanced simulations
- Enable true transparency in the supply chain
- Benefit from further advances in intelligent machining
- Predict and apply manufacturability and operability feedback at the initial design stage

For more details on DMDII — we've only scratched the surface here — following is an interview conducted with three individuals key to DMDII's success: Andrew Watkins (**AW**), managing director – strategy; Haley Stevens (**HS**), director, workforce development and manufacturing engagement; and Kelley Patrick (**KP**), lead manufacturing engineer.

GT: Why Chicago? How fierce was the bidding from competing cities?

Andrew Watkins (AW): Chicago, Illinois, and the Midwest have long been at the epicenter of American manufacturing. Illinois was a logical location for the Digital Manufacturing Design & Innovation Institute (DMDII) given the region's strong ties to the manufacturing sector, an abundance of skilled engineering and computer science talent, and technological assets. DMDII is able to draw from large industrial manufacturing companies, world-class universities in engineering and computer science, local super computers, a large base of small and medium-sized manufacturers, and a growing startup scene for industrial technology. All that said, we are a national institute with partners in more than 30 states that contribute to the network and projects.

The bid process was certainly competitive with bids from all over the country, but our mix of team, assets, and vision for the future of manufacturing made Chicago the ultimate choice.

GT: Who/what was the spark — the big bang — that led DMDII from the what-if stage to today's reality?

AW: The spark was a convergence of forces. Local and state leaders from industry, university, and government were working on a plan for tighter collaboration and use of our assets to lead in areas of historic strength, such as manufacturing. At the same time, President Obama announced the Manufacturing USA program (formerly known as the National Network for Manufacturing Innovation) to launch a series of manufacturing-focused institutes. Our team was well positioned to respond and lead when the topic of digital manufacturing was announced, based on the alignment that was established with our partners over the prior 2-3 years. Our partners had already determined that digital and advanced manufacturing was a good topic to work together on through applied R&D, so it became a natural area to collaborate within.

GT: How, if at all, difficult was it to make it happen?

AW: The biggest challenges we encountered were in establishing the institute. We started with approximately 70 partners and have more than 300 today. Establishing a structure, legal framework, and process that work for each partner is a tall order, which is why these unique partnerships and collaborations do not happen frequently.

GT: How were your key players (core team) recruited? Was it easy or did DMDII have to do some serious selling?

AW: Bringing the initial core partners to buy in was easy in some ways, while difficult in others. It was amazing to see the shared vision of both the challenges and the potential future for manufacturing. Getting all of the partnerships to line up certainly took a lot of effort and time to ensure there was alignment on the structure and details. Our early partners included the University of Illinois, Northwestern, GE, Rolls-Royce, and Procter and Gamble, as well as officials from the city and the state. As additional partners have signed up, they have become our biggest champions.

GT: Please explain the connection with UI Labs — e.g. are they equal shareholders or something else?

AW: UI LABS is Chicago-based in innovation accelerator that addresses problems too big for any one group to solve on its own. The organization has built a portfolio of labs that accelerate the deployment of digital technology within industries. The first lab is the Digital Manufacturing & Design Innovation Institute, established in 2014, and we launched City Digital, focused

on smart city infrastructure, in 2015. UI LABS is a nonprofit entity—the 'UI' stands for University + Industry—that runs and executes the programs of its two labs, with the potential to add other labs to the portfolio in the future.

GT: Is there an existing organization in Europe—Germany comes to mind—that may have served as a model for DMDII?

AW: The Fraunhofer institutes in Germany (*www.fraunhofer.de/en.html*) certainly were a model for the Manufacturing USA network established by the federal government, and a group we have learned from. (*The Fraunhofer Society for the advancement of applied research is a German research organization with 67 institutes spread throughout Germany—each focusing on different fields of applied science.*) There are other examples of government catalysts for industry innovation in the UK (Catapults) and Singapore. We have tried to learn from all of these groups as well as models of innovation that work in the U.S., such as SRI or MIT Media Lab, but have different structures or focus.

GT: Given all this new cost-efficient, energy-saving, data-rich technology, there still must exist a market actually needing/wanting manufactured products. Therefore is there any question among entities like DMDII or, for example, OEM members, that perhaps tomorrow's technology is outstripping today's somewhat iffy economy?

Kelley Patrick (KP). There's always going to be a need to make things. At DMDII we're trying to make things more energy-efficient, and data-rich, with the ultimate goal of producing more here in the United States at a lower cost to help grow the economy—and reduce the amount of work that's outsourced abroad. Raising the capability level of all manufacturing across the United States is a key part of the DMDII mission.

GT: Are you anticipating new funds any time soon from Congress beyond the initial $70 million?

AW: We are constantly working with our partners to understand priorities and ways that our model can help address their problems as they relate to digital manufacturing or transition and commercialization of technology. We have added additional funding to our agreement for specific programs and we continue to see strong support for the institute from Congress and our partners.

GT: Are entities like DMDII frustrated by Washington's continuing refusal to pass a meaningful and comprehensive infrastructure bill—one significantly larger in scope than what was recently passed?

KP: We're excited that the federal government is acknowledging the need to improve the manufacturing capability in the United States, which they've done by supporting the Manufacturing USA network.

GT: DMDII's site states one of its goals as "educate the digital workforce." What does that mean, exactly?

Haley Stevens (HS). Manufacturing has evolved into a highly innovative, interactive, and compelling career. We must begin with challenging the misperceptions that plague manufacturing careers as 'dirty, dark, dangerous, and moving offshore.' According to a recent Deloitte study, only 33% of parents say they want their children to pursue manufacturing as a career, seeing it as potentially unstable and lacking growth opportunities. So, what do we do to create and educate the "digital workforce" we need?

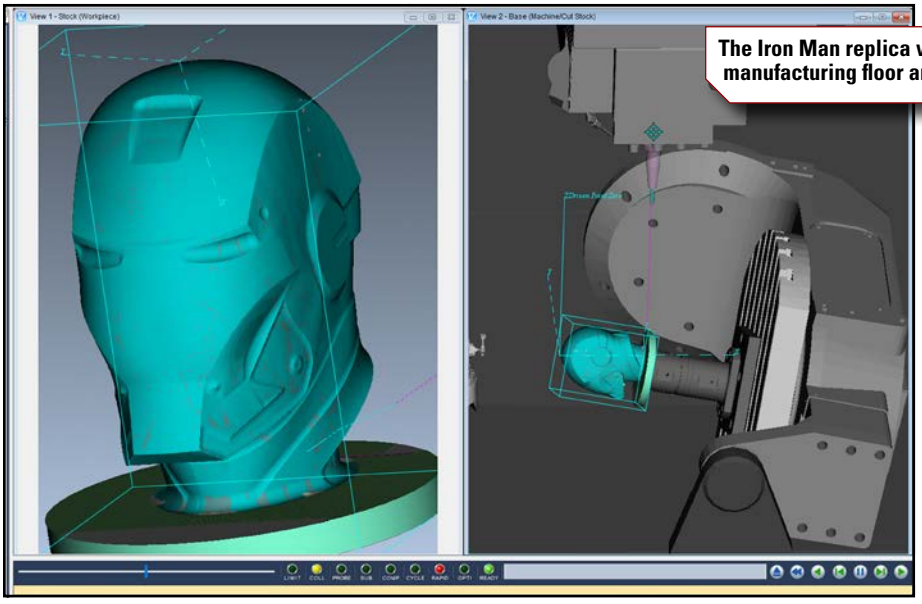
The following a short list of the basic things we need to do:

- Manufacturing has changed and we need to understand what skills are needed today and what skills will be needed tomorrow as manufacturing continues evolving to in the future. We need a 'taxonomy' of all the digital manufacturing jobs as a starting point.
- We need to develop formal training programs that are similar to the old 'apprentice' programs of the past that include technical and hands-on training that result in recognized credentials. We can use the German apprentice program as a model.
- The digital manufacturing workforce needs engineering skills coupled with basic IT skills that allow a digital manufacturing worker to interface with CAD, CAM, Virtual Reality simulation, physics-based software and information system like PLM, ERP, and MES. STEM skills are critical to these new digital manufacturing jobs.
- We need to adopt new methods of training that include online distance learning models like DMDII DM&D (Digital Manufacturing & Design) 101.
- Training programs must be quick to adapt to develop new training programs as new manufacturing technologies like 3-D Additive Manufacturing are perfected.

The U.S. is behind much of the industrial world in creating a skilled digital manufacturing workforce and must play catch up to retain manufacturing in the U.S. The good news is that organizations like DMDII are creating and testing the tools necessary to train the future manufacturing workforce. Those who chose this path will find a bright future with challenging high skilled and high paying jobs.

GT: What would you say are today's most pressing manufacturing challenges?

KP: The most pressing challenge is weaving and integrating the digital thread throughout the entire manufacturing process, and throughout the supply chain. Large players in the industry have the scale and capabilities to do a lot of this in-house, but for the smaller players in the supply chain, digital integration is challenging, leaving us short of the



The Iron Man replica was produced at DMDII using equipment on the manufacturing floor and software to refine the design prior to production.

ultimate goal of a fully digitized supply chain.

GT: While I realize that gear industry manufacturing-specific projects are yet a way off, can you speak to how Intelligent Machining (IM)—which "integrates smart sensors and controls to enable equipment to automatically sense and understand the current production environment in order to conduct self-aware manufacturing"—will benefit for example (wind) gearboxes, gears and gear components—their design and manufacture?

KP: Any and all manufacturing, regardless of the industry, will benefit from the application of smart sensors, data collection, digital twin, etc., which help define what we mean by digital manufacturing. For example, we've partnered with Omative Systems to demonstrate added intelligent machine technology on CNC machines on our manufacturing floor, focusing on adaptive control monitoring and vibration. The technology has real-time reactivity to material uncertainties as well as tool-life optimization and failure prediction.

GT: Might there be any gear-design, etc. -related software in or soon to be in development?

KP: Using manufacturing experts from our partners, we determine which projects and technology to develop based on impact to the industry and technology readiness. The tools, techniques, and methodologies resulting from our products can be applied to a wide variety of products and industries, including gear design. When partners have a specific problem within their industry, we'll work with them to form the right team and solution to address the challenge. Projects such as gear cutting can certainly be developed at DMDII where there is a partner mandate to undertake it.

GT: Will in the future any portion of your attention to metrology be applied to gear quality, etc.?

KP: The digital integration of metrology can be applied to multiple product types and industries, including gears. We're open to future partner-driven projects related to metrology applied to gear quality.

In the metrology lab at DMDII, we've introduced scanning technologies from our partner ChromoLogic that enable fingerprinting products to eliminate the part-marking operations and prevent counterfeiting. We also have an Alicona Infinite Focus unit in the lab that enables surface finish and geometric evaluation with a resolution of 10 nanometers.

GT: These must be heady days for system integrators; or has their traditional role evolved into something else?

KP: These are indeed good days for system integrators. System integration is a challenge, working across different controls, operating systems, etc. Meanwhile, the role is evolving to include digital as well as mechanical systems integration. Integration across the supply chain will be critical to the successful adoption of digital technologies.

GT: The advantages of one-stop suppliers have been documented for years. In this new, increasingly integrated world, how is a one-stop supplier defined? What must a supplier do in order to "get vertical?"

KP: A one-stop supplier is defined by being able to work with and communicate with all data formats within your market and supply chain. In the new integrated world, the supply chain is more flexible and competitive across the entire chain. This empowers OEMs and suppliers to broaden their supply chain. From the supplier perspective, a company can open up its market by being able to deal with more data formats and integrating the digital thread.

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