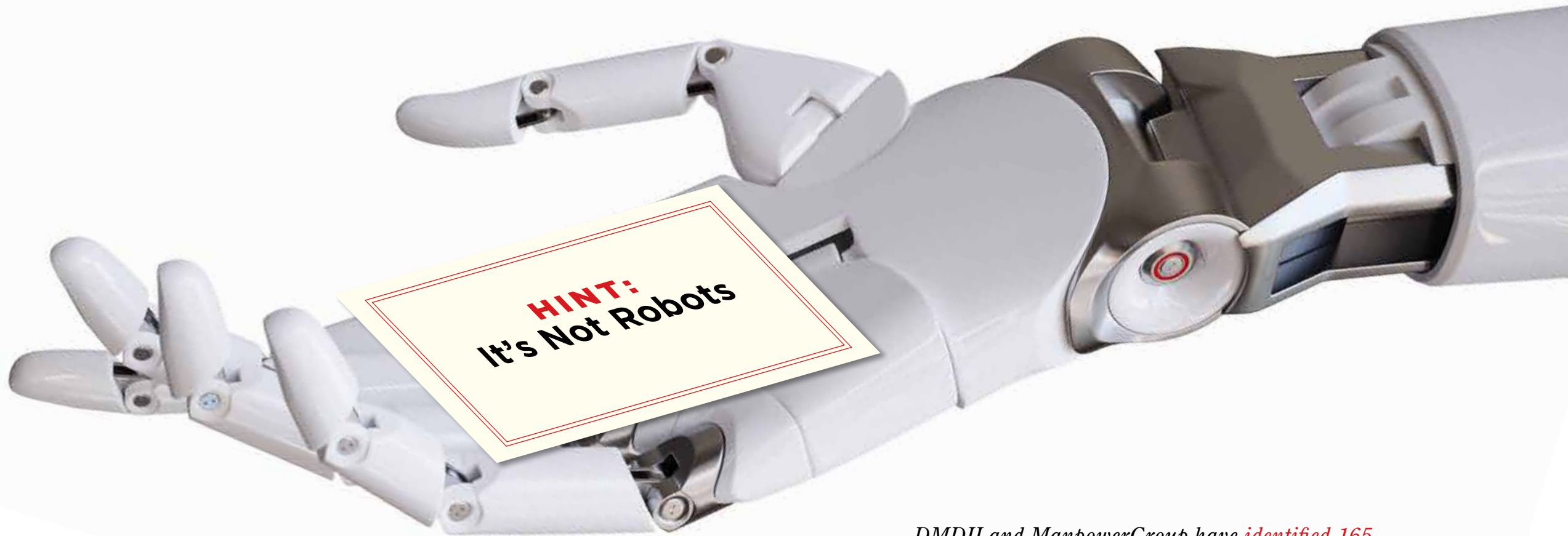


WHAT'S **THE SECRET** TO MANUFACTURING 4.0?

MANUFACTURING
LEADERSHIP JOURNAL

5
NEXT-GENERATION LEADERSHIP



DMDII and ManpowerGroup have identified 165 manufacturing workforce roles that will be critical to the success of digital manufacturing enterprises.

By Caralynn Nowinski Collens
and Rebekah Kowalski

THE U.S. MANUFACTURING SECTOR HAS HAD AN INCREDIBLE run over the past few decades. Fueled by technological progress and automation, our factories today produce more than twice as much as they did in 1984 and their value-added output is at an all-time high. But there are signs that all is not well. Since the so-called Great Recession of 2007-2009, the decades-long, meteoric rise in industrial output per worker has plateaued and productivity growth has stalled. It is a challenge that can't be solved with better technology alone. Fundamentally, it is about people and skills.

According to ManpowerGroup's research, more than 90% of employers expect their organization to be impacted by digitization in the next two years. That translates directly into skills requirements. The World Economic Forum estimates that by 2020, more than one-third of in-demand skill sets in most fields will require skills that aren't considered essential to the job today. Taking a longer-term view, about 65% of the jobs Gen Z will do don't even exist yet! It is fair to say the technological revolution has led to a Skills Revolution.

Most see Manufacturing 4.0 as the way forward for the industry — that is, leveraging digital technologies and data to drive greater efficiency, innovation and ultimately restart productivity growth. But getting there will require a new mindset, focused not just on creating the technology of the future, but also on developing the workforce to match. In general, the requisite systems and processes for digital manufacturing are already within our grasp. What's missing is a solid understanding of what skills and roles are needed to put that technology into practice, and a system for training enough people to fill those fast-evolving jobs.

To that end, the Digital Manufacturing and Design Innovation Institute (DMDII) was established as part of Chicago-based UI

LABS in 2014 to pioneer digital technologies in the manufacturing industry and help industry understand how these new technologies are influencing workforce development requirements. Included in DMDII's work is introducing small- and medium-size manufacturers to newly available technology with the ultimate goal of improving the United States' global manufacturing competitiveness. DMDII convenes universities and industry, along with startups, non-profits, and government stakeholders, on technical and workforce development projects.

In 2016, the institute partnered with ManpowerGroup, the world leader in innovative workforce solutions, to provide manufacturers an essential starting point in defining the work of the digital manufacturing enterprise. Our task has been to map roles and knowledge areas across the enterprise and provide a framework for business, academia, and workforce development groups as they work together to move to and through their digital transformation.

The Challenge of Filling Jobs

It is well known that technology is transforming how we make things, from computer-aided design to robotics and automated production, but

what is less understood is how this shift is fundamentally changing the roles and skills required to do the work. If nothing is done to realign the talent pipeline, it is estimated that of the 3.5 million U.S. manufacturing jobs that will be created over the next decade, up to two million could go unfilled due to skills shortages¹. As with any other challenges manufacturers face, the first step is getting a good look inside the machine to really understand what needs fixing.

Manufacturing generates more data than any other sector of the economy and Manufacturing 4.0 is fundamentally about finding ways to put that information to use. Digital Manufacturing and Design (DM&D) technologies connect every stage of the production cycle to ensure seamless exchanges of information, communicating data about a product's design and fabrication, all the way through its end of life. These data pathways make it easier to follow the development of a product from start to finish, and then feed that information back throughout the enterprise to improve products and solve business problems more efficiently. This "digital thread" will require new ways of working, new roles, and new skills, which will compound the U.S. talent shortage.

To maximize the benefit of digital manufacturing, companies need to move toward operating their enterprise as more of an ecosystem, rather than as a collection of siloed functions. It is a new mindset that will tie

technologies and the workers themselves more closely together. For example, communicating data and information about early-stage product design to on-floor operations will help ensure discrepancies don't arise and negatively impact a produced part. Cost-effective modeling of part performance or possible failure under multiple scenarios before materials are selected saves time, money, reputation, and maybe even lives. Connecting these functions through computing is part of creating that synergy, but so is fostering collaboration among the employees performing those duties.

Unfortunately, in our experience, employers are often unsure or unaware of the types of skills needed to perform data analytics, or how to connect their manufacturing systems to business-side data systems, and what the utility of these skills yields for their business. This is where the rubber meets the road, or doesn't. Regardless of geographic scale, revenue size, or number of employees, a manufacturer's understanding of emerging roles and desired skill sets is particularly relevant for digital manufacturing and design. Without having the people who know how to leverage DM&D technologies, interpret the data, and make it practical, an organization can have all the smartest systems and still won't see a productivity bump.

In February, there were 346,249 open manufacturing jobs in the U.S. — a clear indicator of the strength of demand as well as the growing talent shortage². With an es-



Rebekah Kowalski leads Right Management's (NYSE:MAN) workforce strategy practice. In her role, Kowalski is chartered with creating talent, leadership, and workforce solutions that enable organizational growth. Kowalski is frequently featured in publications providing commentary on the changing skills landscape and participates on the boards of various non-profits focused on the linkage between economic growth and availability of talent.

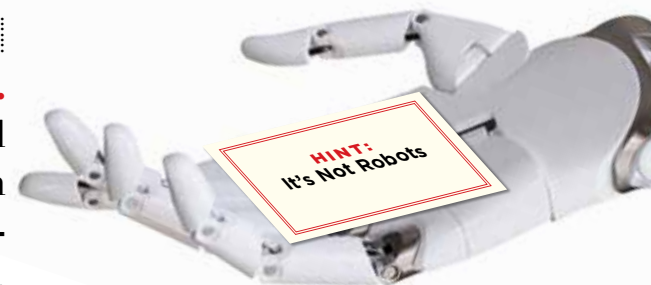
¹ Giffi, Craig. "The Skills Gap in U.S. Manufacturing | Deloitte US | Manufacturing | Deloitte Industrial Products and Services." Deloitte - United States. Web.

² ManpowerGroup analysis of data from Wanted Analytics.



Caralynn Nowinski Collens, M.D., serves as the Chief Executive Officer of UI LABS, a first-of-its-kind innovation accelerator designed to transform entire industries through collaboration. UI LABS solves large-scale challenges by bringing University+Industry together with startups and government to accelerate the deployment of emerging digital technologies, currently focused on digital manufacturing and smart infrastructure. Drawing from her past experiences as an entrepreneur, researcher, and venture capitalist, Collens leads UI LABS' efforts to foster innovation, encourage collaboration, and drive economic growth. UI LABS is an ML Council member.

Most see M4.0 as the way forward. Getting there, however, will require a new mindset focused on not just technology, but also developing the workforce to match.



To maximize the benefits of digital manufacturing, companies need to move toward operating their enterprises as more of an ecosystem, rather than as siloed functions.

estimated 2.5 million manufacturing workers set to retire by 2025 as boomers reach the end of their careers, the problem isn't getting any easier. And while we're seeing a brain drain at one end of the workforce, we have far too few graduates with the skills to replace them. It is a structural problem, compounded by a lack of understanding about the exciting roles and opportunities emerging on the forefront of digital manufacturing. If we can't articulate what jobs we have, how can we attract workers to them, or communicate to educators what skills their graduates will need to be employable? As a result, the whole pipeline has gotten backed up.

The DM&D Role Community

It is time to take a close look at the actual work of digital manufacturing and ask what "roles" — the functions or daily activities that together constitute a full-time job — are needed so that we can

start to realign the manufacturing workforce. As technology remakes the manufacturing process, there is a new ecosystem of roles emerging that will define the jobs of the future. Over the past year, DMDII and ManpowerGroup, in partnership with leading employers, educators and policy-makers, have started the process of defining what they are and answer the question: what skills do employers need to make the jump to Manufacturing 4.0?

In our research, we identified 165 potential roles, such as Lifecycle Digital Twin Architect, Digital Thread Engineer, Data Management Analyst, Digital Product Safety Systems Engineer, and Information Scientist that support digital manufacturing and design technologies, and that overall are seen as critical to the success of digital manufacturing enterprises. These roles may assemble into one discrete job or be spread across multiple positions, depending on the employer. And each manufacturing organization will need different sets or combinations of these roles on different timelines depending on their lifecycle and their business focus.

To help make sense of all this, we break the whole DM&D Role Community into six business and technical areas (domains) within digital manufacturing and design, grouped based on the type of work activity, skills, knowledge, or tools used. These include: digital enterprise, digital thread, digital design, digital manufacturing and processing, digital product, and supply network. If you're a manufacturer trying to figure out how to boost your productivity levels and make the jump to Manufacturing 4.0, chances are your difficulty lies in one or more of these core areas.

Of the 165 roles, we have identified 20 that provide an initial bridge between our

current and future workforce. We have created extensive profiles for each of these to help manufacturers and the broader talent ecosystem improve their development and hiring practices.

Each role within the DM&D Role Community is classified within one of three impact categories: pioneer, keystone, or producer. Understanding the impact of the roles can help with business planning and technology implementations, workforce planning, development, and recruiting. Our definition of the Community of DM&D jobs and the profiles serves as a starting reference for business leaders, educators, workforce development and training suppliers, job candidate recruiters, and vendors/providers. While they may be at different points of having some, or more or less, of the roles already in focus or use, it is certain that more of these roles and their related work contributions will advance individual companies and the industry, and national labor pools as a whole.

Getting to Manufacturing 4.0

Once manufacturers have a clear roadmap of the roles they need to move forward, the next step is realigning their workforce to match. With talent shortages as high as they are, most employers can't just go hire a new workforce, nor would they want to. The trick then is figuring out how to rapidly upskill their existing workforce. Given that we're talking about 12.3 million current manufacturing workers, a blended approach that includes on-the-job learning is the only way it's going to happen. Fortunately, there are strategies employers can pursue to expedite the process.

In our work, we identified more than 35 "transition roles" in the digital manufacturing space that can help facilitate shifting workers from one skillset to the next. These roles, depicted below, represent opportunities to upskill from some of the discrete au-

Future Roles Sneak Preview: The Lifecycle Digital Twin Architect

The Lifecycle Digital Twin Architect is an example of a Pioneer Role. This role is responsible for developing and managing a framework that enables the creation of a virtual representation, or digital twin, of a product. This role enables the exploration of new product capabilities or performance optimization in a digital environment, and designs the framework of data, connections, models, and software that will enable the creation of a digital twin (or digital copy) of a complex product and its subsystems.

This role's strong understanding of the product's lifecycle will allow it to develop a framework for both product optimization as well as to provide valuable data to all product stakeholders from inception and beyond end-of-life. The role enables greater value extraction from effective data collection throughout a product or system's life for enterprises that are both developing and deploying ever more complex products or systems.

20 Roles Providing an Initial Bridge Between Old and New

New Futures, New Roles

<p>DIGITAL ENTERPRISE</p> <ul style="list-style-type: none"> Chief Digital Officer – Manufacturing Digital Manufacturing Organizational Change Management Strategist Enterprise Supply Network Manager Enterprise Digital Ethicist 	<p>DIGITAL THREAD</p> <ul style="list-style-type: none"> Digital Thread Engineer Manufacturing Cybersecurity Strategist Life Cycle Digital Twin Architect IT/OT Systems Engineer
<p>DIGITAL DESIGN</p> <ul style="list-style-type: none"> Model Based Systems Engineer (MBSE) Virtual Reality/Augmented Reality System Specialist Worker Experience Designer User Experience Architect 	<p>DIGITAL PRODUCT</p> <ul style="list-style-type: none"> Embedded Product Prognostics Engineer
<p>SUPPLY NETWORK</p> <ul style="list-style-type: none"> Predictive Supply Network Analytics Engineer Digital Manufacturing Biomimicry Specialist 	
<p>DIGITAL MANUFACTURING</p> <ul style="list-style-type: none"> Digital Manufacturing Engineer Predictive Maintenance System Specialist Machine Learning Specialist Factory Automation Engineer Collaborative Robotics Specialist 	

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tomation areas of conventional production into the newer, connected, smart machine, and augmented tech areas of the increasingly digital enterprise.

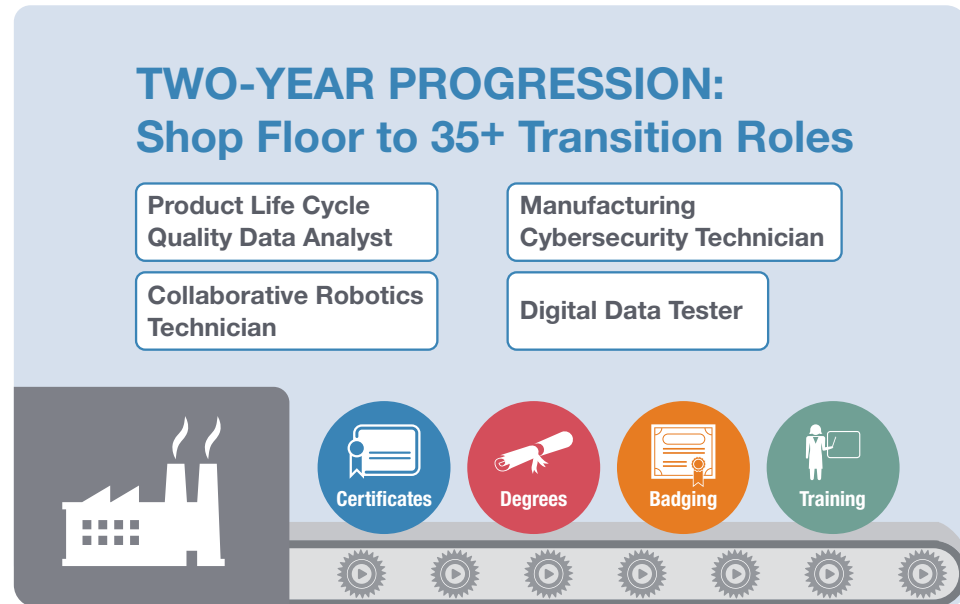
While employers are an important part of the equation, their ability to upskill and transition their workforce will depend in large part on what ManpowerGroup calls the “learnability” of their employees. By that we mean their desire and ability to learn new skills — basically how hungry is your workforce to learn and grow? If you provide the courses or new technology, will they do the training on their own time and put in the effort to master the task? Learning is a two-way street. Employers can help by assessing their employees’ skills against the needs of the business, and finding ways

to guide them toward expanded or new roles in advanced manufacturing.

The Digital Leader

Finally, there is the question of leadership. In our research we found that DM&D requires a different adapted set of skills at the top of the organization, too. Leaders need to embrace and integrate digital at all levels, evolving the roles of DM&D Chief Digital Officer, Chief Technology Officer, and Progressive Strategist, blending the technical, business and organizational opportunity planning tasks. The best DM&D leaders are looking at every aspect of their jobs through a more digital lens, from customer experience strategies, business development, research and development, and ethics, to regulations and compliance, and people manage-

Factory of the Future: Digital Manufacturing Transition Roles



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ment. This will be the new normal.

DM&D leaders also face the same basic question other industries now face: how do you keep the business running smoothly with one hand while preparing for an altogether different future with the other? There is an increased accountability for driving organizational change that requires a different mindset, focused on both short- and long-term visions, managing the paradoxes inherent in a human and machine environment, integrating the extreme demands for connections and collaborations, and enabling greater diversity in everything from business models to products to work arrange-



The Future Is Here

A recent ManpowerGroup survey of 14,000 employers found that most organizations expect manufacturing to be one of the sectors most heavily impacted by digitization over the next two years. Asked what they were doing to ensure their organization has the skills to keep up with these advances, nearly two-thirds reported investing in internal training, and nearly 40 percent said they were bringing in outside experts to help build their workforce capabilities. The trend is clear: employers are shifting from being “consumers of work” to “builders of talent.”

Manufacturers have a tall order as they move forward to digitize their operations. As contributors to the DM&D roles emphasized to DMDII and ManpowerGroup, the technology conversion is the easier part; moving the people, culture, and leadership forward fast enough is much harder. That transformation begins with understanding

the emerging roles in digital manufacturing and design and identifying what stage a business is at in terms of implementing those roles within the factory.

Looking ahead, the U.S. will remain a global manufacturing powerhouse, but as we’ve done before, we need to adapt to stay competitive. We believe the role identifications, technology domains, and profiles DM&DII and ManpowerGroup have developed with our expert contributors will be a powerful first step to ensure the success of U.S. manufacturers in the digital age, including increased employability of our workforce -- present and future.

The release of the DM&D Role Community and Top 20 Success Profiles is scheduled for June 2017 to members of DMDII. Release to the public along with an adoption and utilization workshop will be scheduled for late summer. Please contact Katie Mulligan, at katie.mulligan@uilabs.org; or Alec Wescott, at alec.wescott@manpowergroup.com for more information. **M**

In order to match the requirements of digital manufacturing with their workforces, employers will have to figure out how to rapidly upskill their current employees.