Manufacturing a Way to Career Readiness: How Industry Measures Student Readiness

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Summary

Educators have made improving students' college and career readiness a priority for at least a decade. However, most of that effort has focused on college readiness, whereas career readiness is less understood. More clarity on career readiness and how to measure it would help educators prepare students for adult life and inform industry professionals who hire young adults. This report is a step in providing that information by exploring how a high-wage, high-growth industry—advanced manufacturing—determines the readiness and additional training needs of job applicants and new hires.

Advanced manufacturing is a growing, high-wage industry that employs about 9 percent of the American workforce, with more jobs projected over the next 10 years (National Association of Manufacturers [NAM], 2016). Further, education leaders in Kentucky have indicated a need for additional information for this field, which is supported by career and technical education (CTE) programs statewide.

To examine career readiness in the world of advanced manufacturing, CNA Education reviewed the professional and research literature and interviewed employers at five companies across central Kentucky as well as staff at the Kentucky Chamber of Commerce.

Findings

The interviews and literature provide a picture of current practice and potential best practices for measuring career readiness across advanced manufacturing:

- Manufacturers were not familiar with career readiness assessments used in Kentucky's education system.
- Credentials and certifications are not typically required by manufacturers because credentialing is complicated and manufacturers want more control over employee training.
- Manufacturers respect experience in specific, hands-on education programs.
- Manufacturers use their own readiness measures, which include observations of performance-based tasks, math tests to capture academic knowledge, and prescreening by temporary staffing agencies.

- Career readiness encompasses three layers: foundational readiness, broad industry or manufacturing readiness, and job-specific occupational readiness. Currently, manufacturers focus on applicants' foundational readiness.
- Layered credentials could signify readiness better than a single measure. Such credentials need to be stackable to represent skills accumulated over time, validated by independent accrediting agencies, and clear to employers.

Recommendations

Based on the results, we offer the following recommendations to educators, industry, and researchers.

For educators, manufacturers, and researchers jointly:

1. **Collaborate to align career readiness definitions and assessments around foundational skills.**
2. **Engage in ongoing conversations.**
3. **Jointly develop career readiness performance tasks.**
4. **Reform credentialing approaches to support accredited programs.**

For educators:

1. **Inform manufacturers about the measures educators use to determine career readiness.**
2. **Incorporate experiential learning into additional classes.**

For manufacturers:

1. **Explore additional education partnerships and intern-type programs.**
2. **Consider adopting recommendations of professional organizations to look at multiple types of readiness and multiple measures.**
3. **Consider cross-industry collaboration to further refine common definitions and measures of readiness.**

For researchers:

1. **Examine manufacturers' math tests to determine content and grade level.**
2. **Continue to study certificates and certifications.**
3. **Examine alignment of industry and education systems in other industries.**

Introduction

Improving students' college and career readiness has been a priority for educators for at least a decade. Most of the focus has been on college readiness, however, likely because of the natural academic progression from K-12 to college. Also, educators went to college themselves and are more familiar with college requirements. Finally, college readiness measures such as ACT and SAT exams make the alignment between K-12 education and college readiness clearer.

Career readiness, on the other hand, is less well understood. More clarity on career readiness and how to measure it would benefit both educators as they prepare students for life after high school and industry professionals who hire young adults after they complete their education. This information can also support educators as they review and revise career readiness policies under the new Every Student Succeeds Act (ESSA).

Educators are beginning to collaborate with business and industry to better understand career readiness. In support of that effort, this report explores how employers in a high-wage, high-growth industry—advanced manufacturing—determine the readiness and additional training needs of job applicants and new hires. The need for such information was highlighted in recent conversations with leaders at the Kentucky Department of Education (KDE) and Council on Postsecondary Education (CPE) as they discussed revising career readiness policies. They were particularly interested in finding out how industries measure readiness and whether industries look at any of the readiness measures used by the K-12 or postsecondary education systems.

A need to align education and industry

Both educators and industry professionals are interested in a more integrated system that supports seamless student progression through K-12, postsecondary education, and the workforce. The National Association of Manufacturers (NAM) calls for better communication and alignment, citing a skills gap between job requirements and applicant abilities, as well as disconnects between industry needs and education programs (NAM, 2016). Similarly, the Society of Manufacturing Engineers (SME) mentions the need for coordinated efforts to tackle workforce shortages (SME, 2012).

Researchers also note that colleges overestimate students' readiness relative to employers (Jaschik & Lederman, 2014).

Best practices in industry suggest that education and industry might align their systems by emphasizing customer-focused outcomes (Bryk, Gomez, Grunow, LeMahieu, 2015; George, Rowlands, & Kastle, 2004; Spear, 2009). In this approach, customers collaborate closely with product designers to get the best possible results. When applied to career readiness, industry might be considered the customer, and schools the supplier of workers. A closer focus on industry needs, based on their direct input, can help educators design a better system to close the national skills gap.

Two sides of a coin: Defining and measuring readiness

To prepare students for careers, educators must first understand what career readiness means and then determine how to measure it. This report focuses mostly on measurement, but definitions are essential because measures flow from those definitions.

Defining career readiness is complex because the American workforce is extremely broad. The U.S. Department of Education identifies 16 Career Clusters that students may study in high school through career and technical education (CTE), with 79 career pathways and multiple sectors, industries, and occupations (Advance CTE, n.d.).[1] We might expect variations in career readiness definitions across these pathways and sectors, but such variations are problematic for education systems that must develop definitions and measures that apply to all students.

Another ambiguity issue arises from different categories of career readiness that might be measured:

1. ***Job-specific skills and training***: Many labor reports and initiatives, such as the U.S. Chamber of Commerce Talent Pipeline Initiative, suggest that students need more job-specific skills and training to be ready for careers (Giffi et al., 2015; Selingo, 2017, Tyszko, Sheets, & Fuller, 2014).
2. ***Twenty-first-century employability or professional skills***: Society for Human Resource Management (SHRM) surveys and local industry panels

[1] The 16 Career Clusters are occupational categories—such as Manufacturing or Health Science—into which CTE programs of study are organized by the National Career Clusters Framework.

convened for other CNA projects suggest that career readiness is about applied "soft" skills, including critical thinking, communication, collaboration, enthusiasm, and independence (Carrier & Gunter, 2010; National Association of Colleges and Employers, 2011; SHRM, 2008).

3. ***Basic requirements***: Some industry panelists set a low bar for a definition of readiness, emphasizing that employees must be drug-free and come to work on time.

Given the ambiguities around career readiness definitions, it is no surprise that educators find measuring career readiness challenging. Currently, states use a variety of measures, including the WorkKeys exam by ACT, Inc.; the ASVAB exam by the U.S. Department of Defense; state-specific exams in various fields to meet federal CTE requirements under the Perkins Act; and industry certificates earned through experience or exams.

Manufacturing is a large sector that is expected to grow

To gain insight into the industry perspective on career readiness definitions and measures, this report focuses on a single industry in one state. Advanced manufacturing was selected because it is a high-growth, high-wage industry that has become more important in Kentucky and nationally. According to KDE, advanced manufacturing is one of the top five high-demand industry sectors in the state and comprises occupations in the mechanical, physical, or chemical transformation of materials, substances, or components into new products (KDE, 2017). Automobile and aircraft manufacturing are two of the largest manufacturing subsectors in the state according to the Southern Regional Education Board (SREB, 2014). Advanced manufacturing occupations in Kentucky include high-skill, middle-skill, and low-skill occupations (Appendix A: Table A1).

Nationally, there are over 12 million manufacturing workers, constituting 9 percent of the American workforce. Over the next 10 years, an additional 3.5 million manufacturing jobs will be needed, with 2 million projected to go unfilled because of gaps in skills. The average pay for manufacturing jobs is $26 per hour, or approximately $82,000 annually, including benefits. Further, manufacturing spent $230 billion on research and development (R&D) in 2014 to further drive the U.S. economy. Pharmaceutical manufacturers led this R&D, but aerospace, motor vehicles, parts, and others were significant contributors, making this a topic of national importance (NAM, 2017).

Roadmap

This report shares manufacturers' perspectives on career readiness to inform the efforts of K-12 and postsecondary educators, along with manufacturers, as they work to improve transitions from education to the workforce. First, we summarize the methods we used to identify readiness measures. We then describe professional literature guidelines for measuring readiness, how Kentucky manufacturing employers currently measure readiness, and how these systems align with the readiness measures used by the education system. We conclude with recommendations for educators, manufacturers, and researchers.

Methods

We collected data from two sources: a literature review and interviews. The two-part literature review examined professional literature from manufacturing or education organizations and academic research listed on EbscoHOST databases. We analyzed the literature to identify common themes and develop questions for the interviews, such as the skill categories that are measured, measurement methods, and who performs the measurement.

We also interviewed business leaders, recruiting managers, and CTE leaders representing automotive, aerospace, pharmaceutical, and transportation industries supporting a variety of manufacturing career pathways. Interviews were either by phone or in-person, depending on availability. Specifically, we met with representatives from Catalent Pharma Solutions, Ford Motor Company, Roll Forming Aerospace, Toyota Motor North America, UPS,[2] and the Kentucky Chamber of Commerce. The companies are global leaders that rely on local talent, with plants ranging from around 200 to several thousand employees. Interview results were analyzed to determine commonalities and differences in career readiness approaches.

Findings

Together, the interviews and professional literature provide a picture of how manufacturers currently determine career readiness, approaches not used by manufacturers, and potential future approaches to measuring career readiness. Interviews revealed manufacturers' current practices related to career readiness definitions and measures, while the literature described how manufacturers *could* or *should* approach career readiness. We located little published information about what or how manufacturers *are* measuring.

[2] Although UPS is not a manufacturing company, many of its positions require skills similar to those needed in manufacturing, such as machine maintenance, industrial safety, and computer operation. Other interviewees recommended that we include UPS in the study.

Manufacturers do not use the same career readiness measures as educators

Educators measure student career readiness through a variety of assessments and credentials at the K-12 and college levels (see below). Interestingly, our interviews revealed that manufacturers do not use this information, largely because of their lack of familiarity with those measures.

Manufacturers are unfamiliar with assessments used by schools

The interviews included questions about specific career readiness assessments used mostly in high schools, such as the following:

- WorkKeys by ACT, Inc.
- Armed Services Vocational Aptitude Battery (ASVAB) by Department of Defense.
- National Occupational Competency Testing Institute (NOCTI) assessments.
- Assessments from state departments of education, such as the Kentucky Occupational Skills Standards Assessment (KOSSA).

> "A problem is that there is too much testing that might not meet true demand of the workforce. In addition, schools don't market, which means employers are likely missing out on valuable assessment tools that will impact our business. When a student is certified as "work ready," that may be true, but many employers don't understand what that means." — *Area Director for HR, Catalent Pharma Solutions*

Manufacturers unanimously reported that they never used these assessments, and the majority had never heard of them. They said that applicants do not bring assessment test results to interviews or include them on resumes. Neither have hiring managers requested this information. One interviewee indicated that it would be beneficial for students to bring test results, and another said that he had looked at NOCTI exam results while with a former employer.

Most employers agreed that companies would like to learn more about these assessments and how they can benefit manufacturers. One interviewee who has worked with education programs for the past three years reported mistakenly believing that WorkKeys was a college scholarship program. Another indicated he believes there is a gap between why schools use these exams (for accountability) and why industry might value the exams (to inform decisions about training). Another employer suggested that there are too many assessments in the education system, making it difficult for industry to keep up or contribute to the conversation.

Credentials are not required

Educators developing career readiness measures are considering the use of credentials and certifications. Credentials come in many forms and levels of rigor (ACT, 2011; Manufacturing Institute, 2014a), including postsecondary degrees (two-year or four-year), certificates, apprenticeship certificates, licenses (often from government), or industry-recognized certifications. Certifications are specific credentials that are approved or designated by industry leaders to show technical and academic standards. Certificates, meanwhile, are often awarded after completing a specific curriculum or exam in a certain occupational area. Such certificates may be credit-based or non-credit-based, often requiring less coursework than an associate's degree.

While Kentucky's education system is considering the use of credentials for career readiness measures, the manufacturers we interviewed said they generally do not rely on applicants' credentials, except for degrees, when making hiring or training decisions. Interviewees stated that it is hard to trust credentials because so many agencies award them. Manufacturers lack knowledge of who has granted specific credentials or what they may signify. Further, some interviewees believed there to be little regulation of credentials.

Nevertheless, several interviewees indicated that certain credentials have value. For example, one manufacturer said that certifications from known organizations are a bonus—but rarely a requirement—to help validate information. Others said that a certificate showing that a student completed Project Lead the Way in high school suggests practical, hands-on, team-based experience at solving problems. However, one interviewee stated that school-issued certificates, whether general or specific to industry skills, need a systematic, reliable review mechanism to ensure consistency across teachers and schools.

Views on credentials:

"They help solidify what applicants are communicating about ability to do the job, but they are not necessary." — *Plant Manager, Roll Forming Aerospace*

"A work ethics certificate would be most helpful. Do they come to school, are they respectful, and stay out of trouble?" — *Workforce Development Manager, Ford*

"I was part of a group that looked at all the certificates offered. Half of the industry reps in the group didn't know what the certificates were, and most didn't relate to what we do today. They may have applied 10 years ago, but not today." — *Regional Director, Government Affairs, Toyota*

Employers use a variety of methods to measure readiness

Although manufacturers may not use the same career readiness measures as the education system, they do measure readiness in a variety of ways. These methods include observations of performance-based tasks, mathematics exams, the use of temporary staffing agencies for screening purposes, and completion of specific education programs.

Observational assessment of performance-based tasks is critical

A common approach to assessing career readiness described in interviews is to have applicants perform real work tasks. These tasks may occur over several days and may continue for weeks or months after someone is hired.

Catalent Pharma Solutions provides applicants with a batch record—basically, a recipe—and asks them to follow the instructions. Completing this task requires reading comprehension, attention to detail, math ability, and creativity. The Chamber of Commerce representative reported that YUM! Brands often requires candidates to work in a food processing plant during the interview to see if they can tolerate the tasks. Toyota also simulates the workplace during the interview, placing individuals into groups to see who leads or follows, who offers new ideas, or who jumps directly to a task. Toyota further asks applicants to work through multiple workstations to observe their flexibility, willingness to ask for help, resourcefulness when facing new tasks, and attention to safety. Likewise, Roll Forming Aerospace sends applicants to the shop floor to work in teams and demonstrate capabilities. Ford includes a dexterity test. Meanwhile, UPS uses in-depth behavioral interviews for the initial hiring but then spends extensive time observing performance for the first month to determine additional training needs.

Manufacturers use math tests

Several manufacturers require applicants and new hires to take exams that focus on mathematics and that also provide feedback about reading comprehension and the ability to follow directions. For example, Roll Forming Aerospace developed its own test to measure skills at approximately the grade 8 level. Ford uses a math exam from an outside company. Catalent Pharma Solutions requires new hires to take a math test that focuses on decimals, fractions, and arithmetic. In addition, the batch record for producing a capsule involves proportions, ratios, and unit conversion.

Toyota, meanwhile, uses math scores from the ACT exam for its Advanced Manufacturing Technician (AMT) program.

Using temporary staffing agencies is a growing trend

Several manufacturers mentioned using temporary staffing agencies to help with hiring decisions and vetting career readiness. They cited several reasons for this approach. First, the temporary staffing agency essentially prescreens the applicants' general foundational readiness, which manufacturers may find difficult to do themselves. Second, hiring temporary workers defers some risk by not bringing the candidate on as a full-time, permanent employee immediately. The temporary staffing agency maintains some of the responsibility for management and compensation. Third, hiring a temporary worker gives the manufacturer more time to observe and evaluate the candidate before making a final hiring decision.

Hands-on education programs are respected

> "There are programs out there that are good. Problem solving is an important experience—find a root cause and fix it. Project Lead the Way seems very good at that. It is problem based, practical, hands-on, and team based." — *Regional Director, Government Affairs, Toyota*

Although the interviewees do not use information from many education exams and certificates, they identified specific education programs that are good indicators of career readiness: Project Lead the Way, Reserve Officers Training Corps, CTE programs at Kentucky's regional or area technical centers, Junior Achievement, Youth Employment Solutions (YES!), and Kentucky Federation for Advanced Manufacturing Education (KY FAME) (at the postsecondary level). These programs fit manufacturers' desire for employees with hands-on experience, perhaps through project-based learning, in relevant fields.

> "Sometimes the best employees worked on a farm as kids and learned the basics of equipment, tools, and hard work." — *Area Director for HR, Catalent*

Interestingly, the interviewees also identified other jobs that often translate to relevant manufacturing hires. Examples included pharmacies and grocery store deli counters, which provide experience with regulated, clean environments; dangerous equipment; applied mathematics; and customer service.

A layered system may best capture multiple important skills

Manufacturers struggle to find workers because of a lack of student preparation across several different characteristics. As it turns out, professional organizations and research suggest that all of these characteristics are important and that manufacturing would benefit from a multilevel set of definitions and measures. This approach is reasonable, as industry requires multiskilled workers with solid academic backgrounds and problem-solving skills (Conley & McGaughy, 2012; SREB, 2014).

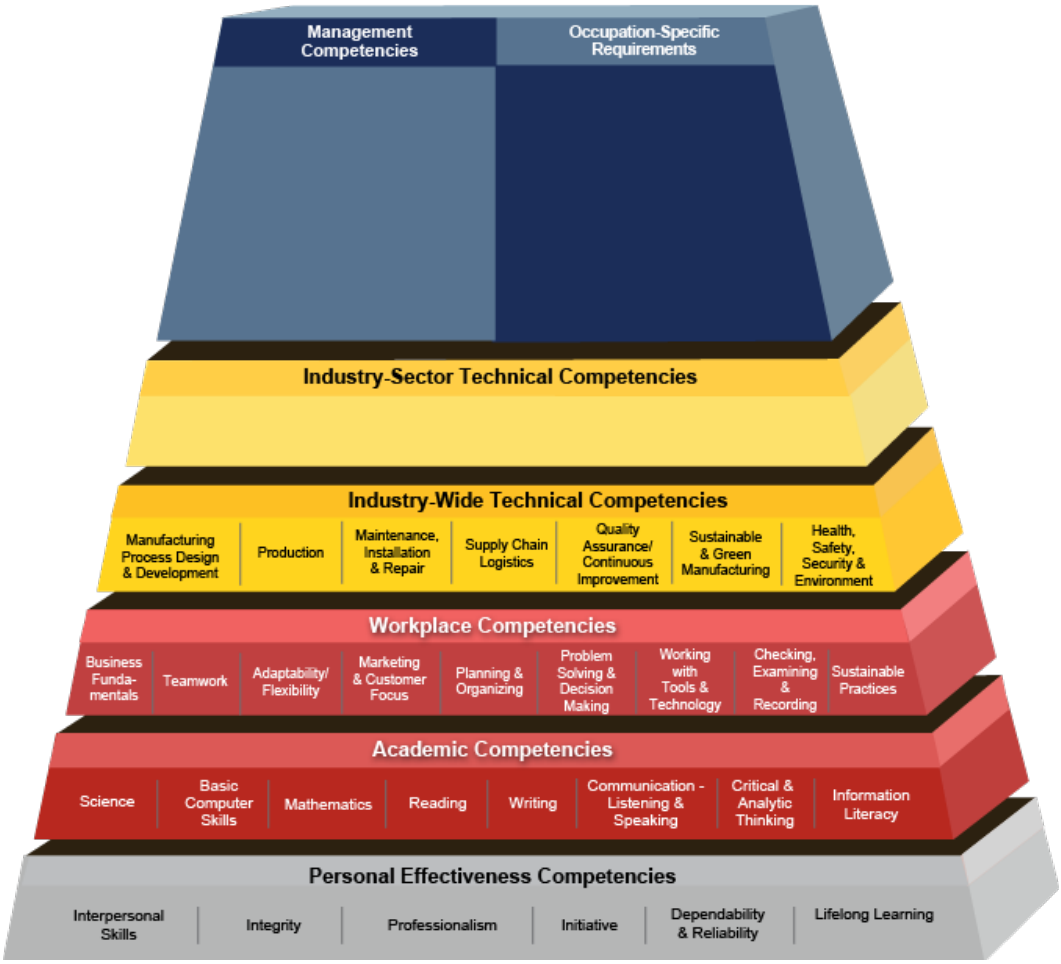
The suggested readiness categories vary slightly by source, but three main types of readiness are suggested: foundational readiness, broad industry or manufacturing readiness, and job-specific occupational readiness. For example, the Advanced Manufacturing Competency Model developed by the U.S. Department of Labor, Employment and Training Administration (ETA), in partnership with several organizations, includes three main levels of "competencies," each with additional tiers (ETA, 2010) (Figure 1):

- Foundation Competencies: The first three tiers are baseline competencies needed to enter the workplace: Personal Effectiveness Competencies, Academic Competencies, and Workplace Competencies.
- Industry Competencies: Tiers 4 and 5 represent skills relevant across an industry or industry sector: Industry-Wide Technical Competencies and Industry-Sector Technical Competencies.
- Occupational Competencies: Tiers 6 through 9 contain competencies specific to occupations within an industry and thus vary. These include Management and Occupation-Specific Competencies.

Other organizations offer slightly different labels. ACT, Inc., for example, has conducted research into both career readiness and college readiness and describes foundational skills, occupational skills, and job-specific skills as the three main layers (ACT, 2011).

The literature suggests that each competency would have its own approach to measurement. Such models do not suggest a one-style-fits-all career readiness measure.

Figure 1. Advanced Manufacturing Competency Model



Source: www.careeronestop.org/competencymodel/pyramid.aspx?hg=Y

General foundational readiness is key to employers

Although the literature describes models for a multitiered readiness system, the employers we interviewed generally focused on one specific piece of that system: applicants' foundational employability skills. Each of the manufacturers described a need for employees who exhibit skills that align with ETA's Personal Effectiveness competencies. The list of competencies described in interviews is lengthy and includes initiative, attention to detail, verbal communication, strong work ethic, and a willingness to learn. They reported additional competencies that have proven

difficult to find in recent years, including willingness to put down cell phones, remaining drug free, and attending work on a regular basis.

The employers also cited skills and dispositions that aligned with ETA's Workplace Competencies, such as teamwork; flexibility, including willingness to stay late or work on different tasks; problem solving; and manual dexterity to work with tools. Within the Academic Competencies, which were mentioned less frequently, there was an emphasis on mathematics, reading, and information literacy.

The interviewees were less concerned about applicants' industry-specific or technical readiness, except for higher-level positions. Several stated that they were comfortable training new employees in the specific manufacturing skills necessary at the company, regardless of prior training. For instance, the manufacturing process used at Catalent Pharma Solutions is unique enough that few applicants would have access to relevant technical training before joining the company. For other employers, continuous technical training in response to ever-evolving technology facilitates training of new employees.

> "If they work hard and are willing, we can train them in the technical side of things. We have done this with people who perhaps have never held a tool." — *Plant Manager, Roll Forming Aerospace*

Ford and Toyota were minor exceptions. The Ford representative reported that some hires are experienced Journeymen who have completed apprenticeships and whose occupation-specific readiness is higher. For the Toyota representative, readiness more closely mirrored the literature, with foundational skills as part of a three-legged stool of personal skills, technical skills, and manufacturing culture.

Layered credentials, especially certifications, can signify readiness

Even though the employers we interviewed reported that they do not use credentials as indicators of career readiness, professional organizations and researchers strongly advocate for layered credentialing systems to measure readiness at each of the levels described above (ACT, 2011; Goodman, Meyer, & Imperatore, 2014; NAM, 2016; Manufacturing Institute, 2014a; Selingo, 2017; SREB, 2009; U.S. Chamber of Commerce Foundation, 2016). The literature emphasizes the role of certifications in verifying manufacturing readiness. Organizations especially recommend stackable certifications that build skills over time and certifications that are validated by third-party entities (ACT, 2011; Goodman et al., 2014; Manufacturing Institute, 2014b; SME, 2012). Bundling credentials also is a recommended way to identify talent (SREB, 2009). Through certifications, "employers gain confidence that their employees are able to perform at a given level of skill" (Accenture, 2014).

A specific set of certifications within manufacturing is the Manufacturing Skills Certification System by NAM (Accenture, 2014; ACT, 2011; Giffi et al., 2015;

Manufacturing Institute, 2014a; SME, 2012). The system addresses 14 manufacturing skills areas, with certifications conferred by national, third-party agencies (Appendix, Table A2). The system is designed to be stackable, transferable, and built over time. ACT (2011) calls this "One of the most powerful concepts developed to systematize the way both educators and employers should be approaching a trained workforce."

Although literature recommends certifications as an effective way to measure readiness, it cautions that the large number of credentials and certificates available, numbering over 10,000, makes the field confusing for both educators and industry (ACT, 2011). Also, fewer than 10 percent of certifications are accredited by a third party, so there is uncertainty related to the rigor of many certifications (Goodman et al., 2014). The interviews confirmed these findings. Finally, some industry-based certifications and exams may require more experience than can be offered in high school, making these difficult to use at the K-12 level (SREB, 2009).

Recommendations for Educators, Manufacturers, and Researchers

Findings from this study suggest several steps to developing a seamless system from K-12 to college to industry that truly meets manufacturers' needs. The following recommendations are aimed at educators, manufacturers, and researchers. These recommendations may serve as a basis for improving collaboration. Although the interviews occurred in a single state, we believe the results have national relevance because results draw from national literature and several interviewees represent multiple states in national companies.

For educators, industry, and researchers

1. **Collaborate to align career readiness definitions and assessments around foundational skills.** Interviewees emphasized the need for foundational skills in employees. Educators and industry officials should collaborate to align, or develop if necessary, foundational readiness definitions and measures. A local or state task force is one possible approach to this process. The task force initially should focus on one Career Cluster, such as manufacturing. Industry and education professionals would review current measures of foundational skills to determine a common approach, resulting in a work ethics certificate. Researchers could facilitate the collaboration, leading research, development, and training related to measurement. The task force could also recommend a way forward to develop common measures of industry- and occupation-level competencies. This effort could reduce redundancy in the measurement system.
2. **Engage in ongoing conversations.** Ongoing, systematic conversations between educators and industry representatives would lead to better understanding of what manufacturers require and what educators can offer. Such conversations are becoming more common but are often disjointed and ad hoc. The interviews suggest that manufacturers are willing to participate in these conversations but that many currently do not. According to the Kentucky Chamber of Commerce, nearly 80 percent of employers have said they would work with educators, but only approximately 10 percent do so now.

3. **Jointly develop career readiness performance tasks.** Manufacturers described readiness measures they use that may be worth developing into performance-based assessments at the high school and postsecondary levels. The jointly developed assessments would provide authentic experiences for students and more familiar information for employers.
4. **Reform credentialing approaches to support accredited programs.** Reforming education programs to emphasize third-party certifications, with input from manufacturers, could mitigate employer perceptions that certifications are too confusing and lack significance. In addition, educators should provide manufacturers with more information about credentialing and certification programs to more fully articulate what the credentials indicate.

> "Employers may not have a choice but to get involved in this type of conversation. We had more candidates than jobs in the past, but not now. The numbers game says they need to be more involved." — *Executive Director, Kentucky Chamber of Commerce Workforce Center*

For educators

1. **Inform manufacturers about the measures educators use to determine career readiness.** Manufacturers consistently reported that they are not familiar with the career readiness measures that educators use. As pointed out in one interview, industry leaders might find these measures useful if they knew more about them, such as which types of measures are used (assessments, certificates, industry-based certifications); what skills or knowledge the measures capture (foundational, industry-wide, or occupation-specific); and how educators believe these measures can benefit manufacturers.
2. **Incorporate experiential learning into additional classes.** Industry representatives stated that they value candidates who have participated in hands-on, project-based education programs. Schools can incorporate aspects of these programs into other classes to provide similar experiences for all students. Educators should then communicate with employers and students to ensure that all stakeholders are aware of these experiences.

For manufacturers

1. **Explore additional education partnerships and intern-type programs.** Manufacturers value applicants with real-world experience and frequently use direct observations to evaluate career readiness. Several interviewees

mentioned education-industry collaboration programs that have led to successful job candidates, such as KY FAME and YES!. Such partnerships give manufacturers the opportunity to shape education programs, provide students with hands-on experience, and allow employers to prepare and screen potential job candidates.

2. **Consider adopting recommendations of professional organizations to look at multiple types of readiness and multiple measures.** This paper shared recommendations for a multilevel, multimeasure system of career readiness, offered by groups such as the U.S. Department of Labor, NAM, SME, and ACT. The companies interviewed here focused primarily on foundational readiness, though they used a variety of approaches to measuring readiness.
3. **Consider cross-industry collaboration to further refine common definitions and measures of readiness.** Manufacturers may be served by meeting with each other and professional organizations to compare current measurement practices to proposed systems. Such collaboration could lead to the development of consistent measures, particularly for foundational skills.

For researchers

1. **Examine manufacturers' math tests to determine content and grade level.** Researchers might examine the types of math skills and knowledge that are tested on industry math exams—for example, arithmetic, algebra, or geometry—and what grade level manufacturers expect—grade 8, grade 10, grade 12, or college level. Results could inform educators of manufacturers' expectations and might contribute to the development of common measures.
2. **Continue to study certificates and certifications.** Both educators and employers report that the credentialing landscape is saturated and confusing. Both sides of the talent pipeline need additional information about the rigor of credentials to make better decisions about how to use them. More studies of employment outcomes are needed to determine how effectively various credentials predict or promote successful employment.
3. **Examine alignment of industry and education systems in other industries.** This study concentrated specifically on advanced manufacturing. CTE programs support dozens more career pathways in K-12 education, with even more specialized programs in higher education. Studies in additional industries would identify commonalities and differences in approaches to career readiness that could help better refine broad foundational skills and measures.

Appendix A:

Table 1. Top 20 advanced manufacturing occupations in Kentucky

High-Skill	Middle-Skill	Low-Skill
• Engineer: Design • Engineer: Process or Manufacturing • Manufacturing manager • Purchasing agent (except wholesale, retail, and farm products)	• First-line supervisor of production or operating workers • Heavy and tractor-trailer truck driver • Machinist • Machine tool operator • Machine maintenance specialist • Welder	• Extruding and drawing machine setter, operator, and tender (Metal and plastic) • Food batchmaker • Inspector, tester, sorter, sampler, or weigher • Manufacturing operator/technician • Meat, poultry, and fish cutter and trimmer • Metal-refining furnace operator and tender • Production, planning, and expediting clerk • Sales representative, wholesale and manufacturing (except technical and scientific products) • Shipping, receiving, and traffic clerk • Slaughterer and meat packer

Source: KDE (2017).

Table 2. Manufacturing Skills Certification System

Skill area	Certificate	Agency
Foundation skills	National Career Readiness Certificate	ACT
Cross-cutting technical skills	Certified Production Technician (CPT)	Manufacturing Skill Standards Council (MSSC)
	Manufacturing Technician (MT1)	Manufacturing Skills Institute (MSI)
Automation	Certified Control Systems Technician (CCST) Certified Automation Professional (CAP)	International Society of Automation (ISA)
Construction	Over 55 craft areas	National Center for Construction Education and Research (NCCER)
Die casting	Die casting certification	North American Die Casting Association (NADCA)
Fabrication	Precision Sheet Metal Operator Certification (PSMO)	Fabricators & Manufacturers Association, International (FMA)
Fluid power	Sixteen different certifications	International Fluid Power Society (IFPS)
Lean	Lean certification	SME
Machining and metalworking	Machining and metal-forming certifications	National Institute for Metalworking Skills (NIMS)
Mechatronics	Certifications grouped in mechanical, electronic, logic control, and computer science	Packaging Machinery Manufacturing Institute (PMMI)
Quality	Quality certification	American Society for Quality (ASQ)
Transportation, Distribution, and Logistics	Logistics Technician Certification (CLT) Certified Supply Chain Professional (CSCP)	MSSC Association for Operations Management (APICS)
Technology and engineering	Certified Manufacturing Technologist (CMfgT) Certified Manufacturing Engineer (CMfgE)	SME
Welding	Certified Welder Certifications	American Welding Society (AWS)

Source: http://www.themanufacturinginstitute.org/Skills-Certification/Certifications/NAM-Endorsed-Certifications.aspx

References

Accenture. (2014). *Out of inventory: Skills shortage threatens growth for U.S .manufacturing*. New York, NY: Accenture.

ACT. (2011). *Breaking new ground: Building a national workforce skills credentialing system*. Iowa City, IA: ACT, Inc.

Advance CTE. (n.d.). *Career Clusters*. Silver Spring, MD: Advance CTE. Retrieved from https://www.careertech.org/career-clusters.

Bryk, A. S., Gomez, L. M., Grunow, A., & LeMahieu, P. G. (2015). *Learning to improve: How America's schools can get better at getting better.* Cambridge, MA: Harvard Education Press.

Carrier, A., & Gunter, M. (2010). *Critical workplace skills for Virginia's economic vitality*. Charlottesville, VA: Demographics & Workforce Group, Weldon Cooper Center, University of Virginia.

Conley, D., & McGaughy, C. (2012, April). College and career. *Educational Leadership*, 28–34.

ETA (Employment and Training Administration). (2010). *Advanced manufacturing competency model*. Washington, DC: U.S. Department of Labor. Retrieved from www.careeronestop.org/competencymodel/pyramid.aspx?hg=Y

George, M., Rowlands, D., & Kastle, B. (2004). *What is Lean Six Sigma?* New York, NY: McGraw-Hill.

Giffi, C., McNelly, J., Dollar, B., Carrick, G., Drew M., & Gangula, B. (2015). *The skills gap in U.S. manufacturing: 2015 and beyond*. New York, NY: Deloitte Development, LLC.

Goodman, T. G., Meyer, M., & Imperatore, C. (2014, Sept.). Incorporating industry-recognized certifications. *Techniques*, *89*(6), 14–19.

Jaschik, S., & Lederman, D. (2014). *The 2014 Inside Higher Ed survey: College & university chief academic officers*. Washington, DC: Inside Higher Ed.

KDE (Kentucky Department of Education). (2017). *Kentucky high-demand industry sectors and top occupations*. Frankfort, KY: Kentucky Department of Education. Retrieved from http://education.ky.gov/CTE/nsfy/Pages/KY-NSFY-P1.aspx.

Manufacturing Institute. (2014a). *Building a manufacturing talent pipeline: A toolkit for educators on how to embed industry certifications to improve outcomes in technical education*. Washington, DC: National Association of Manufacturers.

Manufacturing Institute. (2014b). *Developing skilled workers: A toolkit for educators and workforce professionals on manufacturing certifications*. Washington, DC: Manufacturing Institute.

NAM (National Association of Manufacturers). (2016). *Challenges and solutions for the next president and Congress: Competing to win*. Washington, DC: National Association of Manufacturers.

National Association of Colleges and Employers. (2011). *Job outlook 2012*. Bethlehem, PA.

National Association of Manufacturers. (2017). *Top 20 facts about manufacturing*. Retrieved from http://www.nam.org/Newsroom/Facts-About-Manufacturing/.

Selingo, J. J. (2017, Jan. 30). Wanted: Factory workers, degree required. *The New York Times*. Retrieved from https://nyti.ms/2jMKIx9.

SHRM (Society for Human Resource Management). (2008). *Critical skills needs and resources for the changing workforce: Keeping skills competitive*. Alexandria, VA: Wall Street Journal Career Journal.

SME (Society of Manufacturing Engineers). (2012). *Workforce imperative: A manufacturing education strategy*. Dearborn, MI: Society of Manufacturing Engineers.

SREB (Southern Regional Education Board). (2009). *Measuring technical and academic achievement: Employer/certification examinations' role in high school assessment*. Atlanta, GA: Southern Regional Education Board.

SREB. (2014). *Kentucky report: From two systems to one world-class system of technical centers*. Atlanta, GA: Southern Regional Education Board.

Spear, S. J. (2009). *The high-velocity edge*. New York, NY: McGraw-Hill.

Tyszko, J. A., Sheets, R. G., and Fuller, J. B. (2014). *Managing the talent pipeline: A new approach to closing the skills gap*. Washington, D.C.: U.S. Chamber of Commerce Foundation.

U.S. Chamber of Commerce Foundation. (2016). *Career readiness: A business-led approach for supporting K-12 schools*. Washington, DC: U.S. Chamber of Commerce Foundation, Center for Education and Workforce.

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