



Preparing Advanced Manufacturing Technicians for the Workplace: Perspectives from Rural Employers

Dr. Faye R. Jones, Florida State University

Faye R. Jones is a Senior Research Associate at Florida State University's College of Communication and Information. Her research interests include STEM student outcomes and the exploration of student pathways through institutional research.

Dr. Marcia A. Mardis, Florida A&M University - Florida State University

Marcia A. Mardis is a Professor and Associate Dean at Florida State University's College of Communication & Information and Associate Director of the Information Institute. Author of numerous publications and recipient of over two decades of federally funded research grants, Dr. Mardis' work focuses on professional identity creation, educational text and data mining, and technician education improvement.

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In this work-in-progress paper, we present the preliminary results of semi-structured interviews conducted with advanced manufacturing (AM) employers in rural communities to understand the workplace skills they seek. This study, part of a larger effort to document Northwest Florida's rural AM employers' desired competencies, identified employability skills valuable for entry-level technician positions. The employers who participated in this study represented the growing AM industry sub-sectors of timber, pipeline, and textiles. Our findings suggest that rural employers face challenges common to all AM employers: 1) the need for workplace skills, such as a strong commitment to teamwork and ongoing professional development; and 2) difficulties in encouraging employees' transitions from job to career pathway, thus increasing their in-field persistence. These results have implications for educational institutions that offer AM degrees and for graduates who seek rural employment in the AM field.

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1.0. Introduction

Advanced manufacturing (AM) employers are challenged to find enough adequately trained workers. One reason may be that the K-12 educational system has failed to engage or expose students to technical application or workplace skills either early or extensively enough, or articulate high school students to 2- or 4-year manufacturing programs [1, 2]. Another reason is that institutions of higher education (IHEs) often produce too few graduates to fulfill AM industry demands, and many engineering technology graduates are not gaining the right skill sets for available positions [3]. Quite possibly, this misalignment may include skills that can be hard to manage and measure because new manufacturing technologies frequently require specific new skills that preparation programs do not yet teach and that emerging labor markets do not yet supply [4]. In rural communities, where AM employers rely on the labor market at hand, a skills gap can be a formidable barrier to building and sustaining a presence.

To further explore the mismatch between workforce supply and workplace needs, we conducted semi-structured interviews with Northwest Florida's Rural Area of Opportunity (RAO) employers to identify what they perceived to be important employability for AM technicians. The research question guiding this investigation is *What are essential employability skills that 2-year AM programs graduates need to be successful in AM employment in rural Northwest Florida?*

2.0. Literature Review

2.1. High-Performing Rural Manufacturing.

Advanced manufacturing (AM) effects the economic development of rural and urban areas in essential, but different ways. Although 70% of AM dependent U.S. counties are located in urban areas and 18% in rural areas, manufacturing represents a more essential percentage of jobs and earnings to rural counties [5]. In Florida, rural communities contribute nearly \$1.8 billion or 8% of Florida's total gross domestic product [6]. To understand and promote economic development in Florida's rural areas, Florida's Department of Economic Opportunity (FDEO) established three RAOs composed of rural counties to leverage their economic potential. The Northwest Florida RAO includes Calhoun, Franklin, Gadsden, Gulf, Holmes, Jackson, Liberty, Wakulla, and Washington. In high-performing and emerging firms, the Northwest RAO had 81.3% higher employment growth than like-industries in non-rural areas [6].

2.2. Employment Demands in Rural AM

In a 2011-2015 survey [6], rural employers identified employment recruitment and retention as a major business challenge, along with concerns about continuous improvement, growth opportunities, and product innovation. In Northwest Florida, for example, with economic restructuring and technological change altering the job opportunities that rural AM employers

can provide to local citizens [7], these employers must attract local and recruit non-local technicians who can meet middle skill employment demands for this dynamic field.

2.3. Employability Skills.

Employability skills include non-technical and workplace skills and are often just as important as technical skills [8-10]. Engineering employers have ranked skills such as teamwork, communication, analytical skills, self-confidence, flexibility, customer orientation, and self-organization as highly valuable employability skills [11]. Workplace skills can be grouped into two categories: 1) personal qualities, such as adaptability, attention to detail, commitment, cooperation; and 2) core skills, such listening, ethical soundness, information retrieval, interpersonal skills, leadership, and teamwork) [11]. Although employability skills are desired from engineering and engineering technician program graduates, these skills are not often included in educational mandates; for example, soft skills are not mentioned in Florida's AM curriculum frameworks for two-year programs [12], thus indicating a misalignment between what employers want and what AM curricula include.

Concerns over employees' lack of soft skills have been documented in manufacturing environments for decades, and these concerns still exist today. For example, a study conducted in 1998 with 54 personnel human directors and 16 managers in Texas Manufacturing firms forecasted that the State of Texas would see a 34% decrease in the hiring of high school graduates in manufacturing firms because they lacked personal development and group interaction skills [13]. In 2007, a study conducted by the Mississippi Manufacturers Association (MMA) concluded that employers expected a skills shortage due to the inadequate preparation of the workforce for manufacturing jobs, as 45% of employers were dissatisfied with the preparation of college graduates and 20% expected a shortage of workers holding bachelor's degrees or higher. MMA specifically indicated that employee preparation in problem solving, teamwork, verbal communication, customer service, and supervision and management, along with other soft skills, were inadequate among employees [14]. In 2010, a study of 180 engineering employers conducted a decade ago in Malaysia, Husain et al [8] found that regardless of company size (e.g., number of employees) or type (e.g., civil, chemical), employers placed great emphasis on employability skills, with the highest values on personal qualities, followed by resource skills, basic skills, information skills, and thinking skills. More recently, the highly technical environment exasperates concerns over the skills gap in the AM workplace. In 2018, Deloitte expressed the need to expand on "soft" skills in the digital workplace, especially critical thinking in the face of technology transformation [3]. In 2017, Weaver and Osterman reinforced that problem solving skills, the ability to work in teams, and quality assessment are critical skills needed for modern production systems [15].

Undergraduate employability skills have also been a focus of research studies. In a 2013 study of 30 faculty and 209 senior undergraduate students in manufacturing programs across five

Mississippi postsecondary institutions, Griffin and Annulis [16] concluded that both faculty and students believed that skills in problem solving, team work, project management, and critical thinking were highly integrated in the curriculum; however, customer service, verbal communication, and supervisory/management skills were not adequately integrated. When compared to faculty, students also believed to a greater extent that employability skills should be more integrated into the curriculum [16]. In 2018, Pengnate [11] studied 40 employers across four sectors (i.e., information technology, business, engineering, and service) to identify their perception of employability skills of undergraduate students. Findings revealed that the highest ranked needs by employers were in subject knowledge, core skills, and personal qualities, in that order. Enhancements to work-based learning opportunities in the curriculum, alignment of courses with industry needs, and integration of personal qualities in the curriculum were recommended [11]. To close the gap, it is evident that a multipronged approach that 1) does not undervalue experience over the need to accelerate technical and soft skills development, 2) retrain and retrain current AM employees, and 3) attracts new talent is essential [17].

3.0. Methods

3.1. Data Collection.

This qualitative study includes interviews with three rural manufacturing employers from the Northwest Florida RAO to identify the types of employability skills needed in entry-level AM positions. The employers belonged to different AM sectors: lumber (Larry); pipes and pipelines (Peter); and textiles (Terrence). The interviewees were all manufacturing supervisors with 10-25 years of experience and overseeing 100 to 250 employees. Employers had between 5-20 full-time employees with the rest being seasonal and part-time employees. We asked each of them to respond to the following question: “What are the necessary skills needed for your entry-level AM positions?”

3.2. Data Analysis.

Each employer’s one-hour interview was recorded using Blackboard Collaborate synchronous video software. The interviews were transcribed using the YouTube transcription tool. Each transcript was then open coded for reference to two types of employability skills, personal qualities and core skills. Recurring themes were identified.

4.0. Results.

4.1. Personal Qualities.

Personal qualities are often traits you are born with that are useful in the workplace. Preliminary findings revealed that employers often expressed personal qualities in combination with

technical skills or other employability skills. Instances of personal qualities captured in the interviews are captured in several quotes in this section.

Attitude. One employer used the word “attitude” several times to describe the totality of what personal qualities entail. Larry said referring to job candidates, “*If you don’t have soft skills, it’s a waste of time to invest in them.*” Larry continued, “*I’m looking for attitude because training is always available,*” and shared the following example:

Let’s just say a forklift driver will sometimes will sometimes have an attitude and what I mean by that and I keep using that word but if they’re driving with the forklifts and something falls off going from point A to point B and I need ID on that item then someone needs to get out and pick it up and that’s not their primary function but that’s part of it, but sometimes you see the attitude.

This statement also had implications for employees who demonstrate initiative in the AM workplace.

Adaptability/Flexibility/Multi-Tasker. Employers expressed that they needed employees who are adaptable, flexible, and able to handle many tasks concurrently. They need “*someone moldable to different aptitudes,*” according to Larry. He continued,

We have people that weld but don’t have welder positions, so sometimes they pick up boards they troubleshoot change barons and belts and....that’s what I’m looking for well-rounded people no matter what skill level they have.

Terrence explained,

There are a lot of moving parts and equipment with wiring and power and air compressing and the lines...so we have a lot of moving parts and a lot of when I say moving parts literally and figuratively a lot going on.

Peter also made similar reference:

Our team, they’re the jack-of-all trades. They have so much knowledge across the board and that the team we have could one day be filling in a pothole but the next doing welding on a 30-foot scissor-lift working on our sprinkler system... it’s a lot of different things.

Attention to Detail. AM employers alluded to the importance of quality and the importance of attention to detail in achieving high quality products and service. Peter posited, “*You know you have to be able to understand the importance of doing it right the first time because if you got time to redo it then you had time to do it right the first time.*” Peter also said

You know one of our mottos is if you got time to lean you got time to clean so that general housecleaning even though it’s a dirty environment...but a lot of visitors come in and complement us on that because I have seen other mills and I know how big a mess it can be and it’s silly but it creates a culture of doing things right.

This statement had implications for teamwork (e.g., everyone contributing), initiative (e.g., taking on a task without being told) and customer service (e.g., pleasing others who visit the facility)

Tolerance to Stress. Employers expressed many safety concerns and the importance of safety protocol to minimize accidents in the workplace. Peter said, *“We try to rotate people through the different positions in areas of the mill so that you don’t get burned out.”* Repeated mentions of multiple, as Larry would say, “moving parts,” in an environment where the potential for accidents and fatigue are high, alluded to the ability to handle stressful situations in an AM environment as a valuable personal quality.

4.2. Core Skills.

Core skills are often essential for the performance of tasks that are improvable through repetition or practice. In this section, quotes are shared about core skills that were identified in the employer interviews.

Problem Solving. Problem solving was expressed as a team process that was highly interactive and linked to productivity and competitive advantage. Larry indicated that *“We collaborate as a team to come up with solutions to problems.”* Terrence referred to problem-solving as *“you know it’s common sense and you may not have history with a piece of equipment but how well can you look at the diagrams or the training that comes with this piece of equipment and can you catch on fairly quickly and again work safely with this piece of equipment.”*

The ability to learn things on one’s own was also highly valued. For example, Terrence explained, *“they can’t be afraid of things like technology and learning new things that you may know or not know.”* In this Terrence’s quote, there are also implications for personal qualities such as “courage” and “initiative.”

Peter linked problem solving and idea generation to gaining competitive advantage. Pipe 1 exclaimed that

It’s our job to listen to every associate and every idea and implement where possible you know there’s no wrong answer there’s no wrong statement and we must be willing to try things and not all of them will work but the survivability is absolutely key and textile manufacturing has a lot of competition not only overseas there’s U.S. manufacturers overseas that make it very important that we put ourselves and we find ways to do things better...complacency is probably one of the worst things to have in a competitive environment.

Teamwork or Collaboration. Teamwork was the most frequent employability skill mentioned. Larry indicated that “*There is a heavy collaboration between the maintenance department our supervisors and the production line.*” Larry also ranked teamwork as second behind the technical competency “safety” when he mentioned that

Teamwork is key right behind safety because you you’re always working with somebody else and when I say always almost always there’s going be some stand-alone job but this is a team you know and we’re going succeed as a team or fail as a team...and I get that point across right away.

In this instance, teamwork was portrayed as a non-negotiable employability skill. Terrence explained that “*we try to build our own internal team,*” while Peter stated that

At [a higher education institution] you are forced to work in teams and that is very important and I know that some younger folks don’t like to work in teams you know they’d rather you know handle their own thing...but that’s not how [this company] works.

Larry stressed that,

I’m the general manager and if the toilets need scrubbing I’m going to do whatever I can to make this successful, because ultimately that is my success. That’s what I’m looking for: people that build team and build camaraderie.

Interpersonal Skills/Customer Service. One employer linked customer service to performance and company reputation. Peter indicated that

It’s customer service what we are you know our (company name’s) reputation have always been a quality leader but I mentioned earlier that there were six or even other mills. Back in 2000 so the ones that have survived you know the quality side of this from the customer standpoint. It’s just unexpected you know that’s more about how you differentiate yourself from these other suppliers.

5.0. Discussion

5.1. What are essential employability skills that 2-year AM programs graduates need to be successful in AM employment in rural Northwest Florida?

Consistent with AM employers from national and international settings who have mentioned as the importance of workplace skills [11, 14, 16], the participating rural employers valued personal qualities such as positive attitude, adaptability/flexibility, attention to detail, and stress tolerance; these participating employers viewed core skills such as problem solving, teamwork, and customer service as critical employability skills to meet performance results, maintain a safe work environment, and maintain a competitive advantage. Although the aforementioned employability skills have been mentioned by other researchers, e.g., [5] [9] core skills may be of

higher value because they require integrating manufacturing knowledge to increase performance. Core skills may help to obtain or improve the bottom line.

The findings suggest that employability skills bind other skills together; core skills especially improve an employee's workplace function. For example, core skills, for example, increase performance, safety, and create or promote a positive work environment. This positive effect is evidenced by the Terrence who needed to hear from his team to make better decisions and the need for collaboration and teamwork between departments in order to produce quality products. The need for employability skills in combination with technical skills, such as the need to use personal qualities (e.g., tolerance to stress or attention to detail) to deal with "all the moving parts," suggests that some employability skills many not be optional to perform technical skills, but essential.

5.2. Implications.

There are several implications for two-year postsecondary institutions offering AM programs that can be deduced from the preliminary findings. The employers included in this study believed that employability skills, core skills in particular, should be part of course activities; however, this curriculum integration is difficult to do unless state standards reflect the importance of these skills. Although employers continue to express the essential nature of core skills, such as teamwork and problem-solving, postsecondary institutions may not yet recognize their importance until state policy or standards acknowledge them as well. AM programs may want to determine how students' employability skills can be assessed prior to graduation and align this with how employers will assess these same skills prior to hiring. Students should seek work-integrated learning opportunities in AM prior to graduation in order to increase their employability skills (e.g., core skills and personal qualities) and workforce readiness, as these skills may offer competitive advantage over other graduates who many not have these essential skills. Employers, regardless of size or type seem to desire the same employability skills from graduates entering the workplace [8, 11]. In this study, rural employers' perceptions of employability skills also seem to align.

5.3. Limitations.

The findings of this study are preliminary because the limited sample size does not allow for in-depth findings or generalizations. This work is in progress, and as it develops, study participants and findings will be expanded. Although the findings are not yet complete, the preliminary results have implications for AM employers in the Northwest RAO. The generalization of these findings should not extend beyond Northwest Florida.

5.4. Next Steps

Preliminary findings suggest that more information and research on AM rural employers are needed. Questions that can guide future research on rural AM include:

- 1) How do AM employers assess the employability or “soft” skills of potential hires before or during employment? How can AM programs assess whether students possess these skills? Where in the AM program curriculum should employability skills be integrated?
- 2) What technical competencies are most lacking in recent AM graduates? How do employability skills rank against technical skills in the workplace?
- 3) How have AM employers compensated for employees’ technical or employability skills gaps?
- 4) What are the biggest challenges employers face in recruiting and hiring AM technicians for their organizations? How have AM rural employers overcome these recruiting or hiring challenges?

In addition, further research might include an employer survey to ascertain employability skill rankings and comparisons to technical skills’ importance.

6.0. Conclusion

Employers have indicated that certain personal qualities and core skills are valuable, and even essential, in the AM workplace. To develop future AM technicians for entry-level positions, critical employability skills must be examined and then addressed in educational policy and curriculum practice. Institutions of higher education offering AM programs should integrate these important employability skills, as needed, in curricula. Educational providers and industry employers should also consider proper measures for assessing employability skills among future technicians.

References

- [1] M. A. Feder, G. Pearson, L. Katehi, and Committee on K-12 Engineering Education, "Engineering in K-12 education: Understanding the status and improving the prospects," ed: National Academies Press, 2009.
- [2] The Manufacturing Institute, "Roadmap for manufacturing education," ed, 2012.
- [3] Deloitte, "2018 Deloitte and The Manufacturing Institute skills gap and future of work study," pp. 1-20
- [4] T. Bolli, K. M. Caves, U. Renold, and J. Buerger, "Beyond employer engagement: measuring education-employment linkage in vocational education and training programmes," *Journal of Vocational Education & Training*, vol. 70, no. 4, pp. 524-563, 2018.
- [5] S. A. Low, "Rural manufacturing at a glance, 2017 edition," vol. Bulletin 177, Economic Research Service, Ed., ed: United States Department of Agriculture, 2017, pp. 1-6.
- [6] L. Fowler, P. Hopkins, T. Mahoney, and J. Pernsteiner, "Rural area manufacturing: An assessment of manufacturing in Florida's rural areas and the opportunities for growth and expansion," K. Carr, Ed., ed: Florida Makes, 2016.
- [7] K. Etters, "Panic level: Hurricane Michael's impact on Florida, Georgia timber farms generational," in *Tallahassee Democrat*, ed: Tallahassee Democrat, 2018.
- [8] M. Y. Husain, S. B. Mokhtar, A. A. Ahmad, and M. Ramlee, "Importance of employability skills from employers' perspective," presented at the International conference on learner diversity 2010, 2010. [Online]. Available: https://www.researchgate.net/publication/257714240_Importance_of_Employability_Skills_from_Employers'_Perspective.
- [9] J. M. Hollister, L. I. Spears, M. A. Mardis, J. Lee, C. R. McClure, and E. Liebman, "Employers' perspective on new information technology technicians' employability in North Florida," *Education & Training*, vol. 59, no. 9, pp. 929-945, 2017. Available: <https://doi.org/10.1007/s10639-017-9678-7>
- [10] M. A. Mardis *et al.*, "Assessing alignment between information technology educational opportunities, professional requirements, and industry demands," *Education & Information Technologies*, vol. 23, no. 4, pp. 1547-1584, 2018. Available: <https://doi.org/10.1007/s10639-017-9678-y>.
- [11] W. Pengnate, "Needs of employability skill characteristics based on employers' perception," presented at the IEEE 2018 5th International Conference on Business and Industrial Research, Bangkok, Thailand, 2018.
- [12] (2019). *Engineering Technology (AS-1615000001): Florida Department of Education Curriculum Framework*. [Online] Available: <http://www.fldoe.org/academics/career-adult-edu/career-tech-edu/curriculum-frameworks/2019-20-frameworks/manufacturing.stml>
- [13] J. E. Deleon and R. E. Borchers, "High school graduates employment trends and the skills graduates need to enter Texas manufacturing industries," *Journal of Vocational and Technical Education*, vol. 15, no. 1, pp. 28-41, 1998.
- [14] Mississippi Manufacturers Association, "A study of the workforce training needs of the manufacturing sector in Mississippi," ed, 2007. Available: <http://mma-web.org>.
- [15] A. Weaver and P. Osterman, "Skill demands and mismatch in U.S. manufacturing," *ILR Review*, vol. 70, no. 2, pp. 275-307, 2017, doi: 10.1177/0019793916660067.

- [16] M. Griffin and H. Annulis, "Employability skills in practice: the case of manufacturing education in Mississippi," *International Journal of Training and Development*, vol. 17, no. 3, pp. 221-232, 2013.
- [17] S. W. Behie and M. K. Henwood, "Closing the Skills Gap," *Chemical Engineering Progress*, vol. 114, no. 6, pp. 36-41, 2018.