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Rediscovering, Redefining and Rebuilding Manufacturing in the Education Sector

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Abstract: Manufacturing industries worldwide have undergone dramatic changes in recent years and now demand more from graduating manufacturing engineers. The effects of globalization have forever changed the parameters for success in manufacturing. Our educational institutions must respond to these changes with innovation. Since most of the global economic crisis is developed in manufacturing organizations such as in Europe, Japan. This transition is made even more marked with the economic downturn taking place across the world. There is a strong movement of cost based manufacturing to offshore and low wage economies. The remaining onshore manufacturing activities now focus on innovative new processes and exceptional customer service. The technology and processes required for onshore manufacturing can be complex and challenges the existing skills of engineers and managers to continuously operate and change such systems. Educational bodies struggle to keep up to date. The paper provides a number of suggestions for strategic change to research and education in manufacturing in the future.

Index Terms: Manufacturing, Strategy, Education, Pedagogy, Curricula

I. Introduction

Manufacturing education is in crisis. The evidence is striking and undeniable: Despite a consistently high United States unemployment rate for several years ranging between 8% and 10% from February 2009 through March 2021 as many as 600,000 manufacturing jobs have gone unfilled because of a shortage of skilled workers. The roots of this crisis started with a serious shortage of workers educated in Science, Technology, Engineering and Mathematics (STEM) fields, according to numerous reports. [1]. A 2011 report authored by Deloitte and the Manufacturing Institute, "Boiling Point The Skills Gap in U.S. Manufacturing"[2-3], notes that the biggest areas of workforce shortage "are those that impact operations the most and require the most training. From technicians to engineers, the talent crunch in these critical areas is taking its toll on manufacturers' ability to meet current operation objectives and achieve longer-term goals." The SME Task Force on the Role of SME in Higher Education and members of SME's Manufacturing Education & Research Community [3-8] has examined the state of manufacturing education. This research included a series of events discussing manufacturing education that engaged hundreds of stakeholders from industry, government and academia.

II. Science, Technology, Engineering and Mathematics (Stem) Foundation

Manufacturing must be portrayed as a vibrant industry that offers opportunities that are ample, creative, high-tech and rewarding. Many students tend to be altruistic in their choice of careers, so educational programs should make it clear to students that manufacturing offers the chance to improve the world.[9] For example, students should be educated about the role manufacturing plays in the green revolution that saves energy, increases health, saves lives and creates a new economy.

It is important to stress to students that there are multiple pathways, requiring different education levels, to a career in manufacturing. Figure 1 shows several options. However, a significant portion of the available manufacturing jobs require educational equivalency up to an associate degree. In order to develop technicians, there must be more support for technical education, especially in high schools. Students must have options for manufacturing paths that are hands-on and technical or academic in nature or, ideally, both.

III. Manufacturing and Its Program's

Today, there is little agreement on the answer to that question. But if the crisis in manufacturing education is to be resolved, a better-defined manufacturing curriculum is needed to guide manufacturing education programs, with an eye toward accreditation.

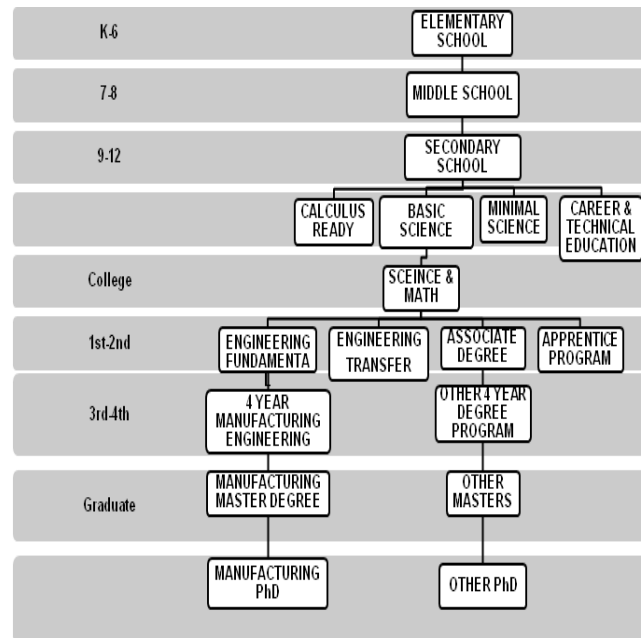


Fig.1 Institutional Pipeline for Manufacturing Knowledge

Figure 2 gives the comparison between 2005 and 2025 of different countries in manufacturing education

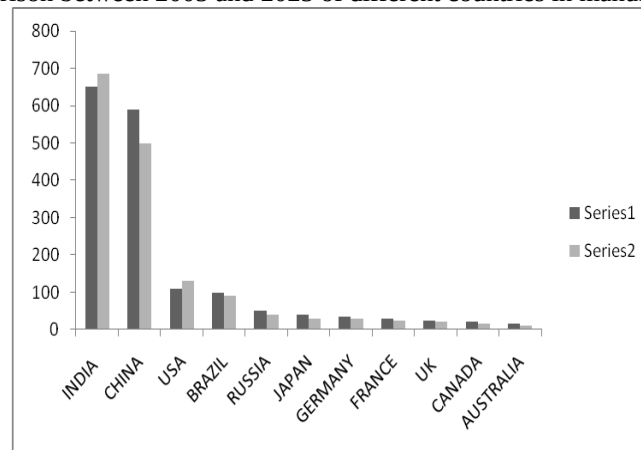


Fig.2. World's Talent Pools of Younger People

This will enhance the understanding and value of certifications and degrees that individuals receive from accredited programs. The Department of Labor has taken a step toward defining the manufacturing skills workers need to be successful in 21st century manufacturing with its Advanced Manufacturing Competency Model [Figure 3].

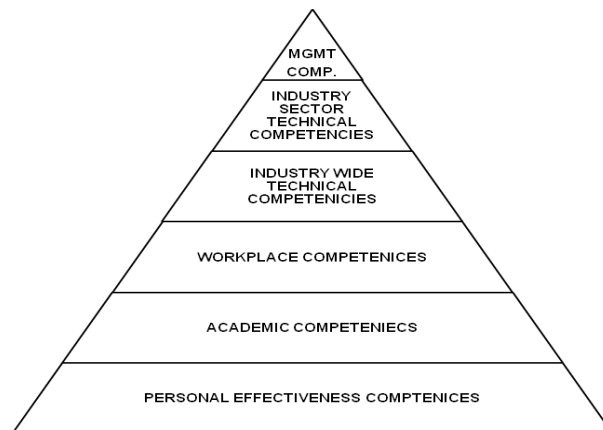


Fig.3. Advanced Manufacturing Competency Model

The model was developed in 2006 in collaboration with the Employment and Training Administration and updated in 2010 with leading industry organizations. The National Association of Manufacturers, the National

Council for Advanced Manufacturing and the Society for Manufacturing Engineers took the lead in collecting feedback from their members to ensure that the updated model includes the most current processes and practices [9]. manufacturing, such as mathematics. The middle levels define the technical competencies required by the manufacturing industry, such as production and quality assurance. The top levels define the competencies required by specific occupations within advanced manufacturing. This model serves as a framework for the National Association of Manufacturers-endorsed Manufacturing Skills Certification System [Figure 4], which is a system of stackable credentials from certification organizations applicable to all sectors in the manufacturing industry. These nationally portable, industry-recognized credentials validate the skills and competencies identified in the Advanced Manufacturing Competency Model [10]. But there has been a missing link between the skills defined in the Advanced Manufacturing Competency Model and the Manufacturing Skills Certification System. A model was needed to define the academic content needed for manufacturing education programs, whether they confer degrees or technical credentials. SME's Center for Education developed and adopted a model, which is included in the "Curricula 2015," [11-16] to provide a solution to this problem.

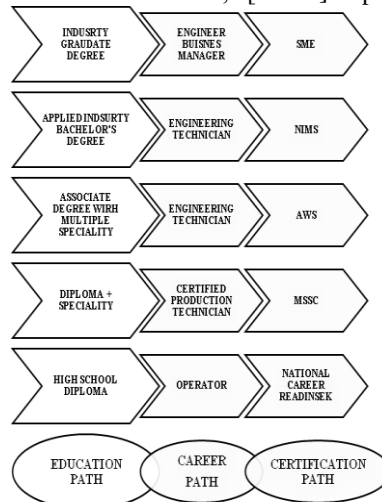


Fig.4 Endorsed Manufacturing Skills Certification System

The Four Pillars of Manufacturing Knowledge is meant to be a standard for recommending curriculum topics and establishing accreditation criteria for manufacturing programs of all kinds.

They also set important standards for accreditation of educational program [17]. Certifications and degrees that come from accredited programs are necessary for industry to verify and trust the level of skills and knowledge that certain individuals bring to the workforce.

IV. Consistency and Quality of Manufacturing

Manufacturing curricula vary greatly from school to school and program to program. While some flexibility is necessary, everyone educated in manufacturing should have a basic core of knowledge. Figure 5 shows the percentage of executive reporting high difficulty attracting and retaining qualified workers in different countries in between 2005 and 2025

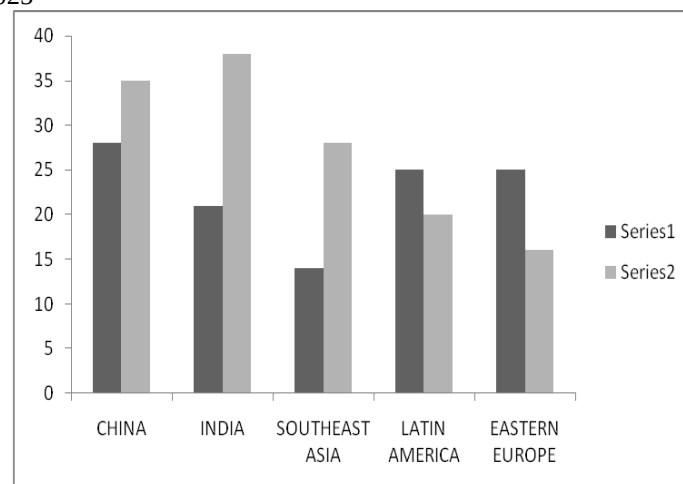


Fig. 5 Comparison of Country wise Qualified Workers (Source: Deloitte search based on United National Department of Social Economic affairs)

SME recommends that educators, industry, professional organizations and government work together to:

- Use the Four Pillars of Manufacturing Knowledge and the Advanced Manufacturing Competency models as a foundation to build manufacturing curricula [18].
- Keep curricula current by monitoring trends in education and industry needs.
- Use curriculum and instructional resources shared through the National Center for Manufacturing Education [19] and industry professionals

V. Faculty Development In World-Class Manufacturing Education

To develop faculty that can deliver an excellent manufacturing education, educators must:

- Keep up to date on using new technologies.
- Work with industry to understand current technical needs and update curriculum.
- Collaborate with industry, professional organizations and government on projects such as design to build competitions and mentorships for both students as well as faculty.
- Research, publish and participate in manufacturing journals and conferences.
- Share best teaching practices. This includes in-service days and conferences, among other examples [20-25].

VI. Manufacturing Education Programs

Manufacturing education is an essential priority and should be funded accordingly. All sources of possible funding should be sought to support manufacturing education, and investments need to be strategic and effective, with measurable results. Figure 6 shows the generation gap between young, medium and old in different countries during manufacturing

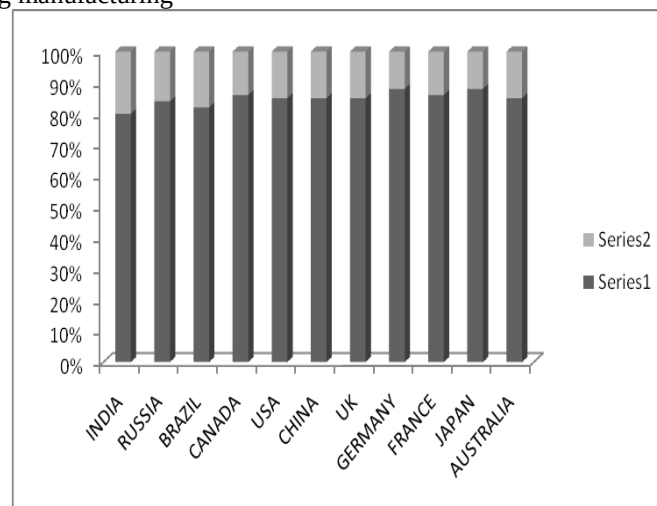


Fig.6. Generation gap by Age in 2005(Source: Deloitte search based on United National Department of Social Economic affairs)

SME recommends that investments be guided by the Four Pillars of Manufacturing Knowledge, the Advanced Manufacturing Competency and the Skills Certification System models. Many educational programs and initiatives that demonstrate the excitement and rewards of manufacturing are now under way for young students. Among the efforts: National Engineers Week activities,[26] “Dream it. Do It.” campaigns, [27] SkillsUSA, [28] FIRST competitions [29].

VII. Conclusion

It includes a discussion on the role of manufacturing in the global economy, the factors affecting the scope of manufacturing, and the current efforts to revitalize manufacturing in various parts of the world. It then presents an overview of the curricular models proposed to address the needs of the manufacturing industry. As an extension of the analysis, a recommendation is made on the key aspects of any manufacturing curriculum with an emphasis on innovation and entrepreneurship. Finally, a set of strategies are proposed for the enhancement of manufacturing education. They include the creation of a flexible degree program that emphasizes learning over teaching, development of a network of academic institutions around the globe to deliver the program, use of communication technologies to provide access to the program to anyone at anytime and anywhere in the world, and an outreach to future manufacturing professionals.

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