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Innovation: Culturally Determined Definition, Application, and Inclusion in Manufacturing

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Abstract

Innovation and manufacturing are two terms forever linked together. Those involved in the industry of manufacturing are told on a daily basis that the key to survival for a company is to embrace and implement innovation. While the word "innovation" is used extensively in manufacturing literature, media, and conversation little word has been done to truly define the term. Manufacturing is comprised of people educated in business school programs, engineering programs, and vocational programs such as machining. In order for a mutual understanding of what is necessary for a manufacturing company to be innovative a commonly understood definition of the word innovation is necessary. This paper presents the results of a study examining how business school students, engineering students, and machining students define the term innovation. The purpose of this study is to address the question of whether these students have a common definition of the term innovation and the potential impact this has on the field of manufacturing. Tools used to examine the term of innovation include content analysis and participant interviews.

Keywords: Innovation, Definition, Manufacturing, Dissemination, Globalization

1. BACKGROUND

On January 25, 2011, United States President Barack Obama delivered his annual State of the Union address. During this address, President Obama stressed the need for an increase in innovation as part of a plan to sustain and grow the economy of the United States. "All these investments — in innovation, education, and infrastructure — will make America a better place to do business and create jobs" (White House Office of the Press Secretary, 2011). This address was not the first mention of innovation by President Obama. Since taking office in 2009, President Obama listed increasing innovation in the United States as an objective of his administration. Nor was the mention of innovation and education in the same sentence circumstantial. White House strategists' perceived a link between innovation and education that necessitated government sponsored economic support.

In 2009, the Obama Administration issued an initiative to generate and sustain innovation in the United States economy (National Economic Council, 2009). In addition to proposing key elements for the industrial sector, the strategy highlighted support for initiatives at the kindergarten through 12th grade level as well as colleges and universities. Also critical was the formation of the National Advisory Council on Innovation and Entrepreneurship (United States Department of Commerce [USDC], 2013). This

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council, comprised of "some of America's leading entrepreneurs, investors and university leaders" (USDC, 2013), provides the US president with "ideas and feedback on policies that nurture innovation and entrepreneurship" (USDC).

Business executives cite the need for continued innovation as a pillar of future economic success in the United States (Bozic & Dunlap, 2013). According to a 2013 United States Department of Commerce report, citing previous work by the National Bureau of Economic Research, 20 percent of gross job creation in the United States from 1993 to 2013 occurred due to startup companies (USDC, 2013). The report maintains that a major impetus behind this trend is "innovation, and the real world application of innovation" (USDC, 2013). This report is rooted in a number of previous US governmental initiatives focusing on this concept of innovation and how to maintain it in the United States economy.

The disturbing trend compelling the USDC to explore the topic of innovation and entrepreneurship is found in a 2011 McKinsey Global Institute report claiming not only that startup formation had slowed since 2007, but that as a result of this sluggishness "the United States could have created almost two million more jobs in 2010 if new business creation and employment at new businesses had remained at the same pace as in 2007" (USDC, 2013).

In order to counter this trend, colleges and universities promote revamped curricula highlighting innovative theory as a critical component. Innovation in manufacturing is considered crucial to driving the economy (Bozic & Dunlap, 2013). In order to achieve this goal in US manufacturing, it is critical to address innovation theories in educational programs for fields such as business, engineering, and machining.

This recognition of a need for an education strategy to increase innovation in the United States reveals the importance placed on innovation for continued economic success in the 21st century. The literature demonstrates that business leaders, government officials, and educational leaders are in agreement that innovation and the teaching of how to be innovative (also known as innovation education) are critical to the continued success of the United States economy. Equally apparent is the lack of conformity in innovation education in the United States.

One such context for innovation is presented in the works of Clayton Christensen, Jeff Dyer, and Hal Gregersen. Their ideas build on Clayton Christensen's theory of disruptive innovation, or "the introduction of an idea or technology into a niche market that over time fundamentally changes the paradigm for that market, almost violently displacing the previous hierarchy" (Dyer, Gregersen, & Christensen, 2011).

This study focuses on how the term innovation is understood and incorporated into the field of manufacturing. The manufacturing industry is critical to the development of any economy. In order to survive manufacturing companies must continue to find new ways to continue to remain profitable in an ever changing global economy. The term innovation is often connected to the strategies and techniques that manufacturers use as a means of addressing this need for continued change and profitability. A common understanding of the term "innovation" is necessary in order for innovation to take root and succeed. This data collected for this study ess derived from a larger study examining innovation education in the northeastern United States. The results of that study will be published in a future work.

While this study uses educational institutions as the context for the case studies, the emphasis of the study is not the education of individuals, but rather it focuses on an understanding of how the terms "innovation" and "innovation education" are understood and disseminated within the three professional areas (business, engineering, and machining) directly involved in the manufacturing industry.

2. Literature Review

Innovation versus Invention

Before examining the current state of the literature regarding innovation, it is important to delineate between the terms innovation and invention. Unfortunately, a review of the literature showed that both terms are typically defined using either the noun or verb form of themselves in the respective definitions. However, the Cambridge Dictionary not only defines both using original verbage, but also demarcates between an "English Dictionary" definition as well as a "Business" definition for each term " (www.dictionary.cambridge.org, 2016). According to the Cambridge Dictionary, the "English Dictionary" definition of invention s "something newly designed or created, or the activity of designing or creating new things"

(www.dictionary.cambridge.org, 2016) while the "Business" definition is "a product or a way of doing something which has never been made or never existed before" (www.dictionary.cambridge.org, 2016).

The Cambridge Dictionary defines the "English Dictionary" version of innovation as "a new idea or method, or the use of new ideas and methods" (www.dictionary.cambridge.org, 2016) and the "Business" definition as "a new idea, design, product, etc." (www.dictionary.cambridge.org, 2016). The Cambridge Dictionary's similarities in definitions for both innovation and invention as well as the lack of original definitions presented in other dictionaries indicates a need to understand with better clarity how these terms are used and understood within different communities such as the business, engineering, and machining communities tied to the manufacturing industry.

United States Department of Commerce

The 2013 US Department of Commerce report entitled "The Innovative and Entrepreneurial University: Higher Education, Innovation & Entrepreneurship in Focus" features the department's study of innovation and the related entrepreneurship education in US institutions of higher education. The report highlights a letter entitled "Recommendations to Facilitate University-Based Technology Commercialization" (United States Department of Commerce [USDC], 2013), stating that the letter "provided a strategic framework for universities, colleges, and its partners in government, philanthropy, and business to advance university-based innovation and entrepreneurship. This framework has become part of the discussion on campuses everywhere as higher education thinks about its future and the desires of its students, faculty, and communities" (USDC, 2013). As a result, the Department of Commerce engaged each of the signatories (representatives from 142 United States colleges and universities) and "found that universities and colleges across America are engaged in an exciting and comprehensive set of programs to nurture innovation and entrepreneurship among their students, faculty and communities with the goal of supporting industry and the regional economy.

Limitations of 2013 USDC report

While this 2013 Department of Commerce report demonstrates that many US institutions of higher learning recognize innovation education and entrepreneurship, it does little to shed light on how these institutions define these terms. The report clearly states that each institution creates its programs based on the organization's needs (USDC, 2013). While identifying areas targeted by these innovation programs, the report fails to identify how each institution defines the term innovation. Without this definition, it is impossible to assess the goals or outcomes of the respective programs (also lacking in the report).

The term innovation is an embedded lexicon for both industries and education institutions in the United States. Yet the paradigm for what constitutes innovation and innovation education remains unclear. This is particularly apparent in the area of manufacturing, where the core educational needs are degrees in business, engineering, and machining.

The aforementioned Obama administration initiatives make innovation education a pertinent subject for 2016. More specifically, as the Obama administration initiatives mark manufacturing in the United States as a target for innovation, it is critical to assess innovation education in those fields of study related to manufacturing. These include business programs, engineering programs, and machining programs.

3. BRIEF METHODOLOGY

The scope of this study was confined to graduate programs of engineering and business as well as vocational programs for machinists that used the word "innovation" (or its derivatives) to define its graduates. The study targeted one to two participant institutions from each category, giving a total of three to six institutions in total.

Once educational institutions were identified and granted institutional participation, the researcher sought the inclusion of a minimum of one student, one instructor, and one program administrator from the respective programs. The students ranged from first year of study to final year of study in their respective programs. In cases with multiple students this allowed for a comparison of answers to the interview questions between a novice student and one who has been influenced by the education institution. This comparison revealed details about the type of innovation education taught at that institution. When possible, interviews of two to three instructors from each program provided an in-depth description of each institution's innovation education system.

A structured interview method was used for this study. The interview questions were derived as a result of the literature review process (Fruehauf and Kohun, 2015) as well as the 2008 Dyer et al. study on the orgins of innovators (Dyer, et al., 2008). The questions taken from the Dyer study were used with permission from the author. As part of the interview process, each participant was asked to define the term innovation. Pursuing the same set of questions with the students supplied additional data on how they perceive the role of innovation education in their academic careers. The goal of using the same interview questions for institutional staff and students at every institution was to provide data for assessing whether or not the students' and administrators' ideas of innovation paralleled. For each institution and each program therein a minimum of one administrator, instructor, and student participated. This resulted in a total of 21 interviews from five programs taken from four institutions in total (See Appendix A for a breakdown of participants from each program and institution).

4. Results and Discussion

Each participant interview began with the participant defining the terms "innovation" and "innovation education." The exact quotes from the participants can be found in their respective case site sections in Appendix A. Analysis of the participants' definitions for the two terms revealed the following:

- 14 of the 21 participants defined innovation in terms of improvements or changes to tangible objects or processes (this was evenly spread among the disciplines)
- 7 of 21 made mention of improvements to ideas in their definition of innovation
- 4 of the 6 graduate business school participants defined innovation in business terms, using words such as market, commercialization, and value

The propensity for the participants to define innovation in terms of tangible goods or processes for making tangible goods is of particular interest. Perhaps this is due to the participants' chosen fields of study (engineering, machining, and business) which all focus on the creation of or management of tangible objects. It could also be indicative of the similarities in the definitions between innovation and invention as discussed in the literature review. It is possible that confusion exists between the definitions of innovation and invention because of similarities in definitions given in dictionaries.

As cited in Appendix A, when interviewing the participants at Case 4, the graduate engineering program, Case 4 student 2 (C4S2) alluded to this problem. "In the beginning I was confused, like, a long ago about, uh-- between innovation and invention. And, uh, when I looked it up on the websites and read some stuff and trying to understand from people, it might – some people do not understand the meaning for each one." C4S2 further elucidated the difference between the two terms. "I believe that innovation, uh, is that something new you add an- any product" while "this is the innovation and oppose the invention which create from the beginning from nothing." Given the US government's push to increase innovation and therefore innovation education, a fuller understanding of the definition of the term innovation is necessary.

The business school participants' desire to discuss the term innovation in a business framework (using terms like "value" and "market") is of particular interest. Whether this is due to the way innovation is defined in graduate business school text books is unknown. It must be noted that the term "disruptive innovation" also contains such language.

Perhaps the most intriguing results came from the machining students. While the business students and engineering students spoke of innovation in a more abstract sense, the machining students used concrete phrases like "thinking outside the box" or looking at a process "through new eyes" (see Appendix A). These phrases imply a sense of stripping down an existing construct and redesigning it. There appears to be a tangible approach to problems for the machinists, as opposed to general statement as given by the other participants.

Regardless of the vocabulary used by the participants, and its slant towards their respective fields of study, there exists a common definition of generating a novel approach to a problem. The impact this has on the generation of creativity in the field of manufacturing is unknown. Does a discussion of innovation using a central core notion enhanced by disparate details generate more creativity? If so, what impact does creating a standardized approach to assessing innovation, such as generated by the Department of Commerce report, have on this creativity. As more institutions replicate the programs cited in

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the letter in order to receive funding, will the creativity level of programs suffer?

It is logical to assume that a unified definition of the term innovation would be in use due to the issuing of monetary grants to educational institutions for this matter. Further study is necessary to understand how the term innovation is used and understood not just at an institutional level, but also within the departments and concentration level within the institution.

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Appendix A

Participant ID	Definition of Term
Machining Program 1 Admin (C1A)	Innovation: "Using various things that you know and observe and applying the knowledge for those process or those items to solve an unrelated problem."
Machining Program 1 Instructor 1 (C1I1)	Innovation: "In my terms is just treating new ideas, coming up with new ideas, and whether it'd be to manufacture something or an idea of a project yourself."
Machining Program 1 Instructor 2 (C1I2)	Innovation: "Taking a process and looking at it with new eyes."
Machining Program 1 Student 1 (C1S1)	Innovation: "Putting your, um, not kind of putting your own twists in things and you're not just doing everything by the book I should say."
Machining Program 1 Student 2 (C1S2)	Innovation: "- I don't know - thinking outside the box. Thinking new ways, or – you know, looking at new or different ways of thinking or doing things - you know, that that might -- somebody may not have thought of, you know."
Machining Program 2 Admin (C2A)	Innovation: "New ideas to solve existing problems, um, make things better, higher quality."
Machining Program 2 Instructor 1 (C2I1)	Innovation: "Something that hasn't been done before. Doing something in a way that improves upon its previous method."
Machining Program 2 Instructor 2 (C2I2)	Innovation: "Always looking for something to do, different um, alternative, different um approach, um, not becoming stagnant."
Machining Program 2 Student 1 (C2S1)	Innovation: "The ability to think outside the norm and create new products and new things that are consumer-friendly and affordable."
Machining Program 2 Student 2 (C2S2)	Innovation: "I don't know, just the way world's moving."
Graduate Business Program 1Admin/ Professor (C3A)	Innovation: "The process of creating something new."
Graduate Business Program 1Instructor 1 (C3I1)	Innovation: "Something new. Right it's something different that is currently being done, you know at this point in time."
Graduate Business Program 1 Student 1 (C3S1)	Innovation: "Changes that happen in a business or entity that create value or measurable benefit. Whether that be increase productivity created creativity, innova-- workflow or employing morale.
Graduate Business Program 2 Admin/Instructor (C5A)	Innovation: "Starting with a creative idea about a product, service something and then making it to the commercialization state, uh, that you can sell it, to offer it to others"
Graduate Business Program 2 Instructor 1 (C5I)	Innovation: "I do differentiate between um, invention and innovation; where an invention is just coming up with an idea for something that's different or new, um and I think much like um, uh, Schumpeter; I think it was Schumpeter anyways. If it wasn't Schumpeter don't um, forgive me for that, but off the top of my head that's who comes to mind. Um, I would differentiate it; inventors, innovators, and entrepreneurs, as being three different things. Um, anybody can come up with an idea, Uh, most of us do it, you know, half a dozen times a day. Um, innovation is where we move that i—from ideation to um, uh, commercialization, and then the entrepreneur of course is the one who actually takes it to market. So in my mind the innovt—innovators are the ones who—who actually find a market for the innovation--uh, invention sorry; for the invention. So in my mind, innovation is finding a market space for that in—invention."
	Innovation Education: "Teaching um, two parts. One is the—is the tools necessary for identifying that market space for the invention. Um, and uh, teaching ways for individuals to um, um, kind of see right? Preparing—well okay, I'll use a Buddhist analogy here. Um so, someone asked the uh, I think it was the uh Dali Lama one time uh, why we meditate because in the--in the Dali Lama's uh, tradition um, uh, they believe that one

	cannot become enlightened in one's current life. And so, then the question of course is well, "Why do we meditate if we can't get enlightenment in our life?" And the answer is, "Ah, to prepare the mind for the potentiality of enlightenment." So, innovation education then, is preparing the mind for the potentiality of identifying the market space for the inventions that come up."
Graduate Engineering Program 1 Admin/ Professor (C4A)	Innovation: "Innovation is something that will improve what we already have. It's more of a creative idea that the population will accept"
Graduate Engineering Program 1 Instructor 1 (C4I1)	Innovation: "The process or, or method of developing new, it could be products, could be new processes systems but, um, the key word there, I think, is new or novel so, developing things that haven't existed before."
Graduate Engineering Program 1 Instructor 2 (C4I2)	Innovation: "Finding new or uh, new or novel ways to, you know, to do things. That could be a product, process, a new method uh, things like this. It can be, I think, abstract or um, you know, it's something physically based."
Graduate Engineering Program 1 Student 1 (C4S1)	Innovation: "Coming up with new ideas, um, really new ways to look at things."
Graduate Engineering Program 1 Student 2 (C4S2)	Innovation: "In the beginning I was confused, like, a long ago about, uh--between innovation and invention. And, uh, when I looked it up on the websites and read some stuff and trying to understand from people, it might – some people do not understand the meaning for each one. But, what, uh, I-I believe that innovation, uh, is that something new you add an- any product, uh--reached, like, reached to last – something new on any product that help or serve the community – uh like it's become like a new service on that product which already exists and become new in the market with a new feature. This is the innovation and oppose the invention which create from the beginning from nothing."