Technology-Driven Innovation—Strengthening Industry and Academia Partnerships for Advanced Manufacturing Gains

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Abstract

Industry-academia collaboration has become a subject of interest to industry, academics, and policy makers. It is now acknowledged by noted industry advisors that such relationships are valuable for innovation. In today's global economy, disruptive innovation and disruptive technology may well be the catalysts that determine whether a manufacturing organization even exists. Industry and academia partnerships could well be the vehicle that propels an industrial organization to the front of its field, or the lack of such a partnership may well doom the organization to oblivion. This paper explores the dichotomy between the strong motivations of both industry and academia that will assist institutions (universities and colleges) to conduct research that promotes new product development, more efficient processes, scholarly productivity, and, of equal importance, to make the collaborative effort effective.

Strengthening industry and academia partnerships means industry personnel in the classroom and academic students in the industrial workplace. To develop cutting-edge products and services at the pace that advanced manufacturing innovation gains demand, academia and

industry must change the way they think about education and industrial relationships. Educators and learners must be engaged in hands-on activities so that learners can contribute immediately to innovate at faster levels. Concepts such as active learning must be encouraged. Nurturing science, technology, engineering, and mathematics (STEM) schools where students who have a propensity for the STEM disciplines are encouraged to pursue career paths in these disciplines early in the education process. New manufacturing programs such as advanced manufacturing and manufacturing execution systems (MES) can be taught along with more mature manufacturing concepts such as Six Sigma, lean manufacturing, supply chain management, and enterprise resource planning (ERP). In our opinion, a joint industry-academic comprehensive approach to this very complex problem of educating the workforce will most likely yield the best results.

Introduction

Since industry and academia collaboration has become a subject of great interest to industry, academics, and policy makers, it is now acknowledged by noted industry advisors that such relationships are valuable for innovation. In today's global economy, disruptive innovation and disruptive technology may well be the catalysts that determine whether a manufacturing or service organization even exists. Two- and four-year public institutions of higher education face dwindling state and federal financial support creating a perfect storm for average higher education institutions to eventually reach zero state funding. Mortenson [1], a senior scholar at The Pell Institute for the Study of Opportunity in Higher Education in Washington, D.C., wrote an article indicting that the average state fiscal support for higher education, trending downwards since 1980, will reach zero by 2059. Meanwhile, it could happen much earlier in some states and later in others. As reported in the article, very soon all public education will be privatized.

Background/Problems

With an undetermined future for state funding, higher education administrators are working in the unknown territory of a skill set (collaboration with business) that could come to be commonly used in industry. It is further stated in [1] that longer-term issues are being addressed in some states and at some public institutions. Therefore, the issues remain: If the public institutions are no longer state supported who owns them? Who should govern them? Who should they serve? Should states be contracting for quite specified outcomes? The inevitability of state governments to fund public schools raises an alarm about who controls them and of whose interest should the public schools serve. The college pricing graphical illustration from the College Board's annual report [2] concurs with [1]'s findings. It also illustrates declining state funding for higher education since its peak of almost +10 % of appropriations per full time equivalent student in the mid-1980s to a drastic low of approximately -10% in 2009, back up to approximately -5% in 2011. Figure 1 shows the graphical representation of the College Board findings.

This graph shows approximately 40.2% decrement in college funding from 1980 to 2011. Extrapolating that trend, the national average state investment in higher education will reach zero in fiscal 2059. In other words, states are already 40% of the way to zero. At this rate of decline, it will take another 48 years to finish off the remaining state support for higher education. Public higher education is gradually being privatized. So, where will the funding for institutions come from?

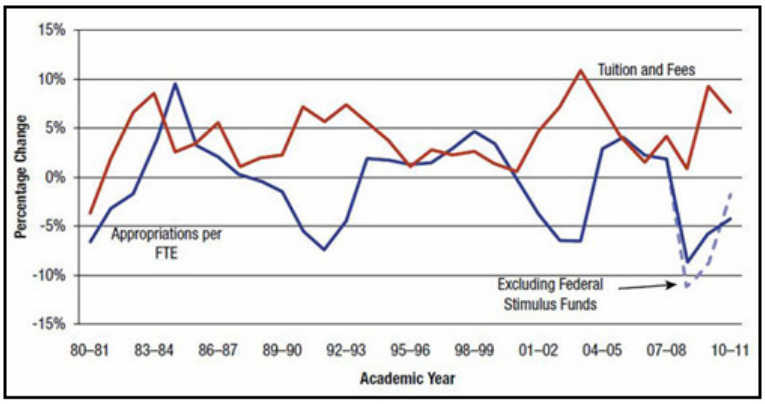

Figure 1. The College Board's annual trends in college pricing 2011 report [2]

Theoretically, today two-year higher education institutions face the same challenges as traditional four-year institutions because of declining government support. The federal government's stimulus money temporarily delayed the inevitable end, or great decrease, in government funding for higher education as showed in Figure 1. In June 2012, the Center for American Progress released an article that proposed a plan to overhaul and reform the workforce training and counseling system. [3] emphasized, "Programs would be implemented with private-sector partners and linked to projected job openings in high-growth regional industries. Participants would earn associate degrees, technical certificates, and industry-recognized credentials." This may suggest a paradigm shift from higher education for general purposes, or liberal arts education, at least in part, to education for specific jobs and career occupations.

Four-year institutions of higher education and industry employers may favor a two-pronged approach to a college education, according to a 2006 study by Hart Research Associates [4] prepared for the Association of American Colleges and Universities, which includes community colleges. As evidenced by the results of this study, Figure 2 showed better understanding of the four- years academics in higher institutions. Therefore, a majority of employers and a majority of recent college graduates reject a higher education approach that focuses narrowly on providing knowledge and skills in a specific field. Hart's study indicates that majorities of employers and recent college graduates believe that an undergraduate college education should provide a balance of a well-rounded education, knowledge, and skills in a specific field.

In presenting the employers' point of view on the responsibility of a college education, the study concluded that the majority of employers think that colleges and universities should place more emphasis in the areas listed in Figure 2.

Figure 2. Adapted from information in a 2006 study by Peter D. Hart Research Associates, Inc., findings of the four areas of need to be taught by colleges and universities [4]

The Hart study [4] further expressed concern of both employers and recent college graduates of the opportunity to put learning outcomes into practice. Employers and recent college graduates believe that higher education should give students more experience with real-world applications of their knowledge and skills through hands-on learning. Upon hearing a description of liberal education, large majorities of employers and recent graduates endorse it as important for colleges and universities to provide this type of education. The study further revealed that about 56% of business executives think that our nation's colleges and universities should focus on providing all students a balanced, well-rounded education. Eleven percent favors a focus primarily on providing a well-rounded education. About 22% endorses a narrow focus on providing skills and knowledge in a specific field as showed in Figure 3. Furthermore, the so-called gen Y, X, and the popularly known "jet" generations' work performances and ethics in the industrial sectors have proved the significant effects of the decline in governmental funding of higher education. Therefore, these demand a quick intervention to safeguard the future of our children.

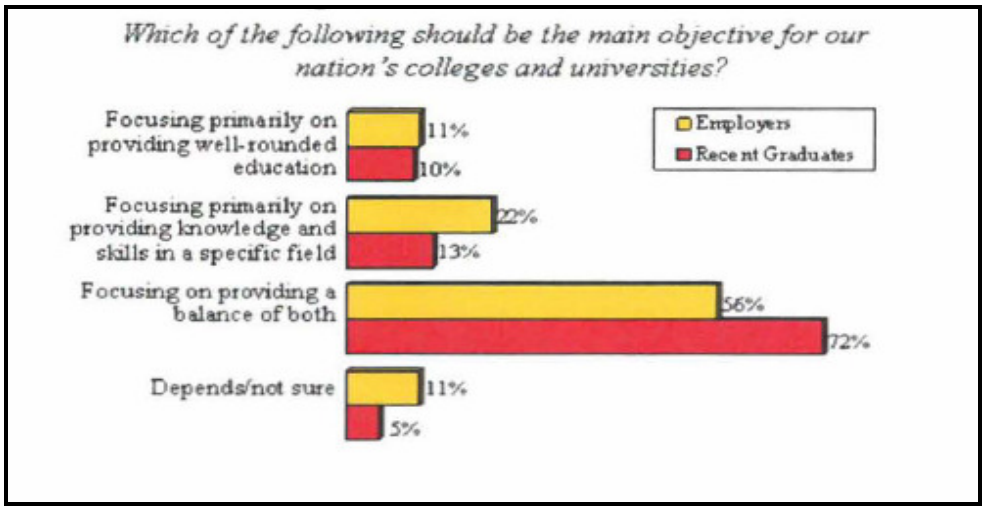

Figure 3. Illustration of the balance of broad knowledge and specific skills [4]

Suggested Solutions

Based on the references in this paper and past studies on the subject matter, it is the authors' opinion that academic institutions, industries, and policy makers/governments should collaborate and strengthen their relationships by soliciting feedback from consumers/ customers of their products and services. Then these collaborators should use that combined feedback to shape academic programs that meet the needs and desires of all constituents.

Industry and academia partnerships could well be the vehicle that propels an industrial organization to the front of its field, or the lack of such a partnership may well doom the organization to oblivion. The same could be said of such partnerships for the rescue of higher education funding. The primary goal of this paper is to explore the dichotomy between the strong motivations of both industry and academia that will assist institutions (universities and colleges) to conduct research that promotes new product development, more efficient processes, scholarly productivity, and, of equal importance, to make the collaborative effort effective.

In support of the manufacturing inclusion of this paper, the authors used the Manufacturing Institute, the 501 (c) 3, non-partisan affiliate of the National Association of Manufacturers whose mantra is, "Making Manufacturing Strong through Education, Innovation, and Research." A Manufacturing Institute article concluded the following concerning American Manufacturing [5]. The study was conducted to provide a running view of the U.S. public's perspectives on manufacturing to supplement the many other research reports and perspectives of economists, policy makers, business leaders and other subject matter experts.

As Americans are hungry for a strong manufacturing sector, they are nervous about the future of American manufacturing. Giffi & DeRocco's [5] findings were based on Deloitte and The Manufacturing Institute's third annual survey on the American public which indicated that

nearly 72% of those surveyed did not believe that the economy has been improving or is in better shape since 2008. Meanwhile, as reported, over two-thirds (67%) of those surveyed believe that the economy remains weak and could fall back into recession. Over this debate, [5] reported that Americans nearly evenly split into 50-50 on whether the economy will show significant signs of improvement by 2015. Additionally, by hearsay and through the report by [5], the public is not confident that business leaders and policy makers necessarily understand how to effectively grow and strengthen the economy. So it is noteworthy that the recent survey of the American public's opinion on manufacturing reveals that throughout one of the most turbulent periods in US economic history, they have maintained remarkably consistent views, year after year, on the importance of manufacturing. Americans' concern about the future is one of the basic reasons why our children's education should be prioritized in all our government debates.

Method Used for Data Collection by Deloitte and The Manufacturing Institute

The Deloitte and The Manufacturing Institute survey was conducted online by an independent research company in August 2011. People sampled were American across the 50 states; altogether. a 1,000-person nationally representative sample was used for the study as reported in the article. Approximately 75% of the sampled population had some level of education. Their ages ranged between 18 and 65 years old. The margin of error for the entire sample was reported as +/- three percentage points [5].

Conclusion

As it is known, manufacturing is the backbone of most developed nations. Strengthening industry, academia, and government partnerships in American institutions will definitely improve the economics of our nation. Therefore, the involvement of industry personnel in the classroom and academic students in the industrial workplace should be encouraged. In a 2013 study, Galdabini [6] states, "During the recent recession, many observers wrote American manufacturing's obituary, claiming that it could no longer be a world leader because of intense competition from low-cost competitors" [6]. In addition, he included the opinion of ESPN College Gameday host Lee Corso, who further states, "Not so fast, my friend, The U.S. manufacturing sector generates $1.7 trillion in value each year equivalent to nearly 12% of GDP. The US manufacturing sector supports over 17 million US jobs. About 12 million Americans or 9% of the workforce are directly employed in the manufacturing industry."

In [6], Perry clarified the differences between U.S. manufacturing and other nations, he emphasized on the following three points in American manufacturing:

1. The combined sales revenue (including global sales) of (only) the top 500 US-based manufacturing firms in 2012 was $6.01 trillion, a 17.2% increase over 2011 sales of $5.13 trillion. To put those sales in perspective, if those 500 US manufacturers were considered as a separate country, their revenue last year of $6.01 trillion would have

ranked as the world's third's largest economy behind No. 1 US and No. 2 China, and slightly ahead of No. 4 Japan's entire GDP of $5.98 trillion in 2012.

2. The sales revenue from the top 10 US manufacturing industries totaled $4.83 trillion in 2012 (see figure 4.), which was 44% more than Germany's entire GDP of $3.36 trillion last year.
3. Annual sales of $1.62 billion in 2012 for America's single largest manufacturing industry— petroleum and coal products—was larger than the GDP of Australia last year, $1.54 trillion, and almost as much as Canada's $1.77 trillion GDP in 2012 [6].

RANK	10 LARGEST MANUFACTURING INDUSTRIES, 2012	REVENUE (MILLIONS)	EXAMPLES
1	Petroleum & Coal Products	$1,629,494	Exxon, Chevron, Conoco
2	Computers & Other Electronic Products	$814,172	HP, IBM, Apple
3	Chemicals	$441,233	P&G, Dow, DuPont
4	Food	$387,855	General Mills, Kellogg, Campbell
5	Motor Vehicles	$333,693	Ford, GM, Harley-Davidson
6	Pharmaceuticals	$317,763	J&J, Pfizer, Merck
7	Machinery	$263,840	Caterpillar, Deere, Xerox
8	Aerospace & Defense	$260,360	Boeing, Lockheed Martin
9	Electrical Equipment & Appliances	$248,864	GE, Emerson, Whirlpool
10	Motor Vehicle Parts	$137,552	Johnson Controls, Cummins, TRW
	Total	**$4,834,826**	

Figure 4. From Mark Perry's *Top 500 U.S. Manufacturing Firms in 2012* [7]

According to Leighty [8], reporting on US Chamber of Commerce Chief Operating Officer David Chavern's observation of US manufacturing jobs, Chavern reported that US jobs have dropped a lot and that manufacturing jobs peaked at 19.5 million in 1979. He argued that by 2010, the number of Americans directly employed in manufacturing fell to 11.4 million. The question he asked was where have those jobs gone? Chavern answered, "mostly to a country called productivity." Technological change, automation, and widespread use of information technologies have enabled firms to boost output even as some have cut payrolls. These advancements are also allowing us to make high value added products that drive growth, innovation, and competitiveness.

To develop cutting-edge products and services in a manufacturing industry at the pace that current global innovation demands and to increase US productivity, academia, industry, and governments must change the way we think about education, industrial, and government relationships. In addition to liberally educating students, educators and students must be engaged in hands-on activities so that students can contribute immediately to innovate at faster levels. Concepts such as active learning, where students take ownership in the design and implementation of their own learning, must be encouraged. More focused manufacturing

learning may involve newer concepts, such as early childhood education intervention for the sake of manufacturing and nurturing post-secondary schools with STEM programs where students who have a propensity for the STEM disciplines are encouraged to pursue career paths in these disciplines early in the education process. New manufacturing programs in advanced manufacturing, additive manufacturing, and MES can be taught along with more mature manufacturing concepts such as Six Sigma, lean manufacturing, supply chain management, and ERP. A joint industry-academic comprehensive approach to this very complex problem of educating the workforce will most likely yield the best results.

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