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Enabling A Strong U.S. Engineering Workforce For Leadership Of Technology Development and Innovation In Industry: The Economic Multiplier of Skill-Set Development For Engineering Innovation and Leadership

1. Introduction

This is the fourth of four papers prepared for a special invited panel session of the National Collaborative Task Force on Engineering Graduate Education Reform that is focusing on the purposeful advancement of professional engineering graduate education to enhance the innovative capacity of the U.S. engineering workforce in industry for global competitiveness. At the heart of America's challenge to unleash its innovation capacity for competitiveness is recognition by industry of the worth of its core engineers. Whereas too many U.S. industries have been lost to foreign competition, many forward thinking technology-based corporations are not just surviving, they are thriving. These companies clearly recognize that their core engineers represent the creative intellectual capital necessary for success. These companies hire entry-level engineers for their potential to grow as contributors to the company's technological progress.

The National Collaborative Task Force believes that we, as a nation, can no longer afford either to view America's engineers as a commodity or to consider their professional development as a fringe benefit. For U.S. industry to compete more effectively over the long-term, it must reassess the worth of its engineers as long-term contributors to and leaders of technology. But industry can not do this alone. American universities must re-invent their mission for professional education in collaboration with industry. This final panel paper summarizes the economic multiplier that can result from the National Collaborative initiative to purposefully advance professional engineering education centered on skill-set development for innovation and engineering leadership from entry-level though the highest leadership levels of the engineering profession.

2. The Global Picture of an Aerospace Company – A world of Impact

Commercial jetliners have helped make the world a global village. This provides for the innovation and production of a new generation of products and services which fulfill the needs of a multi-national market of customers. The defense products are now produced by a multi-national collaboration of partners that have helped stem the major conflicts around the globe and assist in the protection of the movement for peace and freedom in many nations.

The engineering and technology workforces have helped shape history and the world as we know it. This change continues to be on-going.

One Aerospace company with an engineering and technology educated workforce of 157,000 culturally diverse people in 48 states spend more than $24 billion for supplies and materials from 29,000 business in the United States, and multi-billions more around the global supplier base. This provides for economic support to regions that requires additional workforces in engineering and technology to provide the innovation of the products for the world markets.

Today, the vast majority of engineering and technology innovations are customer driven and market focused, which requires purposeful engineering, creativity, engineering problem-solving, and responsible leadership for the systematic engineering innovation processes for retaining competitiveness.

2.1 Example of One High Technology Producers Impact on a Region

In one region an economic study involving one high technology producer of military and commercial products provides an example of the economic multiplier that engineering and high technology companies have on a region.

The employer site is one of the top employers in the region, with 4,300 employees and 926 of those are engineers. This workforce is diverse and well-educated with more than 2,124 degreed professionals. The site invested $1.2 million in formal education programs in 2004 in the regional colleges and universities.

This business is committed to improve the quality of life in the community where it does business and it's employees live and play.

The facts of economic impact on the region:

- $287 million annual payroll
- Average annual salary per employee is $88,141.
- The site pays $12.3 million in taxes in the region annually.
- The site's employees contribute more than $1.5 million in contributions to the regional communities annually from the Employee's Community Fund.

This site is an international company and customers and partner industries from around the globe come to the region and communities at a rate of over 2,000 annually. The site has regional relationships with suppliers and spent $73.1 million with 124 suppliers in 2004. There is a special relationship to assist with the growth and start-up support of small and minority owned businesses with contract awards totaling $62 Million in 2004 with in the region.

2.2 Impact of Graduate Engineering and Technology Education Focused on the Industry Needs

In one of the special programs developed between the site and an engineering and technology educational institution, a Special Technology Leadership Graduate Degree program was provided to the employees in engineering and technology organizations. The program was set up to be provided on evening and weekend schedules with the student population forming cohorts. Each cohort had 32 student employees and worked through the program in 2 cohorts at a time. The major change that was made in this graduate degree program was that the projects were required to be industry internally focused to improve or change the company production and processes. The projects were selected by the students and presented to the graduate faculty for approval; the additional requirement was that the site leadership council in engineering and technology had to approve of the industry based projects.
Each student project was related to the ongoing, proposed or modifications/improvements to the processes, or application to the products the site produced.

In the initial approval reviews the total of the first 2 cohorts (the first 64 students) research industry based projects projected an improvement equal to a $90 Million savings upon application and integration into the sites systems.

In this small short program the multiplier equals 5.6 times each of the employees salary and educational funding during the 2.2 year program, or $1,406,250 saving per student with a pay out of salary and educational funding of $250,000 average per student.

The program had 4 cohort groups of students that successfully completed their degrees and the multi-millions in savings provided the innovations and success to the site operations that promoted the site to a level of achievement that it was recognized and awarded the 2005 Shingo Prize for Excellence in Manufacturing for Large Manufacturing Organizations.

3. The Challenge for Change – Creating a National Collaborative with Industry in Economic Regions

The lack of relevant professionally oriented graduate education for the domestic engineering workforce has been in the past, and continues to be, a major contributing factor to America's diminishing innovative capacity for competitiveness. As the US faces stiff competition in the global economy and as other nations are improving their national innovation systems for competitiveness, the sense of urgency for engineering education reform must be heightened to a new national priority. As the Council on Competitiveness has pointed out, "The United States could lose its preeminence in technology unless a new national innovation agenda is developed."

For all of the importance that university basic scientific research brings to the national innovation system that further graduate development of high-caliber engineers, who are engaged within regional industrial clusters of the domestic engineering workforce surrounding research universities across the nation, is also vitally important and must become a key ingredient in furthering local and regional economic development across the nation. Engineers in these clusters play a very critical and integral role in leading systematic technology development across all regions of the nation as the foundation of US competitiveness.

As the Kellogg Commission has pointed out, universities must change and respond better to the needs of their constituencies. Broad sweeping changes must be made across the country that address the compelling issues to better serve the needs of working professionals in engineering in US industry. And transformative leadership must be undertaken to provide a catalyst for action that transforms US engineering education from the limiting constraints of one-time professional education at the undergraduate level (and singular emphasis on academic scientific research at the graduate level) to more fully develop world-class engineers and technological leaders throughout their professional careers in American industry in order to ensure US innovative capability for global competitiveness.

This strategic plan proposes a bold initiative and an exciting new advancement in partnering professionally oriented graduate engineering education with the practicing profession in American industry that will stimulate technological innovation and regional economic growth across the country. The initiative is a call to action for US industry, participating universities, government (local, state and federal) and the national academies to promote effective change for the nation's engineering workforce in the national interest.

4. Conclusions – A Work in Progress

The systematic practice of engineering for continuous technological innovation and the creation of economic prosperity of nations are intertwined. As Michael Porter has pointed out, "Future U.S. competitiveness will hinge on the capacity to foster clusters of innovation in cities and all regions across the country where industries are based, where the real work of raising productivity and innovative capacity occurs, and where competition actually takes place."

As Porter notes: "Regional economies are the building blocks of US competitiveness." More than ever, US engineering education must take a greater leadership role in improving US innovative capacity for competitiveness through purposeful advancements in professionally oriented graduate education that specifically meet the further graduate needs of the nation's engineers and technological leaders for innovation. The National Collaborative Task Force is pursuing this reform in professional engineering education as a work in progress. The economic multiplier that can result from improving the innovative capacity of the U.S. engineering workforce in industry in each region and state across the nation can be phenomenal.