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Healthcare Quality Partnerships: An Emerging Educational Frontier for Industrial Engineering Technology Programs

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2006-1030: HEALTHCARE QUALITY PARTNERSHIPS: AN EMERGING EDUCATIONAL FRONTIER FOR INDUSTRIAL ENGINEERING TECHNOLOGY PROGRAMS

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HEATHER WOODWARD-HAGG is an assistant Professor of Industrial Engineering Technology at the Indiana University-Purdue University Indianapolis. She is a Certified Six Sigma Black Belt and a Certified Quality Engineer, . Professor Woodward spent 9 years at Intel as a process and quality engineer and manufacturing statistician within semiconductor manufacturing, specifically in the areas of Photolithography, Plasma-Enhanced and High Density Chemical Vapor Deposition. Prof. Woodward's areas of expertise include in the development and implementation of closed-loop process control systems within high volume manufacturing. Professor Woodward's departmental research concentration involves adapting the quality and continuous improvement methodologies and tools (i.e. Six Sigma, Lean) used within high volume manufacturing for the service and healthcare industries, as well as small businesses. An additional research concentration is the optimization of a performance based predictive cost model for high volume manufacturing of Solid Oxide Fuel Cells. Professor Woodward is currently the director for the Laboratory for Enterprise Excellence at IUPUI (LEE-IUPUI) and leading the effort for development of a regional campus Healthcare based Lean Six Sigma initiative.

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Healthcare Quality Partnerships: An Emerging Educational Frontier for Industrial Engineering Technology Programs

Abstract

With the understanding that the industrial engineering profession has grown out of industrial/manufacturing organizations, it is important to note that the profession has gradually matured to the point where it is readily being accepted in service industries such as hospitals, retail stores, and banking. Today, this means that industrial engineers are one of the most versatile of the engineering professions, spanning various degrees of functions within various types of organizations. Therefore, educational institutions that offer Industrial Engineering (IE) and Industrial Engineering Technology (IET) curriculum must also offer a versatile curriculum that will allow their graduates to gain experience in various areas other than traditional manufacturing thereby allowing them greater opportunity to enter into these non-traditional areas.

This paper will focus on strategies that have been used at Purdue University regional campuses to develop successful on-going partnerships between their IE and IET faculty and one of the larger service industries, healthcare and hospitals. The partnerships that have been developing over the past few years have provided various engagement opportunities for faculty and students alike. This paper will discuss topics such as funding of faculty involvement in hospital projects, the integration of students into the on-going efforts, as well as adaptation of curriculum and further collaborative efforts that are being developed with medical/nursing programs within the various university campuses involved.

Introduction

Traditionally, Industrial Engineering (and subsequently Industrial Engineering Technology) has its roots in manufacturing. The first IE course offered at a college or university was titled *Factory Economics* at the University of Kansas for the 1901-1902 term with the first baccalaureate program being offered at Pennsylvania State in 1908. At that time, work design and measurement were the basic techniques behind industrial engineering which involve measuring work so that standards or expectations of work to be completed in a certain amount of time can be determined. The objectives of today's IE and IET course offerings have not changed much from the early days with the exception of where the basic concepts of the profession are now being applied; in the service industries.¹

Healthcare providers are one of the service industries that have recently identified the benefits of utilizing IE concepts within their organizations and have created a need for qualified practitioners to help them implement these fundamental ideas. These ideas are generally being taught today under the umbrella of continuous improvement and quality initiatives such as Six Sigma and Lean methodology programs. The existing healthcare quality systems function through the use of complex compliance indicators. Successful

implementation of new healthcare quality initiatives will require a shift from these compliance driven efforts to continuous improvement focused quality systems. This shift will require that systematic educational efforts be brought to the institutions that provide healthcare. Six Sigma and Lean techniques have been shown to be highly effective for continuous improvement within manufacturing environments and there is much evidence to suggest that appropriately developed and optimized Six Sigma and Lean techniques can be effective within a healthcare setting as well.^{2, 3} The IET faculty members of the Purdue regional campuses in Indiana have recognized this emerging market for IE skills and have successfully initiated collaborative educational healthcare quality partnerships with healthcare providers on a regional, system-wide approach.

Each of the 13 regional Purdue campuses and West Lafayette currently offer curricula in manufacturing-based continuous improvement, Six Sigma and Lean principles. Within the state of Indiana there are 166 IHHA (Indiana Hospital and Health Systems Association) member hospitals of which approximately 85% lie within a 60-mile travel distance from the 13 statewide Purdue regional campuses. With collaborative effort from the various Purdue regional and West Lafayette faculty, a single curriculum has been developed in partnership with several of these IHHA member hospitals, specifically the Sisters of St. Francis Healthcare Services (SSFHS) system-wide facilities, to provide continuous improvement training based in Six Sigma and Lean methodologies as applied to the healthcare industry. This partnership allows for faculty and students to work in “living laboratories” and apply previously manufacturing-based research and knowledge to a healthcare-based environment.

This collaborative effort began with the Laboratory for Enterprise Excellence at Indiana University-Purdue University Indianapolis (LEE-IUPUI) which has been involved with Lean Six Sigma implementation within healthcare through student and faculty lead projects at Indianapolis area hospitals since 2003. LEE-IUPUI then began championing the development of a state-wide Lean Six Sigma in Healthcare initiative by pairing other regional Purdue campus faculty with IHHA affiliated hospitals for development of Healthcare based Lean Six Sigma curriculum and implementation strategies. As of November 2004, IET faculty at Purdue University Calumet (PUC) began working with IET faculty at IUPUI on this long term initiative to apply expertise in Quality Management to the Healthcare Industry focusing on the Northwestern Indiana/ South Suburban Chicago regions. Purdue West Lafayette faculty and Purdue North Central faculty joined the effort in Fall 2005.

Use of IE techniques in healthcare

Noted pioneer of IE techniques, Frank B. Gilbreth, realized the beneficial application of the IE profession in the healthcare arena in the early 1900's. He witnessed hundreds of surgical operations and began intensive studies with hospitals in 1910 including work with the Mayo Clinic. One of his most noted improvements resulting from these studies was the now common practice of doctors, as they perform an operation, to extend their hand and ask a nurse for an instrument rather than leaving the patient to obtain the instrument themselves. This was a recommendation of Frank Gilbreth after observing

that doctors, when operating, spent more time searching for their instruments than actually performing the operation. This new method, which doctors were hesitant to use at first, significantly cut down on operation times and is still used today as the benefits of this standard practice are obviously evident in support of saving lives and improving quality of healthcare. Other significant contributions that are credited to Frank Gilbreth in the healthcare industry are standardizing basic procedure such as tying sutures during operations and everyday tasks such as making hospital beds. He is also recognized by the AMA as having taken the first movies of surgical operations, one of the basic IE techniques he used to conduct his studies.⁴

Today, Industrial Engineering techniques are once again being recognized as beneficial and their use is being encouraged in the healthcare industry. In late 2005, the National Academy of Engineering (NAE) and the Institutes of Medicine (IOM) published an extensive report titled “Building a Better Delivery System: A New Engineering/Health Care Partnership”.⁵ This report recommended a “framework and action plan approach to healthcare delivery based on a partnership between engineers and healthcare professionals.” The central goals of this recommended initiative are the creation of expertise necessary to “demonstrate and diffuse” developed industrial engineering tools through the healthcare delivery system as well as to provide education and training to frontline healthcare professionals in the application of these methodologies within a healthcare setting.

The current Institute for Healthcare Improvement (IHI) 100K lives campaign⁶ is yet another example of current endorsement of the use of industrial engineering techniques in the healthcare industry. This initiative is based on translation of basic IE principles, such as workflow standardization, implementation of best practices and continuous monitoring of process output metrics, into implementation packages targeting at front line staff.

As spoken of previously in this paper, many of the continuous improvement techniques currently being initiated in healthcare are basic industrial engineering techniques shrouded under initiatives labeled “Six Sigma” and/or “Lean” techniques. Some examples of these initiatives have been highlighted in our daily media and highly disseminated periodicals published by the American Society for Quality (ASQ). An article from the Washington Post (June 3, 2005) titled “Toyota Assembly Line Inspires Improvements at Hospital” is littered with examples of IE techniques being used to improve hospital operations at the Virginia Mason Medical Center in downtown Seattle. The article highlights how Virginia Mason is applying techniques pioneered at Toyota and later used by manufacturing giants such as General Motors Corp. and Dell Computer Corp. These techniques are what have come to be known as Lean methods with a fundamental approach that is focused on elimination of waste – “from paperwork and inventory to waiting-room delays and extraneous surgical tools.”

Another article from Quality Progress, a highly disseminated periodical published by ASQ, (Feb 2005) titled “Quality Intervenes at a Hospital” highlights the use of Six Sigma methodology at the Nebraska Medical Center, a hospital in Omaha. The article illustrates how the use of Six Sigma tools aided not only by improving efficiencies, but also by

strengthening relationships between departments and referring clinics and by improving job satisfaction of employees. These types of results are common outcomes of applying Six Sigma tools that have traditionally been associated with IE practices.

Creating Strategic Partnerships

In order to perpetuate faculty and student application of IE principles within the healthcare industry, several strategic partnerships have been developed by IET faculty of Purdue University and various healthcare affiliates. Two current formalized partnerships include 1) the Sisters of St. Francis Healthcare Services (SSFHS) and the Purdue regional IET faculty's "Healthcare Quality Partnership" and 2) the collaboration of this "Healthcare Quality Partnership" program with the IU Center for Health Services and Outcomes Research (IU CHSOR).

The SSFHS Healthcare Quality Partnership was initiated by Purdue IET faculty on the Indiana University-Purdue University Indianapolis (IUPUI) campus. Their interest in the application of IE principles within healthcare started with an IET senior design project at St. Francis Hospitals in Beech Grove, Indiana. The project focused on applying IE principles to improve existing inventory control systems for the radiology department. The implementation of the recommendations from this student project resulted in over \$1.8M of additional revenue generation for this department through the reduction of inventory control responsibilities from the radiology technologist.

A second IUPUI student led project was started in August 2005 and was centered on reduction of false alarm triggers for fetal heart rate monitors within a labor and delivery unit. The implementation of results from this project resulted in reduction of false alarm rate triggers by over 50% as compared to pre-implementation baselines.

Following the success of these two student projects, a formal partnership with the 12 hospitals of the SSFHS system was formed in January 2005. Through this partnership, frontline healthcare staff from the 12 SSFHS healthcare facilities has been paired with faculty from statewide Purdue regional campuses (IUPUI, PUC, Purdue-North Central and Purdue-West Lafayette) in the development and administration of training and mentoring programs for the application of industrial engineering tools and methodologies utilizing the Lean Six Sigma framework. This program has been based on a mid-level entry implementation strategy, coupled with a 15 week executive and front line staff training program in systems engineering techniques based in Lean and Six Sigma methodologies. To date, this program has resulted in approximately \$2M in additional revenue generation to the SSFHS organization, with expected revenue from current projects in excess of \$5M.

One of the key components of this partnership is that a minimum of 1 day/week of on-site mentoring and observation is required for each of the participating faculty. Additionally, engineering and technology students are encouraged to participate through senior design projects, course projects, as well as internship and graduate research assistant

opportunities. During 2005, eight engineering and technology students participated in this program.

The benefits to the Purdue Regional Campus faculty has been far-reaching and extend beyond the over \$500,000 in funding generated by the program to the Purdue Regional Campuses during 2005. Of the fourteen statewide technology faculty currently involved in the program, most had extensive (>8 years) industry experience, but had not worked in a healthcare environment and were not familiar with the cultural and technical challenges present within the healthcare system. Through this partnership, the statewide regional faculty has gained expertise in topics related to successful healthcare implementation, including manual and historical data collection and analysis collection, obtaining physician buy-in, and building the business case to enable executive support. The Purdue regional faculty have created teaching curriculum that includes case studies, workshops and templates specific to healthcare and can be applied to regional healthcare partners across Indiana. Additionally, IUPUI is in the process of creating a healthcare specific graduate level certificate in quality.

In August 2005, the Healthcare Quality Partnership program became a collaborative partner with the IU Center for Health Services and Outcomes Research (IU CHSOR), based at the IUPUI campus. One of the goals of this collaboration has been to develop a strategy for expanding the systems engineering (IE) oriented research base and facilitate engagement with providers pursuing the goal of materially improving healthcare delivery in the areas of safety, quality, accessibility and efficiency. Additionally, this collaboration has provide a foundation for Purdue regional campus faculty and staff interaction with the IU School of Medicine, Regenstrief Institute and VA, fostering partnerships in systems process improvement, research and development as well as best practice dissemination.

Through these partnerships, Purdue faculty have created opportunity to develop and recruit external personnel with expertise in modern IE tools such as the application of simulation and modeling techniques to investigate research areas at the interface of operation, treatment and strategic simulation techniques. Opportunities for simulation applications include the evaluation of alternative treatment methodologies, including financial implications and sensitivity of input parameters, such as patient demographics and infection rates, as well as the creation of healthcare management decision making, process improvement and basic strategic decision models for capital investment.

Changing curriculum to support IEs and IETs in non-traditional fields

The first industrial engineering curriculum created in 1908 at Pennsylvania State was developed by changing and modifying their existing mechanical engineering curriculum. It was *“intended especially to prepare for positions that deal with the side of industrial organizations that has to do with business management, works management, superintendence, purchasing and sales. It deals largely with the application of the sciences and humanistic studies to industrial ends...For the purpose indicated, well-trained engineers are required.”*⁷ Therefore, since IE curriculum has evolved from ME

curriculum the question must be posed that “as the focus of the IE profession has changed, have institutions also changed the curriculum appropriately or have some kept ME courses simply because they have always been there?” The IE profession has started to steer more toward the service industry which is much farther away from the need for mechanical concepts than is working in an industrial environment. Therefore, how critical is the requirement of specifically asking an IET student to take courses such as thermodynamics or statics if this inhibits taking a more in-depth quality, statistics or logistics course. What is in the curriculum because it has always been there and what needs to be there because employers need the IE to have that knowledge?

The IET programs at the various regional Purdue campuses have been asking these questions over the past few years of their faculty and its program stakeholders such as the industrial advisory board members, alumni and students. One Purdue regional campus, PUC, responded to stakeholder input to expand its IET curriculum so that focus could include developing graduates suited to work in various industries interested in quality improvement. This included service industries such as healthcare without excluding the traditional manufacturing-based applications. The result was the development of specializations within the IET basic curriculum that allow future students to focus electives toward either the areas of quality or manufacturing. In addition to the traditional IE elective courses already available on this campus in the area of quality, a senior level course was designed to specifically focus on Lean and Six Sigma applications with many examples from healthcare being integrated into the course.

On the IUPUI campus, faculty has integrated Six Sigma training directly into the traditional TQM course that has been taught on the campus for years. To further add credibility to the knowledge now learned in this course, faculty have also taken the steps to become a certification site for Six Sigma Black Belts through the International Quality Federation (IQF) so that students (who also have the appropriate experience) can obtain this highly desirable certification directly on campus. Other regional Purdue campuses, encouraged by this model, are also in the process of becoming certification sites. Additionally, through the partnership with the IU School of Medicine, Center for Health Services Research and Development, faculty is exploring the addition of healthcare specific courses, such as bio-statistics, to the IUPUI curriculum.

Conclusion

Manufacturing and Industrial organizations are where the IE profession has its roots. Therefore, it is safe to say that applications in these industries will never completely vanish. However, it does not benefit any institution to keep teaching a curriculum that is solely based on historical foundations. Industrial Engineering Technology students possess very marketable and useful skills for service industries such as healthcare. The institutions offering curriculums focused in the Industrial Engineering and Industrial Engineering Technology areas need to make sure they are taking steps to adapt so that they are as versatile as the profession itself.

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