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Opportunities, Challenges, and Locus of Control in Undergraduate Research in Healthcare Settings

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Abstract

A profound shift in the healthcare industry has been sparked in part by legislation and initiatives at the federal level. Among the results of this shift are an emphasis on process improvement and systems thinking, a viewpoint that often conflicts with the traditionally individualistic and compartmentalized culture that has dominated healthcare delivery. As Industrial Engineering faculty members, the authors believe this culture change presents great opportunities and great challenges for undergraduate engineering students. For the past 20 years, we have been involved in a variety of applied research projects involving Industrial Engineering undergraduates and healthcare facilities, primarily hospitals and affiliated clinics. This paper will examine the experiences and observations of the authors as we have watched the healthcare industry evolve over the past 20 years. We will discuss Industrial Engineering methodologies that our students have used to positively influence healthcare outcomes. We will also focus on some of the more concrete challenges involved in facilitating undergraduate research experiences in healthcare settings. These include, among others, changing Human Resource requirements, access to data, and personnel issues such as finding the right sponsor for a project and insuring the students have both administrative and clinical/operational staff support.

Introduction and Background

Recent initiatives such as the creation of the Joint Commission Center for Transforming Healthcare (2008), legislation establishing a link between Hospital Acquired Conditions and reduction in Medicare payments (2008-2010), and the implementation of the Patient Protection and Affordable Care Act (2010), are causing healthcare facilities to sharpen their focus on efforts to improve the quality of healthcare delivery. The Joint Commission's adoption of Robust Process Improvement or RPI® ("a systematic, data-driven methodology that incorporates Lean Six Sigma and formal change management" as defined by the Joint Commission) as its primary performance improvement methodology has influenced many hospitals to offer training sessions in the basic principles of Lean Six Sigma, which has its roots in Industrial Engineering. As a result, administrators and key clinical personnel are exposed to the philosophy and key concepts, but not necessarily to the systems thinking that underlies the approach. Industrial Engineers can bring to the table concepts and methods to support and improve efficiency, standardization, human centered design, and systems thinking. However, the dominant culture in healthcare, which tends to be compartmentalized and individualistic, often conflicts with the systems thinking that can facilitate improvement. The new approach to improving the quality of healthcare is gaining momentum and Industrial Engineers have an opportunity to be a guiding force in that change.

Public awareness of the need for improvement in the quality, safety and efficiency of healthcare delivery in the United States was strongly influenced by the publication of two reports from The Institute of Medicine (IOM) approximately fifteen years ago.[1,2] The statistics that were presented with respect to the number of deaths due to medical errors was shocking; the fact that the acknowledgement came from the medical profession itself was even more noteworthy. Certainly, there was still a culture of silence among some in the healthcare profession. However, the respectability of the members of the IOM made it difficult to deny that a problem existed.

Although progressive hospitals had employed professionals with the title management engineer to improve financial operations, there became an increasing awareness that industrial engineering methods could also improve the clinical side of healthcare. Industrial engineers were called upon to apply their expertise in areas such as computer simulation and Six Sigma to solve specific problems or improve efficiencies[3,4,5,6]

More recently there has been an emphasis on the benefits of interdisciplinary collaboration between healthcare professionals and industrial engineers. Although a publication by the IOM[7] called for an increase in interdisciplinary research, support from the Agency for Healthcare Research and Quality (AHRQ) was most influential. In *Industrial and systems engineering and health care: Critical areas of research – final report*, Valdez et al[6] document successful approaches and outline specific recommendations for future interdisciplinary research projects.

There is evidence that the resistance to change that was once prevalent in the healthcare community is diminishing. As was mentioned earlier, outside forces such as legislation and accreditation agencies are encouraging the implementation of quality improvement techniques. However, articles by healthcare administrators in healthcare journals and engineers in engineering journals indicate that the use of industrial engineering methods by interdisciplinary teams is having a positive effect on the delivery of healthcare.[8,9, 10,11]

This paper documents aspects of our fifteen year history of collaboration between Mercer University Department of Industrial Engineering and healthcare facilities in Georgia. It includes both a summary of the successes and an exploration of the challenges faced as these relationships were built and sustained. The resulting lessons learned will, we believe, give valuable insights and advice to faculty members and programs who are embarking on similar collaborations.

Opportunities and Successes

Partnerships with healthcare providers for student projects can result in a number of benefits for the healthcare institutions, students, and faculty members. One of the primary gains for institutions is the ability to draw on the skills and knowledge of faculty and students in Industrial Engineering and Industrial Management to solve real problems. The solutions provided by Mercer students have included process maps, time studies, 5S studies, inventory management systems, simulations, survey analyses, standardized process recommendations, training plans, staffing and resource allocation plans, and conceptual design of human-machine interfaces. A

partial list of projects and their deliverables can be found in Table 1. Many of these deliverables also serve as evidence of continuous process improvement that the organization needs to demonstrate as part of their accreditation process.

In addition to these concrete deliverables the exposure to systems thinking and lean approaches to the solution of problems, as well as the knowledge of methodologies for process improvement and quality, benefit the organization as a whole and individual constituents as they continue to recognize and address opportunities for improvement in the healthcare outcomes of their organization. The best indicator that the value of this new perspective is recognized by the healthcare organizations who have partnered with Mercer may be the number of students who have been offered internships, part time employment, and career opportunities by a number of these organizations.

The benefits that students gain from working on projects in these healthcare organizations are both tangible and intangible. In addition to the benefits inherent with many real world projects – the opportunity to put their academic training to work on "messy" problems, the building of teamwork and communication skills, time management, etc. – the students have been afforded some very concrete opportunities that may not otherwise have been available. For example, students working on one project were able to obtain their Lean Six Sigma Certification as part of their project work. Other students have been offered unpaid internships, paid internships, and part time employment while they were still in school. A number of students obtained offers of full time employment with the organization upon graduation as a direct result of the project work. Several of our graduates who participated in senior design projects 10 to 15 years ago are now in senior management positions in healthcare facilities and are actively involved in recruiting our students for full-time employment or paid/unpaid internships at their institutions.

The faculty involved in these projects gain many of the benefits that one would expect from collaboration with professionals in the field. By advising and supervising students the faculty themselves are maintaining currency in their field and sharpening existing skills. Because of the complex nature of the problems addressed by student teams, the faculty will often find themselves learning new skills in order to help the students resolve unexpected issues. Furthermore, the relationships faculty advisors develop with healthcare professionals have led to collaboration on research proposals and publications.

Finally, it should be noted that both faculty and students have benefited from a decision in one healthcare organization to commit to innovation throughout the organization. This has resulted in the creation of an executive-level position within the organization devoted to the integration of the organization and support of innovation projects. A strong working relationship with this person has already begun to result in improved coordination of projects and implementation of results. Similar initiatives on the part of the leadership of other healthcare organizations have similarly aided in the successful completion of student projects and implementation of the results.

Table 1. Partial List of Student Projects

Project	Level of Effort	Deliverable(s)
Patient falls prevention/reduction	Two-semester senior design project	Identification of major contributing factors, recommendations, and training program
Prevention of retained objects during surgery	Two-semester senior design project	Low-tech simulator and training program
Redesign of existing performance measuring system	Two-semester senior design project	Customized software package that consolidates information from different software platforms
Emergency Department registration process	One-semester course-related project	Process analysis and redesign of workflow
Transport efficiency	Honors project	Multi-year project that included data analysis, model development and simulation using ARENA
Prevention of retained objects during surgery	One-semester course-related project	Benefit cost analysis
Employee survey data analysis	One-semester course-related project	Data analysis, Pareto charts, written report, oral presentation to upper management
Consolidation of three practitioners into a single practice	One-semester course-related project	Collected data and analyzed patient flow for the three different physicians
Supply cart restocking	One-semester course-related project	Observation, application of 5 S
Simulation in healthcare	Honors project Independent study	Training materials, delivery to students and hospital personnel, annotated bibliography
Allocation of technicians in a multi-location clinic	Two-semester senior design project	Data collection, data analysis, and simulation using ARENA
Emergency Department door-to-disposition time improvement	Two-semester senior design project	Data collection, data analysis, value stream mapping and simulation using ARENA
Laboratory Services turnaround time reduction	Two-semester senior design project	Data collection, data analysis, and process redesign
Hospital door-to-balloon time reduction	Two-semester senior design project	Value stream mapping, process redesign
Nurse interruption observational study	One-semester course-related project	Documented source, time and frequency of interruptions experienced as nursing staff administered medications
Inventory tracking and management system	Two-semester senior design project	5S, layout changes, development of Access database, employee training for implementation of new system
Conceptual design of a patient registration interface	One-semester course-related project	Paper and pencil prototype of a kiosk interface for patient registration.

Challenges

Challenges students, faculty, and clients face when students engage in projects with healthcare organizations include those that are typical for any student group working with real world clients as well as some that are unique to the healthcare field. Some of the "typical" challenges faced by students include the additional time commitment and (sometimes extensive) travel required to visit off-campus clients. As with many outside clients, the contact person for the client can change due to personnel changes, moves, promotions, etc., requiring the students and faculty advisor to rely on the organization to appoint a new contact and then read that person in on the progress so far. Even more problematic, organizational changes and shifting priorities can sometimes cause changes in the level of support for the project. Both faculty and students must be prepared for these challenges and faculty, in particular, must have a plan in place to respond in worst case scenarios.

In addition to these challenges, though, there are certain situations that can arise when working in the healthcare field for which faculty should be prepared. The first of these involves the compliance requirements that students must meet before they can work in a hospital environment. Even though these student teams seldom interact directly with patients, they will be required to pass background checks, have up to date immunizations, and complete an online training session on HIPAA and other regulations. In addition to the time involved in completing the necessary paperwork there is often a cost involved and these costs must be negotiated with the client ahead of time.

Other challenges for both students and faculty can be directly traced to the culture and the complexity of the healthcare system and the organizational structures within that system. As an example, students working on a process improvement project in one unit of a hospital encountered some difficulty when they investigated the possibility of changing the scheduling and workload of the personnel involved. As it happened, one of the key groups included independent contractors whose agreement with the hospital would potentially be impacted by the change under investigation. Other groups have encountered resistance when seeking to define standard practices for groups of specialists whose practices had merged.

Similarly, the differences in background and experience between industrial engineering (and industrial management) students and healthcare professionals necessitates sometimes significant education on both sides early in the project. Students must learn medical terminology and regulations, while healthcare professionals must learn the methods and terminology of process improvement and quality. Lack of knowledge and experience on the part of the former can result in miscommunication and potential violations of patient privacy. Such lack on the part of the latter can cause conflicts over the scope of the project and the time commitment required to analyze processes, as well as the commitment required to implement and sustain meaningful change.

Another consequence of the complexity of the culture and the lack of familiarity with the methods of process improvement and quality is that it can also increase the likelihood that the stakeholders in a healthcare organization will be resistant to recommendations for change. As noted previously, the lack of a common culture throughout the organization as a result of the merging of previously independent practices can make it difficult to persuade stakeholders to relinquish procedures that worked well for a single office but lead to inefficiencies within the larger organization. This challenge is compounded when the stakeholder is an independent contractor with no incentive to change his or her procedures to accommodate the recommendations resulting from the project.

Lessons Learned and Conclusions

The revolutionary changes in healthcare organizations over the past decade has provided a unique and powerful opportunity for undergraduate industrial engineering and industrial management students to engage in projects and research that can have a real impact on these organizations. A review of the successes and the challenges involved in developing and guiding student projects within healthcare organizations reveals a number of lessons that should inform the approach to developing and guiding projects in the future.

- Buy-in and support from upper administration is critical to the success of any project. While this is the case for most industrial projects, in an organization as complex as these and in which there may be multiple competing cultures that must be navigated, the strong support of leadership is essential to gain the buy-in of the various constituencies impacted by the project. The support of upper management will also improve the chances that whatever recommendations are implemented as a result of the project will be sustained after the student team leaves.
- Students will usually need specific guidance and training on how to work with healthcare organizations. From understanding the terminology and regulations to recognizing the culture(s) and constraints of the organization in which they will be working, students must be prepared to work in this new environment.
- Similarly, the leadership and individual units within healthcare organizations must be sufficiently prepared to work with the student teams. This includes education regarding the application of process improvement and quality approaches to healthcare, developing an appropriate scope for the project, the requirements for participation and support on the part of healthcare personnel for the individual project, and the time constraints imposed by the academic calendar and the schedules of individual students.
- Faculty must be aware of and plan for all regulatory and organizational requirements that must be followed in order for student teams to work in the hospital. In some cases meeting these requirements will impact the starting date of the project, but if it is well understood that time can be used by the faculty to prepare students to work in the hospital environment.

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