The Native Healthcare Engineering Internship: Interprofessional Approaches to Improving Rural Healthcare

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Abstract

Industry and engineering accreditors alike recognize the need for engineers who function well on interdisciplinary teams. To meet this need, undergraduate engineering programs often include project-based course work that brings a variety of engineering disciplines together for work on an engineering design problem. Studies show these courses increase the diversity of ideas and styles that engineering students are exposed to during their education. However, educators must also recognize that merely bringing different engineers together is a poor representation of the groups with which engineers must work collaboratively while in industry. Montana State University has a lengthy track record of developing graduate interprofessional education between the colleges of engineering and nursing. A new program, the Native Healthcare Engineering Internship, was recently piloted to expand this experience to undergraduate students. The program partners undergraduate engineering and nursing students to work with industry in order to improve the operations of rural healthcare centers in Montana. Through this program, students not only gain experience working on an interprofessional team, they also work to address key challenges facing our nation and Montana. The costs of the health care system in the United States have rapidly become a critical national issue. Health care spending currently absorbs over 17% of GDP, nearly twice the average of the 34 OECD member nations and nearly 1.5 times the next highest country. While prior research has generated meaningful improvements in health care delivery, the vast majority of this activity focuses on improvements in large urban centers, which has placed "rural communities . . . at the margins of the health care quality movement [with] most quality initiatives . . . not directly applicable to rural health care settings." This work explores the design of the internship program, the challenges of interprofessional education and approaching improvement projects in rural healthcare settings, and the benefits the partner organizations and students received from the experience.

Introduction

While rural health care systems serve over 50 million Americans (Morris & Committee on Homeland Security and Governmental Affairs, Subcommittee on the Efficiency and Effectiveness of Federal Programs and the Federal Workforce, U.S. Senate, 2013), these areas of health care delivery are generally underserved by the research community and present meaningful opportunities for improvements (Paez, Schur, Zhao, & Lucado, 2013). This issue is especially true in the healthcare systems in Native communities. In order to help address these needs, while providing a vehicle to improve recruitment and retention of American Indian / Alaska Native (AI/AN) students at Montana State University (MSU), a pilot program that partnered undergraduate engineering and nursing students was created, the Native Healthcare Engineering Internship (NHEI).

The NHEI is a pilot program to improve operations in rural healthcare facilities, with a focus on those serving AI/AN populations. The program funded the summer employment of two AI/AN undergraduate students, one from Nursing and one from Industrial and Management Systems Engineering, to perform process improvement projects at rural healthcare facilities in Montana. The program sought to achieve several objectives:

1. Provide an opportunity to improve the retention and success of AI/AN students by employing one engineer and one nursing student in mentored research projects serving the AI/AN healthcare system within Montana.
2. Develop new research partnerships with AI/AN serving healthcare systems that build on the success of ongoing work with rural healthcare systems throughout the state.
3. Improve the ability of both nursing and engineering students to successfully work in an interprofessional setting.
4. Improve the operations of AI/AN serving healthcare systems by performing engineering process improvement projects.

This paper focuses on the work completed in support of Objectives 3 and 4, including student and client feedback that indicate the relative effectiveness of the program in these areas.

Background

The costs of the health care system in the United States are rapidly becoming a critical national issue. Recent studies show health care spending currently absorbs over 17% of GDP, nearly twice the average of the 34 OECD member nations and nearly 1.5 times the next highest country ("OECD Health Data: Health care resources," 2013). This increasing burden on the U.S. economy is a key driver for a great deal of the research activity trying to improve the effectiveness and efficiency of the nation's health care delivery. As evident by increasing numbers of publications, a key activity area is the application of engineering management approaches to the work of health care delivery (e.g. Moody & Burtner, 2016; Schell & Kuntz, 2013; Sobek, Claudio, & Bischoff, 2012; Sobek & Lang, 2010; Waliullah & Schell, 2013). Engineering approaches, including Lean, Six Sigma, and others, are finding widespread adoption in health care because the approaches can be highly successful in improving operations and transforming care delivery (Grossmann, Goolsby, Olsen, & McGinnis, 2011).

While prior research has generated meaningful improvements in health care delivery, the vast majority of this activity focuses on improvements in large urban centers, which has placed "rural communities . . . at the margins of the health care quality movement [with] most quality initiatives . . . not directly applicable to rural health care settings" (*Quality Through Collaboration: The Future of Rural Health Care*, 2005, p. ix). This relative lack of attention is further complicated by the fact that the challenges associated with rising costs and delivery of quality care are different, and often even more acute, in rural locations. Rural Americans face a unique combination of factors that create disparities in their care delivery such as: fewer physicians per capita, generally poorer residents with greater reliance on federal support programs, lower rates of employer-provided health care coverage, and lower Medicare payments forcing closure of many small locations (Organisation for Economic Cooperation and Development (OECD), 2013). Due to their remote nature, even greater percentage of at-risk population and substantial financial challenges, the systems serving AI/AN are often in even greater need of quality improvement support (Cunningham, 1993; Gryczynski & Johnson, 2011).

Addressing the challenges and opportunities of the changing and increasingly complex healthcare environment will require new approaches by inter-professional teams working together to solve multi-faceted system and population-based problems that reach beyond the scope of a single discipline (Institute of Medicine, 2005). Engineers skilled in process

improvement initiatives are invaluable members of the healthcare team. Together with point-of-care partners, this type of team is well positioned to assess the need for change, design and implement improvements, and then evaluate their effectiveness.

In 2005 the National Academy of Engineering (NAE) and the Institute of Medicine launched a study intended "to bridge the knowledge/awareness divide separating health care professionals from their potential partners in systems engineering and related disciplines" [i.e. engineering management]. The study recommended "a strategy for building a vigorous partnership between engineering and health care through cross-disciplinary research, education, and outreach" (*Building a Better Delivery System: A New Engineering/Health Care Partnership*, 2005, p. 2). The NAHI program incorporated this strategy by expanding the expertise represented in the student team beyond engineers. By involving students and faculty from both engineering and nursing, assigning them to an interdisciplinary team and having the teams work together with health care professionals at the partner sites, the NAHI sought to further promote the inter-disciplinary partnerships critical for successful research efforts in health care delivery.

Program Overview

This project funded a one-year pilot to explore the impact of mentored research, interdisciplinary collaboration, and project work that gives back to the AI/AN community on retention of at risk AI/AN students currently enrolled at MSU.

Student activities were broken into four distinct phases during the ten week internship. As outlined in Figure 1, these phases are designed to start students in a highly supported research environment and gradually move participants toward greater independence in their research efforts. The NHEI builds on the success of the ongoing Rapid Improvement Internship led by members of the MSU Industrial Engineering Faculty. Over the past six years Rapid Improvement Internship has successfully delivered projects focused on process improvement to over 25 Critical Access Hospital sites and provided twelve engineering students with the opportunity for hands on learning about how to improve healthcare.

Phase I – Preparing for Interdisciplinary and Cross Cultural Research in Healthcare

In this phase students participated in a variety of seminars and began exploratory work on their training project. Training seminars gave students a solid foundation in core areas of process improvement in healthcare, topics included a general introduction to healthcare process improvement, working with other professions, understanding healthcare processes, designing and testing process improvements, and data collection methodologies. Seminars were led by engineering faculty. This phase concluded with the cohort participating in seminars on process improvement tools and leading Kaizen events. Students from the NHEI project will complete both Phase I and Phase II of the program together with students from the Rapid Improvement Internship program.

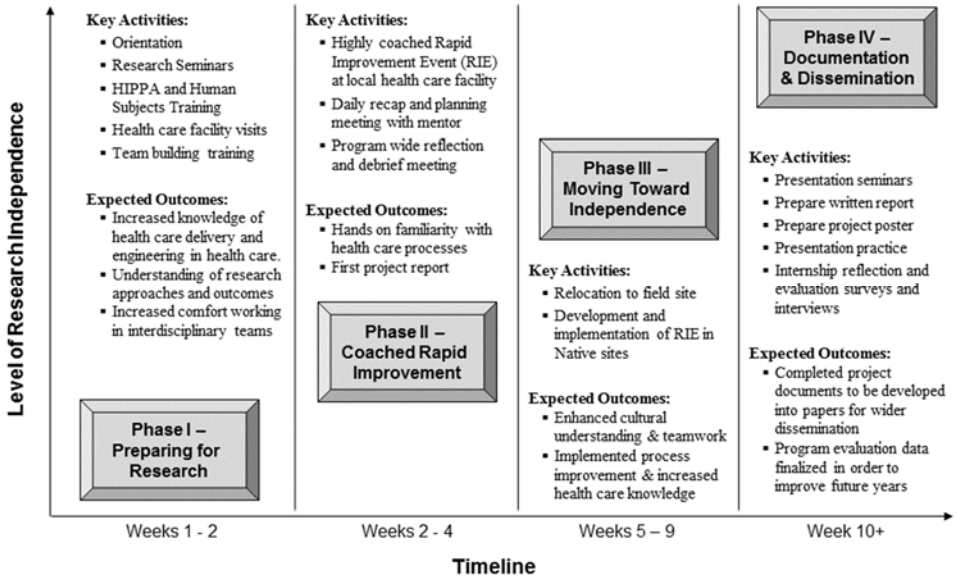


Figure 1- Overview of Internship Phases

Phase II – Highly Supported Process Improvement – A Coached Rapid Improvement Event

The second phase immersed the student team into the process improvement process by having them lead a highly structured and coached Rapid Improvement Event (RIE), also called kaizen events, at a local health care site. The phase began with the team receiving greater details on their training project from the host organization and developing their initial project plan under the close guidance of their project mentor. The team then moved to the partner site to conduct a RIE to create positive change for the organization. The team was responsible for facilitating an agreed upon definition of the problem, observing and documenting process flows for related areas, and collecting and analyzing key data related to the problem. This information was then utilized to generate potential solutions, finalize and implement the selected solution(s), and design and implement appropriate controls to ensure that the problem stays fixed following solution implementation. These activities were run as a PDCA cycle consistent with the healthcare approaches of Worth, et al. (2012).

During this phase, the NHEI team met daily with their faculty mentor to debrief the progress made, identify any new problems, brainstorm solutions and plan the following day's activities. The phase concludes at the end of the fourth week with a formal report and reflection meeting to debrief metacognitive learning from the experience and prepare for future events.

Phase III – Moving Toward Independent Research

At five weeks of duration the third phase of the internship is the longest component of the program and was designed to grow each student's ability to assume a greater level of autonomy in improvement efforts within their team. During this phase student teams moved to different partner locations for two – three weeks at each location. On day one at each site, the student team met the lead member from the partner organization who provided an orientation to the site, outlined the desired outcomes for the project, and served as the primary point of contact for the students during their time at the partner site. From there, the student team met with the project team from the partner site to begin work on the process improvement initiative.

During this phase of the project, the level of structured mentoring support was reduced, allowing for the student team to gain confidence and experience with independent work. In this phase teams completed two projects of similar or slightly larger scope than that used during Phase II. Project teams met formally with their project mentor using distance meeting technology two to three times during each week of the project.

Phase IV – Documentation and Dissemination

During the final week of the internship, student teams returned to campus in order to prepare reports for dissemination and reflect on their experience. Students developed formal project reports using an A3 methodology (Sobek II & Smalley, 2011). The updated report showing the results of their work was provided to the partner organization and served as a foundation for those students wishing to submit their work for dissemination in an appropriate venue

Process Improvement Efforts and Results

During the pilot year of the program, the NHEI completed projects at three different locations using the process outlined above. This section describes two of these projects along with highlights of the project results.

WIC Office Project: Issue, Approach, and Solutions

A local county health office invited the team to work with their Women, Infants, and Children Office (WIC) to improve the office's ability to see more clients. The office's primary issue was an inability to see the desired number of clients each day using current staff levels. This reduced patient volume was directly impacting the office's ability to meet the needs of WIC eligible clients in a timely manner. Current expectations are that pregnant women who are new to WIC should be seen within 10 business days of contacting the WIC office, a performance level that the office was not meeting due to current scheduling methods and workflow delays. The objective of the two-week project was to increase workflow efficiency in order to allow more time per day to see new clients. Given that target, the metrics used to define success included the amount of time saved per day, as well as the number of new clients seen per week, and the number of added appointments by week. The team was tasked with collecting additional data to better understand the problem while leveraging existing data on monthly WIC participation, daily no-show rate, number and type of appointments per day , and estimated time by appointment type.

The student team approached this issue by first focusing on current workflow to identify sources of delays or other issues. The team found developing the client map for different appointments at the WIC office challenging due to the level of variation in the process. This variation made it difficult for both the team and new employees to learn WIC's scheduling rules. In order to better grasp the situation, the PDCA method was deployed to develop a current state map. While performing this step, the team was able to get to know the employees, begin building a relationship with them, and start to see issues that create waste in the process.

One area that quickly gained the attention of the team involved data entry into the client tracking system both following and during appointments. What became evident through the process review and subsequent analysis was that providers were spending considerable time entering data

into the system and that this process involved considerable rework. This prompted the team to perform a second level of analysis which identified substantial differences in the manner in which different employees performed their work. Figure 2 shows an representative example of how providers kept their appointment notes for later data entry.

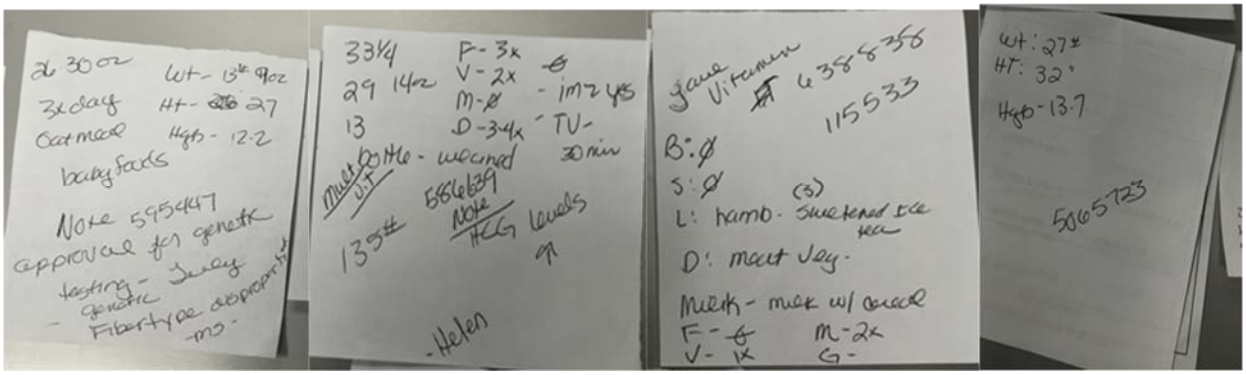
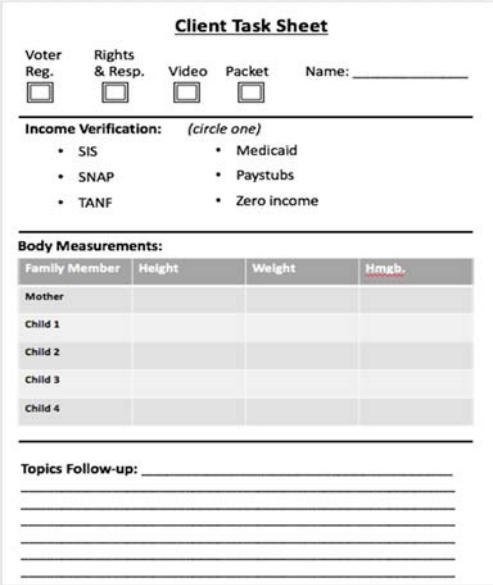


Figure 2 - Samples of the current condition of collecting health assessment information for later entry.

The analysis involved using flow diagrams and swim lane charts to learn the client flow, and fishbone diagrams to help identify the root cause of issues. Finding the root cause took time because the team had to develop a good understanding of WIC as a whole through data collection. This data provided evidence of the causes of low client visit rates. Once the team's evidence was developed, they were able to develop countermeasures. A key countermeasure addressing issues with information flow is illustrated in Figure 3. The evidence showed that appointments were not organized, and the passing of clients to the next person was not efficient. There was uncertainty of who collected what information, and the information about the type of appointment varied, which changed the type of information that had to be collected. A second key issue involved client education. This education required staff to obtain educational materials to provide the client. The current state of the educational materials was unorganized, creating wasted staff and client time while materials were located. Time studies showed that the time taken ranged from one to seven minutes. To solve this issue, a countermeasure using 5S methods was developed and deployed.



Client Task Sheet

Voter Reg. ☐ Rights & Resp. ☐ Video ☐ Packet ☐ Name: _____

Income Verification: *(circle one)*

- SIS
- SNAP
- TANF
- Medicaid
- Paystubs
- Zero income

Body Measurements:

Family Member	Height	Weight	Hmgb.
Mother			
Child 1			
Child 2			
Child 3			
Child 4			

Topics Follow-up: _____

Figure 3 - A countermeasure to improve workflow, standardized client information sheet

After developing countermeasures, the team worked with staff to gain support of the countermeasure and determine how it could be modified to fit their needs. The project was closed out with a meeting to review final A3 style report with clinic staff.

Rural AI/AN Serving Clinic: Issue, Approach, and Solutions

The scope for the second project was to improve documentation scan quality. The project was triggered when a process audit of the clinic that found a number of items that should have appeared in scanned patient records and were not located. So the goal of the project was to reduce missing patient records information through the development of process documentation, identification of areas of failure, and development of solutions to failure points identified. Again following the standards of PDCA, the team interviewed people from the different departments involved to learn about the flow of patient information, and collected data to show evidence of where documents were lost. The key gap was found to be hand-offs of information from providers, who were not consistently turning in and signing off on patient information. This prevented the health information management (HIM) group from picking up the patient's information to begin scanning it into their records, code it, and send it to billing. It could take anywhere from one to fourteen days to get the patient's visit added to their record. The main driver of this high variation was due to the providers holding patient information that should have been added to the medical records. This behavior forced HIM to track down physicians to get a signature and waiting to re-enter the patient's visit into their record. One reason for this behavior was that doctors had a lack of trust in the system's ability to make the EKG visible to doctors within the patient's record. The diagram in Figure 4 depicts this process. The team identified a second issue regarding the security of patient paperwork as it moved from providers to HIM. The existing system created the possibility that documents could be lost because the patient information was being stored in poorly labelled areas for HIM to pick up.

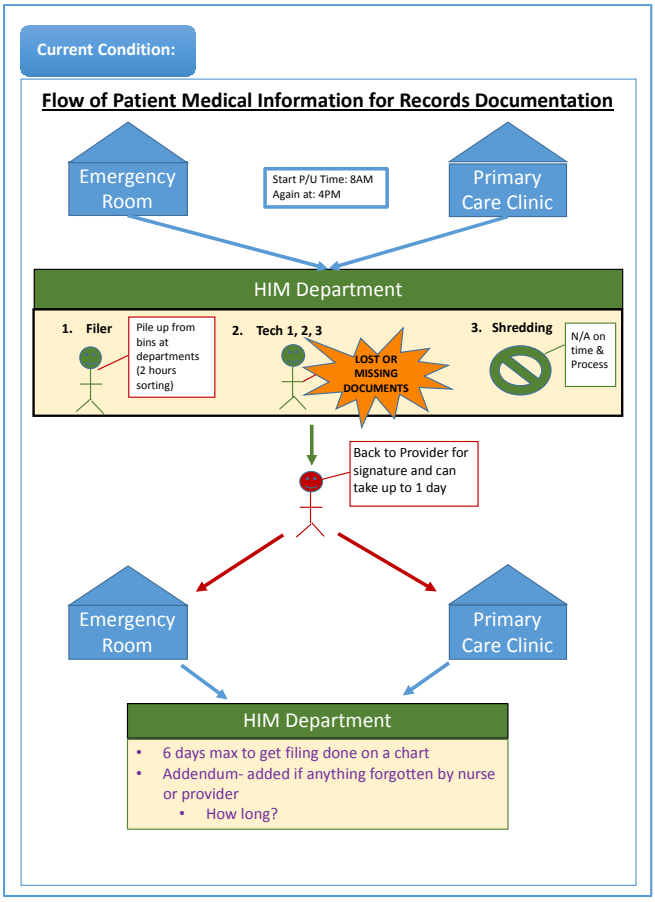


Figure 4 - Map of the current process showing the problem area in red.

The first countermeasure developed was an electronic signature (e-sig), created to help doctors sign-off on records more quickly and more efficiently with less chance of losing information. The e-sig was implemented to update the patients record more quickly and efficiently. To combat the issue of securing patient records, the team designed a countermeasure of organization and security into the nurses' stations.

Project Results

A review of changes made in the WIC office was performed six months following project completion. This review found that the task sheet countermeasure is still in use and the staff have used their learnings from the project to make additional improvements to the flow of information within the office. The 5S implementation around the educational material is still well kept and serving the needs of the office. These changes along with the addition of new staff has enabled the office to see a dramatic increase in new clients served in recent months. During the follow-up visit, staff identified one new area where they would like assistance and one member of the student team is now engaged with them in a follow-up project expanding the original scope.

The team provided the rural AI/AN serving clinic with a plan to implement the recommended changes awaiting approval from the clinic's full executive team. A recent review with the clinic

found that only information security measures and the e-sig change were implemented. Discussions with clinic staff identified that this change had to overcome substantial resistance and the use of educational materials built by the team played a critical role in overcoming this resistance. At this time, data is just now being collected to measure the impact of the e-sig on cycle time. In addition, the team's work set the groundwork for the clinic to discover another problem with the process to add EKGs into patient records. This problem involved extra steps to be done to see an EKG in a patient's record into the electronic medical record system which were not being completed. The process is now understood and corrected procedures have been adopted.

Faculty follow-up discussions with leadership in both sites found management to be generally thrilled with the student work. In fact, both facilities have invited students back to perform future projects and one site offered one of the students a position where they could perform process improvement work during academic breaks.

Student Reflection and Conclusion

Overall, students found the internship a great learning experience. The nursing student gained considerable knowledge about health facility operations. Despite that at the beginning of the experience was a bit overwhelming. Due to unexpected issues, that student was working alone for the first week, and did not feel that she knew "at all" what was supposed to be done. To alleviate this fear, before going to the WIC office every day, the student met with faculty to come up with a plan for the day. This helped a lot, because as a nursing student trying to perform engineering style process work, an expectation well outside their area of study. In fact, after a few days spent at WIC, the employees began to ask what was going to be implemented, and the student felt uncomfortable with her only answer being, "I'm not sure."

Once the engineering student joined the team, the nursing student also found that they became more comfortable working in process improvement. However, this interprofessional relationship was also one of the most difficult parts of the internship for both students. As partners, the students found they had very different personalities, different working styles, and different priorities. This manifested itself in things as simple as the nursing student finding they loved chatting with people and getting to know the employees in the different departments, while the engineering student didn't enjoy the socializing as much and sometimes did not appear to appreciate the importance of these working relationships. At times, especially later in the internship after spending a great deal of time together, the students found that they began to "bump heads," like "two moose fighting." Despite this conflict, in general both students found working together generated useful alternative points of view and perspectives. For instance, the nursing student often prodded the engineer in a direction to get to know the facility, and the engineering student helped the nursing student with understanding of process flow and bottlenecks.

From a faculty perspective, the program was successful in both its effort to create interprofessional understanding and improve rural healthcare operations. Exit interviews and surveys with the student team and host facilities support these perspectives. The interpersonal issues between the students were more difficult to resolve than many other student teams (e.g. capstone groups) due to the issues being minimal or non-existent during the training project and

then escalating quickly after business hours while the team was at a facility several hundred miles from the main campus. By tapping into remote faculty in the needed locations during the last project, this issue was somewhat resolved; however, additional team building and faculty support on this topic in remote projects will be designed into any future editions of the internship.

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