The Community College Baccalaureate and Iron Range Engineering: Limiting Rural Brain Drain in Northeastern Minnesota by Offering a Hands-On Baccalaureate Degree on a Community College Campus

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Trent Patrick Janezich

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Dr. Frank Guldbrandsen, Advisor
Dr. Randy Hyman, Co-Advisor

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Dedication

This work is dedicated to my boys, Brady and Charlie. It is my hope that neither one of you knew or could feel that daddy was busy and stressed out with this project or this program. It is also my hope that when you are older you will understand the significance of completing this project and that it will make you feel as proud of me as I am of you every time you both reach your goals or milestones. I love you both with all my heart.

Abstract

Two educational organizations have collaborated on a nationally recognized, innovative, project-centered engineering curriculum for the third and fourth year of a baccalaureate degree in which hands-on experiences and industry-sponsored projects are the fundamental component of the degree. The Iron Range Engineering (IRE) program curriculum is of a type that has never been attempted in the state of Minnesota. This program creates a career pathway for engineering students in rural northeastern Minnesota in the hopes to help stop *rural brain drain* in an area of Minnesota losing its young human capital in alarming numbers**.** IRE also provides access to a baccalaureate degree in engineering on a community college campus of the Northeast (Minnesota) Higher Education District by partnering with Minnesota State University, Mankato. The heart of this curricular innovation is a shift from a conventional classroom learning environment to industry-style learning environments where baccalaureate-level students will work on real-world projects alongside practicing engineers. These projects are not merely internships or field trips. They are in fact the very content of the curriculum, experienced by students in a competency-based, experiential approach never before used for engineering education in Minnesota. This descriptive case study allows the first generation cohort of students to describe in their own words the Iron Range Engineering program. Ten findings that describe the Iron Range Engineering program emerged. Implications for community college baccalaureate delivery are discussed, and future research possibilities are presented.

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Chapter 1

Introduction

> The flight of so many young people is transforming rural communities throughout the nation into impoverished ghost towns. A new birth simply cannot replace the loss that results every time a college-educated twenty-something on the verge of becoming a worker, taxpayer, homeowner, or parent leaves. And as more manufacturing jobs disappear every day, the rural crisis that was a slow-acting wasting disease over the past two decades has evolved into a metastasized cancer.
>
> ~Patrick Carr and Maria Kefalas
> *Rural Brain Drain* (2009b)

The Problem

Rural brain drain is a problem plaguing many of the rural communities in the U. S. as well as northeastern Minnesota's Iron Range communities. It is defined as "the out-migration of young, college-educated workers from the nation's rural areas, it poses a serious threat to the social and economic vitality of rural America" (Artz, 2003). Education, if packaged correctly, can be a driver for economic development and may help curtail out-migration.

The Iron Range communities of northeastern Minnesota are currently experiencing rural brain drain. The population in northeastern Minnesota under the age of 29 will decrease by an average of 7-10% between 2005 and 2015, according to the U. S. Census Bureau. Between 2005 and 2015, the number of high school graduates from the rural region of northeastern Minnesota, known as the Iron Range, is expected to decline

as well by 17% (Minnesota Office of Higher Education, 2006). The pool of available students living on the Iron Range is dwindling based upon previous generations of parents migrating to urban locations. The only region of the state of Minnesota where the high school graduation rate is either increasing or holding steady is the metropolitan area of Minneapolis and St. Paul (Minnesota Office of Higher Education, 2006).

No matter what economic indicator or data set you look at, rural communities are grappling with the challenge of providing economic opportunities for those who choose to stay, to find a job, and to live out their lives in these communities. Community colleges offer the potential to address this problem, especially when they can be adapted to fit the region's economic demands. This qualitative case study explores the student experience in the Iron Range Engineering (IRE) program, a program designed specifically to provide a regionally significant degree for students and become a business incubator for future economic growth.

Background of Study

There are multiple levels to the background of this study. They consist of (a) the history of community colleges, (b) the community college baccalaureate reform movement as well as contextual information about the setting of this case study, (c) the delivery platform of Arrowhead University and how this program came to be, (d) the political forces at play, (e) the funding mechanism used, and finally (f) an introduction into what makes this program so unique.

Community colleges have been described as having three characteristics that distinguish them from all other postsecondary educational institutions. They are

strategically positioned to (a) meet the needs of a rural, place-bound population; (b) adapt curriculum to the needs of local industry; and (c) allow everyone open access to a college education if they so choose, no matter their entry test scores (Walker, 2005). Wattenbarger (1974) describes community colleges as institutions that have shifted their mission in multiple ways to adjust with the demographic, economic, and societal changes of the times. Initially, community colleges were meant to be a substitute for the freshman and sophomore years at the university. Next, community colleges became a place for "terminal" or vocational education, because students were purposely not finishing the bachelor's degree after the first two years, instead choosing to move on to opportunities available to them in the job market, usually in manufacturing in the industrial-based economy. Then, community colleges began providing other non-credit courses to adult learners, hence the increase in use of the term "community" instead of "junior" to describe these institutions. It was during this time in the 1950s when community colleges developed technical occupational programs which prepared students for specific jobs in two years and positioned themselves as preparers of the industry workforce (Wattenbarger, 1974).

Milliron (2005) discussed the next three waves of the community college transformation. First, he described the comprehensive institution, where community colleges and vocational or technical colleges merged during the 1960s and 1970s, bringing together their two missions. The technical or vocational education mission was providing employees with the training industry needs, and the community college was providing students with the opportunity to transfer to a university. The second wave

during the 1980s and 1990s, as described by Milliron (2005), was the entrepreneurial expansion of workforce development, or customized training for local industries. Community colleges, currently in the third (institutional advancement) wave are literally reshaping their foundations, right down to the name of their institution. This case study exists within this third wave.

Numerous community colleges around the country, spanning 17 states, are now offering baccalaureate degrees. This phenomenon is called the Community College Baccalaureate, where community colleges provide access to bachelor's degrees through various types of models and provide a type of degree not being offered by other regional four-year universities. Walker (1997), founder of the Community College Baccalaureate Association, says:

> It is imperative that we take advantage of the vast system of community colleges. The facilities, faculty, staff and programs are already in place at convenient locations. Expansion of the mission to include the baccalaureate degree, while retaining the open-door philosophy and local governance to assure responsiveness to local needs is a logical option for solving the problems of rising demand, access and cost. (p. 2)

Walker (1997) is not, however, promoting turning the community college into a four-year college. He emphasizes community colleges**,** offering bachelor's degrees important to local industry, can increase access for students not wanting to leave the area. This expands on one of the main missions of community colleges, which is to be responsive to

community needs and be aware of positive economic development opportunities. One very compelling example of this phenomenon is on the Iron Range.

Setting and Context of the Study

The Northeast Higher Education District (NHED), a legal entity, is comprised of five technical and community colleges serving six communities and the surrounding areas in a 13,000 square mile region (larger than the state of West Virginia) of northeastern Minnesota known as the Arrowhead. The five colleges of NHED include (a) Hibbing Community College in Hibbing, (b) Itasca Community College in Grand Rapids, (c) Rainy River Community College in International Falls, (d) Vermilion Community College in Ely, and (e) two campuses of Mesabi Range Community and Technical College in Eveleth and Virginia. Each of the colleges has a specific mission promoting the needs of its students and the community it serves. The six college communities (as well as smaller towns in the region) cover an expansive area in northeastern Minnesota that does not presently have a four-year university geographically located to meet the needs of its citizens.

The major industries in this area are timber, tourism, and ferrous and non-ferrous mining, although all of the communities are committed to more economic diversification. These community colleges are committed to serving the business-training and educational needs of the local and regional industries. The NHED's mission is to provide quality higher education to the communities throughout northeastern Minnesota by developing a regional structure that will preserve college autonomy, and also align

programs and services to better prepare residents and students for learning, employment, citizenship (locally and globally), and for enjoying life.

To do this, NHED colleges share institutional services, increase instructional investment, and reward creativity and innovation. NHED was founded in 1999. It has a combined enrollment of more than 5,400 students and more than 4,300 full-year equivalent learners, with a budget of over $50 million, and approximately 600 employees within the five colleges across the six college campuses. All five colleges are members of the Minnesota State Colleges and Universities system (MnSCU), the largest higher education system in Minnesota, whose membership includes 34 institutions of higher education. Beyond NHED's main community and technical college mission, there are strategic partnerships in place with major regional universities, Bemidji State University, University of Minnesota-Duluth, College of St. Scholastica, and Minnesota State University, Mankato. These partnerships provide baccalaureate and master's degree opportunities to its students through an organization called Arrowhead University.

Arrowhead University, formerly Arrowhead University Center and Arrowhead University Consortium, facilitates the delivery of bachelor's and graduate degree programs and their associated student services to the communities of northeastern Minnesota that otherwise are not served by nearby four-year institutions of higher learning. Arrowhead University was originally founded through legislative action in 1989. For the first decade, Arrowhead University was operated as a extension campus branch of Bemidji State University, (a baccalaureate and master's degree institution located two hours west of Hibbing, Minnesota where Arrowhead University's main office

is located) and financed through state appropriation separate from Bemidji State University's general appropriation. Since 2000, Arrowhead University has become a shared resource of the NHED**,** operated by the five community colleges and financed through the same state appropriation as in 1989. There are and have been numerous types of academic programming offered in multiple delivery methods: (a) face-to-face, (b) hybrid (online and face-to-face), (c) online, and (d) interactive television. In total, Arrowhead University currently has 20 degree programs, at both the undergraduate and graduate level, and enrolls over 200 students. Over the years, state appropriation has continually been declining which has led the organization to seek out alternative funding options.

The Iron Range is strategically located in what is called the Taconite Tax Assistance Area. This area consists of 13,000 square miles and 15 primary through secondary school districts (within northeastern Minnesota). The taconite tax is paid by the mining companies for extracting the state's natural resources. The boundaries of the Taconite Tax Assistance Area were decided based on whether or not "there is a taconite concentrating plant or where taconite is mined, [sic] quarried or where there is located an electric generating plant which qualifies as a taconite facility" (Iron Range Resources & Rehabilitation Board [IRRRB], 2009). If this occurs within the boundaries of a school district, the whole district receives the benefit of the taconite tax. The amount of money the state receives for use in the Taconite Tax Assistance Area is computed based upon how many tons of taconite are produced by the mining companies each year. The state agency IRRRB receives a total of $2. 38 for every ton of taconite produced. This money

is then divided based on the various initiatives legislators and their constituents deem most important, like property tax relief, public infrastructure projects, economic development loans for small businesses, or, in the case of this qualitative case study, education initiatives.

In spring 2008, IRRRB, began to acquire five cents for every ton of taconite produced by mining companies in the area. This money is controlled by a newly appointed subcommittee of IRRRB made up of legislators, educators, and citizen appointees called the Iron Range Higher Education Committee (IRHEC). The result of this money being contributed to the IRHEC is the ability to provide new baccalaureate programs to the community colleges of the NHED to help increase access to baccalaureate degrees. Sertich Consulting (2009) writes about the IRHEC:

> [It] was created to provide higher education programs in the taconite assistance area of Northeast Minnesota. Concern for the provision of higher education, especially that related to technical learning and training, in northeast Minnesota is being driven by the over $6 billion of potential new investment in mines, steel production and energy generation and the unfolding turnover of the workforce due to large scale retirements. The region correctly perceives a need for reengineering the higher educational infrastructure to anticipate the needs of employers and workers, and to foster a level of creativity and entrepreneurship that will energize the regional economy. (p. i)

The flagship program for the IRHEC is the IRE program. In addition to providing more access to baccalaureate degrees, there is another major rationale for the community college baccalaureate, according to Floyd and Skolnik (2005):

> The rationale for the community college baccalaureate is to provide a different type of baccalaureate education than is typically provided by universities; one that combines a more hands-on type of learning with academic study, producing graduates that some observers believe will be in high demand by industry. This type of baccalaureate degree has been called a workforce baccalaureate, or an applied baccalaureate. (p. 192)

There is additional hope this program becomes a driver for economic development for the region. It will create a steady state of engineering graduates industry will be able to choose from for employment. The unique, project-centered curriculum the program employs will help to become a business incubator for the region through patentable outputs or creations.

IRE offers an engineering degree consistent with the above rationale of helping to create access to something unique that will also help limit the outmigration of the region's young human capital. This qualitative case study describes the experience of students choosing and participating in a different type of professional engineering degree on a community college campus made possible by partnering with a state university.

Profile of the Iron Range Engineering Program

Educating Engineers: Designing for the Future of the Field (Sheppard, Macatangay, Colby, & Sullivan, 2008), together with other recent research and reports on

engineering education, make a compelling case for envisioning engineering education in a new way. The new IRE program explores a completely different way of approaching engineering education in an effort to (a) make its graduates more appealing to industry, (b) make the rural communities of northeastern Minnesota more appealing to prospective students, and (c) provide an example as to what types of programs should be offered on community college campuses. Some of the characteristics of this new approach are:

1. Primary emphasis is on development of learning outcomes that have been spelled out in national reports, including *The Engineer of 2020: Visions of Engineering in the New Century* (2004) and *Educating the Engineer of 2020: Adapting Engineering Education to the New Century* (2005). This emphasis is contrasted with primary emphasis on coverage of topical material that characterizes many of the standard engineering programs throughout the world.

2. Faculty members in the new program invest heavily in developing abilities of students in the program to assess their development with respect to these outcomes. To support self-assessment, faculty members must be able to articulate criteria with which development in respect to these outcomes can be evaluated.

3. All learning activities are organized around externally-sponsored projects. Each semester students work on several externally-sponsored projects. Faculty members use the projects as contexts for developing competencies and learning subject matter. Students enroll in courses primarily to address the logistical requirements of university procedures, but these are not courses following patterns used throughout the world.

4. Students complete course and graduation requirements by exceeding or meeting levels of competencies with respect to clearly articulated outcomes.

5. The program is an upper division program. Students are recruited from community colleges where they have fulfilled their lower division requirements.

Projects are industry sponsored. For that reason, IRE is centrally located in the heart of Minnesota's Iron Range in Virginia, Minnesota. Within short driving distance, there are five iron ore mines, two coal generation power plants, a wind-turbine farm, two paper mills, a new precious metals mine, and a proposed steel mill (IRRRB, 2009). The managers and engineers in these industries have embraced this program and are committed to providing real projects, project guidance, facilities for job shadowing, technical expertise for student learning, assistance in assessment, and finally and most importantly a job interview to every student. It is the working assumption of the program and this research that all 14 graduates from this program will have at least one job offer from a regional industry in northeastern Minnesota.

Purpose of Study

Skolnik and Floyd (2005) have observed two primary needs to justify offering a community college baccalaureate degree program**.** First, it should provide increased access to bachelor's degrees**.** Second, the degree should provide something that the universities do not, as in this case study, a curriculum that collaborates with working engineers in the field on industry sponsored projects. Upon graduation, these students will be more marketable to local industries. The IRE program in northeast Minnesota effectively responds to both of these observed needs.

The purpose of this study is to ascertain whether or not the IRE program in its first year of existence has provided students with an experience that will help them to earn their degree and obtain employment all while not leaving the communities of the Iron Range. The students will describe in their own words the experience of (a) choosing this specific community college baccalaureate program for their upper division experience; (b) being part of a baccalaureate degree program on the campus of a community college in northeastern Minnesota; (c) being part of a unique professional engineering baccalaureate degree program where the curriculum focuses on real-life, industry-sponsored projects and experiences; and (d) exploring the employment potential of this new type of engineering degree.

Research Questions

This study asks the question, *How can offering baccalaureate degrees on community college campuses help stop "rural brain drain" in northeastern Minnesota?* Additional secondary research questions guiding this study and serving as a basis for the development of the interview questions are:

1. Why do students choose to enroll in this program and what was their alternative plan?
2. How do students describe living on a community college campus while attempting to earn a baccalaureate degree?
3. How do students describe the teaching and learning that goes on within the IRE program curriculum?

4. What does this program mean for students' futures upon graduation, and in particular for the likelihood of remaining in the area?

This study's first research question addresses the motivation of the students for entering the IRE program. The second question deals directly with the students defining the experience of being upper division students on a community college campus, or the community college baccalaureate. The third question allows students to describe the experience of participating in an innovative engineering education program that provides more hands-on learning experiences with industry partners and practicing engineers. The final question allows for the students to contemplate their future after completing this new type of degree.

Significance of the Study

There are four elements that make this study unique and significant on the national stage. First, this program is a community college baccalaureate program (university center model) in which local community colleges partner with four-year institutions to bring education to areas not being served by their local four-year universities.

In a break from university center partnership tradition, the curriculum development and the conception of this programmatic idea emerged from within the community colleges ranks. It was built upon the model of a successful community college engineering program within the NHED (Itasca Community College). Second, it is the third and fourth year of an engineering degree on a community college campus, which is a very unique program to be delivered through a partnership model. Thirdly,

students will combine learning of theoretical information with the execution of hands-on engineering design projects (sponsored by local industry). Students do not register for traditional courses; instead they register for a block of credits, ensuring that learning does not stop when their 50-minute lecture is over, if there is even a lecture at all. Finally, there is a lack of qualitative research from the perspective of students in regards to both the community college baccalaureate experience and the experience learning in the industry and project-centered pedagogy that this engineering program uses.

These four characteristics, when combined, make this program a very unique case study for what types of baccalaureate programs should be offered by community colleges or delivered on community college campuses by partnering with four-year institutions to help attract students to rural communities and retain them for life thereafter.

Limitations

This study is an example of one engineering degree program in the university center model of the community college baccalaureate movement in northeastern Minnesota's NHED, on the campus of Mesabi Range Community and Technical College in Virginia, Minnesota. It is a study of the IRE students and their educational experiences in the unique environment and with the unique pedagogy. This study is limited in its scope. Due to the nature of case studies, any findings cannot be generalized to a larger population. However, through rich and thick description best-practices can be gained from this one example.

Definitions

Community College Baccalaureate – Providing access to four-year baccalaureate degrees to students within areas that are not already being served by four-year colleges and universities. Community college baccalaureate takes four forms: (a) the articulation model, (b) the university center model, (c) university extension model, and (d) the pure community college baccalaureate model. The last of these is the most controversial model as it is said to create a new degree in between an associate degree and a university baccalaureate degree.

Iron Range Engineering Program – The IRE program is an initiative by the NHED in northeastern Minnesota to provide an upper division engineering degree to transferring two-year students using a pedagogical method that is unique in the state of Minnesota and the country.

Iron Range Resources & Rehabilitation Board – A Minnesota Economic Development State Agency that has helped to provide leadership as well as operational funding for the IRE program. The IRRRB is led by legislators as well as citizen members appointed by the governor of Minnesota.

Iron Range Higher Education Committee – A subcommittee of IRRRB made up of legislators and educators to recommend to the IRRRB how to spend five cents for every ton of taconite, which is earmarked for higher education programs.

Northeast Higher Education District – The governing body for five community colleges and one university center in northeastern Minnesota's Arrowhead Region.

Project-Centered Learning – For this case study the term project-centered learning (PCL) will be used so as not to confuse it with project-based learning (PjBL) and problem-based learning (PBL). PBL and PjBL are older pedagogies that have had considerable influence on the IRE model of PCL. PCL's main difference is a very close working connection to local industry and the use of projects industry provides the program. These projects have a net-positive impact on regional economic development.

Learner-Centered Environment – This has been defined by Bransford, Brown, and Cocking (1999) as paying attention to the cultural diversity, skills, learning styles, knowledge, attitudes, and opinions that students bring to class. Instructors of learner-centered environments are aware that students construct their own meanings.

Taconite Tax – A tax paid by mining companies for extracting the state of Minnesota's natural resources. This tax is managed by IRRRB and their board.

Taconite Tax Assistance Area – Fifteen school districts in northeastern Minnesota's Arrowhead Region make up the taconite tax assistance area.

Industry – The following companies have been actively involved in developing the IRE program: Hibbing Taconite, North Shore Mining, United Taconite, Minnesota Power, Polymet Mining, TriTec of Minnesota Inc. , Minnesota DNR, Barr Engineering, Medtronic, Jasper Engineering, and Boise Paper.

Rural Brain Drain – Rural communities throughout the country are losing population and their young human capital to urban living, which is filled with many options for a college education as well as a better employment outlook.

Summary

Chapter one of this study has presented community colleges' missions as always changing and adapting with the times. It has presented the community college baccalaureate as the next step in this adaptation due to the community college's location in rural communities and urban settings. Secondly, this chapter also has provided background information of the NHED, Arrowhead University, and IRRRB. Finally, Chapter one has presented the problem being studied, the purpose of the study, the research questions, significance of the study, limitations, and the definition of terms to help the reader moving forward.

Chapter 2

Review of Literature

This literature review represents the merger of two reform movements within higher education. It addresses the problem of increasing human capital in a region of Minnesota losing its younger population to urban areas that have more perceived opportunity. The first reform movement is the community colleges' attempt to supplement their mission to include a new type of baccalaureate degree. Currently, this degree is not being offered at four-year universities in the state of Minnesota. This degree is more responsive to what industry wants and more applied while being theoretical. The second reform movement is the transformation of engineering education. This reform movement shifts the learning of engineering from the conventional classroom to industry sites, where baccalaureate-level students work on real-world projects alongside practicing engineers. In essence, this new curriculum trains engineers the way medical doctors are trained: on rotations at actual work sites and with actual real-world projects, where real skills are tried and tested on real problems within learning teams led by experienced educators and practitioners.

This literature review provides the foundational knowledge behind this case study as it relates to the offering of a brand new, innovative, professional engineering degree on a community college campus in northeastern Minnesota which creates a career pathway for students on the Iron Range who would otherwise leave the area. This case study describes the experience of the first cohort's participation in this engineering degree program created through the partnering of upper division and lower division institutions.

Education can be a driver for economic development. Being responsive to community needs and industry needs is historically the trademark of the community college mission.

History of Community Colleges

Gellar (2001) cites Tillery and Deegan (1985) when describing the progression of community colleges in the U. S. Tillery and Deegan (1985) provide a general overview of community colleges by discussing their evolution through the years while helping to articulate that community colleges have continually changed their mission.

Tillery and Deegan (1985) identify four generations of community college development and corresponding time periods as follows:

1. 1900-1930 is described as an *extension of the secondary schools*, where typically high schools were allowed to award college credit on their campuses.

2. 1930-1950 was the *junior college generation*, where the number of junior colleges and the enrollment started to increase based on the initiation of the Serviceman's Readjustment Act of 1944 which allowed students to receive financial support for college after serving in the military.

3. The third generation, from 1950-1970, is described as the *community college generation* for the rebranding of the term "junior college" as well as the explosion of enrollment due to the baby boom generation.

4. The fourth generation, from 1970-1985, is the *comprehensive community college generation* where community colleges merged with technical colleges to provide students with access to the best vocational education and transfer functions.

These four time periods set the stage for the present day community college. The late 1980s and 1990s gave way for entrepreneurial workforce development and customized training, which led to the present day institutional advancement and reshaping of the community college mission (Milliron, 2005). In each one of these periods there were many social, political, and economic forces at work that led to each new evolution.

The term "junior college," the beginning of the modern community college, and the associate degree itself are generally attributed to William Rainey Harper, former president of the University of Chicago (Gellar, 2001; Kane & Rouse, 1999; Tillery & Deegan, 1985; Wattenbarger & Witt, 1995). While Harper has a large footprint in the community college movement, the first overtures in this direction came in 1851 from Henry Tappan, the president of the University of Michigan, followed in 1896 by William Folwell, then president of the University of Minnesota (Cohen & Brawer, 2003). Both Folwell and Tappan wanted to create an institution that would lead students toward a university degree but helped release pressure the universities were feeling from the burden of increasing enrollment. Furthermore, Harper took this a step further and wanted to mimic the European institutions in leaving the higher order scholarship to the best universities and turn the worst universities into junior colleges (Cohen & Brawer, 1996; Kane & Rouse, 1999). Harper's work led to the establishment of the first junior college in the country, Joliet Junior College.

In 1901 there were already nine two-year colleges (Cohen & Brawer, 1996) including the first junior college, Joliet Junior College in Illinois (Walker, 2005). These

colleges were mainly high schools that began to offer college credits. In 1907 California granted its high schools the ability to offer college credits and provided support for these junior colleges, which became an extension of the high schools (Cohen & Brawer, 1996; Tillery & Deegan, 1985; Wattenbarger & Witt, 1995). The law said that secondary school boards shall offer post-graduate courses that "approximate the studies prescribed in the first two years of university courses" (Cohen & Brawer, 1996, p. 14). Over the next decade, the number of two-year schools would jump to more than 74. Enrollments in two-year colleges would level off in the 1920s with World War I but they would increase again after the war, and by 1921 there were over 200 two-year colleges (Cohen & Brawer, 1996). This was the beginning of the largest expansion of community colleges in their history.

World War II ended in 1945 and soldiers were able to return home. They returned to the Servicemen's Readjustment Act of 1944 (G. I. bill). This allowed veterans to come home and receive their vocational or college education free of tuition. It also provided other monthly benefits and assistance (Kane & Rouse, 1999). The G. I. bill, as it is now called, led to a massive explosion in enrollment during this time frame as well as during the Korean War's unofficial end in 1953. The beginning and end of the Vietnam War in the 1960s and 1970s marked the last major expansion of community colleges. During this time, not only were U. S. veterans taking advantage of the G. I. bill when returning from war, but also the baby boom generation was reaching college age. This led to a large growth in the number of two-year institutions which increased the number of access points across the country and in turn increased the enrollment at these institutions (Kane

& Rouse, 1999). These efforts, combined with additional legislative initiatives like the Higher Education Act of 1965, aided in allowing everyone access to education.

From 1921 until 1975, the number of two-year colleges increased from 207 to 1,203, with the ratio of public versus private tilting more to public every year. During that same time period, enrollments at each institution on average went from less than 100 to more than 3,500 per institution (Cohen & Brawer, 1996). To this day, California's community college system is the largest higher education system in the world with over 100 campuses as well as over 2,700,000 students (Keller, 2009).

Throughout the history of community colleges, there have been changes: to what the public has called them (junior college to community colleges), to provide more access to education (legislative action and increase in the number of schools), and to provide technical degrees consistent with the industry hiring practices of the times. Presently, students are graduating from high school at the highest levels ever, and almost 30% of the population age 25 and older has a bachelor's degree (Planty et al., 2009). This means more people have a higher level of education than in any other time in history, paid a higher cost for that education, and have a degree that can be more easily devalued. Employers have more choices when hiring, which is leaving the bachelor's degree as the entry level degree (Ip, 2008; Oloffson, 2009). The community college baccalaureate increases access to what is becoming the standard degree level for competition in the employment marketplace and creates opportunities to position community colleges for another historic adaptation of their mission.

The Community College Baccalaureate

Kenneth Walker (2005), President of Edison College and founder of the Community College Baccalaureate Association, has said that there are a number of new issues that are changing the way students, parents, community members, politicians, and activists look at community colleges. The same issues are also changing the way community colleges are attempting to position themselves. First, he believes that the market for higher education has become international. Secondly, he believes that instead of the associate degree being most important to gain entry level work similar to 10, 20, or 30 years ago, baccalaureate degrees are now that standard. Lastly, he believes community colleges and their typical boundaries are being challenged by online colleges and other for-profit colleges. Walker (2005) believes that to be competitive moving forward, community colleges, which are strategically located in both rural and urban settings, "must develop new products and delivery systems, and shed the confining title of 'two year college'" (p. 14).

Community college baccalaureate programs have continued to make headway across the country to becoming a realistic way to increase access to a baccalaureate degree (Cook, 2000). There currently are 17 states that offer the purest form of the community college baccalaureate degree, the model in which a community college awards the four-year degree. Westark Community College in Arkansas was the first community college in the nation to receive legislative permission to offer a bachelor's degree in 1997; but presently Florida is the farthest along in developing this type of baccalaureate degree on community college campuses on a large scale.

In 2001, Florida passed legislation to allow for the first baccalaureate degree granted from a community college in the state. As of 2009, the Florida higher education system has 10 of their 28 community colleges offering baccalaureate degrees. Florida is the leader in administering community college baccalaureate models; all across the country various types community college baccalaureate concepts are being implemented. Floyd (2005) and Floyd and Walker (2009) describe the four main models of community college baccalaureate delivery.

The first is the university center model. The university center model for community college baccalaureate promotes a partnership arrangement between the community college and the four-year degree granting institution. Within these partnerships, students spend their first two years as community college students and then transfer to four-year institutions usually on the same community college campus. Furthermore, the universities control the degree requirements and often control the pedagogy attached to the degree program. Lorenzo (2005) describes six models within the university center model: (a) the co-location model where institutions share facilities; (b) the enterprise model, where multiple institutions form a consortium to operate a higher education center; (c) the virtual model, where the upper division courses are offered online after two years at the community college; (d) the integrated model, where the university center is an integrated part of the community college; (e) the sponsorship model, where community colleges are in charge of the university center and the courses that are offered; and finally (f) the hybrid model, where community colleges offer some degrees and universities offer some degrees.

One example of this university center model is the Macomb Community College's University Center in Michigan, where the community college partners with other four-year colleges and universities such as Ferris State University, Oakland University, and Northwestern Michigan College among others (Floyd, 2006). Macomb Community College's University Center has over 5,000 students enrolled in over 50 academic programs in both bachelor's degree level and graduate degree level (Michigan Community College Association [MCCA], 2010).

The second model of the community college baccalaureate is the university extension baccalaureate. The university extension baccalaureate degrees are arms or distance education campuses of a four-year degree granting university usually located on the community college campus or near a community college campus. For instance, Arrowhead University, the organization used in this case study, in 1989 was first a university extension. It was under the governing structure of Bemidji State University, a local four-year institution in Bemidji, Minnesota. In 1999 the governing body then changed and Arrowhead University became an entity of the NHED and the model was changed to a university center model, as it is run presently. These university extension models are often seen as distance campuses for four-year universities where degrees are awarded by the mother campus but often have a designator on the transcript that shows where the degree was earned. Other colleges that employ this model are Hawaii's Maui Community College and West Virginia's Parkersburg Community College (Floyd, 2006).

The third model of community college baccalaureate is the articulation model. In this model students usually complete two years at a local community college and then are

guaranteed that their courses will transfer and the students can complete their education at a university in two years. Often times this model is called a "2+2" model and usually this articulation model has official documentation called an "articulation agreement" to solidify the partnership between the two institutions. Floyd (2006) says, "Creative partnerships such as those of Florida's Brevard Community College (BCC) and the University of Central Florida (UCF) not only guarantee admission to community college graduates, but give them preferential status for admission to selective programs" (Floyd, 2006). Floyd (2006) adds that BCC and UCF are working to add more degrees while also sharing faculty, an important step in cost containment. This model often is not plausible for those students who are place bound because it does require students to transfer to the university campus after two years and oftentimes defeats the purpose of the more progressive models of the community college baccalaureate (Floyd, 2006).

The final model is described as the most pure and most contentious form of the community college baccalaureate. It is when the community college actually awards a baccalaureate degree. This allows the community college faculty and administration to control the curriculum—control how the program is delivered and adapt it according to local industry demands. It also allows the community college to decide on the degree graduation requirements (Floyd, 2005). As mentioned previously, Florida leads the country in delivering this type of community college baccalaureate degree. The degrees offered are overwhelmingly education, health, and business related degrees (Floyd & Walker, 2009). They are also, with the exception of teacher education, "applied" bachelor's degrees (Floyd, 2006). These various models of the community college

baccalaureate all have a very principled rationale. Walker (2001) believes that community college baccalaureate degrees would provide a lower cost, convenient, and accessible degree. It would also continue to expand on the community college mission which has existed for over one hundred years. “Our mission need not be defined by the needs of the past; rather, it should be defined by responsiveness, adaptation and growth” (Walker, 2001, p. 4). All across the country there are numerous programs in the various community college baccalaureate models aimed at increasing access to the baccalaureate degree and the cost of a college degree.

McKee (2005) described the process of developing the first community college in the country to offer a baccalaureate degree, Westark Community College in Arkansas. This program is a bachelor’s degree in Manufacturing Technology in direct response to the local and regional needs of the manufacturing workforce. The Westark Community College program is outcome based. The students have to show that they have acquired certain competencies across foundational learning modules. These learning modules are created by students, faculty, administrators, and industry. They consist of leadership competencies and technical competencies that are finalized in a capstone experience. This program is also self-paced. Teachers are available when the students need guidance (McKee, 2001, 2005).

The state of Florida ranked close to last by most measures in providing baccalaureate access to students despite ranking in the top ten in the number of associate of arts and associate of science graduates (Furlong, 2005). St. Petersburg College, Florida’s oldest two-year college, formerly called St. Petersburg Junior College, was

attempting to change that. The college is located in Pinellas County on the peninsula of Tampa Bay, Florida**.** Pinellas County ranks last in the state in baccalaureate access compared to the other counties in Florida despite a population of around one million people (Furlong, 2005). The college has evolved from a junior college**,** conferring associate degrees to offering 62 baccalaureate, master's, and doctoral degrees from 14 partnering institutions in what is now called the University Partnership Center. In addition, the Florida legislature in 2001 granted St. Petersburg College the authority to offer a few niche bachelor's degrees as well as change their name from St. Petersburg Community College to St. Petersburg College. St. Petersburg College now offers extensive online education, and baccalaureate programs on six campuses. It is now one of the largest partnership models in the country serving over 4,000 students (Furlong, 2005).

Criticism of Community College Baccalaureate

There are many critics of the community college baccalaureate movement, mainly the model where community colleges offer their own baccalaureate degrees. These critics are concerned about the changing mission of a community college even though the mission of community colleges has constantly changed (Wattenbarger, 1974). Critics are also concerned about the financial implications this may have when duplicating what universities are already doing, the identity problems that may come from changing the mission, and finally the concern that a community college baccalaureate degree will never be valued on the same level as university baccalaureate degrees.

One of the most vocal critics has been James Wattenbarger (2000), said to be the architect of the Florida Community College system: "It would be difficult, if not

impossible, to convince anyone that the bachelor's degree offered by a community college is as important as the one offered by a university or a four-year college" (p. 5). This is echoed by McKee (2001), who believes that a community college baccalaureate degree may not be accepted by universities for graduate degree entrance. One of the principal arguments against community colleges developing baccalaureate degrees is because "community colleges may not be able to offer a baccalaureate because it has never done so, was not designed to do so, and could not possibly do as well as four-year institutions" (Townsend, 2005, p. 184). The response from proponents to this argument is that community colleges should continue with their mission, but then also add baccalaureate degrees, otherwise their mission as it currently exists gets the students halfway to the end goal and hands them off (Walker, 2005). This type of hands-off philosophy also fuels rural brain drain for communities that do not have a four-year institution close by.

Another criticism of the community college movement is the identity confusion that happens on the community college campus when adding baccalaureate programs in a collective bargaining environment. For instance, the dynamic between four-year faculty and staff, and two-year faculty and staff becomes tense when items such as contract length and salary come into play (Levin, 2003; Mills, 2003). Furthermore, Levin (2003) has shown that there can be hard feelings from traditional vocational faculty if the dynamic is not monitored due to the differences in potential collective bargaining agreements. The values of the four-year university faculty may be different than the values of the two-year faculty. For example, four-year faculty may want research valued

more, or when a president leaves, a president with a university background may be hired, thus further embedding an "us versus them" culture (Pedersen, 2001).

Concerns have also been expressed about the duplication of effort. Critics ask why community colleges should take on hiring additional faculty and staff and be spending time and money developing curriculum when community colleges can partner with universities. Universities are ready-made to handle this. It is just working on a partnership. If a partnership cannot be reached and community colleges have exhausted all their options, then they should look into providing their own degrees as a last resort (Eaton, 2005). Currently in Florida, the state appropriates money for community college baccalaureate programs, but in trying times, there is a question as to how these programs are going to be funded. Wattenbarger (2000) writes;

> Imagine the dilemma that community college presidents would face when having to allocate funds from a limited budget to the programs that serve the students mentioned above or the new bachelor's degree programs. The president's philosophical commitments would surely be tested, and traditional students of community colleges would be shortchanged by the only institution that was established to serve them in particular. (p. 4)

Many are worried that there will be a tuition increase levied against the lower division community college associate degree programs to help pay for the baccalaureate initiatives (Pedersen, 2001; Townsend, 2005).

Community colleges have always had a value oriented mission. One very important value within their mission has been the open access to education or what is

called non-selective admissions process (Cohen & Brawer, 2003). The process is open, regardless of test scores. Community colleges provide developmental (remedial) courses to their incoming students to ensure that every student gets to the college level, or the level required by a technical degree. It is this safety net that critics of the community college baccalaureate worry will be eventually removed (Mills, 2003; Townsend, 2005). The removal of the open access value of community colleges may, however, be an indirect outcome of adding upper division faculty. University faculty may value different things like research, which in time and with the tightening of resources, may switch the emphasis from open access values to research-oriented values (Manzo, 2001).

All of these criticisms have been answered in various ways. The rationale for the community college baccalaureate movement is to provide (a) geographic access to a college degree, (b) financial access to a degree so students do not have to leave home, (c) access to a degree that is of interest to the industries regionally and nationally (Floyd & Walker, 2009), and lastly (d) the ability to get a degree that is not being offered by other four-year institutions, a unique hands-on degree which upon graduation will result in students being in high demand (Skolnik & Floyd, 2005). Wattenbarger (2000) proposes that any baccalaureate degrees that are offered on community college campuses should be offered through a partnership arrangement with regional four-year institutions, much like this case study.

No matter what the criticism of the community college baccalaureate reform movement is, students currently have three options with regards to community college attendance and the pursuit of a baccalaureate degree. The first allows students to attend a

four-year university immediately in pursuit of a bachelor's degree. The second option is for students to attend a community college, then after two years they would relocate to a city that houses a university or four-year college. They also could attempt to earn their baccalaureate degree online, which limits degree program options and may be more expensive. The transfer option has continued to exacerbate the problem of rural brain drain (Carr & Kefalas, 2009b). This option is also expensive for traditional students with regard to room and board, and even more expensive for non-traditional students who have to pay for relocation expenses (Floyd & Walker, 2009). This new movement would provide another option—one where students who are place-bound can stay where they live and get their education in a cost-effective manner while working with industry in an innovative manner. This can be accomplished all while staying at the local community college where they have been attending for two years.

The approval process for community colleges to offer a baccalaureate degree varies from state to state. Florida, for example, has a very specific process for approving these programs, while other states have established pilot programs and have concrete limits on how many baccalaureate degrees can be offered on a community college campus.

Approval Process

In this movement toward a new mission and its inherent changes, approval becomes a significant issue. Currently the state of Florida offers the most baccalaureate degrees on community college campuses in the U. S. Florida's approval process may provide a blueprint for other states to follow because it does give other four-year

institutions the option of countering a proposal by a community college to offer a baccalaureate degree so as not to duplicate resources, which is a major criticism of the community college baccalaureate movement (Wattenbarger, 2000). In Florida, when any community college wants to offer a baccalaureate degree program, they first, according to Glennon (2005), must complete the following steps:

1. The community college president and board of trustees need to submit a proposal to the Florida Board of Education.
2. The proposal then has a 60-day alternative proposal period where state universities can provide alternative proposals to meet the need of the community colleges in the form of partnership models.
3. If there is no proposal by state universities or if the proposal has not been approved, then there is an additional 30-day alternative proposal period for private colleges and universities to partner with community colleges.
4. Florida State Board of Education, after a thorough internal review, considers both the alternative proposals and the community college proposal and makes final decision.

The Florida State Board of Education was developed to ensure that there is not any duplication in the K-20 system. When proposing a new baccalaureate degree in Florida, community colleges need to provide a large amount of background information regarding each program.

Schools must provide information about the demand for the degree; availability of jobs for future graduates; enrollment estimates; evaluation of the potential impact

> on faculty, students and other institutions; implementation and accountability procedures. Cost estimates must be provided, including estimates of state funding, since approved programs are eligible for state funds. A description of the process for collecting enrollment, expenditure, completion performance data, which must be collected for the purpose of evaluating the degree program, is also required. (Glennon, 2005, p. 10)

Other states, however, have unique approval processes and policies for implementation of community college baccalaureate programs. For instance, Hawaii's community colleges need to gain approval of an academic program from Hawaii's Board of Regents, the same body that represents state universities. What is unique to Hawaii is that the Board of Regents has a policy that is based on local demand. The policy allows all of Hawaii's community colleges to each offer one baccalaureate degree program. If the community colleges want to offer more than one degree program, they would then have to change the community college status to a four-year institution (Glennon, 2005).

The state of Washington has taken a different path. In 2005 the Washington State Board for Community and Technical Colleges (WSBCTC) approved the recommendation made by a task force on community college baccalaureate (Glennon, 2005). Those task force recommendations were to start a pilot project that consisted of offering eight applied baccalaureate degrees at seven different community colleges as well as creating a publically funded university center with partnership models throughout the state (WSBCTC, 2010). This is the only mechanism currently in place in Washington to offer baccalaureate degrees on community college campuses.

Proposals for community college baccalaureate degree programs, no matter what model of delivery, should incorporate something that is not being offered by local institutions of higher learning (Floyd & Skolnik, 2005). This, in effect, creates a learner and industry-responsive mentality of higher education delivery. The latter is the main part of the current community college mission. The community college baccalaureate movement may have found a partner in the engineering education community, a system that is also looking to transform the way they are offering engineering education to students. Both are looking to move from a traditional engineering experience to one that is more hands-on, more industry responsive, more like what a real engineer would see practicing in the field.

Engineering Education

Engineering in this country has been passionately described (Mills & Treagust, 2003; Sheppard et al., 2008) as continuing the "chalk and talk" ways of the 1950s, despite calls by the engineering profession and accrediting bodies to change and adapt the way we teach engineering. Towards the end of the 19th century, engineering education consisted of an apprenticeship education experience in machine shops using a drawing board or at various construction sites. There have been many changes that have occurred throughout the history of engineering education and debates that have taken place to transform engineering education from what was a hands-on learning environment in a machine shop to a more traditional theoretical college classroom as we see today. Steadily throughout the 20th century, chemical and electrical technologies have developed at such a rapid rate that hands-on approaches to engineering did not make sense anymore

because everything that was learned was quickly out of date (Seely, 2005; Sheppard et al., 2008).

The focus turned to making sure the basics of math and science were at the forefront of engineering. What is more, throughout the country at this time there was an undercurrent within the industries of engineering, medicine, and law that scientific knowledge was the most essential component of a developing and improving country. People within these organizations also believed that because of this, they should be given the leadership, authority, and the respective social status that comes along with it. They found that the best way to gain these science and math skills was at the university (Seely, 2005; Sheppard et al., 2008). Since this decision early on in the 20th century, federal funding increased and reports were published calling for less hands-on education and more specialized technical engineering. In the 1960s there was a backlash about these types of requirements (Seely, 2005, Sheppard et al., 2008).

The backlash of the 1960s prompted a move back to focusing engineering on developing connections between industry and education, and certain aspects of the curriculum like the design process one would see working in industry upon graduation. This static learning curriculum was in place until an historical decision by the major accrediting body for engineering in the U. S. , the Accrediting Board for Engineering and Technology (ABET) (Seely, 2005; Sheppard et al., 2008). This historical decision is described accordingly:

> In 1996, the ABET Board of Directors adopted the new set of standards, called *Engineering Criteria 2000* (EC2000). EC2000 shifted the basis for accreditation

> from inputs, such as what is taught, to outputs — what is learned. The new criteria specify 11 learning outcomes and require programs to assess and demonstrate their students' achievement in each of those areas. EC2000 retains earlier accreditation standards' emphases on the development of students' mathematical, scientific, and technical knowledge, as well as standards for program faculty and facilities, but it also emphasizes developing other professional skills, such as solving unstructured problems, communicating effectively, and working in teams. In addition, EC2000 stresses awareness of ethical and contextual considerations in engineering. (Lattuca, Terenzini, & Volkwein, 2006)

These new guidelines served as a new starting point for what should be taught and what a well-rounded engineering program should look like. Presently, engineering education is still having a hard time repositioning itself.

Mills and Treagust (2003) suggest that the profession deals daily with so much uncertainty from their clients and the world that it makes sense to change to create a better, more well-rounded engineer. The engineering curriculum that is in place today, according to Mills and Teagust (2003) is too focused on science and technical courses and does not allow students the experiences to apply those areas of study directly to industry to see how they fit. These authors believe that there is also a lack of design experience, communication skills, teamwork experience, and a lack of faculty with actual practical experience working in areas other than academia.

Sheppard et al. (2008) have found that throughout the world, countries have been transforming the engineering profession, except for the U. S., despite the call to do so

from major U. S. accrediting bodies. The U. S. is holding on to an approach rooted in acquiring technical theoretical knowledge first, and then eventually preparing students for what they will experience upon graduation; usually this takes place on the job or through some sort of customized training process. Sheppard et al. (2008) advocate for just the opposite, a curriculum that puts professional engineering practice above traditions of the past and allows students a rich learning environment. To do this, Vest (2005) has quoted a friend as saying that teachers need to "move from the sage on the stage, to the guide on the side" (p. 167). Moving professors from the typical instruction to a more active instruction method is a difficult challenge to overcome.

Professors in the science and engineering courses have a tendency to not want to take risks (Pundak, Rozner, Yacobson, & Toledano-Kitay, 2008). Instructors also feel an obligation to continue on a certain course of teaching even though it may be failing because it was the decision they made early on, and they need justification for that decision, or they at least need to follow through with that decision until they have a small token of success (Pundak et al., 2008). Furthermore, teachers tend not to use more inductive teaching methods in the classroom because of the traditionalist mentality of leading universities with regards to pedagogy and assessment. Teachers feel pressure to do what the universities are doing, which is typically lecturing and administering an exam at the end of the semester; in other words, a very traditionalist teaching methodology. This traditionalist teaching methodology is a deeply rooted value not only in science and engineering education, but also in higher education as well (Pundak et al. , 2008).

Inductive teaching methods have been considered by many to be a way forward in fulfilling the new outcomes of major accrediting bodies. It allows the engineering educators the opportunity to create a paradigm shift that favors engineering practice as a primary learning tool while also teaching the engineering theory (Sheppard et al., 2008).

Traditional teaching and learning, especially in science, technology, engineering, and math is deductive, where the teacher lectures about a certain topic, gives students homework or assignments in class and then tests the students at the end of the unit. Very little is mentioned in deductive teaching about the real-world application or use of the material being learned. Inductive teaching and learning however is quite the opposite—it creates personal meaning for the students. Students work with a set of real work problems, case studies, or data sets to generate the guiding principles or big ideas for themselves or with gentle instructor involvement. Inductive teaching takes on a variety of different catchphrases but the best way to describe this type of teaching and learning instruction is student-centered (Prince & Felder, 2006). This means that the students come to class with preconceptions. If what they are learning does not fit those preconceptions, the students will have difficult time learning. Students have more responsibility for their education in this model. This can be characterized as *constructivist learning*. This is where students construct their own reality rather than the instructor constructing the information for the students (Bereiter, 2002). This type of approach manifests itself with students actively discussing problems and topics mostly in groups (Prince & Felder, 2006).

Project-centered learning (PCL) is derived from two main sources, according to Thomas (2000). They are (a) Outward Bound wilderness expeditions, and (b) models of problem-based learning. Outward Bound experiences provide unique experiences for students. They involve "fieldwork, service, teamwork, character building, reflection, and building a connection to the world outside of the classroom" (Thomas, 2000, p. 5). Problem-based learning (PBL) has been used in many educational situations**.** The most prominent example of its use is in the medical profession where students are introduced to patients, told symptoms, and diagnose the patients' illness. PCL, according to Thomas (2000) is when curriculum is set up around one or several projects. Some projects may take the whole semester and consist of many smaller projects while others are smaller short-term projects. These projects allow students to see practical outcomes and processes within their studies, theories, or facts. These projects are also real-life projects that do not have the typical school feel which allows students to see the application of what they are learning in a real-world environment.

PCL allows for the consideration of the cognitive development of college-age students. Sheppard et al. (2008) cite Patricia King and Karen Kitchener (1994) and their description of three categories of cognitive development in college-age students. The three categories that make up the development continuum are (a) pre-reflective thinking, (b) quasi-reflective thinking, and (c) reflective thinking. The idea is to, over the course of a college career, help move students along this continuum of reflective judgment, which are the judgments students make about problems that have multiple possible solutions. Students entering college are usually in the pre-reflective thinking stage. This stage is

when an individual's knowledge is certain and concrete. Students see authorities as the holder of the knowledge. The second stage of cognitive development in college-age students is quasi-reflective thinking. In this stage of development students start to understand that some of the problems they face have elements of uncertainty. Other views, opinions, and interpretations are starting to become part of their understanding of problems. Finally, the last stage of development is reflective thinking, where students understand that knowledge is never absolute, but rather knowledge is a collaboration of opinions, evidence and evaluation. This type of reflective project-centered approach, when packaged with a constructivist learning environment and a rigorous student life experience, makes up a learning community.

Learning Communities

At the heart of any college experience is a social function and an academic function. Learning communities allow for a more holistic and integrated college environment (Tinto, 2000). Learning communities are defined as groups of people engaged in intellectual interaction for the purpose of learning (Cross, 1998). According to Caine and Caine (1994), the brain is innately social. Learning communities typically consist of constructivist learning as well as a rigorous student life program which helps blur the line between what is social and what is academic. Sometimes this takes place by having the students with the same academic pursuit living together in the same residence hall. Students in the learning community model work in teams with instructors rather than having lecture instruction where the teacher knows all the information and presents it to the students. In a learning community the student and teacher hierarchy is eliminated

creating more student empowerment, motivation, and interest (Smith & MacGregor, 1992). This is a major shift in the way knowledge has typically been constructed over the last 400 years in higher education. Patricia Cross (1998) has said:

> The traditional view of knowledge as foundational contends that there is a reality "out there," a foundation on which all knowledge is built. It is the task of learners to discover the external reality that exists…in the non-foundational view of knowledge, however, a community of learners is not only advantageous, it is also necessary, because people construct knowledge by working together, not just cooperatively but inter-dependently. The foundational assumption of constructivism is that knowledge is actively built by learners as they shape and build mental frameworks to make sense of their environments. (p. 5)

It also allows for less passive learning, and more active learning; an example of active learning as previously discussed is project-centered learning. Engineering education has many project-centered courses but very few project-centered curricula are in place (Prince & Felder, 2006).

One example of a project-centered curriculum and the development of a learning community that served as the guide for the IRE program featured in this case study is the story of the establishment and development of Olin College in Massachusetts.

The case of Olin College. In 1997 land was chartered to the F. W. Olin Foundation of New York to offer a bachelor's of science degree in mechanical, electrical, computer engineering, and general engineering. In return, the F. W. Olin Foundation made a financial commitment of $300 million to establish and develop the Franklin W.

Olin College of Engineering, and construction on a new high-tech campus began. Olin College then hired an administrative team in 2000 followed in 2001 by the "Olin Partners" (Kerns, Miller, & Kerns, 2006; Somerville et al., 2005).

The Olin Partners consisted of 30 students who gave up their freshman year to help develop curriculum for the college. This lasted for one full academic year. The partners then joined another group of 45 students (a year younger than the initial cohort). Together, these 75 students made up the first official class of Olin College. There were several features of the Olin College curriculum that were innovative (Kerns et al., 2006; Somerville et al., 2005). The partners, administrators, and faculty all believe that:

> The curriculum is based on the "Olin Triangle," a combination of rigorous science and engineering fundamentals, entrepreneurship and the liberal arts. There is a deep commitment at all levels to active learning and interdisciplinary courses built around hands-on projects. At Olin, learning and doing go together from the start. This real-world approach culminates in SCOPE (Senior Consulting Program for Engineering), a significant, year-long engineering project for an actual client. (Olin College of Engineering, 2010, n.p.)

Furthermore, the curriculum should motivate, include the design process throughout the curriculum, allow students to lead, be a team member and an individual, increase communication skills, and graduate students who are motivated, self-sufficient individuals with diverse intercultural experiences.

The Olin curriculum also has a rigorous student life program called the "Learning Continuum" where students are able to select from a variety of interest areas. Students

can play on intramural sports teams or take part in a "passionate pursuit" of some kind. Passionate pursuits consist of opportunities like designing board games, taking part in service activities like Big Brothers and Big Sisters, or taking specific courses titled "Energy Management at Olin," and "Sewing for Engineers." Students are also required to live on campus throughout their entire four years at Olin. All of these options try to tie engineering to the typically unstructured zone between academics and extracurricular activities (Kerns et al., 2006; Somerville et al., 2005). All students accepted to the college are awarded a merit scholarship that covers the cost of tuition for their four years (Somerville et al., 2005). The Olin College curriculum received ABET accreditation in August 2007, 10 years after originally being chartered land by the Massachusetts Board of Higher Education. There currently are over 300 students going to school at Olin College and the college hopes to reach a steady state of 600 in the future (Olin College of Engineering, 2010).

This is one example of an engineering institution changing the way engineering education is being delivered. Its project-centered, integrated approach aligns more closely with what national reports are calling for. It allows for more personal meaning to the students, more choice, and more responsibility in their education which breeds more motivation. The movement toward a more hands-on, industry responsive learning environment for engineering education throughout the country parallels the rationale that a community college baccalaureate degree attempts to adhere to, all for the sake of providing something different and attractive to retain our young human capital.

Summary

In this chapter the author has reviewed three main foundational aspects of this case study that will potentially combat the outmigration of the youth of northeastern Minnesota's rural communities. The first was the overall context that this study exists in. The main context is the community college baccalaureate reform movement where community colleges across the country are being transformed into access points for a baccalaureate degree, without changing their original mission. The community college baccalaureate movement's main purpose is to provide access to baccalaureate degrees, and secondly, the reform movement wants to begin to offer more hands-on degree programs that are not being offered by four-year institutions or universities. Finally, this chapter has reviewed the state of engineering education and the reform taking shape to move from a theoretical "chalk and talk" type of instruction, to a more integrated type of instruction. Using Olin College's project and student-centered curriculum as a blueprint, the IRE degree program mimics the real-world design projects that students will face while working in industry upon graduation.

Chapter 3

Methodology

The purpose of this case study is to ascertain whether or not the IRE program, in its first year of existence, has provided students with an experience that will help them to earn their degree and obtain employment all while not leaving the communities of the Iron Range. Students describe in their own words, the experience of (a) choosing this specific community college baccalaureate program for their upper division experience; (b) being part of a baccalaureate degree program on the campus of a community college in northeastern Minnesota; (c) being part of a unique professional engineering baccalaureate degree program where the curriculum focuses on real-life, industry-sponsored projects and experiences; and (d) exploring the employment potential of this new type of engineering degree in the community.

This chapter elaborates on the researcher's choice of a qualitative case study methodology as the strategy of inquiry. This chapter will also provide more contextual information in regards to the program setting; it will (a) include a discussion of the role of the researcher in this study, (b) describe the sample population that was selected for the study, and finally (c) describe the process of data collection and data analysis for this project.

The strategy of inquiry chosen to examine these questions is a case study. This strategy of inquiry was selected because case study research usually occurs in "a bounded system." Furthermore:

> Qualitative research takes place in a natural setting. The qualitative researcher often goes to the site of the participant to conduct the research. This enables the researcher to develop a level of detail about the individual or place and to be highly involved in the actual experiences of the participants. (Creswell, 2003, p. 181)

Stake (1995) describes three types of case study: (a) collective, (b) intrinsic, and (c) single instrumental.

Collective case study is used when there is an issue and there are multiple cases that are studied to come to a consensus on the issue. For instance, Stake (1995) uses the example of a national grading policy change and the teacher reaction to that change. In collective case study a researcher would examine several teachers and the way they grade or change their teaching to the new grading system. An instrumental case study would involve examination of one teacher and the effect of the policy change on that teacher's grading style. Intrinsic case study, on the other hand, involves examination of something because it is unique (Stake, 1995). This study is an intrinsic case study since it is being studied because the program is unique. Furthermore, this study is also a descriptive case study. The students collectively in their own words described what it is like to be part of a unique engineering education program, taught in a unique way and located on a community college campus (Creswell, 2007; Stake, 1995). Merriam (1988) describes this type of qualitative research: "a descriptive case study in education is one that presents a detailed account of the phenomenon under study. Innovative programs and practices are often the focus of descriptive case studies in education" (p. 27).

Context of Study

This descriptive case study was conducted on the two campuses of Mesabi Range Community and Technical College in Virginia and Eveleth located in northeastern Minnesota. There are currently 34 two-year community and technical college campuses in the MNSCU system. Mesabi Range Community and Technical College has been accredited since 1923. Despite name changes, merger, and dissolutions in response to legislative mandates and board action, this institution has educated generations of students from the region and is one of five institutions that make up the NHED. Arrowhead University is also part of the NHED.

Arrowhead University partners with four-year and graduate level universities to facilitate the delivery of baccalaureate and graduate degree opportunities for students in areas of northeastern Minnesota that are not being served by other regional four-year universities. It also serves as the main marketing and student services mechanism for these programs to help bridge the gap between the community college campus and the partnering university. Arrowhead University currently has 20 total undergraduate and graduate degrees. One of these degree programs is the IRE program.

The typical university center model of the community college baccalaureate movement allows community colleges to partner with sponsoring universities. The sponsoring universities generally are the organizations that develop the curriculum and propose the program (Floyd & Walker, 2009). Contrary to the typical university center model of the community college baccalaureate movement, the IRE program was designed by the NHED and proposed to potential partnering institutions. In 2009, Minnesota State

University, Mankato (a state university within the MNSCU system), located in Mankato, Minnesota, accepted the proposal to be the sponsor of the IRE program, which was built upon the innovations within the two-year engineering education curriculum at another NHED campus, Itasca Community College located in Grand Rapids, Minnesota.

Research Questions

This study asked the question, *How can offering unique baccalaureate degrees on community college campuses, that are not offered at other regional universities, help stop "rural brain drain" in northeastern Minnesota?* Additional secondary research questions that guided this study and served as a basis for the development of the interview questions were:

1. Why do students choose to enroll in this program and what was their alternative plan?
2. How do students describe living on a community college campus while attempting to earn a baccalaureate degree?
3. How do students describe the teaching and learning that goes on within the IRE program curriculum?
4. What does this program mean for your future upon graduation, and in particular for the likelihood of you remaining in the area?

This study's first research question addresses the motivation of the students for entering the IRE program. The second question deals directly with the students defining the experience of being upper division students on a community college campus, i. e. , the community college baccalaureate. The third question allows students to describe the

experience of participating in an innovative engineering education program that provides them more hands-on learning experiences with industry partners and practicing engineers. The final research question gives the students an opportunity to discuss what this new degree may mean for their future employment prospects; this question relates directly to the issue of rural brain drain in northeastern Minnesota.

Study Participants

There were 14 students enrolled in the IRE program inaugural class, the "First Generation," which began its curriculum in January, 2010. They were all from rural hometowns spread out all across northern Minnesota and were 2009 graduates of Itasca Community College's Associate of Science in Engineering program. Much like Olin College's "Olin Partners" in Massachusetts, these 14 students were student employees who were paid during the fall semester 2009 to help develop the program curriculum and experiences with Minnesota State University, Mankato. These 14 students and their work served as the population as well as the sample for this case study. Both the setting and the population for this case study were purposefully selected as this program is very unique on the national landscape (Creswell, 2007).

Before the interviews began the students were provided with an explanation of the research by the IRE Program Director (see Appendix A). Students then were presented an opportunity to sign up for the interview or pass on the opportunity. All 14 students from the first generation cohort chose to accept the invitation to participate in the interview process. In the opening minutes of the interview, the researcher also read an explanatory script (see Appendix B) that was designed to make sure students were aware of the risks

and benefits that were associated with this study. It was at this time that the students all signed the research consent form (see Appendix C).

Data Collection

There were multiple forms of data collected to insure that any findings or trends that were analyzed were considered valid. Interviews were selected for this study because as Seidman (1998) has said, "At the root of in-depth interviewing is an interest in understanding the experience of other people and the meaning they make of that experience" (p. 3). The first set of data collection methods were structured one-on-one in-depth interviews with the first generation of IRE students (See Appendix D). Each interview was one hour in length and was audio recorded for transcription purposes only.

The second data collection method was a document analysis. Each student who applied to the IRE program was required to write an essay that outlined "why they want to participate" in the program. Each first generation student was required to complete this step.

The last form of data collection was the analysis of the IRE program's blog, which was posted publically on the Internet. This piece of data was an ongoing work product for the students within the IRE program. Every other day a student was required to post descriptions of what they were doing and what was happening within the program. These posts were student-generated for the most part and the students kept a running diary of their experience working with industry and working in this new model of engineering education. There was no faculty member reviewing or editing the posts

prior to their online publication. The blog posts analyzed were dated from August, 2009 until September, 2010.

Data Analysis

There are many different ways to analyze data. For instance, Stake (1995) presents four different types of data analysis and interpretation:

1. Categorical Aggregation – the researcher records repetitive instances from the data and hopes that meaningful patterns will occur.
2. Direct Interpretation – the researcher draws meaning from a single instance within the data collected.
3. Patterns – the researcher looks for patterns among categories of coded data.
4. Naturalistic generalizations – the researcher analyzes the data and comes to generalized best practices that can help inform other cases or people.

The researcher used the categorical aggregation from Stake (1995) for this case study as well as the following step-by-step guide for data analysis and the coding process (Creswell, 2003):

1. Organize and prepare the data for analysis. Oftentimes this includes transcribing the data from voice recordings or video recordings to a word processor.
2. Read through all the data once transcribed to gain a general sense as to what the data really means.

3. Begin the coding process. Coding is processing the data into chunks or groups of meaning. Oftentimes this coding is the actual language that the participants used during an interview.
4. Organizing the coded categories into themes for description, so that readers have a clearer vision of what is going on.
5. Start to develop how the emerging themes are going to be represented in the final written qualitative narrative.
6. Interpret your data and make meaning from them.

This study used Microsoft Word documents for storage of transcriptions and for use during the coding process. Initially the researcher identified four coding categories based on the study's four primary research questions. They were:

1. Enrollment motivation
2. Experience earning baccalaureate degree on a community college campus
3. Teaching and learning
4. Future

Each coding category had one Microsoft Word document to store the various quotations for sorting purposes. The primary researcher then broke the four categories down into subcategories of emerging significant findings**.** Further synthesis (see Appendix E) resulted in the identification of 10 defining characteristics of the IRE program**,** highlighting meaningful quotations and phrases that shared common meaning and topics and organizing them accordingly (Creswell, 2003).

Creswell (2007) cautions that there are advantages and disadvantages to using a computer program to store data like the way the researcher did in this study. Creswell (2007) argues that while all the good that comes with computers making their data analysis easier, there is some bad. Creswell (2007) believes that computer programs extend the distance between the data and the researcher, and sometimes the reliance on a machine backfires when programs slow down or can crash altogether. Also, using computer programs does mean that the researcher will have to learn these programs, which for some can require time, and it will also require individuals to make the choice of which product to buy themselves, as there are many options (Creswell, 2007).

Researcher Bias

The researcher currently serves as the Director of Arrowhead University within the NHED. He reports directly to the President of NHED, and he leads and manages Arrowhead University in collaboration with regional founding university partners and other four-year higher education institutions, as well as the colleges of the NHED. The researcher has worked collaboratively on many district-wide initiatives like the IRE program.

The researcher had previous contact with the participants of this case study research and had worked with the students on a number of initiatives, so there was familiarity between the researcher and the potential participants.

The researcher also attended a community college in the NHED as a student and is sympathetic toward this region in Minnesota because it contains most of his extended family. The researcher is aware that this region of northeastern Minnesota is losing

population, and with it, its human capital knowledge base. The researcher is interested in positioning Arrowhead University to become one of the engines that drives economic development for the region, provide access to a baccalaureate or graduate degrees to those that are place-bound, and curb outmigration and "rural brain-drain" (Carr & Kefalas, 2009a).

Validation of Data

Within qualitative research, validating data proves to be a challenge and is often a major criticism of choosing qualitative strategies of inquiry. The researcher followed through on a number of different suggested "safeguards" to ensure the data are valid. This study used three of Creswell and Miller's (2000) eight validation strategies because Creswell (2007) argues that qualitative researchers should engage in at least two of these strategies to insure or help insure validity.

The first validation method the researcher used was *triangulation of data*. Triangulation is a method researchers use to provide supplemental evidence or data to help make a qualitative study more valid. This method consists of using multiple data collection methods. This study used three data collection methods as previously mentioned. The first data collection method used was one-on-one, in-depth interviews with the students of the IRE program. The second method was analyzing the application essays students wrote, and the third was an analysis of the IRE blog that students have produced over the last year.

The second strategy of validating the data the researcher used was *member checking*. Creswell (2007) suggested that convening a focus group after the above steps

have been completed is a way to accomplish this. The researcher met with the entire group of 14 students who participated in the case study and presented the data and the findings back to them. The researcher first gave them an opportunity to read verbatim the final analysis and write-up, then met with them to insure the data were interpreted correctly. There is wide support for this type of validation strategy (Creswell, 2007; Glesne & Peshkin, 1992; Merriam, 1988).

The primary researcher also utilized what is described as *rich and thick description*. Rich and thick description is defined by Denzin (1988, as cited in Glesne & Peshkin, 1992) as a "description that goes beyond the mere or bare reporting of an act (thin description), but describes and probes the intentions, motives, meanings, contexts, situations and circumstances of action" (p. 19). This type of description lays the transferability of the findings in the hands of the reader, because they will know in great detail the case study for themselves (Creswell, 2007).

Finally, the researcher documented his potential bias as Merriam (1998) suggests. Creswell (2003) says stating bias as the researcher did previously, "creates an open and honest narrative that will resonate well with readers" (p. 196).

Summary

Chapter Three has reviewed the researcher's selection of a qualitative descriptive case study for the research design. This chapter has also discussed the context of the study and the methodology for data collection and data analysis. Chapter Three concluded with the researcher documenting potential researcher bias and a conversation regarding validity.

Chapter 4

Presentation of Findings

This study asks the question, *How can offering baccalaureate degrees on community college campuses help stop "rural brain drain" in northeastern Minnesota?* Furthermore, the purpose of this qualitative case study is to ascertain whether or not the IRE program, in its first year of existence, has provided students with an experience that will help them earn their degree and obtain employment, all while not leaving the communities of the Iron Range to help stop "rural brain drain." Additional secondary research questions guiding this study and serving as a basis for the development of the interview questions are:

1. Why do students choose to enroll in this program and what was their alternative plan?
2. How do students describe living on a community college campus while attempting to earn a baccalaureate degree?
3. How do students describe the teaching and learning that goes on within the IRE program curriculum?
4. What does this program mean for your future upon graduation, and in particular for the likelihood of you remaining in the area?

The data collection methodology was described in Chapter 3. The data analysis categorized into major themes emerging from this case study is presented in the following chapter.

Fourteen students were interviewed in a structured interview environment and the interviews were recorded and transcribed verbatim. Supplementing the interviews were two document reviews. The first was a document review of admissions essays that all 14 students wrote before entering the program answering the question, "Why do you want to participate in the IRE program?" The second document review was of daily journal posts that the students made on the IRE blog. In this publically viewed, but privately operated blog, students were assigned the task of documenting their activities in a "daily journal." The students' thoughts, feelings, and daily work of the program emerged from this blog. It is from these three sources that data were collected and the following descriptive findings emerged.

Findings

All of the data were coded into the following categories based on the primary research questions for this study:

1. Enrollment motivation
2. Experience earning baccalaureate degree on a community college campus
3. Teaching and learning
4. Future

These categories were then broken down even further into subsets or meaningful themes and then organized into the following findings that describe, using the students' own words, the IRE program and position it as a best practice for future community college baccalaureate delivery.

Finding 1: There was an attraction to living in rural northeastern Minnesota. The vast majority of students in the IRE program felt there was something positive about living in rural northeastern Minnesota. They were attracted to it for numerous reasons. Students were asked why they enrolled in the IRE program in both the document analysis and interview portion of the data collection methodology. Much of the students' interest and excitement about this area is rooted in the fact they had family and friends close by, they liked the outdoor activities present in the area, or they grew up here and loved the small town life and it is where they would like to stay. A participant remarked:

> I love Northern Minnesota. I've always been into hunting, fishing, camping and it's what everyone does around here. I grew up in a small town, I graduated with 18 kids. I like having my family close, and all my friends close. Everyone seems to know everybody. (Student B)

Additionally, students also identified local industries on the Iron Range as having more hands-on employment opportunities in the future.

> Probably the outdoors activities, the hunting and that. And with the mines and stuff. It seemed like one of those jobs where you wouldn't be in an office all day you'd actually have the opportunity to do something like that. (Student A)

Students expressed that their draw to rural northeastern Minnesota was just a feeling that they could not describe. It just fit with who they are and it is what they know; it is normal.

Finding 2: The students enrolled in the program because they were going to be experiencing a new pedagogical approach to engineering education, something

transformational. The IRE students believed the way IRE is structured was a better way to learn engineering theory and principles and it would in turn make them more marketable down the line by allowing them to experience industry-based design projects. Addressing the same question as Finding 1, a student responded:

> Working in real-world engineering settings would allow us to see real applications and give us a better meaning of what goes on behind the calculations. Taking part in various companies would give me a better feel for a work-like setting. Also taking part in various jobs given by the companies will allow for more freedom in creativity and design. That is sometimes lost in lecture classrooms at most common four-year universities. (Student G)

A few students had already attended another university and were able to make initial comparisons between IRE and other regional universities. The IRE experience was intriguing to them and many other students because they saw the real-world application opportunities as something that will give them a leg up on the competition when applying for jobs after graduation. One student discussed:

> I have already had the big college experience because I attended last year. It didn't turn out the way I had hoped it would. The learning at IRE involves real engineering experience, real engineering applications, and real-life problems and constraints. In other words, it involved real learning. I believe that being able to have real work experience would put me far ahead of others, who have been learning mainly from reading textbooks and taking quizzes. (Student H)

The students said, in one form or another, they felt the typical engineering program was not for them. They felt constrained to fit into a system. Students discussed this and reiterated that the reform movement national engineering education bodies are attempting (from lecture-based classroom to more hands-on and experiential classrooms) was a major draw. They felt, in a sense, they were trailblazing a new pedagogy in engineering education and that was an exciting part of attending IRE. They believed that this new approach to learning was what they were looking for.

> The first reason I want to participate is my belief that assumptions of the current engineering educational system are obsolete in comparison to current engineering practices…I feel that the Iron Range Engineering program's new approach to teaching would be exactly what I need to learn the material and techniques I will need to integrate into the engineering profession. (Student K)

Finally, students commented they were glad they had ownership over their experience and this was a big reason for attending the program. They said:

> The other big selling point is that I own my education. It was up to me. . . We were going to get projects from business and industry. We had to learn what we needed to get the project done and we didn't have to take all that extra stuff. (Student M)

Overwhelmingly, students decided to attend IRE because it was located where it was, because it is something completely different than what other schools were offering, and because they felt it would give them a leg up on their competition for employment upon graduation.

Finding 3: The students saw positives in living together on campus, much like a cohort. Students in the first IRE cohort were required to live together on campus at Mesabi Range Community and Technical College. The students were first asked what it was like living with their cohort. They responded in two ways. First they believed strongly that living together is helpful with regard to the logistics of working together in larger teams like the program's PCL pedagogy requires. Secondly, they believe they can trust the other members of their cohort. They also said it brought them closer together and strengthened the group. The students articulated:

> It was great. They'll be life-long friends. As opposed to…I mean you don't make as many friends as at a big four-year school but the quality of the friends is so much better just because how close we are at work and school and everything. We do everything together. (Student A)

Another student commented:

> I like it first of all because the people I'm living with have proven themselves to be responsible members of society, after going through several years of engineering education which is fairly difficult. And the other thing that's nice about being…living with people in the same program is I know that if you have a big project deadline coming up…and we all do…no one's going to be up until 4 a. m. throwing a party because we all know we have homework to do and you got to get it done. Plus a lot of ride sharing and knowing where everyone is. Plus being able to communicate about life…or living. (Student D)

However, some students also commented there were times when living so close and being with the same group over and over again was frustrating. Overall, they believed the positives of living together outweighed the negatives of living together.

Finding 4: The Iron Range Engineering students participated in two-year student life activities, but still felt a disconnect between the larger two-year campus community. Along with being asked about their interactions with their own cohort, students were asked about the interaction between Mesabi Range Community and Technical College students and the IRE students. There seemed to be a struggle between the IRE program and the community college campus, which is often the case when baccalaureate degree programs are offered on community college campuses (Levin, 2003). The students remarked:

> The Mesabi connection between us has gotten a lot better over the past year. We go out and play football now with them. The Mesabi students got to know us and they'll come and play with. Same with the faculty, you can kind of tell a few of them… you could tell kind of they didn't want us here and that's gotten better… our relationships. (Student B)

Another student mentioned:

> We didn't have much interaction with them. So there aren't…We played football with a couple of them once or twice. I couldn't even pick out the RAs. I wouldn't know what they look like. We participated in several (student life activities) and we made some of our own. We had a movie night. We had a BBQ at one point.

> We made an effort to make ourselves seem as a positive presence. We know we are…we just wanted everyone to know that. (Student D)

Other students felt like the program was segregated being in one corner of campus. Overall, the IRE students tried to make sure they were a positive addition to the campus community and while they felt some negative tensions, it really didn't bother the IRE students or impact the program in an obvious, negative way.

Finding 5: Iron Range Engineering offers its students a robust student life experience further cementing the living and learning model of the program. IRE has provided students with numerous and wide ranging student life activities and opportunities by design and students were put in control of bringing these experiences to fruition. Early on, the program set up a student life committee that drafted plans for the entire year and set up each activity. The students described their experiences with student life:

> Student life-wise we did a lot of really, really cool stuff. We took that really long trip (spring break) and we get to go to like football games and baseball games which is really cool because it makes everybody bond. I think that, like, I think the program is better because of it because like it's like a way to get students to interact like outside instead of sitting inside and studying all the time and we like get to know each other better because of that. (Student N)

The students also enjoyed they had ownership over their experiences. They got to choose their experience.

> We went to the west coast and numerous other ones like the Twins game and the Mankato hockey game. And there was curling, bowling night through Mesabi. There were numerous ones. We got to decide what to do instead of having a set one, like you do this, so we kind of got to decide. (Student H)

Other students mentioned that all of these experiences strengthened the bond that the cohort had. They were able to interact outside of their learning, in a different environment than the on-campus apartments can provide.

Finding 6: The Iron Range Engineering program operates more like a real-life private engineering firm than a higher education institution. The structure and function of the IRE program breaks down barriers of what is a typical weekly college experience. Students do not have classes. They do not have a typical schedule. Their schedule is about their projects and their learning. However long it takes to get their projects completed and prove their mastery of topics (learning), it takes. Students were asked to describe their "typical week and typical day." The following response mirrored other responses:

> If you get your project done, your learning done, you can be here 20 hours a week or 80 hours a week, it's kind of up to you. This year we have it a lot more structured where we have project and industry time. We have some students who are working on finishing projects through their industry from the summer and who are also working making some money with industry. We also have every Tuesday and Thursday afternoons set up from 2 to 4 for learning conversations because we're supposed to learn…we have 8 (technical) learning competencies

> each semester we have to learn them and if you can't learn it in your project then you have to self learn it. So we have learning conversations for that. (Student B)

Just like when working in private industry, when meetings came up and opportunities presented themselves students were able to participate in learning experiences on a local industry site with very short notice if any notice at all.

> We did have the opportunities too if we did have to go to industry…we'd get a vehicle and we'd go to industry. It's very on demand type learning. We're very reactive to change so anything we need to do we just do it. We have to be self-sufficient. (Student F)

While students come into the day with a plan to get their various projects and learning done, their experiences are guided by their learning, and that could take them in a number of different directions, talking to instructors, working with other students, or picking up a textbook or other reading material on the Internet.

> We get here every day from 8 to 4. Usually mornings are project work… depending on the day and afternoons are learning and then…either learning conversations or independent learning. Picking up a textbook and reading it. Learning conversations are either led by a student or a member of the faculty and will involve a topic that is needed for one of the competencies. So for instance we had a conversation on advanced power cycles led by our instructor and involved our project and other members who weren't working on our project were there as well and it lasted for about two hours. And we have those three a week…then the self guided learning is for things you're not necessarily working on for your

> project or you realize it's something you need to learn and you grab a textbook and figure it out and if you have questions you talk to a member of the faculty or other students and try to fill in the gaps. (Student K)

There is nothing typical about the students' schedules on a day-to-day basis. This schedule is attempting to mimic what their experience will be like working in private industry upon graduation. There is also nothing typical about the way students are assessed.

Finding 7: Students are assessed using holistic methods. Students within the IRE program are assessed using multiple methods keeping in mind that everyone learns differently. During the document analysis portion of the data collection, it was revealed that students are assessed on a continuum from one to six in 60 different learning competencies which make up the third and fourth year of their baccalaureate degree in place of actual courses. Some of the learning competencies are (a) heat transfer, (b) thermodynamics, (c) fluid mechanics, and (d) material science (see Appendix F). Furthermore, students are asked to "build evidence" for their learning in the above competencies as well as the 44 other secondary competencies, including 28 professional (soft skill) competencies. Students need to prove to the instructors their learning based on a pre-agreed-upon rubric (the continuum of learning, one to six, described above), which is adapted from Bloom's Taxonomy of Learning. Types of evidence include but are not limited to (a) essays, (b) oral examinations, (c) learning reports, (d) learning reviews, (e) memos to industry, and (f) narratives of learning along with your more typical college examinations.

Students are also assessed through self-reflection, their peers, and faculty on the 28 professional (soft) skills. During the data collection students were asked about the process of assessing their learning and how they are graded within this program; they responded:

> You bring evidence in. They have a list of criteria that you have to know. They split the professional and design competencies up from the technical ones. So the design professional ones (soft skills) are being here on time, managing your project, getting the task done. The technical knowledge is your book work…then throughout the semester with everything we do (projects) we gather evidence, hard copies, electronic copies, oral interviews, and basically they gauge, between the four of them, the faculty members, how well you've proven your knowledge. (Student M)

Another student described the competencies:

> Competencies are just another name for your classes. Each one is broken down into one credit and you need 16 competencies I believe to fulfill your third and fourth years for graduation. And they (technical competencies) would be like fluid mechanics, statics, dynamics, thermodynamics, mechanics materials, those classes at an advanced level, as well as the professional ones. They're all grouped into one category. I don't know if it's one credit or three credits. Leadership, communication, public speaking, and things like that. (Student K)

Another student described the assessment method known as a design review:

> Yesterday I had our design review of our cement trowel project with our instructors. The first 45-50 minutes were spent presenting a PowerPoint of where we were at with the project. Along the way, they would prod us with questions and concerns they had with the design. Each design review we present the PowerPoint, which allows us to hone our presentation skills—answering questions under pressure that the consumer or others might have at our final presentation. The next 45 minutes were spent discussing and proving our learning that has taken place from the project. We are able to show how we have learned important topics and showcase our work at that time. The faculty will also give us more avenues of learning to take. Each design review from now to the end of the school year will have a portion showing the design and a portion that demonstrates our learning; it could be compared to a test or grading session. (Student O)

Students are required to demonstrate their learning to faculty and do so in a variety of different ways (see Appendix G).

Finding 8: Industry is integrated into the Iron Range Engineering program in a transformational way. IRE seems to pride itself on its connection and involvement with industry. Companies have provided students with job shadowing experiences, paid internships in the summer, guidance via an industry advisory board, but most of all industry has provided the program with projects off their shelves that their engineers are working on to serve as the centerpiece of the IRE students' learning. Students were asked

about how closely industry is involved with the program; their experiences were well represented by the following observation:

> Most of the projects are from some industry partner and most of them are obviously ones that industry could have done themselves but they're seen as a complex enough problem that it has to be done and it's worth someone doing but not too complex for second year or third year…second term juniors to accomplish so they're not easy but a little bit simplified. Like for Alaskan, we're designing a system to help them monitor plant performance…this year we're trying to tie the learning in to what our projects are doing as in what our project is concerned with, we're learning. And then we can tack other things on top of that. (Student J)

Another student provided a specific example of the project that he or she worked on with a local company:

> Well my last project was with Spring Creek Outfitters out of Mountain Iron (MN). And they design and manufacture canoe and kayak accessories, outriggers and stuff. And one thing with his company is he's kind of limited on resources and employment and he had an idea that he wanted to explore for a long time and he came to us with his idea and we kind of went through and developed it for him. (Student E)

Overall, students described the fact that these are real-life projects that have importance in the real world. They are not just experiences created for education sake. The students are in fact providing a service to the various companies that are participating, much like a local engineering firm would. Throughout the course of the semester, students are also

interacting with their industry contacts on a regular basis to insure that their project is meeting the needs of the company, very much like what a real engineer would do in the real world.

Finding 9: Overall, project-centered learning and the students' ownership over their learning has provided students with a positive experience. Much of the IRE program is based on projects, which are the centerpieces of where student learning and acquisition of competencies is meant to occur. Students were asked to describe the learning that goes on within the IRE program, how PCL fits with their learning style, and lastly what they see as the positive and negatives of this type of learning. The students described the positives of PCL as having "more lifelong learning. It actually has some application to it" (Student A). The students viewed the environment PCL promoted as much more dynamic than sitting in a lecture-based classroom. They felt they could learn more by using project-centered learning, a more hands-on approach, as opposed to other methods. They said:

> You don't have to sit in lecture all day. Sometimes with lectures you could be 10 minutes into it and you're already bored. You don't care. Here you learn what you want to learn but with the lecture you're stuck with it. (Student H)

The students also described the professional attributes project-centered learning hopes to develop. They said:

> I think we come away learning a lot more especially in the professional area. They've been looking for the program, the people to improve technically as well as professionally and working with other industries or clients. It's all teamwork.

> You're working together every day. When you go to a university you don't experience, you just go to class and you sit there and take tests. It's not just project-centered; it's real work experience. I think we could have students graduate from here just doing projects and going out in industry and do just as well as students who graduated from universities. I know that I can't remember that much I learned at my other school because it was lectures. You just learn it to take the tests and you don't necessarily retain it. That's what they've been trying to get us to do as well as to be more professional. (Student B)

Another student described the benefit and negatives to project-centered learning:

> The pros and cons are that you know what you don't know. What's it going to take to understand it? And when you finally go and get help, it's like Oh, here's why it is the way it is and all of a sudden in a matter of five minutes it all makes sense. So you're able to cement information that way. And the con is it's all on your own shoulders and it's hard to find direction. (Student G)

Students also saw the correlation between project-centered learning and being a more prepared employee upon graduation. One student said:

> The positives are it definitely gives you a real-world idea of what's going on. You hear horror stories of engineers leaving school and have absolutely no idea of how things work. They can just tell you the math behind it. And it gives us definitely an idea of what's going on and you get interaction with industry partners. And it pushes the professionalism because you end up talking to people in industry, and doing interviews, and making presentations, where, if you went to a four-year

> school and you sit in a classroom and do the work you're never going to have that interaction. (Student J)

Overall, students felt that PCL allowed for more retention and a more real-world approach to engineering education. They oftentimes compare their experience to experiences of other students who have attended a four-year university or other engineers who have had an experience working in industry. Above all, these students seem to want to improve on both the engineering education experience of students in general and what it means to be a practicing engineer working for a local company; they want to be the new standard for engineering graduates.

Finding 10: The type of engineering degree being delivered may lend itself nicely to students getting jobs more locally due to connections being made with local industry, and its lack of ABET accreditation and widespread name recognition for the time being. As any new program, the IRE program has yet to receive ABET accreditation, which is the national standard for any engineering program. Accreditation is not granted until the program has their first graduating class. The degree being offered through the IRE program is a Bachelor of Science in Engineering. The degree was originally developed to be a Bachelor of Science in Mechanical Engineering. Due to a number of different issues dealing with the long term sustainability of the program and the flexibility that "emphasis areas" can provide a program, the type of degree IRE is offering has been adapted. The new type of degree is more general than your typical mechanical and electrical engineering and also has a much shorter history than those traditional engineering degrees. It does, however, allow for more flexibility in

pedagogical approach. Students were asked about their employment prospects upon graduation since their degree has allowed them to work on industry sponsored projects alongside practicing engineers even though their degree does not carry the typical "mechanical" or "electrical" title. They answered in three ways. Students believed that having industry sponsored projects as the centerpiece of the curriculum and being able to put those projects on their resume will help no matter where they are applying for a job.

> It definitely helps. Just putting those projects on your resume and you have those big name industries on your resume already looks pretty darn good. It's an experience you can get at school without having to be out there and having a degree and get a job…you're getting experience right from school. (Student A)

They also believe that getting an interview is the key because then they can explain what their degree means.

> I would definitely say it will increase my chances of getting a job in the region. I would say it will increase my chances of getting a job period. And that is because when I go into an interview…the trick is outside the region. The trick is getting the interview. If they look at IRE and it's not on the list of schools they're going to hire from you're not going to get the interview. And then you don't have the opportunity to explain why your learning was better than the other option. So aside from that problem, once you get to the interview I think this style of education once I can get to explain it and say what, how and why and how much better it was, I think it will greatly increase my chances of getting a job. (Student D)

Finally, the students were already able to experience the business and design cycle that local companies put their engineers through on a day-to-day basis.

> I feel like the work we've done with industry, the things we've done, any of the first gen students could go out and get a job as an engineer right now. Just because I've seen engineers in the field and I've seen what they do and how they're just based on real-world application and I've seen all of us just do that. You really learn how business really works. And you learn to become organized, which is stuff I've never really had to deal with ever in my entire life. (Student G)

The program is helping to slow rural brain drain immediately. The program is closely tied with industry to the point that local companies will know about the program and get the "first choice" of the IRE graduates.

Summary

The preceding chapter has presented 10 findings that, via the words of students, define the distinctiveness and attractiveness of the IRE program in a collective effort to decrease rural brain drain in northeastern Minnesota. These findings, while not necessarily transferrable to others' situations, can serve as a guide for the implementation of other unique community college baccalaureate degree programs.

Chapter 5

Discussion and Conclusion

This chapter reviews the major findings that describe the IRE program, an upper division engineering program taught on a community college campus using PCL and integration with local industry in the context of the community college baccalaureate movement. Chapter 5 also discusses the implications of the findings. Finally, this chapter reviews the potential for future research on the IRE program.

In 2010 the state of Michigan attempted to join the list of 17 states that allow their community colleges to offer baccalaureate degrees. Through policy language, the Michigan state legislature is now considering allowing its community colleges to offer baccalaureate degrees in nursing, cement technology, maritime technology, nuclear technology, and culinary arts (MCCA, 2010). The arguments for and against this policy change are numerous and similar to the other historical arguments against this policy reform as described in Chapter 2. The main argument for the switch in policy is that community colleges offering baccalaureate degrees increases access (Cook, 2000; Walker, 2001). Furthermore, when there is an identified workforce need like in certain areas of Michigan, the view is that community colleges are positioned to adapt curriculum quickly and offer high-value baccalaureate degrees for less cost to the student and taxpayer (Walker, 1997). The arguments against this policy change in Michigan are that community colleges have had a specific mission for years and shouldn't change that (Wattenbarger, 2000). Community colleges offer students a terminal workforce degree, preparation to transfer to a university, and developmental education through an open

admissions process. Some say changing their mission now would result in the duplication of resources and potentially move community colleges away from open admission toward selective admissions which would decrease access to developmental education for the masses. Opponents also say there are many universities that could meet demand by partnering with community colleges much like the IRE program currently does and should consider community colleges offering baccalaureate degrees as a last resort (Wattenbarger, 2000). What makes the IRE program unique is not just that the program is offered on a community college campus. It is the way the program is offered. It is the pedagogy, not just the degree offered, that will attract students to rural locations in northeastern Minnesota and in the case of the IRE program it is both the degree offered and the pedagogy that is starting to attract students to the region and helping to stop rural brain drain.

The IRE program is attempting to increase collaboration with industry in a transformational way and bring the actual learning of students and the students' workforce readiness to the forefront of their education experience. If community colleges are planning on offering baccalaureate degrees on their campuses, they need to offer programs that will be an attraction because of the way they are taught, rather than being a similar program that is being offered down the road at the local university and competing for students. The findings of this study create the description of a program that is attempting to do something different pedagogically while also making a positive impact on the economic development of a region that is losing its young human capital to other major metropolitan areas in the region.

Summary of Findings and Implications

Finding 1: There was an attraction to living in rural northeastern Minnesota. One key to decreasing rural brain drain in northeastern Minnesota is to create opportunities for those students who want to stay, but students still have to want to stay. The communities of the Iron Range are perfect for those students looking to take advantage of outdoor recreation opportunities, industrial hands-on employment, or the characteristics of a small town. Admittedly, this is not for everyone. There are arguably more opportunities in terms of employment and entertainment generally in major metropolitan areas, which is the attraction of our young population.

Overwhelmingly, the students in the IRE program felt there was a reason they wanted to stay in this region. In some instances students said it was because this was near home and family lived nearby. Other students said they really enjoy hunting, fishing, and all the outdoor activities that this area provides. The implication and recommendation of this finding is that during the recruiting process there has to be a way to identify those students who want to live in this type of rural, small town region. It was, however, not the only reason why the students wanted to stay.

Finding 2: The students enrolled in the program because they were going to be experiencing a new pedagogical approach to engineering education, something transformational. The other big factor for students enrolling in this program was that this program was going to be different than the degree programs other local universities were offering. There were three students that had already attended a local four-year

university and did not like the experience very much and reverse transferred back to the IRE program because it was going to be taught in a different way.

The students from the IRE program felt that the hands-on experience working with industry would put them at an advantage when it came time to apply for a job. They also believed that the program and the way the program was taught was more in line with how students learn most effectively. In this way faculty know that each student is an individual and may learn in different ways rather than students going through a one-size-fits-all model of engineering education. It is recommended that community colleges, if they pursue baccalaureate degrees offerings, set themselves apart from traditional universities by offering a baccalaureate degree delivered with a unique pedagogy, much like the IRE program.

Finding 3: The students saw positives in living together on campus, much like a cohort. The IRE program requires that students live together during their first year together. The students themselves felt that this was helpful from a logistical perspective and from an academic perspective. They felt that living together allowed them to be able to function better in their academics when teamwork was needed. They felt more comfortable working on projects together, trusting that everyone was doing their work, and if necessary, to confront fellow classmates because they were so close. The living and learning model creates a cohesive unit, one that can bring upon trust and establish positive environments for programs. It is recommended that when starting new community college baccalaureate programs geared toward traditional students, a living and learning model of residence life should be incorporated at least initially.

Finding 4: The Iron Range Engineering students participated in two-year student life activities, but still felt a disconnect with the larger two-year campus community. Students attempted to become part of the Mesabi Range Community and Technical College community by participating in various student life events and activities. Despite these efforts students still believed they were viewed by the campus community as "special" because they received so much attention and financial support. They felt like they were segregated in their location of campus and they did not belong to the campus as a whole. This reiterates previous findings by Levin (2003). It is recommended that the dynamic between the two-year and four-year campus community be monitored and adjustments be made to blend the programming together in a positive way.

Finding 5: Iron Range Engineering offers its students a robust student life experience further cementing the living and learning model of the program. Besides living together on campus, the IRE students were able to take advantage of numerous student life opportunities that were sponsored by the IRE program. The IRE program was designed to allow the students to have ownership over their academic experience and student life experience. The students felt the experiences they picked were fun and exciting and helped bring the students together. While their experiences may not be unique, what is unique is how many experiences they were able to participate in. The program had a robust student life budget. The student life budget was robust because it was felt by administration and faculty that the students were (a) taking a risk by attending this new program, (b) not able to participate in their home campus's (Minnesota State

University, Mankato) student life activities due to the campus being five hours away, and (c) this in turn would allow students to bond and in turn positively affect their own academic performance.

It is recommended that a robust student life budget be incorporated into any community college baccalaureate program. Community college baccalaureate programs do not have the same fanfare that goes along with a traditional university in terms of athletics or student life. A robust student life budget can help alleviate those differences. Additionally, the on-campus living experience promoted in the IRE program encourages students to have a complementary living-learning experience**.** Sometimes the line between the two becomes blurred to the point where students are learning more together, even when they are supposed to be doing something for fun, or vice versa. While some students were annoyed by the amount of time they were spending together, they overwhelmingly felt that all of these experiences had a positive impact on the academic side of the program.

Finding 6: The Iron Range Engineering program operates more like a real-life private engineering firm than a higher education institution. The IRE students operate on a schedule much like a private engineering firm office. They show up Monday morning at around eight o'clock. They do not leave until four in the afternoon and sometimes later if there is a need to put in extra work on their projects or learning competencies. There are no classes. The students own their learning and are able to schedule their day-to-day activities as they see fit to ensure they are gaining the skills they need. A few students even said there was nothing typical about their daily and

weekly schedule; it changes every day. The student interaction with instructors varies depending upon what the students' individual needs are at the time. If students need direct instruction on a certain topic, they schedule "learning conversations" about a certain topic.

This is meaningful because students in the IRE program register for a block of credits rather than individual classes and are putting in a significant amount more time on a day-to-day basis than their traditional university counterparts. This program does not follow typical Carnegie unit requirements that traditional universities follow**.** Student registration for block-credits allows for required compliance with federal financial aid regulations**.** It is recommended that community college baccalaureate programs push the boundaries of what it traditionally means to earn a degree with regards to student seat time and faculty time.

Finding 7: Students are assessed using holistic methods. Students are assessed in a variety of ways. Each student in the program has different needs and is tracked according to those unique needs. Student learning is based on 60 different competencies, which at a traditional school would be within courses that are assigned various credit amounts. Students in the IRE program need to build evidence of their mastery of the competencies for their instructors. Since industry sponsored projects are the centerpiece of this program, the projects themselves can help show mastery of some or all of the competencies. Additional evidence of mastery for the programs' assessment are (a) essays, (b) oral examinations, (c) learning reports, (d) learning reviews, (e) technical design reports, (f) technical design reviews, (g) final examinations, (h) memos to

industry, (i) lab reports, (j) lab write-ups, (k) various PowerPoint presentations, and (l) narratives of learning.

The IRE program allows students to demonstrate their understanding using a variety of different assessment methods and the choice is up to the student for the most part. This is an example of a program not trying to fit a student to a system, but of a system adapting to a student's learning needs. It is recommended that community college baccalaureate programs adopt a different type of assessment model, one that requires student motivation and student ownership over their learning.

Finding 8: Industry is integrated into the Iron Range Engineering program in a transformational way. Much of what makes the IRE program unique is its connection with industry. In traditional engineering programs, students will have internship experiences at the end of their degree program or they will have a senior level project that is within the final semester of class that may be industry sponsored. In the IRE program industry is involved from the beginning and throughout the coursework. Since the IRE program operates like a private engineering firm, the students are able to have a variety of industry experiences. One example is job shadowing. Students can in the middle of the semester, regardless of scheduling and courses (since there are no courses), follow a local engineer around on-site at local industry.

Besides job shadowing experiences, industry has been a part of the planning and continues to be involved on a day-to-day basis with the program. This connection really allows the students to be a resource for any local industry that needs engineering expertise. The implication from this finding is that the higher education system does not

go far enough to allow engineers to be job-ready on their first day of employment. We need to rethink the way industry is used in classrooms. Industry integration should not just be an internship or capstone experience at the end of a program, but rather be integrated in a meaningful way through the curriculum. Another way industries are constantly involved is with the project-centered learning.

Finding 9: Overall, project-centered learning and the students' ownership over their learning has provided students with a positive experience. Project-centered learning, in the students' opinions, will give them an experience that other students will not get at any other institution. The IRE program allows students to experience and learn the full design process that real-world engineers use on the job and it gives them an ongoing connection with local industry that students are not getting in other engineering programs. At the beginning of each project cycle students have to meet with leaders of the company that are sponsoring their project. Those leaders usually hold a meeting with the students and present the students with the project specifications. The students then take their project specifications and develop the design project in consultation with their respective company contacts. Upon completion of their project, students then present the project back to the company in a presentation format in which the company gives constructive feedback and advice.

This type of industry connection is meaningful because the projects (a) serve as the centerpiece of the students competency learning, (b) allow students to interact with companies like they would upon graduation, and (c) are services that are provided to companies and in the future these services could help the program generate revenue and

long term sustainability. Overall, the projects are the main product of the program and also serve as another example of how the program operates like a private engineering firm.

Finding 10: The type of engineering degree being delivered may lend itself nicely to students getting jobs more locally due to, connections being made with local industry, and its lack of ABET accreditation and widespread name recognition for the time being. Students of this program believe that upon graduation their job prospects will be better locally, rather than in other portions of the state because of (a) the new type of degree that is being offered, (b) the program is not yet ABET accredited, and (c) the close connection with local industry and the design projects that students have worked on for these companies. Upon ABET accreditation and once the program is more well known, the degree then may have more of a national and statewide impact. For the time being, this program is immediately helping to decrease rural brain drain in northeastern Minnesota.

Recommendations for Further Research

This descriptive case study touches on just one researchable element of the IRE program. There are numerous opportunities for further research dealing with the faculty voice, student employment outcomes, business interest, comparative analyses with other university engineering programs, and other broader research opportunities associated with the community college baccalaureate concept.

Future research is needed to determine where the students find employment upon completing the program**.** Additional study of the nature of that employment and

compensation is also warranted. This potential area of research could further answer the question of whether the program helps to eliminate or slow rural brain drain in northeastern Minnesota.

Another opportunity for future research would come from the business sector. It would ask the questions, "How do you feel about the graduates of the IRE program or about the program in general? Since the level of industry involvement is promoted as being transformational, what does industry themselves think about the program? How involved are businesses with the IRE program?"

A third opportunity for research would be a comparative analysis of the IRE program and another regional university's traditional engineering program graduates. The comparative analysis would consist of comparing (a) student FE exam scores, which is the first major exam in a graduating engineer's path to professional engineering licensure; (b) comparing grades and grade point average; and finally (c) surveying students in both programs about their experiences**.**

The story of the IRE program is missing an important piece: the faculty and administrative voice during development. There are multiple faculty members and administrators from Minnesota and from major universities across the country who have been a part of the implementation of the IRE program at one point or another through advisory groups, direct instruction, or during the development stages. It is important at some point to capture their voice through the development process.

Finally, there are additional research opportunities dealing with the outcomes of community college baccalaureate graduates with regards to their job search upon

graduation. Are students with community college baccalaureate degrees getting better jobs or lower-level jobs in comparison to their traditional university counterparts? Are they successfully being admitted to graduate schools? These questions would all help answer the broader question, "Is a community college baccalaureate degree more or less valuable than a traditional baccalaureate degree?"

Summary and Conclusion

Rural brain drain in northeastern Minnesota is very real. The communities of rural northeastern Minnesota are attempting in some way, shape, or form to make their communities more attractive to young people who are leaving the area in rapid numbers. The IRE program is attempting to help solve this problem on a small scale by offering a bachelor's degree in engineering on a community college campus located on the Iron Range. This would increase access to a baccalaureate degree for students who want to stay in the area after attending a local community college. The real excitement that is generated by the IRE program is the fact the program is beginning to draw students from major metropolitan areas to the Iron Range because of the pedagogy of the program. The project-centered learning, student ownership of their experience, and the integration of industry create a powerful and dynamic higher education environment, one that has been supported for years but rarely acted on as evidenced by the following:

> Dry and lifeless text book recitation work yields by itself little enough that is desirable, while the pure lecture method is equally unsatisfactory. The one is uninteresting routine and utterly ill adapted to the development of mental fertility and strength, while the other involves a mass of misdirected labor on the part of

> the lecturer, which, without supplementary exercises, leaves the student to shift for himself, without producing much of any result. The main purpose is to convey instruction, and it should be done in such a way as to induce the student to do his own thinking. No instructor can justify himself in merely puzzling the student with grotesque problems, or in harassing him with abnormal difficulties, but on the other hand the student should be made constantly to feel himself a working part of the system, and that he cannot, without serious loss to himself, take a mere passive part. (Burr, 1894, as cited in Lohmann, 2004, n. p.)

Students learn most effectively by doing, and by seeing the real-life application of their work (Bransford et al., 1999). That is why community colleges, especially those in rural communities should offer baccalaureate degrees taught in unique and creative ways like the Iron Range Engineering program. The support from local industry, a regional state economic development agency, administrators, and faculty from around the country is creating an environment that will have a net-positive impact on the region and most importantly help stop rural brain drain.

References

Albertson, H., & Wattenbarger, J. (2007). *A succinct history of the Florida community college system*. Retrieved from www.facc.org.

Artz, G. (2003). Rural area brain drain: Is it a reality? *Choices, 4*, 11-16.

Bereiter, C. (2002). *Education and mind in the knowledge age*. Mahwah, NJ: Lawrence Erlbaum and Associates.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (1999). *How people learn: Brain, mind, experience, and school.* Washington, DC: The National Academies Press.

Burr, W. M. (1894). The ideal engineering education. *Society for the Promotion of Engineering Education, 1,* 17-49.

Caine, R., & Caine, G. (1994). *Making connections: Teaching and the human brain.* Alexandria, VA: The Association for Supervision and Curriculum Development.

Carr, P., & Kefalas, M. (2009a). *Hollowing out the middle: The rural brain drain and what it means for America.* Boston: Beacon Press.

Carr, P., & Kefalas, M. (2009b). The rural brain drain [Electronic version]. *The Chronicle of Higher Education*. Retrieved from http://chronicle. com/article/The-Rural-Brain-Drain/48425/

Cohen, A. M. (1990). The case for the community college. *American Journal of Education, 98,* 426-442.

Cohen, A. M., & Brawer, F. (2003). *The American community college*. San Francisco: Jossey-Bass.

Cook, A. (2000). *Community college baccalaureate degrees: A delivery model for the future?* Denver: Education Commission of the States. Retrieved from ERIC database. (ED439765)

Creswell, J. W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.

Creswell, J. W., & Miller, D. L. (2000). Determining validity in qualitative inquiry. *Theory into Practice, 39*(3), 124-131.

Cross, K. P. (1998). Why learning communities? Why now? *About Campus*, *3*(3), 4-11.

Eaton, J. (2005, October 28). Why community colleges shouldn't offer baccalaureates [Electronic version]. *Chronicle of Higher Education*. Retrieved from http://chronicle. com/article/Why-Community-Colleges/22874/

Evelyn, J. (2003, April 11). Making waves in Miami: A leading community college offers bachelor's degrees, reflecting national tension between 2- and 4-year sectors [Electronic version]. *Chronicle of Higher Education.* Retrieved from http://chronicle. com/article/Making-Waves-in-Miami/6564/

Floyd, D. L. (2005). Community college baccalaureate in the U. S. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues* (pp. 25-47). Sterling, VA: Stylus.

Floyd, D. L. (2006). Achieving the baccalaureate through the community college. In D. D. Bragg & E. A. Barnett (Eds.), *New directions in community colleges* (pp. 59-72). San Francisco: Jossey-Bass.

Floyd, D. L. , & Skolnik, M. L. (2005). Perspectives on the baccalaureate. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends & policy issues* (pp. 1-7). Sterling, VA: Stylus.

Floyd, D. L. , Skolnik, M. L. , & Walker, K. P. (Eds). (2005). *The community college baccalaureate: Emerging trends and policy issues*. Sterling, VA: Stylus.

Floyd, D. L., & Walker, K. P. (2009). The community college baccalaureate: Putting the pieces together. *Community College Journal of Research and Practice, 33,* 90-124.

Furlong, T. E., Jr. (2005). St. Petersburg College. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends & policy issues* (pp. 103-127). Sterling, VA: Stylus.

Gellar, H. (2001). *A brief history of community colleges and a personal view of some issues*. George Mason University. Retrieved from ERIC database. (ED459881)

Glennon, K. (2005). *Community college baccalaureate degrees: A review of issues, policies, and other states' programs*. Retrieved from http://www4.nau.edu /insidenau/bumps/12 7 05/Four year degree report. pdf

Glesne, C. , & Peshkin, P. (1992). *Becoming qualitative researches: An introduction.* New York: Longman.

Grant, M. M. (2002, Winter). Getting a grip on project-based learning: Theory, cases and recommendations. *Meridian: A Middle School Computer Technologies Journal*, 5.

Ip, G. (2008, July 17). The declining value of your college degree. *The Wall Street Journal*. Available from http://online.wsj.com/home-page

Iron Range Resources & Rehabilitation Board. (2009, Spring). It's more than ore. *Range View*. Retrieved from http://www.irrrb. org/_site_components/lists /aboutrangeview/RV09Spring.pdf

Iron Range Resources & Rehabilitation Board. (2010). *Minnesota economic development incentives for businesses*. Retrieved from http://www.ironrangeresources.org /?gclid=CPr4377diqcCFcXD7Qod7TKv3g#

Kane, T. J., & Rouse, C. E. (1999). The community college: Educating students at the margin between college and work. *Journal of Economic Perspectives, 13*, 63-84.

Keller, J. (2009). California's 'gold standard' for higher education falls upon hard times [Electronic version]. *Chronicle of Higher Education*. Retrieved from http://chronicle. com/article/Californias-Gold-Standard/44468/

Kerns, S. E. , Miller, R. K. , & Kerns, D. V. (2005). Designing from a blank slate: The development of the initial Olin College curriculum. In *Educating the engineer of 2020: Adapting engineering education to the new century* (pp. 71-82). Washington, DC: The National Academies Press.

Laden, B.V. (2005). The new ABD: Applied baccalaureate degrees in Ontario. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues.* Sterling, VA: Stylus.

Lattuca, L. R. , Terenzini, P. T. , & Volkwein J. F. (2006). *Engineering change: A study of the impact of EC2000* [Executive summary]. Baltimore: ABET.

Levin, J. (2003). Organizational paradigm shift and the university colleges of British Columbia. *Higher Education, 46*, 447-467.

Levin, J. (2004). The community college as a baccalaureate-granting institution. *The Review of Higher Education, 28*(1), 1-22.

Levin, J. S. (2002, November 21). *Institutional identity: The community college as a baccalaureate degree granting institution.* Paper presented at the annual meeting of the Association for the Study of Higher Education, Sacramento, CA. Retrieved from ERIC database. (ED474578)

Lohmann, J. R. (2004, October). The ideal engineering education. *Journal of Engineering Education*. Retrieved from http://findarticles.com/p/articles/mi_qa3886/is_200410 /ai_n9470225/

Lorenzo, A. L. (2005). The university center: A collaborative approach to baccalaureate degrees. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues.* Sterling, VA: Stylus.

Macomb Community College. (2010). *Bachelor's and master's degree options*. Retrieved from http://www.macomb.edu/University+Center/Bachelors+and+Masters +Degree+Options.htm

Manzo, K. K. (2001) Community colleges: Breaking on through to the other side. *Community College Week, 13*. Retrieved from Professional Development Collection database.

McKee, J. V. (2001). *Factors and issues surrounding development of one community college baccalaureate degree program* (Unpublished doctoral dissertation). Oregon State University, Corvallis.

McKee, J. V. (2005). Westark's workforce baccalaureate. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues* (pp. 129-138). Sterling, VA: Stylus.

Merriam, S. (1988). *Case study research in education*. New York: Teachers College, Columbia University.

Michigan Community College Association. (2010). *Legislative summary: Community college authority to grant baccalaureate degrees in applied and technical areas*. Retrieved from www.mcca.org/content.cfm?m=25&id=25&startRow=1&mm=0

Milliron, M. D. (2005). Forward. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues* (pp. ix-xi). Sterling, VA: Stylus.

Mills, J. E., & Treagust, D. F. (2003). Engineering education: Is problem-based or project-based learning the answer? *Australian Journal of Engineering Education* [Electronic version]. Retrieved from http://www.aaee.com. au/journal/2003 /mills_treagust03.pdf

Mills, K. (2003). Community college baccalaureate: Some critics decry the trend as ―mission creep. *National Crosstalk.* The National Center for Public Policy and Higher Education. Retrieved from http://www. highereducation.org/crosstalk /ct0103/news0103-community.shtml

Minnesota Office of Higher Education. (2006, April). Minnesota high school graduates will peak in 2009. *Insight Newsletter.* Retrieved from http://www.ohe.state.mn. us/pdf/Enrollment/INSIGHT/InsightApr06.htm

Muffo, J., & Voorhees, R., & Hyslop, L. (2008). *An analysis of the feasibility for the bachelor's degree in applied science and technology in the state of Michigan*. Retrieved from http://www.mcca.org/uploads/fckeditor//file /Michigan%20Applied%20Baccalaureate%20Report.pdf

O'Banion, T. (1997). *A learning college for the 21st century.* Phoenix: Oryx Press.

Olin College of Engineering. (2010). *Overview*. Retrieved from http://www.olin.edu /student_life/overview.aspx

Oloffson, K. (2009, December 8). The job market: Is a college degree worth less? [Electronic version]. *Time Magazine.* Retrieved from http://www. time. com/time /business/article/0,8599,1946088,00.html

Pedersen, R. P. (2001). You say you want an evolution? Read the fine print first. *Community College Week,* 13.

Planty, M., Hussar, W., Snyder, T., Kena, G., KewalRamani, A., Kemp, J., Dinkes, R. (2009). *The condition of education 2009* (NCES 2009-081). Washington, DC:

National Center for Education Statistics, Institute of Education Sciences, U. S. Department of Education.

Prados, J. W. (1998). *Engineering education in the United States: Past, present, and future*. Proceedings of the International Conference on Engineering Education, Rio de Janeiro, Brazil.

Prince, M., & Felder, R. M. (2006). Inductive teaching and learning methods: Definitions, comparisons, and research bases. *Journal of Engineering Education, 95*(2), 123-138.

Pundak, D., Rozner, S., Yacobson, F., & Toledano-Kitay, D. (2008). How to adopt active learning*? Al Hagova – Journal on Teaching in Higher Education, 7*, 18-21.

Seely, B. E. (2005). Patterns in the history of engineering education reform: A brief essay. In *Educating the engineer of 2020: Adapting engineering education to the new century* (pp. 83-96). Washington, DC: The National Academies Press.

Seidman, I. (1998). *Interviewing as qualitative research: A guide for researchers in education and the social sciences.* New York: Teachers College Press.

Sertich Consulting. (2009, October). *Arrowhead Institute of Technology: A comprehensive plan for providing post secondary, upper division, and graduate technical education in northeastern Minnesota*. Retrieved from http://www.itascacc.edu/academics/programreview/2010/ait_complanindtech2010.pdf

Sheppard, S. D. , Macatangay, K. , Colby, A. , & Sullivan, W. M. (2008). *Educating engineers: Designing the future of the field*. San Francisco: Jossey-Bass.

Skolnik, M. (2009). Theorizing about the emergence of the community college baccalaureate. *Community College Journal of Research and Practice, 33*(2), 125-150.

Skolnik, M. L. (2001, February). *The community college baccalaureate: Its meaning and implications for the organization of postsecondary education, the mission and character of the community college, and the bachelor's degree*. Paper presented at the First Annual Community College Baccalaureate Association Conference, Orlando, Florida.

Skolnik, M. L. (2005). The community college baccalaureate in Canada: Addressing accessibility and workforce needs. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues* (pp. 49-72). Sterling, VA: Stylus.

Skolnik, M. L., & Floyd, D. L. (2005). Community college baccalaureate: Toward an agenda for policy and research. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends & policy issues* (pp. 191-198). Sterling, VA: Stylus.

Smith, B., & MacGregor, J. (1992). What is collaborative learning? In A. M. Goodsell, V. Tinto Mahler, B. L. Smith, & J. MacGreger (Eds.), *Collaborative Learning: A sourcebook for higher education.* University Park, PA: National Center on Postsecondary Teaching, Learning and Assessment.

Somerville, M., Anderson, D., Berbeco, H. , Bourne, J. R. , Crisman, J., Dabby, D., Zastavker,Y. (2005). The Olin curriculum: Thinking toward the future. *IEEE Transactions on Education, 48*(1), 198-205.

Stake, R. (1995). *The art of case study research*. Thousand Oaks, CA: Sage.

Thomas, J. W. (2000). *A review of research on project-based learning*. San Rafael, CA: Autodesk Foundation.

Tillery, D., & Deegan, W. (1985). The evolution of two year colleges through four generations. In W. Deegan & D. Tillery (Eds.), *Renewing the American community college: Priorities and strategies for effective leadership* (pp. 3-33). San Francisco: Jossey-Bass.

Tinto, V. (2000). Learning better together: The impact of learning communities on student success in higher education. *Journal of Institutional Research, 9*(1), 48-53.

Townsend, B. K. (2001). *The shrinking divide between upper and lower division courses: A baccalaureate meltdown?* Columbia, MO: Missouri University. Retrieved from ERIC database. (ED346082)

Townsend, B. K. (2005). A cautionary view. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues.* Sterling, VA: Stylus.

Vest, C. M. (2005). Educating engineers for 2020 and beyond. In *Educating the engineer of 2020: Adapting engineering education to the new century* (pp. 119-125). Washington, DC: The National Academies Press.

Walker, K. P. (1997). Should community colleges offer bachelor's degrees? *Community College Times,* 1-6.

Walker, K. P. (2000). The community college baccalaureate degree [Electronic version]. *Trustee Quarterly*, *3*, 13-16.

Walker, K. P. (2001). *An open door to the bachelor's degree* [Leadership abstracts]. Phoenix: The League for Innovation in the Community College.

Walker, K. P. (2002). The case for the community college baccalaureate degree. In R. Lundberg (Ed.), *U. S. society & values* (pp. 15-17). Washington, DC: U. S. Department of State. Retrieved from ERIC database. (ED469783)

Walker, K. P. (2005). History, rationale, and community college baccalaureate association. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends & policy issues* (pp. 9-23). Sterling, VA: Stylus.

Walker, K. P. , & Floyd, D. L. (2005). Applied and workforce baccalaureates. In D. L. Floyd, M. L. Skolnik, & K. P. Walker (Eds.), *The community college baccalaureate: Emerging trends and policy issues.* Sterling, VA: Stylus.

Washington State Board of Community and Technical Colleges. (2010). *Transfer*. Retrieved from http://www.sbctc.ctc.edu/college/e_transfer.aspx

Wattenbarger, J. (1971). The future of the community junior college. *Peabody Journal of Education*, *48*(4), 307-313.

Wattenbarger, J. (1974). Community college curriculum: Establishing and implementing institutional objectives. *Peabody Journal of Education, 51*(2), 107-113.

Wattenbarger, J. (2000). Colleges should stick to what they do best. *The Community College Week, 12*(18), 4-5.

Wattenbarger, J. L., & Witt, A. (1995). Origins of the California system: How the junior college movement came to California. *Community College Review*, *22*(4), 17-25.

Appendices

Appendix A

Iron Range Engineering Program Director Introduction of Research Script

Trent Janezich, the Director of Arrowhead University Consortium is a student in the Ed. D. in Teaching and Learning program at the University of Minnesota-Duluth. He is working on a research study about Iron Range Engineering and the opinion's you have about what we are doing. I am hoping all fourteen of you will take the time out to participate in this research study. It is important to know that any descriptions of the Iron Range Engineering program that you give, both positive and negative, will not get you extra credit, or get you into trouble with anyone associated with this program. In fact, what is said in these interviews will be kept confidential by Trent through the FERPA guidelines that protect all of your privacy at any higher education institution. Moving forward, there is a tremendous opportunity for you, as students, to create a best practice for what types of programs should be offered on community college campuses in the future. It is Trent's hope that your opinions and descriptions will help make policy decisions in the future to bring more programs like Iron Range Engineering to the communities of rural northeastern Minnesota. If you are interested in participating in this study, please come and sign up for an interview and pick up a informed consent form. Please read it thoroughly and if you feel comfortable, sign it, if you do not want to participate, do not sign it, if you have questions please feel free to talk to me. If you aren't sure, and want to wait, you can bring your consent form to the interview with you and just hand it to Trent.

Appendix B

Iron Range Engineering Pre-Interview Script

Are you aware of any risks and benefits for your participation in this study? Please explain. What this project is all about is you defining your Iron Range Engineering program experience, living and getting your degree on a community college campus, learning in the way you learn in this program, and projecting out what this program means for you in the future. Do you have any questions about the informed consent form you filled out? It is important that you know your name will not be associated with any of the information we talk about. In fact after I transcribe this interview, you name won't ever be associated with this data again. I want to make sure you are comfortable, so if there are any questions you don't want to answer, please let me know and you can pass on them. Do you have and questions at all before we get started?

Appendix C

Research Consent Form

Iron Range Engineering: Limiting "Rural Brain Drain" in Northeastern Minnesota by offering regionally significant and unique hands-on baccalaureate degrees on community college campuses.

You are invited to be in a research study of the Iron Range Engineering program, its defining characteristics, and whether or not those defining characteristics could help limit "rural brain drain" in Northeastern Minnesota. You were selected as a possible participant because you are enrolled in and experiencing this program. We ask that you read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by: Trent Janezich, a student in the Doctorate of Education program at University of Minnesota-Duluth.

Background Information:

The purpose of this case study is to ascertain whether or not the Iron Range Engineering program, in its first year of existence, has provided students with an experience that will help them to earn their degree and obtain employment all while not leaving the communities of the Iron Range by describing, in their own words, the experience of (a) choosing this specific community college baccalaureate program for their upper division experience, (b) being part of a baccalaureate degree program on the campus of a community college in northeastern Minnesota, and (c) being part of a unique professional engineering baccalaureate degree program where the curriculum focuses on real life, industry-sponsored projects and experiences.

Procedures:

If you agree to be in this study, we would ask you to do the following things:

- Participate in a 1 hour one on one interview with the researcher on campus at Mesabi Range Community and Technical College.
- Allow that interview to be recorded via digital audio recorder.
- The interview will consist of you providing your honest opinion about the Iron Range Engineering program.

Risks and Benefits of being in the Study:

There are very minimal to no risks to participating in this study.

There are no benefits to participating in this study as well.

Compensation:
You will not receive any payment of compensation for agreeing to participate in this study. You will also not receive any priority standing or "extra credit" in any of your coursework for participating in this study.

Confidentiality:
The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records. Upon completion of the transcription (1 month), the recordings will be destroyed.

Voluntary Nature of the Study:
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University of Minnesota, the University of Minnesota-Duluth, Minnesota State University, Mankato, Arrowhead University, and any of the colleges within Northeast Higher Education District. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:
The researcher conducting this study is Trent Janezich. You may ask any questions you have now. If you have questions later, you are encouraged to contact him at 4621 5th Ave West, Hibbing, Mn, 55746, 218-208-7054, janez011@d.umn.edu, or contact his advisor, Dr. Frank Guldbrandsen at, 218-726-8172 or fguldbra@d.umn.edu.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher(s), you are encouraged to contact the Research Subjects' Advocate Line, D528 Mayo, 420 Delaware St. Southeast, Minneapolis, Minnesota 55455; (612) 625-1650.

Appendix D

Interview Questionnaire

1. What was it that attracted you to this program when deciding what college to transfer to?
a. Please describe your thought process for deciding.

2. Were you planning on attending somewhere else?
a. If yes, where and why?

3. Did you want to stay in the region?
a. If yes, what is it about this region? If no, what is it about this region?

4. What are your plans upon graduation? How do you feel about working and living in the area?

5. Please describe your student life activities within Iron Range Engineering?

6. What is it like living with the other members of the engineering program?

7. What is it like living in the same residence hall as Mesabi Range Community and Technical College students?

8. Did you participate in Mesabi Range Community and Technical College activities?
a. If yes, why? If no, why not?

9. Overall, was your experience living on campus a positive one or negative one?
a. Please explain?

10. Please describe your typical school week and school day?

11. What is it like going to class in the Iron Range Engineering program?
a. Positive or Negative, please explain

12. Describe industries involvement and their relationship with the Iron Range Engineering program and the coursework.

13. You are taking part in a project-centered learning where you work on real world projects supplied by industry. Please describe the industry design project. What do you see as the positives, if there are any, or the negatives, if there are any, to this type of learning environment?

14. Do you think this program, with the type of curriculum you have described will help or hurt your chances of getting a job in the region, why? Please Explain.

Appendix E

Raw Initial Meaningful Quotations

Finding 1: There was an attraction to living in rural northeastern Minnesota.

-1-

"I love Northern Minnesota. I've always been into hunting, fishing, camping and it's what everyone does around here. I grew up in a small town, I graduated with 18 kids. I like having my family close, and all my friends close. Everyone seems to know everybody" (Student B).

-2-

"Probably the outdoors activities, the hunting and that. And with the mines and stuff. It seemed like one of those jobs where you wouldn't be in an office all day you'd actually have the opportunity to do something like that" (Student A, Interview, 2010).

-3-

"It's the outdoors and the hunting and the fishing and you name it. Also just family, some of my family lives in the cities but a majority lives up here. That's why I chose to come here" (Student H, Interview, 2010).

-4-

"I hope to be able to stay in an area that I enjoy such as the Iron Range. I like the small town lifestyles people have in the area. I don't want to be stuck in an office all day, glued to a computer screen for twelve hours a day, or have to worry about traffic on my morning commute" (Student A, Document Analysis, 2010).

-5-

"Everything I grew up with, the outdoors, everything. You can't get this in the city unless you travel. Go hunting or fishing, that kind of thing" (Student M, Interview, 2010).

-6-

"My sister lives in Chisholm so that's not very far away. It was kind of nice" (Student N, Interviews, 2010).

-7-

"I didn't want to go far away…I'd like to stay around here" (Student B, Interview, 2010).

-8-

"But when I go down to the Cities I don't want to be there. I don't. I mean we can go back to hunting and fishing, that's a huge part of it but, raising a family here is the ultimate goal. I just see it matching my lifestyle, matching my interests. It just lines right up. It's hard to describe in words but…it's what…you've grown up and that's the norm for you. And that's what you want to continue doing. Support your lifestyle" (Student F, Interview, 2010).

Finding 2: The students enrolled in the program because they were going to be experiencing a new pedagogical approach to engineering education, something transformational.

-1-

"Working in real world engineering settings would allow us to see real applications and give us a better meaning of what goes on behind the calculations. Taking part in various companies would give me a better feel for a work-like setting. Also taking part in various jobs given by the companies will allow for more freedom in creativity and design. That is sometimes lost in lecture classrooms at most common four year universities" (Student G, Document Analysis, 2010).

-2-

"I have already had the big college experience because I attended last year. It didn't turn out the way I had hoped it would. The learning at IRE involves real engineering experience, real engineering applications, and real life problems and constraints. In other words, it involved real learning. I believe that being able to have real work experience would put me far ahead of others, who have been learning mainly from reading textbooks and taking quizzes" (Student H, Document Analysis, 2010).

-3-

"Whether it is the new style of learning involved, the student life, or the ability to be part of the design process, I am intrigued by this new program" (Student I, Document Analysis, 2010).

-4-

"The first aspect that stood out to me was the ability to not only learn in the classroom but venture into the real world to learn and apply new knowledge. What better way to learn engineering than to actually work with real engineers on real engineering projects. I feel that being able to visualize concepts in school, and applying them outside of school will keep us from falling into a boring routine" (Student I, Document Analysis, 2010).

-5-

"The first reason I want to participate is my belief that assumptions of the current engineering educational system are obsolete in comparison to current engineering practices. The other main reason that I would like to participate in the innovative engineering program is that in my time at my current university, I feel my learning has stagnated. Over the past three years, I have taken courses at two different institutions. At each of these institutions, I was taught that each person has a unique way of learning and each person has a unique set of skills and knowledge. However, the traditional way to educate students assumes that all students learn in the same way; that all students learn by watching the instructor do problems, derive equations, or work out examples on a white board. Traditional education also assumes that all students come into class having a similar set of knowledge. In reality, some students know the material being

presented and it stagnates their learning. Other students don't know anything about the material being presented and struggle to keep up, which often times discourages their desire to learn. In classes I have taken, I have been on both sides of this spectrum and neither of them is conducive to truly understanding the material. I feel that the Iron Range Engineering program's new approach to teaching would be exactly what I need to learn the material and techniques I will need to integrate into the engineering profession" (Student K, Document Analysis, 2010).

-5-

"The other big selling point is that I own my education. It was up to me. It was going to be designed as a consulting firm. That's how we were going to operate. We were going to get projects from business and industry. We had to learn what we needed to get the project done and we didn't have to take all that extra stuff" (Student M, Interview, 2010)

-6-

"The hands on experience. Getting to work with industry. Seeing what's out there. Seeing how real engineering works. That's the biggest thing" (Student E, Interview, 2010).

-7-

"Mostly because I went to another four year institution for a year and I liked the idea of not having to be in a class with 200 people and not know the teacher and I liked the idea of learning hands-on and not sitting in a classroom. I never liked that environment" (Student C, Interview, 2010).

-8-

"I am very book smart. I have the ability to take knowledge from the books and I could easily succeed in any university I could get into. This program would give me the opportunities to get knowledge and skills that other universities wouldn't give me the opportunities to gain. The professionalism, the social skills, the learning why this particular thing works the way it does and why you put it there. Most of them are all focused on the how and the science of it and I can learn that if I want to but what I have trouble with is the application of all these things. At this program I get the exposure to the applications, the projects, the people that give me the skill set I don't currently have" (Student D, Interview, 2010).

-9-

"And I went through and I was thinking to myself I wasn't excited about going to any of the schools I applied to. I applied to a couple in North Dakota and the cities. I saw all of the programs and none of them had excited me. But as soon as I heard about this and what they were doing and how it was going to be different I was excited. I could have some control over my own learning. I could go at my pace. I can get knowledge from not only a small subset of instructors who may not care whether I learn, but also all the students and resources that they can gather. So that's why I came" (Student D, Interview, 2010).

-10-

"The fact that it was supposed to be project centered. We were supposed to work with industry and in industry and learn everything through projects. That's what attracted me most to the program" (Student N, Interview, 2010).

Finding 3: The students saw positives in living together on campus, much like a cohort.

-1-

"It helped and in the chemistry of being able to trust people to do stuff. At the same time…you had a power struggle, when one person was doing work and stuff and the rest of the people weren't doing stuff you could have some swinging there if the rest of the people weren't doing it" (Student A, Interview, 2010).

-2-

"It was great. They'll be life-long friends. As opposed to…I mean you don't make as many friends as at a big four-year school but the quality of the friends is so much better just because how close we are at work and school and everything. We do everything together" (Student A, Interview, 2010).

-3-

"I don't know if I can clarify that, um, living with the students helped. And I don't know if it was…um…another thing is we were right next to school…just walk over and do homework. It was nothing to getting people rounded up to do homework and do projects. With the project-based learning. . . it's to get everyone together…living on campus it helped" (Student A, Interview, 2010).

-4-

"It was fun. Sometimes people got a little frustrated being with the same people all day every day. You were in class 8 hours a day and then you lived with them" (Student B, Interview, 2010).

-5-

"It was nice last year having everyone in the same building. If you want to see someone you don't have to start your car. It was nice to have everyone around if you had questions or something or had to get together with my group, just go down stairs or over to the next dorm. That was really helpful" (Student C, Interview, 2010).

-6-

"It was a positive one. It was nice to be here. It was nice to have everyone close by and visit with" (Student C, Interview, 2010).

-7-

"I like it first of all because the people I'm living with have proven themselves to be responsible members of society, after going through several years of engineering education which is fairly difficult. And the other thing that's nice about being…living with people in the same program is I know that if you have a big project deadline coming up…and we all do…no one's going to be up until 4 a. m. throwing a party because we all know we have homework to do and you got to

get it done. Plus a lot of ride sharing and knowing where everyone is. Plus being able to communicate about life…or living" (Student D, Interview, 2010).

-8-

"I liked it a lot. Everyone was right there. We could run around, drop in on another apartment and see what they're doing. We pretty much did everything together the whole year" (Student E, Interview, 2010).

-9-

"I'd say it kind of built a strong group. Everyone was kind of in with everyone else. We're not afraid to speak up" (Student E, Interview, 2010).

Finding 4: The Iron Range Engineering students participated in two-year student life activities, but still felt a disconnect between the larger two-year campus community.

-1-

"It was fine. We were kind of segregated almost. Being the way the program is in the corner of the school and stuff… That was the only tough part. We were kind of outsiders. We don't want people looking down on us. Or the opposite" (Student A, Interview, 2010).

-2-

"I mean we are using their campus and I don't think that many of them know what we're doing here. And we want to know more about Mesabi students. It would just be us walking through the school in our suits. It was kind of the thing where everyone thought we got everything we wanted. The same thing now in the music area. There were signs up about not taking the music area. I don't think they know about us or our program" (Student B, Interview, 2010).

-3-

"We don't know many of the Mesabi students. We go to volleyball games and that kind of stuff… baseball games. All the students we have here are who we hang out with. We're trying to get a little more interaction" (Student B, Interview, 2010).

-4-

"The Mesabi connection between us has gotten a lot better over the past year. We go out and play football now with them. The Mesabi students got to know us and they'll come and play with. Same with the faculty, you can kind of tell a few of them… you could tell kind of they didn't want us here and that's gotten better… our relationships" (Student B, Interview, 2010).

-5-

"We didn't know any of them or hang out with them so sometimes it was awkward. We don't have classes with them so we don't get to know them" (Student C, Interview, 2010).

-6-

"We didn't have much interaction with them. So there aren't…We played football with a couple of them once or twice. I couldn't even pick out the RAs. I wouldn't

know what they look like. We participated in several (student life activities) and we made some of our own. We had a movie night. We had a BBQ at one point. We made an effort to make ourselves seem as a positive presence. We know we are… we just wanted everyone to know that" (Student D, Interview, 2010).

-7-

"We did the bowling league last year. That was pretty fun. We got to interact with students that we don't normally see much" (Student E, Interview, 2010).

-8-

"I never really noticed that they were there. We never really did anything with them" (Student E, Interview, 2010)

-9-

"It was fine. To be honest we really didn't have much interaction. We didn't ever have classes with them so you didn't know students unless they or you were willing to break the boundaries. Break the ice. We played tag football outside with some of the members of the baseball team. They just lived next door and down. But other than that there wasn't much interaction" (Student K, Interview, 2010).

-10-

"Well, most of them had a lifestyle I wasn't used to and had to watch out for. There were a couple robberies and stuff in the dorms. Up late at night and screaming and loud. So you had to get used to that. For the most part the interactions were mostly friendly. We pretty much kept to ourselves" (Student M, Interview, 2010).

-11-

"I thought it was different than what I was used to. There were a lot of ethnic groups which was okay. I didn't have any issues. I didn't have any problems. I know other students did but I didn't personally have any issues" (Student N, Interview, 2010).

-12-

"The first semester at Mesabi we spent a lot of time going there. Worked in the concession stand with some of theirs' and then we did a movie night and campus clean ups and that kind of stuff. One big thing we're working on this year is to have better contact with Mesabi students and Mankato students. The first time we ever really had any interaction with Mankato students was in the last semester and we went to present our final projects and they presented theirs' and we talked to a few of them and talked about going out afterwards. And actually next week we're going down again and Monday we're having a softball game with them on Monday night we're having like a softball game with them and a BBQ and the same with Mesabi students" (Student B, Interview, 2010).

-13-

"I felt like we got to join in on their activities, going to movie nights and stuff" (Student C, Interview, 2010).

Finding 5: Iron Range Engineering offers its students a robust student life experience further cementing the living and learning model of the program.

-1-

"Student life-wise we did a lot of really, really cool stuff. We took that really long trip and we get to go to football games and baseball games which is really cool because it makes everybody bond. I think the program is better because of it because it's a way to get students to interact outside instead of sitting inside and studying all the time and we get to know each other better because of that" (Student N, Interview, 2010).

-2-

"Last year we went to a lot of professional sports games. We watched the Twins, we went to a Vikings game, we went and watched the Wild" (Student B, Interview, 2010).

-3-

"When we went on the spring break trip, one week was supposed to be all fun and the other week it was supposed to be school work and I don't know if it was fully even that way. We did do a lot of touring and when we were there we still blogged and took pictures and created videos from that" (Student B, Interview, 2010).

-4-

"We went to volleyball games and basketball games. We all went to ICC for one of their football games against ICC. We participated in their bonfire they had on their tennis court" (Student C, Interview, 2010).

-5-

"We went to the west coast and numerous other ones like the Twins game and the Mankato hockey game. And there was curling, bowling night through Mesabi. There were numerous ones. We got to decide what to do instead of having a set one, like you do this, so we kind of got to decide" (Student H, Interview, 2010).

-6-

"For myself one of the best parts of this trip [spring break trip] was being with my classmates in a different setting. I feel that it strengthened the bond between us" (Document Analysis Blog, 2010).

-7-

"I guess the biggest one would be the west coast trip. They paid for our travels. We stopped at Hoover Dam. Just to see other cultures within our nation. We went to a Mankato hockey game and even had movie nights and played football" (Student M, Interview, 2010).

-8-

"I volunteered. I played softball; I played softball since I was two years old. I played two years at ICC. And then last year would have been the first year I never did it and so I went to the coach and told him I pitched. I pitched in high school, I pitched in college. And so batting practice… I coached batting practice a couple days a week" (Student N, Interview, 2010).

Finding 6: The Iron Range Engineering program operates more like a real life private engineering firm than a higher education institution.

-1-

"We put in 40 hours a week of the school itself and then usually we put in 2 hours a night 10 hours a week outside of the normal 8 to 4" (Student A, Interview, 2010).

-2-

"We go to school 8 to 4 everyday. Some people come in later. Some people leave later, it just depends. They always say you don't have to come until 10 o'clock if your group decides that. The basic thing we look at is it's like we're getting paid on salary" (Student B, Interview, 2010).

-3-

"If you get your project done, your learning done, you can be here 20 hours a week or 80 hours a week, it's kind of up to you. This year we have it a lot more structured where we have project and industry time. We have some students who are working on finishing projects through their industry from the summer and who are also working making some money with industry. We also have every Tuesday and Thursday afternoons set up from 2 to 4 for learning conversations because we're supposed to learn…we have 8 (technical) learning competencies each semester we have to learn them and if you can't learn it in your project then you have to self learn it. So we have learning conversations for that. We usually have a lunch speaker every week. Friday morning we take an assessment exam. Last week was FE. Other than that we've done word type questions where you don't have to go through and do calculations. We also do something called "Ideals" which is assessing all the other students and yourself. Other than that it's kind of on your own, it's not fully structured. They just have some things they want us to do but as long as we're learning and projects get done…" (Student B, Interview, 2010).

-4-

"Fridays we usually leave about 2:00. It's usually 8 to 4 every day. Friday we get out at 2" (Student C, Interview, 2010).

-5-

"We're supposed to be here at 8 if you're on time. But most people are working on their projects or trying to learn some new topics or in learning conversations" (Student C, Interview, 2010).

-6-

"So today I got here at 8, had a student meeting that a student led, and we organized some groups and some student life activities and right after that, 9 to 11, we had learning conversation with our project manager and he told us all the basics about AC circuits and how they work and focused on some areas and he taught us all the specifics of some stuff and after that we went to lunch. And now my group and I are going to be doing a meeting trying to design our actual system

project for Blandin to build their tests for their paper so that's what I've got going on" (Student C, Interview, 2010).

-7-

"I can start with the things that apply to every day. I learn a lot and I'm always busy. Those are the two things that are consistent across the days. Sometimes we'll have a guest speaker come in and run the day. And we'll be with him the whole day, from 8 to 4" (Student D, Interview, 2010).

-8-

"We don't have classes" (Student D, Interview, 2010).

-9-

"8 to 4 everyday. You come to class. You have an hour lunch. First part of the day do some learning when you're fresh out of bed and later in the day work on your projects and what not. We did have the opportunities too if we did have to go to industry…we'd get a vehicle and we'd go to industry. It's very on demand type learning. We're very reactive to change so anything we need to do we just do it. We have to be self-sufficient" (Student F, Interview, 2010).

-10-

"At 4:00pm lately people have been staying later than 4. It's not required. It's just something you have to do to get things done. You have to get done what you have to get done. But, yeah, 4 o'clock we're done. We can go" (Student F, Interview, 2010).

-11-

"People are engaged in the program they're engaged in their project so they know they need to…like homework…we have to stay after…we have to wrap some things up" (Student F, Interview, 2010).

-12-

"As far as our time, the students organize their time and on their own" (Student F, Interview, 2010).

-13-

"So my biggest thing is that we start every day 8 a. m. in the classroom and we do what is required. And that goes until lunch which is 11:30 a. m. Take an hour-long lunch, and come back. Then we basically do what it takes until 4 and everyday is different. No day is the same" (Student G, Interview, 2010).

-14-

"I try to keep it from Monday to Friday and take weekends off but sometimes that doesn't work" (Student H, Interview, 2010).

-15-

"We talk about our projects at about 8:20 and start doing something. It's not like lectures where you start at 8 and you have to be there and learn something. It's almost like you get your regular morning gossip session in and then get going after that. It's kind of unique. You won't find many colleges like that" (Student H, Interview, 2010).

-16-

"There isn't really a typical" (Student I, Interview, 2010).

-17-

"You come into it with a plan. I mean, I don't really have a plan of how the day should go. But by the end of the week I'll have this learned, I'll have this done with my project, I'll have goals set for the day or for the week. And then just make sure that for the day, even if it means staying over for two, three, four hours that gets done. Whether meetings pop up or you have to go somewhere" (Student I, Interview, 2010).

-18-

"We're the first to attend a school that's 100% project based learning. There's no classes, there's no lectures…" (Student I, Interview, 2010).

-19-

"Typical school week…it was pretty open ended for the most part. In the end you just set deadlines and you go for them. It was pretty much open ended. It was 8 to 4 every day. You'd go and work on a project and half the time you just say let's do this because you found it interested you and you'd research or work on a design for one of our projects and usually the problem with last spring was we pushed the learning part to the back burner because we were always worried about the designs and projects" (Student J, Interview, 2010).

-20-

"I would say 4 to 5 days out of the week are pretty much just based on building on the design for projects. We have to satisfy a (industry) client, externally or one of the local businesses. And then one day you'd spend trying to learn something or go to workshops with one of our teachers or an external source" (Student J, Interview, 2010).

-21-

"We did some personal work in the morning. Project related, we work in our groups. I have 5 in my group. And then…At noon we have an ideals workshop, which is a system for grading or rating professionalism and design competency. And at 2 we have a learning competency with our instructor about heat transfer. In the morning we have…Generally, Mondays, Tuesdays, and Fridays we have …the teachers pretty much have planned for us. The afternoons on Tuesdays, Wednesday, and most of Thursday are pretty much our own time to work on our projects. On Thursday there's a lunch speaker come in from industry and tell us what their experience is and how they got to be where they are. Help give us perspective" (Student J, Interview, 2010).

-22-

"We get here every day from 8 to 4. Usually mornings are project work… depending on the day and afternoons are learning and then…either learning conversations or independent learning. Picking up a textbook and reading it. Learning conversations are either led by a student or a member of the faculty and will involve a topic that is needed for one of the competencies. So for instance we

had a conversation on advanced power cycles led by our instructor and involved our project and other members who weren't working on our project were there as well and it lasted for about two hours. And we have those three a week. And they're supposed to be video recorded so if you're not able to attend you are able to watch it at another time. But you're not able to participate back and forth. And then the self guided learning is for things you're not necessarily working on for your project or you realize it's something you need to learn and you grab a textbook and figure it out and if you have questions you talk to a member of the faculty or other students and try to fill in the gaps" (Student K, Interview, 2010).

-23-

"For the most part the 8 to 4 is different from any other school" (Student K, Interview, 2010).

-24-

"Well I am in the classroom 8-4 on a typical day, but we also get about 4 hours of homework a day. We are spending on average about three days working with industry to every one day in a classroom setting. We have been creating our own learning, but we are not teaching one another. We have been learning together as a group and when the correct time comes, we are then given the information we need" (Document Analysis Blog, 2010).

-25-

"We arrive at 8 until 4, 4:30. We work on our projects, basically" (Student N, Interview, 2010).

-26-

"I guess by classes we have three different…I don't know if you call them classes…but we have three different classes we signed up for through Mankato that we get grades on. One's on fluid mechanics, heat transfer, one's like mechanics and materials and stuff like that and we have to prove that we've learned something in each area and we get graded on it" (Student N, Interview, 2010).

Finding 7: Students are assessed using holistic methods.

-1-

"You bring evidence in. They have a list of criteria that you have to know. They split the professional and design competencies up from the technical ones. So the design professional ones (soft skills) are being here on time, managing your project, getting the task done. The technical knowledge is your book work…then throughout the semester with everything we do we gather evidence, hard copies, electronic copies, oral interviews, and basically they gauge, between the four of them, the faculty members, how well you've proven your knowledge" (Student M, Interview, 2010).

-2-

"Competencies are just another name for your classes. Each one is broken down into one credit and you need 16 competencies I believe to fulfill your third and

fourth years for graduation. And they would be like fluid mechanics, statics, dynamics, thermodynamics, mechanics materials, those classes at an advanced level, as well as the professional ones. They're all grouped into one category. I don't know if it's one credit or three credits. Leadership, communication, public speaking, and things like that" (Student K, Interview, 2010).

-3-

"Competencies are the technical stuff we have to learn so it's like a class in a way. We have heat transfer so we learn on our own or with other students. You also have learning conversations with the teachers so you have that to help with the learning competencies that you have to cover. And that's kind of like your class…and you have to cover by yourself. Everyone kind of does it different" (Student H, Interview, 2010).

-4-

"Building evidence. Going through what you wrote. What's new from last semester is that we have these narratives of what you've learned and how you learned it and stuff like that. So when you do the learning review you can talk about it. That's your evidence" (Student H, Interview, 2010).

-5-

"They have something called learning reviews every other week and we're supposed to write a memo that talks about what we've learned" (Student N, Interview, 2010).

-6-

"Yesterday I had our design review of our cement trowel project with our instructors. The first 45-50 minutes were spent presenting a power point of where we were at with the project. Along the way, they would prod us with questions and concerns they had with the design. Each design review we present the powerpoint, which allows us to hone our presentation skills--answering questions under pressure that the consumer or others might have at our final presentation. The next 45 minutes were spent discussing and proving our learning that has taken place from the project. We are able to show how we have learned important topics and showcase our work at that time. The faculty will also give us more avenues of learning to take. Each design review from now to the end of the school year will have a portion showing the design and a portion that demonstrates our learning; it could be compared to a test or grading session" (Document Analysis Blog, 2010).

Finding 8: Industry is integrated into the Iron Range Engineering program in a transformational way.

-1-

"Right now the industries are…we're going out there and meeting with them…they are giving us a project and we kind of go off and do it. We're meeting with them and there are a few contacts in between" (Student A, Interview, 2010).

-2-

"We have some really good industry relationships. U-Tac has been a big supporter. We had 5 of our 14 students last year working for them for the summer. We had a project last year, a project this year with them. We have projects with Blandin and Thermal. Somebody interned at Blandin but nobody interned at Minnesota Power, but we did job shadowing there. They've kind of been going a little bigger getting some industries…like we're working with Medtronic. I think we have a lot of industries who want to be a part of it and help. The same with The MN Cup (a statewide entrepreneurship competition) was a big thing where we had students entering … and getting to top 3 for one of them and top ten for the other 3…that it kind of shows this area there is a lot of innovation in this area that industries want to be a part of it" (Student B, Interview, 2010).

-3-

"We go to Blandin once in a while. We went to several mines and visit their sites and sometimes take tours and learn about their operations and how they do it. Then you get into more specifics if you have a project with them" (Student C, Interview, 2010).

-4-

"They could have picked and called around from the mines there but they decided they were going to pick three individuals from…as engineering interns, mind you…three individuals from Iron Range Engineering. And every time we had an interview they would ask how the program's going and they were very excited. That goes for Minnesota Power and some of the other industries we're working with. They are interested in what we're doing and want the engineer that's going to come out in this program. And they've said that time and time again" (Student F, Interviews, 2010).

-5-

"It's mainly we go to a jobsite, get the project and get every aspect of the project we need to know about so it's mainly you go with a whole bunch of questions, do what needs to be done, and then head back to the classroom and do the whole project. We show up later with a full design and notes and a power point to industry. . . the design and everything we need to do…so it's all theoretical, for the most part, and then we go and present it to industry. And we're like, okay, here's what we have. Do you like it? Do you want it? Here's the numbers. It should work" (Student G, Interview, 2010).

-6-

"They give us their projects so far. We haven't had any student led projects. I would say United Taconite would probably be our biggest supporter. I worked on a project with them last semester. And they have a project with them this semester" (Student I, Interview, 2010).

-7-

"So first off we have been assigned projects and haven't been able to pick them. From there you get your contact and meet your contact at the site and you do a scoping meeting at the beginning of that project. We were working with United Taconite on their dust collectors. And just kind of the general idea of what we're working on. You meet with your contacts out there and do the big scoping meetings and see exactly what they want and the deliverables and exactly how they want the information. And you start working. You have to do some sort of schedule to make sure all the goals are accomplished. We kind of made some errors last semester. We didn't…we weren't aware I guess…that it would help more if we kept in contact. Make sure you have weekly or biweekly updates to make sure we're doing what they want and make sure we're on track. The positives are that. . . the industry experience. Once another student and I got finished with our semester project we had a big meeting with six people at United Taconite that included people who weren't our contacts, people who really didn't know much about our project and having that meeting, they definitely had valuable input. We liked that. It would have been nice along the way. But even at the end it adds. We know to build our contacts, build your professional skills. There are projects…not necessarily like last semester… it definitely does help you learn like, doing our program, it's not really core competencies. The five of us have learned a lot about computer programming in a short amount of time. And when you're working on a project like this you're hands on, you're doing it. It's something that's going to make it stick in your head a lot better than just writing out a problem and reading out of a book or whatever" (Student I, Interviews, 2010).

-8-

"Most of the projects are from some industry partner and most of them are obviously ones that industry could have done them themselves but they're seen as a complex enough problem that it has to be done and it's worth someone doing but not too complex for second year, third year…we're second term juniors to accomplish so they're not easy but a little bit simplified. Like for Alaskan, we're designing a system to help them monitor plant performance. Well, like Boswell, they're in Cohasset, by Rapids, they're huge and they have a lot of money and they have the computer program…anyway…this year we're trying to tie the learning in to what our projects are doing as in what our project is concerned with, we're learning. And then we can tack other things on top of that. But last year was like learn this and here's a project and they were completely separate and now they're more intertwined" (Student J, Interview, 2010).

-9-

"Right now all of our projects are for an industry partner. Every team has one or two contacts they talk to" (Student L, Interview, 2010).

-10-

"The major reason for the creation of Iron Range Engineering is to change the way students learn engineering technical and professional skills. Up until this

semester, all we have done is talk about the different learning style and how it is supposed to work. Well now that we are a few weeks into the semester, this learning is actually taking place. The first project that I am involved in is a sauna heater that uses steam as an input. This project is taking me down several different learning paths. I am looking through textbooks and engineering handbooks trying to find information about heat transfer topics such as convection and conduction. I have never taken a heat transfer class, but I am learning the material as I am applying it to the project. The great part about this learning is that I can relate the learning topics to the project. This makes the learning objectives easier to understand and, because I need to learn the information to complete the project, I am engaged and motivated to learn. I am doing a lot of research on my own, but there are times when I need help. The new style of learning is actually taking place and it already helped me learn several topics" (Document Analysis Blog, 2010).

-11-

"We get assigned projects in groups. This semester I'm in a group of five and the group's project is always industry based or will have some sort of industry component. We're talking about, for next semester, having student groups where the students come up with the idea…the students are developing the idea and the students will own…the intellectual property. So it doesn't have to be industry based but it does have to be a real application for it. For whatever you're doing. And what we do is we identify…we learn about what we need to do to do our project and if there's something we don't know, something we need to know that we can't get by ourselves, we'll work through a learning conversation with one of our instructors. They'll either do it themselves or if they don't have the expertise they'll have an external expert come in. These learning conversations can be about anything from project management to electrical machines to heat transfer to cardiovascular engineering. We do two of those a week. And every time we have a learning conversation we bring our learning notebook and write down what we learned. It can be notes. It can be reflections. I take the notes and I hear them and what they are saying, and I think about it and I write down my thoughts. Not the notes. Notes are fairly useless. If you just write down notes you're not doing any learning at that juncture. You have to write it down and re-read it. Not everything will apply to our project. You'll have to do learning outside of your project. Cardiovascular engineering is a good example of that. This semester I'm doing a competency on heat transfer and that has nothing to do with my project. It's all about efficiency and so forth so…learning conversations. All of these compile to give us the ability to get the learning. And then what we have to do to at the end of the semester…and in two week increments…we have what are called learning reviews. These are similar to a design review for a project…they are scheduled on the opposite weeks of our design reviews. . . but all we discuss is how far along we are on the learning continuum for the semester, what we did in the last two weeks, what we'll do in the next two weeks. And the final learning review will be

where we attempt to prove that we've learned all the things we said we were going to. This is where we'll bring deliverables from our project or observations from our learning conversations for some oral presentation. We bring evaluations from our instructors as well. And we have to prove that we learned with evidence" (Student D, Interview, 2010).

-12-

"Well my last project was with Spring Creek Outfitters out of Mountain Iron (MN). And they design and manufacture canoe and kayak accessories, outriggers and stuff. And one thing with his company is he's kind of limited on resources and employment and he had an idea that he wanted to explore for a long time and he came to us with his idea and we kind of went through and developed it for him" (Student E, Interview, 2010).

Finding 9: Overall, project-centered learning and the students ownership over their learning has provided students with a positive experience.

-1-

"The positive is it is more lifelong learning. It actually has some application to it" (Student A, Interview, 2010).

-2-

"I think we come away learning a lot more especially in the professional area. They've been looking for the program, the people to improve technically as well as professionally and working with other industries or clients. It's all teamwork. You're working together every day. When you go to a university you don't experience, you just go to class, you sit there and take tests. It's not just project centered; it's real work experience. I think we could have students graduate from here just doing projects and going out in industry and do just as well as students who graduated from universities. I know that I can't remember that much I learned at my other school because it was lectures. You just learn it to take the tests and you don't necessarily retain it. That's what they've been trying to get us to do as well as to be more professional" (Student B, Interview, 2010).

-3-

"When we do the hands on stuff it really helps my learning style…In a normal week, the way I learn, I would say that this way of learning it is positive, it's good for me" (Student C, Inteview, 2010).

-4-

"Basically their idea was to have the projects drive the learning. Whatever you need to do for your project and you don't know how to do it, it's going to force you to learn it" (Student C, Interview, 2010).

-5-

"Well I guess it would depend on your learning style…but for me the hands-on, project centered learning is definitely a positive in that respect because you're actually doing the calculations and doing the learning for a reason because you have to apply it to something. For me, if I learn something and apply it to my

project it sticks with me a lot better because when I learned it I learned it for a reason. And when I learned it I used it for something. So as far as that goes it's a positive. I'd say the only negative would be that having these projects we don't cover a whole lot of the areas that you need…you'll go in depth on a few of them but then a lot of them are blank…working on one or two big projects limits the learning" (Student C, Interview, 2010).

-6-

"You study out of a book or talk with or discuss with your classmates or just research it online, watch YouTube videos. That's a great resource" (Student D, Interview, 2010).

-7-

"The positives are that you can actually see how your learning can be used in industry. One of the things that bugged me most about math in high school was 'when would this be used?' I wasn't asking because I didn't like learning math. I was asking because I like math and I want to know when I'll be actually able to use this math. Most of the time my teachers couldn't give me an answer. If it wasn't obvious there was no answer. That's one of the reasons why engineering appealed to me. So this project-centered learning gives me the ability to do what I thought engineering education would be doing is actually using it somewhat while you are learning. Learning how to apply it, all that stuff. Another good thing about project-based learning is you can learn at your own pace. The better you are at getting the materials, the better you are at learning. The more learning you can do. In a lecture scenario, the speed the teacher talks or presents data is the speed that you're learning. That's the most you can get. One of the downsides is, if you are an individual that is not motivated to learn or if your just in a mood that day where you don't feel like putting the effort in that day you won't learn anything. Nothing is handed to you. Nothing is presented to you like that. You have to be involved in your learning. You have to own it. So the more you put in, the more you get out" (Student D, Interview, 2010).

-8-

"It's not like you get there in the morning and wait for your teacher to come in and tell you what to do and give you your homework. You kind of delegate your day as you need because everyone has different schedules. You need to know what you need to do and so you kind of correlate yourself with your group and what project work needs to be done and what learning needs to be done" (Student E, Interview, 2010).

-9-

"Sometimes I think it would be kind of nice to show up for class and have a teacher just sit there and lecture you and you take notes cause it's so easy and it feels like a quick way to get information but I remember all my times at my other school and you'd be dosing off a few minutes into the lecture so it's nice that you kind of decide in the end what you're going to accomplish" (Student E, Interview, 2010).

-10-

"One of the positives is that it definitely makes me think more. Like the typical labs like the first two years there's a set of steps that you follow and you get the same results every time and you run it through. With these projects we don't really know…there isn't really a right or wrong way to do it. You have to figure it out on your own and find the best way to organize it and document it. Last year with our canoe project we struggled with it for a few weeks just trying to figure out what to do because all the books just give common geometry so you can't find something in a book to tell you how to solve it so you have to kind of design your own experiments and kind of learn as you're going" (Student E, Interview, 2010).

-11-

"We've gone two years, some of us more than two years, sitting in a class in that lecture format. So now we need to reform our learning…but it's on our own" (Student F, Interview, 2010).

-12-

"Everything is self…everything is on you, which is nice. No one is going to tell you what to do with your day, but you need to know what to do with your day. So you can't tell someone you can't do this because you need to get something done. It's nice in that respect" (Student G, Interview, 2010).

-13-

"What's really cool about IRE, what I've learned, there's been a reason for it. It's like oh this is why this math looks like this. This is why this equation is the way it is. You find the meaning behind it and you really do cement it. The difference is that it takes a lot longer to do that" (Student G, Interview, 2010).

-14-

"The pros and cons are that you know what you don't know. What's it going to take to understand it? And when you finally go and get help, it's like Oh, here's why it is the way it is and all of a sudden in a matter of five minutes it all makes sense. So you're able to cement information that way. And the con is it's all on your own shoulders and it's hard to find direction" (Student G, Interview, 2010).

-15-

"You don't have to sit in lecture all day. Sometimes with lectures you could be ten minutes into it and you're already bored. You don't care. Here you learn what you want to learn but with the lecture you're stuck with it" (Student H, Interview, 2010).

-16-

"I think the positive is that you get to see what engineers deal with on a daily basis. The negative is too much in one dimension. Maybe cover all of heat transfer or integrated circuits. You get too focused on one area. In some ways you become an expert in one area but you don't have the breadth of topics. The professors are pretty good about not letting you do that, but on your own you

could do that. That's the only problem. And if you just get fluids projects you don't get heat transfer. You could get focused on only one area. But you have four projects so you have options" (Student H, Interview, 2010).

-17-

"It's a double bladed sword. You get the freedom. You don't have to sit through a lecture with 150 kids for two hours. The one thing you encountered as a student you're doing the learning, you're teaching yourself, you're doing a project and a lot of the professional stuff like planning your day, even student life events, so it's almost like you're going to school and you're working a job for that school" (Student J, Interview, 2010).

-18-

"The positives are it definitely gives you a real world idea of what's going on. You hear horror stories of engineers leaving school and have absolutely no idea of how things work. They can just tell you the math behind it. And it gives us definitely an idea of what's going on and you get interaction with industry partners. And it pushes the professionalism because you end up talking to people in industry, and doing interviews, and making presentations, where, if you went to a four-year school and you sit in a classroom and do the work you're never going to have that interaction. On the negative side, sometimes it takes a long time, so that's time you could have spent learning but to counteract that it keeps your interest because you're not sitting around learning, learning, learning. Things vary a little bit" (Student J, Interview, 2010).

-19-

"The first project I worked on was for our instructor and we built a raft cart. And I actually think I learned the best because the learning and the project were not separated, because we have design and learning reviews and I think they should all be incorporated into one review because you're saying, well, here's your design and here's your learning and they make it separate. It shouldn't be separate because the first semester, the first trial run we had, it wasn't separate. And that's where I learned the most, like the mechanics and materials. I learned a lot from doing problems on that" (Student N, Interview, 2010).

Finding 10: The type of engineering degree being delivered may lend itself nicely to students getting jobs more locally due to, connections being made with local industry, and its lack of ABET accreditation and widespread name recognition for the time being.

-1-

"It definitely helps. Just putting those projects on your resume and you have those big name industries on your resume already looks pretty darn good. It's an experience you can get at school without having to be out there and having a degree and get a job. The internships…you're getting experience right from school" (Student A, Interview, 2010).

-2-

"I think the curriculum will eventually take. I'm still skeptical right now in applying to the outside, just because of the way that…it's not a proven system. I mean, who's to say kids, students coming from this program are better or worse than a four-year university" (Student A, Interview, 2010).

-3-

"I'd still like to go to grad school. If I graduated from here and had a job offer that I really liked I'd definitely take it" (Student B, Interview, 2010).

-4-

"Within the region here I think it's going to be a lot easier to get a job here than it is let's say if someone wanted to go to a different state or Minneapolis. A lot of people around here when we graduate will know what this program is and know what we've done. And we've probably been working with a lot of industries that people will apply for. A big thing that a lot of us are worried now is we have that bachelor of science degree in engineering instead of just the mechanical where they always say it's going to be fine if you can go there and sell yourself in an interview … But there is a lot of people who can't sit in front of somebody and sell themselves. It's just not some peoples' strongpoint so if you can't then they're basically saying… and you have to get past the point of if you're applying for something and they say you need mechanical degree and it says bachelor of science in engineering and you don't have it and they might not even look at it. It might just get thrown out the window. I think the program will get accredited and it will improve as the years go on. I don't know about the Bachelor of Science degree in engineering instead of… it was just supposed to be mechanical…I think that you can get mechanical emphasis or biomedical emphasis … but it's still kind of a worry. I think it will be fine in this region to have that but in other places when they have 100 applicants, if they're looking for certain requirements and if you don't meet that right off the top you won't even have a chance" (Student B, Interview, 2010).

-5-

"The program itself and the type of learning you do will help because that's what employers are looking for. The recent graduates that are able to do projects and be team leaders and do that kind of stuff I think it's going to help" (Student C, Interview, 2010).

-6-

"I don't know. I guess that's going to depend on if they know who we are and stuff. We're definitely going to have a better chance of getting a job up here (northeastern Minnesota) where the companies know who we are. I don't even know what to expect if we move away and try to get a job and nobody's even heard of us" (Student C, Interview, 2010).

-7-

"I would definitely say it will increase my chances of getting a job in the region. I would say it will increase my chances of getting a job period. And that is because when I go into an interview…the trick is outside the region. The trick is getting the interview. If they look at IRE and it's not on the list of schools they're going to hire from you're not going to get the interview. And then you don't have the opportunity to explain why your learning was better than the other option. So aside from that problem, once you get to the interview I think this style of education once I can get to explain it and say what, how and why and how much better it was, I think it will greatly increase my chances of getting a job" (Student D, Interview, 2010).

-8-

"I'd say definitely in this region it would help a lot because they're already establishing relationships with the different companies and we're getting experience with the things that … with the engineers. . that we get" (Student E, Interview, 2010).

-9-

"From the get-go, yes, I think it's going to help. I've seen strong industry support. I've seen what I've needed to see and it seems like the region is engaged and they're very interested in what we're doing" (Student F, Interview, 2010).

-10-

"I feel like the work we've done with industry, the things we've done, any of the first gen students could go out and get a job as an engineer right now. Just because I've seen engineers in the field and I've seen what they do and how they're just based on real world application and I've seen all of us just do that. I think we could make good engineers but I think what's going to hurt us most is the credibility of IRE as a new college. I hope that doesn't have any negatives because as far as the curriculum…I think it should actually help us because we've actually already worked with industry. We learned from industry the steps that it takes to go through and get something done professionally. If you need this information and you need something from this company, you need to make sure it's okay to work with this company first. If you go to them underneath their nose without them knowing about it, there is some liabilities struggles and troubles and stuff. You really learn how business really works. And you learn to become organized, which is stuff I've never really had to deal with ever in my entire life" (Student G, Interview, 2010).

-11-

"I think it will help. When you think about classes in a regular university how much you remember…like what you remember six months down the road? When I did my Minnesota Power project with the condensers and heat transfer and fluid I could probably talk about it for an hour or so and remember 50 percent of the topics we covered or better. And at a four-year university…how much of the class do you remember you know? You know maybe 10 percent of what you went over in that class. You retain more but maybe you don't go in depth or cover as much

but you're able to focus on the big topics…but you kind of say you have this big topic with specialty areas but at a four year you say this is a big topic and these are little areas and here maybe we don't have the breadth but you get the depth. You're able to focus on just the basics of it vs. trying to make it more advanced at a four-year. They stay with the basics. If you got heat transfer at IRE you got the basics. You can't try to…for me I have to get a base and go from there. You can build a foundation and go from there" (Student H, Interview, 2010).

-12-

"We're not accredited and stuff. But I think with our experience we can get a job anywhere, especially in this area. I would be open to getting a job here if one presents itself" (Student I, Interview, 2010).

-13-

"In the region I definitely think it will help, especially with people who are working with projects with the taconite industry. But even with Medtronic. We're working on a Medtronic project. People get a biomedical or cardiovascular engineering type thing, you know, they can get jobs at the local hospitals even with that experience. Outside of the region, it will be kind of difficult to explain to people what this is and what our degree is and the whole curriculum but I think …you know if you put it on a resume, like mine's going to say I have a project with United Taconite and Medtronic. My next semester's project I'm already planning and doing a proposal. That if people see this type of experience already coming out of college that there would be a good chance that we could get through that first barrier. They'll be a good chance of getting a job" (Student I, Interview, 2010).

-14-

"I have to think about this. Once we graduate, I think we have enough interaction in the region and our name gets out there enough where people recognize this is a legitimate program and I think there may be a few skeptics who may be willing to give a chance right away. As soon as a few people who have graduated from the program get into industry here, I think they'll realize that, we're going to have a lot of the skills that graduating engineers don't have. And for example we go out in industry and meet with engineers and they don't do any of the calculations you see people do in a classroom on a certain subject, doing these crazy advanced calculations that take 30 hours to do a single problem. They're doing simple things like hosting an interview or managing people. Well we're doing that every day here. That's supposed to be the point of it. And I think that's going to prepare us a lot for the workforces. There may be some skepticism when we first walk into the door, but if they give us the chance I think they'll be pleasantly surprised and it will just grow from that. Outside of the region I think the biggest problem is just going to be the exposure. They've never heard of it. I mean, it's kind of skeptical. I don't know too much because ignorance is bliss and I don't really plan on going away. But like I said I think it's just going to be the exposure. I think we'll be well prepared enough where we'll impress the people so they'll want to

have workers like us. But if they've never heard of it, we'll never get the chance. You're going to miss out" (Student J, Interview, 2010).

-15-

"In the region? Probably. Outside of the region I think there will be a lot of problems. You have a non-accredited, off-base degree (different) from an off-base (different) program so if I were to go outside of the state I feel I would have a lot of trouble because it's not a mechanical engineering degree. It's just an engineering degree. And they'll say "what's Iron Range Engineering?" And I'll say "it's Mankato State. " And they'll look and they won't really know anything about it. If we were coming directly from there that would be another thing" (Student K, Interview, 2010).

-16-

"What do I think? I've talked to several people working out there. I've talked to people working at Boise Cascade. I know a guy from Barr Engineering and everything is hands-on and they think it's great. They think it's great and they think the hands-on experience is the best thing because they've all been to school and they know what it's like. But then again you kind of get the skeptical look on their faces like, well, you're not really going to classes so how are you getting the knowledge? Like the professional skills are important but the technical skills are important too. Almost like what we said…we have one side and then we have the other side where it's just project work and you have to find some place in the middle. To say it hurts my chances of getting a job up here I think I'll do alright. I think I'll find a job. To say there's not going to be hurdles to jump over and struggle, there probably will. But I think I'm capable of getting a job up here" (Student L, Interview, 2010).

-17-

"I think it's definitely going to help. As long as we can maintain the industry support and the internships and the projects and satisfying industry. In the long run the degree itself isn't going to matter. It's the relationships. Like at Blandin they know me pretty well over all the rest of them so just the fact that they know me and they're comfortable with me I'll definitely have an advantage. Really having the degree…obviously they can't hire you without the degree…but I'm already sliding into Blandin which I think is like most students. They'll slide into it" (Student M, Interview, 2010).

-18-

"I think now that the degree has been changed that will really hinder us. I first heard about it this summer and I had talked to one of the section managers at United Taconite and asked them about it and they loved having myself and the other intern there and they appreciated the fact that we were hard workers and I attribute some of that to the fact that I've done so many projects in IRE. And I do think that working on the projects in IRE help in that sense because, like, I didn't use anything that I learned at my other college…and at IRE I learned how to start a project and finish a project. But I talked to the section manager about the new

degree he said I would have a problem hiring you guys with an off-degree even though I know what you're capable of. Because they can't even…the engineers there if I asked, they couldn't even write me a letter of recommendation because they're worried about…if I built a bridge and it failed, their reputations and everything are on the line. So I mean if they hired someone with an off-degree and something happens or someone gets hurt they're still liable for it. And so he was really very skeptical of that. And I think if I were to ever go anywhere else with a bachelors of science in engineering with an emphasis in whatever I think it would have a very negative impact on the fact that I might not get hired" (Student N, Interview, 2010).

APPENDIX F

Technical Core Competencies

Heat transfer
Thermodynamics
Adv Statics
Adv Dynamics
Mechanics of Materials
Properties
Fluid Mechanics
Material Science
Digital Logic
Electronics
Instrumentation
AC Circuits
DC Circuits
3-Phase
Electric Machines
Electromagnetics

APPENDIX G

Assessment Instruments

Essays
Oral Examinations
Learning Reports
Learning Reviews
Technical Design Reports
Technical Design Reviews
Final Examinations
Memos to Industry
Lab Reports
Lab Write-Ups
Various Powerpoint Presentations
Narratives of Learning
Self-Reflection
Peer Assessment
Faculty Assessment