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Academia Meeting The Needs Of Industry: A Case Study Of Developing A New Degree Program For Petroleum Engineering

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ACADEMIA MEETING THE NEEDS OF INDUSTRY: A CASE STUDY OF DEVELOPING A NEW DEGREE PROGRAM FOR PETROLEUM ENGINEERING

by

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This dissertation, submitted by Rosemary Vogt in partial fulfillment of the requirements for the Degree of Doctor of Philosophy from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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Rosemary Vogt
May 26, 2016

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ABSTRACT

The recent oil boom in western North Dakota's Bakken formation in the Williston Basin resulted in numerous opportunities for skilled professionals (for which an academic credential is required) in petroleum engineering. Oil and gas industries operating in the state approached leaders at the University of North Dakota (UND) with the request to develop a petroleum engineering program for the purpose of contributing to the need for a skilled workforce in the state. In 2012, the North Dakota State Board of Higher Education approved a new Department of Petroleum Engineering at the University of North Dakota. What is unknown or understood to a lesser degree is how the development of the petroleum engineering program progressed: the relationship between drivers of the program development, the interaction between various stakeholders, and the process of developing a new degree program. It is important to know how universities develop new degree programs to meet the needs of industry, as it is plausible that in the future more university degree programs will be created to better prepare students for future employment. This qualitative case study documents the perceptions of selected key participants associated with the development of the Petroleum Engineering program at UND. Twenty-one individuals participated in this study including administrators, current and former faculty, students and industry executives. Open-ended questions linked to the literature and the Innovation System Framework prompted participants to reflect on their experiences. The study validates the importance of higher education sensitivity to

regional needs and the significance of successful collaboration between stakeholders. The study also examines innovation alignment with innovation driver, the innovative behavior and the end result of innovative behavior.

CHAPTER I

INTRODUCTION

In 2002, the state of North Dakota had an estimated population of 634,110 and the second smallest economy in the United States just ahead of Vermont. By 2013, the state's economic output had more than doubled and estimated population had reached 723,393; a 14.8% increase (Ellis, 2014; The United States Census Bureau; U.S. Department of Commerce Bureau of Economic Analysis, 2013). Fueled by a massive oil boom, North Dakota's economy doubled in a period of eleven years producing far-reaching economic repercussions within the state. Rural communities in western North Dakota that had formerly seen decades of depopulation and economic struggle experienced economic expansion and population growth (Weber, Geigle, & Barkdull, 2014). For example, between April 2010 and July 2011, the population in and around Williston, a town in the heart of oil country swelled by 8.8% (Nicas, 2012). While many parts of the rest of America remained besieged as a result of the 2007-2008 recession, the oil boom in North Dakota created numerous opportunities for employment (Artz, 2014). Oil companies noted that there were more jobs than people in the state as North Dakota was swarming with field hands who had followed drilling rigs into the Williston Basin (Gebrekidan, 2012). By November 2012, the International Energy Agency predicted that by 2020, the US would be the world's largest producer of crude oil as a result of the Bakken shale in

western North Dakota's Williston Basin. The ensuing energy rush created an increased demand for petroleum engineering professionals (Miller, 2013).

With plenty of opportunities for employment in the oil patch, the University of North Dakota (UND) developed a new undergraduate degree program in petroleum engineering specifically to provide students with professional training that would provide a career option in the oil industry (Nelson, 2014). The Petroleum Engineering curriculum was organized primarily by faculty within the Department of Geology and Geological Engineering with input from other engineering departments and outside stakeholders. Petroleum Engineering was eventually constituted as a separate department within the (then) School of Engineering and Mines. Subsequently, the School of Engineering and Mines became the College of Engineering and Mines. Harold Hamm, Chairman and Chief Executive Officer of Continental Resources, donated $10 million to establish the Harold Hamm School of Geology and Geological Engineering within the renamed College of Engineering and Mines; the state's Industrial Commission and Gas Program contributed $4 million to the new School from oil taxes and royalties. About 80% of Hamm's contribution supported two endowed professorships in petroleum geology and engineering; the remaining 20% of the funds afforded scholarships and supported the purchase of new technologies and geological core samples. Between 2011 and 2012, undergraduate student enrollment in Petroleum Engineering at UND increased from around 10 to 105 students (Miller, 2013).

At the time of its inception, it was unknown how large the Petroleum Engineering department at UND would become; however, speculation at the time held that enrollment

was not likely to decrease any time soon (Hageman, 2013). According to the North Dakota University System (2012):

> In just one year, the program grew to 24 majors on-campus and seven distance students. That rate of expansion exceeds everyone's expectations and underscores the timelines of the Board's move today that will broaden the scope of petroleum studies and research at UND.

Whether the enrollments will fluctuate in response to the volatility of oil and gas prices is yet to be determined. The development of the Petroleum Engineering curriculum followed UND's Essential Studies guidelines as well as the requirements associated with the Engineering Accreditation Commission (EAC) of ABET (North Dakota University System, 2012).

With financial support from the Hess Corporation and the North Dakota Education Challenge Fund, the University of North Dakota financed laboratories and simulation labs for 3-D visualization, reservoir simulation and Hess drilling simulation. The North Dakota Challenge Fund matches $1 for every $2 contributed by private donors; qualified gifts must be used to support scholarships, faculty positions or educational infrastructure (UND Alumni Association Foundation, 2016). Hess Corporation has operated in North Dakota for over 60 years, and is a leading independent energy company involved in meeting the world's growing need for energy (United States Senator John Hoeven for North Dakota, 2014). As a result of its long-standing relationship with North Dakota, the Hess Corporation seeks to develop their workforce locally to meet the growing demand for skilled labor in the oil industry. Senator John

Hoeven noted, “It’s a great investment for UND, a great investment for Hess and the petroleum industry, and a great investment for our state” (United States Senator John Hoeven for North Dakota, 2014, para. 3). In the Grand Forks, North Dakota-based *Prairie Business Magazine,* Hvidsten (2010) writes, “There was no question that a petroleum engineering program would be launched at some point. The question revolved more around the when, where, and how” (para. 4). According to an administrator at UND, conversations about establishing a Petroleum Engineering program at the University of North Dakota date back to 2008 (Hvidsten, 2010).

Statement of the Problem

The North Dakota State Board of Higher Education approved a new Department of Petroleum Engineering at the University of North Dakota in 2011. The department became part of the UND School of Engineering and Mines (SEM), now known as the College of Engineering and Mines, and offers the only undergraduate or graduate Petroleum Engineering degree program in the state. Robert Kelly, who was UND’s president at the time, indicated that it was the right time to establish a Petroleum Engineering degree program due to the advances in the petroleum industry in North Dakota (North Dakota University System, 2012). North Dakota’s oil production had been rapidly increasing from holding eighth place in the US in 2005, and occupying second place just after Texas by 2010 (North Dakota University System, 2012). What is unknown or understood to a lesser degree is how the development of the Petroleum Engineering degree program progressed: the relationship between the drivers of the

program development initiative, the interaction between various stakeholders and the processes of developing a new degree program.

It is important to know how universities develop new degree programs to meet the needs of industry, as it is plausible that in the future more university degree programs will be created for this purpose (Goddard, 1997; Chatterton, & Goddard, 2000; Boccanfuso, 2012; Ainsworth, 2014). Offering new degree programs to meet the needs of industry will help to better prepare students for employment. Presently, universities are looking beyond providing students with a broad general education to also providing them with skills to be more adequately prepared for gainful employment (Goddard, 1997; Chatterton & Goddard, 2000; Boccanfuso, 2012; Ainsworth, 2014).

Purpose of the Study

The purpose of this qualitative study is to understand the experiences and perspectives of key participants in the development of the Petroleum Engineering program at the University of North Dakota, and to do so within the Innovation System Framework. The overarching research question that guides this study is: How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program? Some additional questions that will inform this study are:

1. How do key participants describe their experiences and perspectives about the development of the Petroleum Engineering program?
2. What light do key documents shed on the development of the Petroleum Engineering program?

3. To what extent and in what ways does the Innovation System Framework help explain the development of the Petroleum Engineering program?

Significance of the Study

The study is significant in the light of the fact that the North Dakota University System in its most recent strategic plan noted, "Meeting the need for a trained and educated workforce is just one of the many essential functions of the North Dakota University System's 11 institutions" (NDUS Strategic Plan, 2014, para. 4). The report explains that universities do not exist in isolation, and developing plans for the future involves the contribution of stakeholders comprising not only faculty and staff, but also business and community leaders. Among NDUS system strategies are staying abreast of the changes in the economy, ensuring programs are relevant, building strong business partnerships and recognizing workforce shortages in the state that require training (NDUS Strategic Plan, 2014). The report also emphasizes the need to meet workforce needs through strategic initiatives.

This research has the potential to provide guidance to institutions of higher education (IHE) within the NDUS system or elsewhere that may be considering the development of a new degree program to meet the needs of industry. Academia has the potential to benefit from the findings of this study as higher education plays a key role in supporting knowledge creation in a region or state. In a position paper for the Business/Higher Education Roundtable (2002), Cairney (2000) suggested that regional communities will increasingly look to universities for skills and knowledge, and this phenomenon is incongruent with how universities have historically interacted as elite

places of learning within their community. Higher education diversification towards improving the relevance of tertiary education and responsiveness to regional economic development contributes to stimulating economic growth and the quality of life within a region. Higher education networks with industry are important to support the production of the knowledge economy necessary for sustained development and growth (The World Bank, 2016). The study will fill a gap in the literature as the empirical literature is scarce regarding higher education program development to meet the needs of industry.

The study may also be important to industry leaders seeking to partner with a university for the purpose of program development. Rapid changes in the economy and labor market make it essential for people to have the skills required for the variations in the labor market. College and universities are uniquely situated to meet the challenges associated with providing education and skills tailored to the labor market needs within regions (Business/Higher Education Roundtable, 2002; The World Bank, 2016). Industry can play a significant role by partnering with post-secondary institutions by participating in the development of educational programs that meets the demand for skilled workforces who have the capacity to contribute to regional economic development (Business/Higher Education Roundtable, 2002; Soares, 2010; The World Bank, 2016).

Existing Theory That Relates to the Study

The Innovation System Framework (Lundvall, 1985) is an existing theory that relates to this study as it brings together various themes that apply to higher education program development to meet the needs of industry. The concept of the innovation system notes that the flow of technology and information among people is needed to turn

ideas into processes, products or services. The theory suggests that organizations do not innovate in isolation, but within a larger system involving human networks: networks of funds and university industry partnerships. Innovation is considered important to attaining developmental goals through the promotion of economic growth. The innovation systems approach focuses on the driving force behind the innovation, organizations and surrounding participants that influence the innovative behavior at organizations, research centers and universities; the Innovation System Framework also looks at the background that shapes the innovative behavior of the participants such as socio-economic conditions. This framework captures knowledge flow in a holistic way and can be applied to innovation in educational contexts (Organization for Economic Co-Operation and Development, 2005; Anderson et al., 2002; Metcalfe, 1995).

Conceptual Framework

The Innovation System Framework was selected to provide a conceptual framework for this study, as it is helpful for understanding the innovative process and knowledge flow between stakeholders contributing to economic development. Innovation strategy is commonly associated with finding new ways to use knowledge to solve problems or improve processes and covers numerous topics related to technology including human, financial and structural resources (Fagerberg, Martin, & Anderson, 2013). Innovation is considered of key importance in reaching developmental goals to promote economic growth (Lizuka, 2013). The innovation system approach looks at the drivers behind innovation that influence the innovative behavior as well as the

background that shapes the innovative behavior such as socio-economic conditions (Lizuka, 2013).

Innovation systems have been categorized into several systems such as Sectoral Innovation Systems, Technological Innovation Systems, Local Innovation Systems, Regional Innovation Systems and National Innovation Systems, although there is no agreement on an exact definition of an innovation system (OECD, The Measurement of Scientific and Technological Activities, 2005). What is agreed upon is that most frequently, innovation is the result of the interaction among diverse stakeholders. Freeman (1987) described systems of innovation as networks of institutions whose interaction diffuses new technologies. Similarly, Metcalfe (1995) described them as systems of interconnected institutions that transfer skills that define new technology. Hwang and Horowitt (2012) explain innovative systems as a human sociobiological system where individuals have found ways to minimize the barriers to innovation resulting from lack of trust, inefficient social networks or geographical location.

Innovation is the result of a complex set of relationships between stakeholders who produce and distribute different kinds of knowledge. The idea behind the Innovation System Framework is that it is important to understand the link between all the individuals involved in an innovative initiative. Performance or results depend on how stakeholders relate to each other as parts of a collective system. Lundvall, Johnson, Andersen and Dalum (2002) draw attention to elements related to relationships in the collective system that interact in the production of new knowledge while Patel and Pavitt (1994) highlight incentive structures associated with driving technological learning.

Metcalfe (1995) sums it up quite nicely by describing innovative systems as institutions, including post-secondary, that either jointly or individually contribute to the advancement of new technologies which provide a framework in which administrations can play a role in influencing innovative processes. It is a system of interconnected associations that create, store or transfer knowledge or skills. Thomas Koulopoulos (2012), who has been providing leadership to global organizations for over 20 years states: "Innovation is always a tense conversation between affected parties. That will not change and it should not change. It is the basic mechanism by which we align ideas with the value they can produce" (para. 13). Innovation means that organizations need to push the envelope based on needs in the market and then collaborate with the market to determine how innovations can add value to organizations (Koulopoulos, 2012).

The Innovation System Framework is an appropriate conceptual framework for examining the development of the Petroleum Engineering degree program at the University of North Dakota. The framework helps to conceptualize the process of higher education program development to meet the needs of industry. The framework will guide the exploration of the links between all the stakeholders in a system comprising many individuals with vested interests. Likewise, the Innovation System Framework is an appropriate conceptual framework as it focuses on collective innovative systems for developing new technologies and skills. The study will explore the elements of the relationships that bind stakeholders together and delve into incentive structures behind the initiative. Figure 1 illustrates the conceptual framework for the study.

There is no agreement on an exact definition of an innovation system (OECD, The Measurement of Scientific and Technological Activities, 2005), and this study found numerous illustrations of varying Innovation System Frameworks. The Innovation System Framework illustrated in this research is helpful for understanding the drivers behind the innovation as the oil boom in North Dakota and the need for skilled workers,

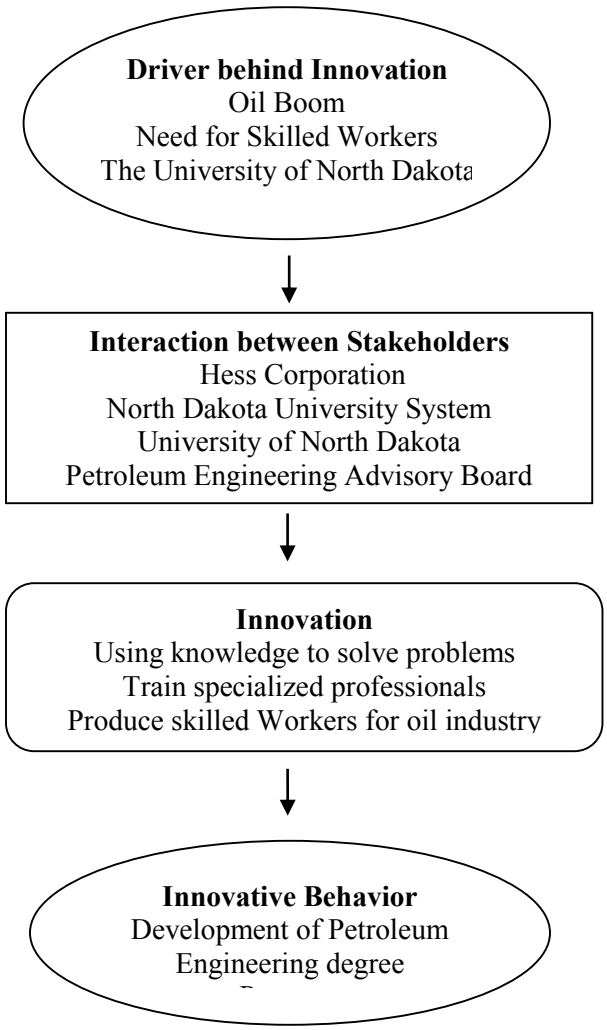

Figure 1. The conceptual framework for the study. Adapted from Cleveland's (2005), "A Framework for Manufacturing Innovations".

which resulted in the interaction of stakeholders to design, develop and deliver a new degree program in petroleum engineering. The Framework shows how innovation is the result of a complex set of relationships.

Research Goals

A clear understanding of the research goals is as important as the research design or plan (Maxwell, 2013). Maxwell identifies the importance of considering three research goals: personal, practical and intellectual or scholarly. Personal goals that motivated this study stemmed from five years of experience in various roles such as Instructional Designer in program curriculum development, Project Manager and Project Liaison in a college partnership with government to design, develop and deliver new courses and programs for apprenticeship trades to meet the needs of industry in Manitoba, Canada. Personal experiences in program and curriculum developed influenced personal interest in higher education program development to meet the needs of industry. Attending the University of North Dakota to pursue graduate studies stimulated curiosity about the development of the Petroleum Engineering degree program at UND to meet the needs of industry in the North Dakota oil fields: that interest resulted in the desire to research the university's decision to develop a new degree program to meet the needs of industry.

An advantage of basing a research topic on personal interest or experience is motivation (Maxwell, 2013). Motivation to conduct research on this topic resulted from personal experiences, a gap in the literature on the development of new degree programs to meet the needs of industry, and the growing significance of higher education program development to meet the needs of industry. The reasons for conducting this research were

compatible with the goals, research questions and the activities involved in doing a qualitative study; qualitative research is compatible with personal interests and abilities. The goals for this research resonate with Maxwell who notes that, "Decisions about research methods are personal" (p. 26).

Knowing more about the circumstances surrounding the development of the Petroleum Engineering degree program at the University of North Dakota also fulfills a practical goal to improve existing practices, meet some need, or change a situation (Maxwell, 2013). Gaining insight into what is going on during program development in higher education and why it is happening has the potential to answer some questions that previous research has not adequately answered; therefore, the goal of this research to improve existing practices. The study is significant and of importance to stakeholders in higher education program development as it sheds light on the circumstances surrounding the development of a new degree program. The overarching research question is: How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program?

A Gap in the Literature

University partnerships with industry can take various forms and include different methods of engagement (Martin, 2000). A considerable body of research highlights university-industry-government partnerships in the sciences, especially biopharmaceuticals or engineering for the purpose of research and the commercialization of knowledge (Heidrick, Kramers, & Godin, 2005; Aggarwal & Hsu, 2007). The literature search for this study found only a scant body of empirical literature focused on

higher education program development to meet the needs of industry. There are many reasons for universities to partner with industry (Mowery, 1999; Maurana, Wolff, Beck, & Simpson, 2000; Laninga, Austin, & McClure, 2012). This research study fills a gap in the literature by discovering how the University of North Dakota proceeded with establishing a Petroleum Engineering degree program to meet the needs of industry.

Previous Research

Previous research on innovative initiatives involving university partnerships with industry have employed a broad range of research methods including quantitative, qualitative and mixed methods research. Although university partnerships with industry are escalating, the research indicates that the traditional disconnect between universities and industry has not been entirely eliminated (Santoro & Betts, 2002; Martin, Smith &, Phillips, 2005; Edmondson, Valigra, Kenward, Hudson, & Belfield, 2012; Meredith & Burkle, 2008). Berman (2008) identified the cultural gap between academia and industry as a significant impediment to successful collaboration.

Edmondson et al. (2012) studied US and European educational institutions that spearheaded collaborative relationships with large industry players and noted the importance of putting the right people in charge - people who can cross boundaries. This sentiment is echoed by Santoro and Betts (2002) who highly recommend champions to serve as pivotal players in formulating meaningful incentives that satisfy the needs of all stakeholders; champion refers to someone who helps obtain support for a project (Pertuzé, Calder, Greitzer, & Lucas 2010). Likewise, Meredith and Burkle (2008) are big believers in building bridges over cultural gaps based on mutually beneficial objectives.

Cultural divides can also be navigated through creative solutions to problems (Martin et al., 2005). Hagen (2002) suggests that university collaborative partnerships require the adoption of a long-term strategic approach in order to achieve success in transformational roles focused on economic regeneration.

Petroleum Engineering Programs in the United States

A brief survey of Petroleum Engineering Schools in the United States and Canada sought responses to what prompted the development of the Petroleum Engineering program at that school, and how the development was funded. Inquiries were sent via email in July 2015 to 27 universities and colleges advertising programs in Petroleum Engineering producing varied responses from the following seven in Table 1.

One of the respondents in this brief survey indicted alumni funding to develop the program and the remainder were uncertain as to the origin of the funding to initiate a petroleum engineering program; two of the respondents were also uncertain of the year the program was founded.

Personal Interest

The Petroleum Engineering degree program at the University of North Dakota was selected as the context for this research for several reasons. First, a researcher is a gatherer and teller of stories (Gabriel, 2013). Since commencing doctoral studies at the University of North Dakota in 2012, the stories that were assembled became part of the literature that has contributed to this study. Second, the purpose of the university is to serve the needs of the community (Kerr, 1963). Therefore, this study was conducted with the intention of contributing to the mosaic of stories on university partnerships with

Table 1. Survey of Petroleum Engineering Programs in the United States.

Institution	Program	Year Founded	Funding
Marietta College, Ohio	B.S. Petroleum Engineering	1946	Edwy R. Brown (Alumnus)
Missouri University of Science and Technology	B.S. Petroleum Engineering	1911	Unknown
New Mexico Tech	B.S. Petroleum Engineering	1934	Unknown
Louisiana State University	B.S. Petroleum Engineering	1922-23	Unknown
Stanford University	B.S. Petroleum Engineering	Unknown (Early 1900s)	Unknown
University of Kansas	B.S. Petroleum Engineering	Unknown	Unknown
West Virginia University	B.S. Petroleum Engineering	1916	Unknown

industry. Lastly, the goal of this study was to assist other researchers, administrators, or industry executives exploring university partnerships with industry.

Definition of Terms

- *Entrepreneurial University*: Universities interested in business affairs (Thorp & Goldstein, 2010).
- *Fracking*: Also known as hydraulic fracturing, it is a high-tech type of drilling used in U.S. oil and gas production (What is Fracking, 2015).

- *Incubator Movements*: Initiatives intended to help establish business growth. They may be non-profit or for-profit entities. Incubator movements may focus on technology, manufacturing or service organizations (US Legal, 2016).
- *Innovation*: A new method, idea or product: a change or alteration.
- *Ivory Tower Institution*: A term used to refer to an environment where individuals engage in activities that are disconnected from everyday affairs (Maurana et al., 2000).
- *Laissez faire*: Freedom from government interference in the economic affairs of individuals and society (Rothbard, 2004).
- *Multiversity*: A large university with many different departments (Kerr, 1963).
- Professional: Relating to a job that requires specific education and training (Merriam-Webster). The term *skilled professionals* is frequently used in this study to refer to petroleum engineers.
- *Skilled labor*: A workforce sector with a high skill level that creates significant economic value through work performed: generally characterized by high education/expertise levels that require specific skill sets, education or training (Investopedia, 2016). The terms *skilled workers* and *skilled professionals* are used interchangeably in this study in reference to petroleum engineers who are a workforce sector with a high skill level characterized by a high level of specific education and training.
- *Technical skills*: Knowledge and abilities to accomplish mathematical, engineering or scientific duties/tasks (Investopedia, 2016).

- *U-I-G Partnerships*: University, industry, government partnerships.
- *Unconventional oil recovery*: A term associated with tight oil formations in North Dakota resulting in the need for hydraulic fracturing (Ratner & Tiemann, 2015).

Chapter Summary

The oil boom in North Dakota's Williston Basin created an increased demand for petroleum engineering professionals. The University of North Dakota developed a degree program in petroleum engineering to provide students with professional training that would provide a career option in the oil industry. The first chapter has identified the research problem, and stated the purpose as well as significance of the study; it has also provided an explanation of existing theory as it relates to the study, the conceptual framework, research goals, discussed prior research, gaps in the literature, disclosed individual interest in the study and provided definitions of terms. The next chapter will examine the literature related to higher education program development to meet the needs of industry.

CHAPTER II

LITERATURE REVIEW

The purpose of this qualitative research study is to examine the circumstances surrounding the development of a new degree program in Petroleum Engineering at the University of North Dakota, in Grand Forks North Dakota. The literature that informs the study comes from a wide range of subject matter as no single body of literature captures the context of higher education program development to meet the needs of industry entirely. In addition to an introductory section which establishes the contemporary context of higher education in this study, the following assemblages of literature are examined: (a) educational reform, (b) higher education response to regional needs, (c) the changing climate of higher education, (d) partnerships and economic regeneration, (e) outreach, engagement and research hubs, (f) development of higher education programs, (g) recommendations for successful partnerships, and (h) leadership in higher education. The chapter concludes with a discussion of the various forms of university-community engagement.

Figure 2 provides a map of the literature and how the various topics included in the literature review are related to the focus of the research. In one way or another each topic in the map of the literature informs the realm of higher education program development to meet the needs of industry. Ultimately, program development to meet the

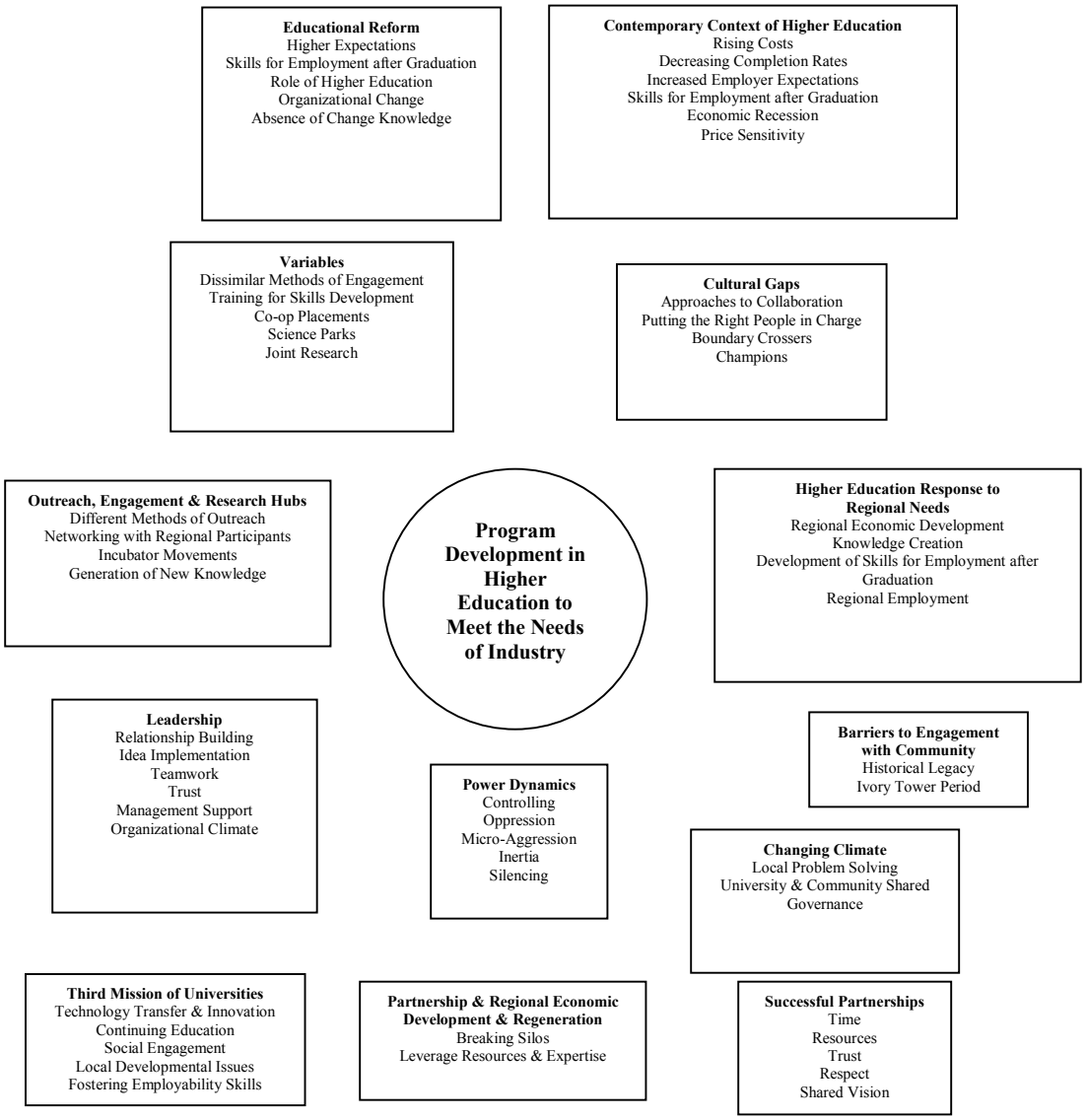

Figure 2. Literature map illustrating how the topics in the literature review are related to the focus of the research.

needs of industry does not happen in a vacuum, but as the result of a complex set of inter-relationships.

Contemporary Context of Higher Education

The context in which higher education operates is changing dramatically as a result of rising college costs, decreasing college completion rates, increased employer expectations of graduates and questions about the value of higher education as a college or university degree does not guarantee employment in a chosen field (Leveille, 2006; Milnar, 2015; Kirst & Stevens, 2015). A recent survey found that many college graduates essentially never work in their chosen field of study (O'Shaughnessy, 2013). Research under the sponsorship of the Center for Analysis of Postsecondary Education and Employment found that a large proportion of students who major in the humanities, liberal arts, and general studies receive little reward for their time, effort and financial investment (Marcus, 2014). However, a Pew Research Center report on higher education notes that college graduates still earn more than non-college grads, and the benefits of a college education exceed the value of financial remuneration such as greater job satisfaction and overall quality of life (Caumont, 2014). Researchers at the Organization for Economic Cooperation and Development (OECD) state, "Tertiary education has become a necessity, not just an option" (Lingenfelter, 2006, p. 4) in the growing competition for educated professionals in the world economy. Currently, some colleges and universities are being pressured to steer students away from programs with lower market value and limited return on investment (Evans, 2013). As student costs continue to escalate, the viability of public higher education is at risk (Fogel, 2012).

Although the number of high school graduates going to college rose steadily for decades it now seems to be declining. In October 2013, only "65.9 % of people who had graduated from high school the previous year had gone to college . . . . That was down from 66.2% the previous year and was the lowest figure in a decade. The high point came in 2009, when 70.1% of new graduates had gone to college" (Norris, 2014). With declining college enrollment, upward mobility is more difficult for working class high school graduates. According to Heidi Shierholkz, an economist with the Economic Policy Institute in Washington, this phenomenon is a lesser-known aspect of the residual effects of the Great Recession (2007-2008) that has been noted as the worst economic downturn since the Great Depression. The *Financial Times* argues that the changes associated with the economic downturn are here to stay; the current economic climate has been dubbed as the, "New Normal" and is characterized by greater price sensitivity, fewer resources, greater competition and the struggle to survive (Murtha, 2014).

While it would be reassuring to view the current climate of change in higher education as a transitional process, expectations of returning to, or realizing a state of normalcy is unlikely to occur (Heifetz, Grashow, & Linsky, 2009). The future will be about aftershocks from a financial system in disarray and the trailing reactions of financial service industries, political systems and the current overall economy; "We face the challenge of navigating a bumpy journey to a 'new normal'" (El-Erian, 2009, para. 3). At the most basic level, the future will be about restoring financial markets and a reconfiguration of the landscape (El-Erian, 2009). Reconfiguring the landscape will require new models of leadership that require new skills tailored to an environment of

uncertainty (El-Erian, 2009; Heifetz, Grashow, & Linsky, 2009). Erikson (2012) predicts that some institutions will resist the new normal while others will adjust to doing more with less.

Educational Reform

Educational reform refers to initiatives directed at reforming the existing system of education to make it more effective, with higher standards, achievement and increased focus on the needs of students (Stevens & Kirst, 2015). Heller (2009) notes, "This first decade of the 21st century has seen a number of calls for reform and changes to higher education and how it serves American society" (p. 4). The author concedes that in the United States, policymakers and the general public have scrutinized higher education for as long as it has existed. As participation in higher education grew in the 20th century becoming an important contributor to the economic needs of the nation, the scrutiny became even more intense (Heller, 2009).

Over the years, the states and the federal government have formed various commissions and review panels to examine the role of higher education in serving society. In 2005, US Secretary of Education Margaret Spellings drew attention to the importance of capitalizing on national investment in higher education and making certain that the higher education system meets the nations need for a competitive workforce. Since its inception, the Spellings Commission was received with criticism driven by concerns over the impending increased role by the federal government in regulating higher education. Over time, the Commission focused more narrowly on higher education's role in preparing Americans for the workforce. Agenda items included higher

education topics related to affordability, accessibility, quality, innovative financing, teaching and learning strategies as well as models of program delivery. In reality, much of the momentum behind the formation of the Spellings Commission and its subsequent report was never realized due to the sheer size, diversity and scope of higher education in the United States (Heller, 2009). Much like the Truman Commission report in 1947, the Spellings Commission report was largely considered a blueprint for making changes to higher education; however, how those changes were going to be made and who was going to pay for them was unclear (Atwell, 2006).

Educational reform is stifled on many college and university campuses due to an absence of change knowledge, or having an understanding and insight about the change process and the drivers that facilitate successful change practice (Fullan et al., 2005). The presence of core concepts for facilitating change processes does not necessarily guarantee success, "But their absence ensures failure" (Fullan et al., 2005. p. 54). Higher education leaders need to foster adaptation by developing practices for thriving in a new context beginning by embracing the changing context of higher education and generating leadership that supports individuals through changing times (Heifetz, Grashow, & Linsky, 2009). Heifetz et al. describe the process as keep[ing] your hand on the thermostat. If the heat's too low, people won't make difficult decisions. If it's too high, they might panic . . . and flee" (p. 5). Kezar (2009) notes that higher education is a unique type of institution that needs to approach change differently than other organizations as it is characterized by multiple power and authority structures, shared governance systems and distinct professional and administrative values striving towards disparate outcomes

and goals. Kyle (1993) notes that organizational change causes individuals to experience a reaction to the process, and various authors have noted that adapting to change is a challenging process for many individuals as it involves going from what is known to what is unknown (Zaltman & Duncan, 1977; Nadler, 1981; Myers & Robinson, 1991; Coghlan, 1993). Adapting to change is the hallmark of survival as no one can predict precisely what is around the next corner and beyond; all we know is that tomorrow will be different than today (Kezar, 2009).

Higher Education Response to Regional Needs

There is a general concern that higher education is insufficiently directed toward regional economic needs and development. Being located within regions, universities and colleges are being asked to make a contribution to the development of their region (Chatterton & Goddard, 2000). "Within this environment, the regional availability of knowledge and skills is as important as the physical infrastructure" (Chatterton & Goddard, 2000, p. 475). Therefore, regionally engaged institutions of higher education have the potential to become key assets for regional economic development. Among the needs for regional development in higher education are flexible structures for learning and the awareness of changing skill demands. "Responding to regional needs is not a clear-cut process for higher education institutions" (Chatterton & Goddard, 2000, p. 491). However, it is embedded in the history of individual institutions and the political-economic structure of the region (Chatterton & Goddard, 2000). What is needed is a new way of thinking about the regional environment; it means collaboration and developing

leaders who can work across borders of the university in effective discourse with other stakeholders to enrich their learning region (Duke, 1998).

Higher education institutions have the capacity to make significant contributions to regional economic development and the relevance of their activities is of growing importance. The OECD examined how universities and other higher education institutions contribute to regional development in a comparative review during 2005 and 2006 in 14 regions across 12 countries. The project, managed by OECD's Institutional Management Higher Education Programme (IMHE) involved higher education stakeholders, policymakers and members from business and community based organizations. Their findings suggest that in order to be competitive, regional innovation systems need strengthening (Marmolejo & Puukka, 2006). The engagement of higher education in regional development may include:

> (1) Knowledge creation through research and its exploitation via knowledge transfer; (2) knowledge transfer through human resources development, education, localizing the learning processes by work-based learning, graduate employment in the region, and continuing education and professional development; and (3) cultural and community development, creating the milieu of social cohesion and sustainable development on which innovation depends. (Marmolejo & Puukka, 2006, p. 5)

Institutions of higher education have the capacity to connect various entities that focus on learning, and the development of skills as well as research and innovation. In reality, internal and external barriers may interfere with institutions of higher education

becoming more regionally engaged. Some of the barriers to engagement include, but are not limited to legal, cultural, structural, governance and financial barriers (Marmolejo & Puukka, 2006).

History of University Engagement With Community

Universities and their surrounding communities have a long history of endeavoring to collaborate cooperatively to address mutual concerns (Bender, 1988; Baker-Minkel et al., 2004; Carr, 1999; Martin et al., 2005). The situation can be traced back to the historical isolation of universities in remote geographical locations far removed from the social problems within broader society. As universities became threatened by the expansion of urban areas, many were absorbed by surrounding communities inadvertently becoming urban campuses not by choice, but by circumstance (Maurana et al., 2000). The period of time between 1914 and the late 1980's has been described as the *Ivory Tower* period in American higher education as academic efforts began to be directed toward research and publication (Maurana et al., 2000). After World Wars I and II American higher education progressively competed for prestige and material resources focusing inwardly on scholastic issues as opposed to external problems enveloping American society that interfered with the promise of the American Dream (Harkavy, 1998). Economic and social problems within the broader society continued to infiltrate university campuses and relationships between communities and universities further declined. Although universities bring prestige to a community, they are often perceived by citizens as formidable, non-tax-paying entities that expend city services, but provide little in return (Kysiak, 1986).

Shifting Paradigms

The relationship between the university and community has begun to change as a result of an increasing awareness on the part of the university that in order to grow and prosper it needs to be linked to the surrounding community (Martin et al., 2005). This paradigm shift represents the changing relationship between universities and their surrounding community. New affiliations between universities, communities, industries and government are now promoting collaboration and alliances between previously autonomous organizations. The purpose of the new association is to focus on public problem solving unifying universities and communities in a joint effort to resolve local concerns (Reddel, 2002). Moving toward a model of shared governance has resulted in more attention to how and why university-community partnerships are created, how they function and what they achieve (Rubin, 1975).

Martin, Smith, and Phillips (2005) asserted that U-I partnerships require stakeholders to produce innovative programs and projects through synergistic relationships. The authors stated that U-I partnerships present enriching opportunities for students to link theory to practice by providing real world experiences. Klawe (2013) noted that collaborative U-I partnerships are also shifting the culture in higher education by providing opportunities for faculty to move between industry and academia. In various jurisdictions, models of engagement are emerging for efficiently supporting and enhancing innovative U-I partnerships (McGill University and École de Technologie Supérieure, 2011; Giachino, 2013). Edmondson, Valigra, Kenard, Hudson, and Belfield (2012) maintain that innovation does not happen in a vacuum; stakeholders shape and set

the context through effective working models. Boccanfuso (2012) posits that U-I partnerships matter as the research that results from collaborative partnerships sets the foundation for innovations that have the potential to create new products, processes, services or experiences that benefit society. This is not a linear one-way process, but rather a dynamic and multifaceted endeavor.

Turk-Bicakci and Brint (2005) as well as Martin (2000) observed that U-I partnerships have become prominent agenda items in higher education at institutional as well as national levels for their potential service value. As part of this growing trend more countries are providing incentive schemes or tax exemptions for the development of U-I linkages. With the potential connections to new forms of funding, higher education institutions are more open to collaborating with industry than ever before. Duderstadt (2005) detected that policies and programs for the management of U-I partnerships are in need of consideration. This may stem from the fact that these partnerships have made the management of university research more problematic specifically in regards to litigation over contractual agreements, intellectual property, research misconduct and conflicts-of-interest (Koehn, 1998).

Universities once existed as single societies comprising of masters and students; however, today they are a series of societies and activities held together by a unifying name, shared governing body and related purposes. The university is a unique type of institution that is neither entirely private nor totally public (Kerr, 1963). They are viewed as protectors of science and knowledge and described as existing inside the very social fabric of an era simultaneously expressing both the future and the present (Flexner,

1930). The idea of a modern university, a multiversity, is then a product of social evolution which has brought new departments onto campuses and become more focused on pursing knowledge and solving problems (Kerr, 1963).

The Third Mission of Universities

There is a growing awareness around the world that the role of higher education plays a significant role in economic growth in the knowledge economy; there is also evidence that university partnerships with industry and society in general are escalating (Etzkowitz et al., 2000; Vorely & Nelles, 2008). The idea of university partnerships with industry and society for the purpose of improving regional development is not a new one and can be traced back to the Royal Charter of the University San Marcos de Lima (1551) which is the oldest officially established university in the Americas, and one of the oldest in the world (Brand, 1940). University partnerships with industry and society are typically associated with third mission activities. Usually, third mission activities include, "technology transfer and innovation, continuing education and social engagement" (European Indicators and Ranking Methodology for University Third Mission, 2008). Many authors agree that third mission activities encompass all those activities not included in the first two missions: teaching and research (Jongbloed, Enders, & Salerno, 2008). Generally, third mission captures the mandate for universities taking an active role in steering the deployment of "knowledge for social, cultural and economic development" (European Indicators and Ranking Methodology for University Third Mission, 2008).

Contributing to the welfare of the community is a way for the university to respond to the needs of the economy and society. Recent studies have shown that higher education involvement in the economy depends on the context of the environment, be it friendly or hostile and infrastructure such as human relations and leadership decisions (Albulescu, Litra, & Neagu, 2014). Analysts argue that innovative initiatives in higher education are the result of complex internal and external factors combined in different ways in different contents (Etzkowitz & Ranga, 2008). Implementing the third mission must take into account factors concerning resources, the environment, regulations, conflicts of interest as well as leadership (Albulescu, Litra, & Neagu, 2014).

New initiatives bring challenges to a university campus particularly in regards to leadership and alignment with institutional vision and mission. Some authors have argued that the third mission of the university is indirectly linked to the aim of the university itself (Koscielniak, Mickiewicz, & Roemer, 2013). Questions arise about whether or not the third mission makes the university more attractive and improves status beyond the walls of the organization. Undeniably, universities are compelled to respond to the appeals from regional stakeholders. The question universities must ask is whether or not it is going to be more attractive as a result of adopting a new initiative (Koscielniak, Mickiewicz & Roemer, 2013). Universities can contribute to regional development by capitalizing on their own individual strengths serving as foundations of expertise in their region acting as leaders with stakeholders fostering skills development and future employability (Burton & Dlouha, 2011).

Laredo (2007) examines underpinning assumptions about the importance of connections between fostering employability skills development at university and future employability in society. The author notes that frequently expectations concerning the third mission of universities is linked to local developmental issues. Quite possibly then, the most important local economic dimension of higher education is related to undergraduate and vocational studies. As a university most directly addresses the local population it serves including issues related to local employment, employability and adequate shaping of curricula are timely topics for discussion. How differently these topics are addressed are directly related to, "The configuration of university activities and upon its embedding in its geographical territory" (Laredo, 2007, p. 9).

If employability of future graduates is of central concern, then what is required is the development of, "Professional degrees that are relevant to the local economy" (Laredo, 2007, p. 10). Herein lies the, "First layer of interaction between the university, the region, and the established representations of industry" (Laredo, 2007, p. 10). Linking back to the region is often at the heart of regional economic specialization in which the university is situated. Such positioning of the university and the territory it supports helps to ensure the valorization of the knowledge produced and potential future employment. All universities are a unique mix of providing professional degrees that are relevant to the local economy, although the positioning is likely the result of local historical factors (Laredo, 2007).

While the concept of community engagement is not new, until recently it has not received significant recognition (The Business/Higher Education Round Table, 2006).

The Business/Higher Education Round Table (2006) notes that community engagement "Has the capacity to generate significant economic and social value" (p. 3). The two-way relationships formed through university partnerships with community have the potential to produce mutually beneficial outcomes such as regional economic growth. Policy makers, industry and academic leaders in higher education have a rising interest in contributing to economic development in a more substantial way than their predecessors. This has been attributed to the mounting interest in curriculum development to build talent for roles relating to economic development (The Business/Higher Education Round Table, 2006).

Partnerships and Regional Economic Development/Regeneration

Higher education is notorious for operating in silos and individualism looms large. "Each institution is its own universe, each department its own country, each course its own state" (Rickard, 2003). Partnering is providing new opportunities for breaking down silos in organizations as it gets things moving. Organizational silos, much like agricultural silos, enclose something of significance. That is great if you are protecting wheat and grain from the elements; however, it is not conducive for fostering innovation across sectors (Govindarajan, 2011). Some campuses are finding that partnerships help leverage resources or expertise that may otherwise be out of reach; they provide new opportunities to reconfigure funding and innovation in a climate of technological change (Rickard, 2003).

In the current climate of technological change universities are progressively playing a more central role in economic development, and their involvement with

industry has increased (Giuliana & Arza, 2009). Giuliana and Arza question assumptions surrounding the benefit of university – industry linkages and suggest that not all relationships are created equally. Studies have shown that a firm's internal characteristics and knowledge base affect the relationship and development of linkages to universities (Cohen, Nelson, & Walsh, 2002; Fontana, Geuna, & Matt, 2003; Arundel & Geuna, 2004; Laursen & Salter, 2004). The authors consider firms with stronger knowledge bases to have enhanced capabilities for seeking out and exploiting valuable external knowledge. This view is supported by Schartinger, Rammer, Fischer, and Frohlich (2002) who note that firms with higher research and development focus are likely to engage in more university collaboration. Gaskill, Morrison, Sanders, Forster, Edwards, Fleming, and McClure (2003) as well as Meredith and Burkle (2008) note the significance of a common goal that binds linkages between universities and industry: common goals centering on linking theory and practice. Heidrick, Kramers, and Godin (2005) found that by working collaboratively toward common goals universities and industry can share the cost of conducting research and gain access to equipment they may not otherwise be able to access. By working for mutual benefit industry receives needed research, universities get funding, and communities receive new technology and products (Jachimowicz & Umali, 2000).

Hagen's (2002) research found that pressures from globalization and alliance capitalism have transformed universities' traditional role of engagement in research and teaching to also include the role of participant in economic regional development. The author draws on findings from the literature on strategic alliances and examines the

pressure on universities to form partnerships with industry and government in order to accomplish the additional role in economic regeneration. Hagen determines that U-I partnerships are inevitable, but questions the expectation that such partnerships will automatically produce results. He posits that tripartite partnerships are high-risk strategies that require an adoption of a long-term strategic approach if universities are to achieve the objectives of their new transformational role in economic regeneration. Hagen reports that a-third to two thirds of all alliances fail. Das (2010), on the other hand reports a 50% failure rate with some statistics being substantially lower; Lowe and Gawne (2005) reported the failure rate of alliances between 55 and 70 %. Das attributes the differences in success rates to investing in the right leadership. Hagen resolves that when alliances are successful the mutual benefits are more than the sum of their parts.

Studies by Bartlett and Ghosha (1993) as well as Martinez and Jarillo (1989) found that the pressure on universities to form partnerships with industry and government for the purpose of economic regeneration is a fact of life. A background paper to the OECD project on the response of higher education to regional needs identifies universities as major players in regional economic regeneration (Goddard, 1997). The European Union Regional Policy, "Connecting Universities to Regional Growth" (2011) provides insights on connecting universities to regional development, and these insights are valuable beyond the European context.

This review of the literature has found that the recommendation for universities to collaborate with regional partners for the purpose of human resource development is a universal theme in the literature (Langina et al., 2012; Mader et al., 2013). Edmondson,

Valigra, Hudson, and Belfield (2012) as well as Pertuzé, Calder, Greitzer, and Lucas (2010) studied university collaboration with regional actors noting these cooperative partnerships require project leaders with boundary spanning skills who foster relationships between the university and industry.

Outreach, Engagement, and Research Hubs

Increasingly, universities are adopting the idea that they should engage in local problem solving for the greater good of their communities through partnerships that are mutually beneficial (Baum, 2000; Myers & Banerjee, 2005). Laninga, Austin, and McClure (2012) propose that the initial step is outreach and engagement through a democratic and participatory process enlarging the opportunities for who participates. The authors also noted that university capacity to partner with communities at different stages in the formation process of collaboration is contingent on a vigorous yet adjustable interdisciplinary approach to outreach and engagement coordinated at the university level. They explain that interdisciplinary models of outreach and engagement are rarely perfectly executed as communication breakdowns or mismatches occur between the academy and community needs. The authors are resolute that every consideration must be taken to ensure that the process is implemented professionally and honored by all participants.

Mader, Zimmerman, Gorsdorf-Lechevin, and Diethart (2013) reflect on and analyze the contemporary diverse roles of higher education institutions in networking with regional actors. Like Langina et al. (2012), they used case studies of networking and capacity building between higher education and regional participants. However, in

contrast to the research by Langina et al. set in small town Idaho in the United States, Mader et al. based their investigations on case studies in Egypt, Sweden as well as the United States. Both sets of authors are in agreement that the roles of higher education institutions in regional networks are diverse, multifaceted and as complex as the various functions within these networks. The findings from this research demonstrate the universal applicability of the themes emerging from studies of U-I partnerships.

Etzkowitz, Dzisah, Ranga, and Zhou (2007) note that the interactions between university, industry and government are the source of the development of incubator movements that are important to the flow of innovation. The authors argue that the future of economic development lies in the university, not just because of its research potential, but because the university has a renewable resource of fresh ideas in students. The authors use a case study of the University of Saskatchewan to show how one university transitioned from a *laissez faire* environment to an interactive triple helix model housing Innovation Place – one of the most successful science and technology parks in North America. The authors explain that the move from *laissez faire* to a triple helix model began when the federal government solicited help from the University of Saskatchewan to search for a solution to the disease of wheat rust which was costing the provincial economy about 25 million a year. The university's drive to be the research hub of Western Canada has propelled innovation and is reflected in the transformation of the university from an ivory tower institution to an entrepreneurial university (Etzkowitz et al., 2007). Similarly, Weddle, Rooks, and Valdecanas (2006) examine the evolution of Research Triangle Park in the Raleigh-Durham region of North Carolina that evolved

from only a vision for changing a region's economic base to the manifestation of how U-I-G partnerships can positively impact an economy. Likewise, Smilor, Gibson and Kozmetsky (1989) explored organizational engagement in boundary spanning programs during the emergence of the Austin Texas technopolis.

Youtie and Shapira (2008) observed that the functions that universities undertake in society change and evolve over time. Huxley (1892) explained that in medieval times the university looked backwards professing to be the storehouse of old knowledge. However, in modern times the university looks forward as a factory of new knowledge. Youtie and Shapira use a case study of the Georgia Institute of Technology to examine how state efforts changed the region from an agricultural to an industrial and innovative economy. Like Etzkowitz, et al., Youtie and Shapira explain how U-I collaborative efforts can have positive outcomes in producing boundary-spanning programs in a region. Both Youtie and Shapira and Etzkowitz, et al. recognize that training students and conducting research to produce new knowledge remains the bread and butter of universities. However, in recent decades the university has emerged as a knowledge hub that seeks to be involved in regional development and innovation.

Recommendations for Successful Partnerships

Creating meaningful and effective alliances requires a substantial investment of time and human resources (Nichols, Phipps, Gaetz, & Fisher, 2014). Nichols et al. (2014) found that the literature on partnerships between academia and the community fails to draw adequate attention to the contexts in which partnerships occur and the activities people actually perform; one of the most overlooked aspects of partnerships is

the engendering of trust. Following an examination of four case studies the authors posit that, "Bridging structures/personnel maximize the success of collaborations by facilitating connections, increasing accessibility of university resources, formalizing interinstitutional partnerships, and supporting project coordination" (p. 85). A shared vision brings people together, however, productive collaboration requires a joint effort for sustained results. Sustained community-academic partnerships have the potential to produce conditions conducive to bolstering regional economic development; however organizational support plays a key role in determining meaningful relationships (Nichols et al., 2014).

A study by Pertuzé, Calder, Greitzer, and Lucas (2010) examined the influence of U-I collaboration on the generation of new knowledge and the applicability of the new knowledge for industry. The authors were interested in learning more about how collaboration can best be carried out once agreements are made. Based on their research they propose a set of seven guidelines that companies should follow to get the most value out of collaborating with industry. Similar to the study by Heidrick, Kramers and Godin (2005), this study also noted the importance of fostering productive relationships between universities and industry. The authors emphasize that talking a good game is not enough to ensure success in the collaborative process. What is needed is implementation strategies, continuing relationships, longer-term projects and project leaders who make the contract feel like a partnership.

Similar to the study by Pertuzé et al., Martin, Smith, and Philips (2005) also identify seven factors considered essential to successful U-I partnerships. Where Pertuzé

et al. recommended seven best practices emphasizing collaborative process execution and the value of relationship building, Martin et al. highlight the importance of partnership synergy, organizational compatibility and a process for evaluation and measurable outcome assessment. The authors state that U-I partnerships are frequently grossly underestimated in terms of time, money required and the level of skills necessary for success. Sandman and Baker-Clark (1997) found that it is not uncommon for partners to enter into collaborations without being adequately prepared and then becoming overwhelmed by the complexity of the project.

Prigge and Torraco (2006) examined organizational structures and processes in American universities that have a history of establishing and maintaining partnerships with industry. The authors noted that as public funding for higher education continues to decline universities will be required to seek alternative sources of private funding to survive. The literature is replete with exemplars of benefits and risks correlated to U-I partnerships; as these partnerships continue to proliferate universities must clearly identify the benefits and risks for the purpose of developing organizational structures to maximize potential outcomes. Jones and Clulow (2012) note that collaborative partnerships provide opportunities for stretching intellectual capacitates, enhancing reputations and potential revenue streams; however, senior management buy-in is mandatory.

Universities and industry have been entering into collaborative relationships for a long time; however, growth in the global knowledge economy has increased the demand for strategic partnerships (Turk-Bicakci & Brint, 2005; Mowery, 1999; Pertuzé et al.,

2010; Edmondson et al., 2012). Many universities are at the forefront in creating partnerships with industry that enhance and improve the competitiveness of universities, industries and regions for the purpose of addressing social challenges and driving economic growth. The lessons that can be learned from the research are best summarized by Edmondson et al.; keep the ship steady, allow universities to have autonomy (its own board as opposed to government ministries), reward activists and help stakeholders strive for excellence. The most productive collaborations are strategic, long term and built around a shared vision. When universities and industry work together to develop new knowledge, they become powerful innovators of economic growth.

Cultural Gaps

Although university and industry partnerships continue to escalate, the research indicates that the traditional disconnect between universities and industry or communities has not been entirely eliminated (Santoro & Betts, 2002; Hagen, 2002; Martin et al., 2005; Berman, 2008; Meredith & Burkle, 2008; Edmondson et al., 2012). Berman (2008) identified the cultural gap between academia and industry as a significant impediment to successful collaboration. A disconnect or cultural gap nearly derailed a collaborative research project by Gaskell et al. (2003) before it was ameliorated by university professors who recommended decelerating the research project and focusing on relationship building and patience. The authors' learned the hard way that trust is vital to successful collaboration, and "It is unlikely that a so-called 'quick and dirty' approach would ever result in successful collaboration" (p. 353).

Edmondson et al. (2012) studied US and European educational institutions that spearheaded collaborative relationships with large industry players and noted the importance of putting the right people in charge; people who can cross boundaries. This sentiment is echoed by Santoro and Betts (2002) who highly recommend champions to serve as pivotal players in formulating meaningful incentives that satisfy the needs of all stakeholders; champion referring to someone who helps obtain support for a project (Pertuzé et al., 2010). Likewise Meredith and Burkle (2008) are big believers in building bridges over cultural gaps based on mutually beneficial objectives. Martin et al. (2005) believe the cultural divide can be navigated through innovation and partnerships demonstrating creativity while Hagen (2002) suggests that collaborative partnerships require the adoption of a long-term strategic approach if universities are to achieve the objectives of their new transformational role in economic regeneration.

Various Forms of University Partnerships

University, industry and government partnerships can take various forms and include dissimilar methods of engagement (Martin, 2000). Homma and Attalage (2008) as well as Munyoki, Kibera, and Ogutu (2011) indicate that sometimes universities offer professional courses to industry in response to particular skills and the training needs related to future employment. Universities may also collaborate with industry for the purpose of course or program curriculum development to ensure degree programs produce graduates with the required knowledge and skills. Boersmaa, Reineckeb, and Gibbons (2008) indicate that U-I partnerships create opportunities for student co-op placements and may facilitate student research projects that focus on issues or problems

of importance to industry. Lundval (2009) observed that some universities establish industry liaison offices and in some cases establish science parks on or near campuses to enable collaboration. Basant and Chandra (2007) state that industries frequently commission a specific research project and sponsor an area of interest or engage in joint research and development (R & D).

Leadership in Higher Education

Effective leadership is urgently required in adult educational organizations and efforts targeted at deploying organizational initiatives depend heavily on effective leadership (Buchanan & Badham, 1999; Carnall, 2003; Martincic, 2010). Leadership plays a central and important function in initiative processes that require leaders who possess the ability to communicate the desired vision and managerial skills to deal with the complex aspects of the initiative. While academic leadership requires many skills and knowledge in any given situation or leadership role, organizing and implementing a new initiative also requires understanding how organizational culture and history may impact aspects of the initiative (McRoy & Gibbs, 2009).

Martincic examined organizational climate and its correlation to leadership style. The author found that numerous factors contribute to successful leadership and asserts that successful initiatives depend on leadership style. Using a multiple qualitative case study of managing transitional processes in three adult educational organizations, Martincic found that factors associated with successful management can be attributed to an organizational communication plan and managers with organizational cultural awareness who can move things from a stand-still, who are enthusiastic, encouraging and

offer support in a collegial environment. In a preceding similar multiple qualitative case study, Bottomley, Spratt, and Rice (1999) also noted that cultural awareness is directly associated with successful organizational leadership.

Axtell, Holman, and Wall (2006) found that organizational leadership and idea implementation appear to be associated with management support and an environment that promotes teamwork. In a longitudinal quantitative study the authors found that different predictors for navigating fluctuating environments were active at different phases during an organizational initiative. Initially changes in idea implementation were associated with management support and later changes in suggestion making were associated with team support for innovation. These findings are consistent with the idea that managerial support is crucial particularly in the initial stages of an innovative initiative. A qualitative study by McRoy and Gibbs (2009) made similar observations through the use of semi-structured interviews identifying the need for managerial support during innovative processes coupled with coherent vision, good communication and cultivated relationships.

Various researchers have started to examine the psychological processes involved in employees' experiences during organizational initiatives (Schyns, 2004; Stanley, Meyer, & Topolnytsky, 2005; Van Dam, 2008; Oreg, 2006;). Van Dam, Oreg, and Schyns (2008) studied characteristics of the daily work context to explore employees' reaction to implement organizational initiatives and found that the relationship between leaders and followers was significantly impacted by organizational climate that fostered trust and relationship building. One of the challenges for leadership has been the tension

between top down mandated initiatives and bottom up growth (Swaffield & MacBeth, 2006). The rapid growth of innovative initiatives on many campuses has brought increased attention to organizational leadership roles and the power dynamics between those who lead and those who follow (Van Dam, Oreg, & Schyns, 2008).

Power Dynamics

Kezar (2011) examines the nature of power dynamics that faculty and staff experience during innovative initiatives. The author identifies five distinctive types of power dynamics: "oppression, silencing, controlling, inertia and micro-aggressions from the most overt to more subtle and covert forms" (p. 471). Kezar defines power based on Pfeffer's (1981) definition of power in an organization as "a force sufficient to change the behaviour of others and achieve a desired outcome" (p. 472). Pfeffer also notes, "Power is context and relationship-specific and typically becomes rooted in institutional structures, moving beyond individuals" (p. 472). Kezar found that faculty and staff experience different power dynamics during innovative initiatives depending on the degree of power they already own, the power they experience between groups and how much power and control they are perceived to have; each individual group responds differently to institutional agents within campus culture and power conditions. Group strategies in power dynamics are also associated with background experience, and level of comfort with opposition (Kezar, 2011, p. 496).

Lueddeke (1999) recommends planning models for managing complex innovative initiatives in higher education noting how classical sequential models have moved from identifying the need for adaptation to providing a solution and rolling out

implementation. Developing a practical framework for guiding revolutionary processes combines theory, practice and experience, through collegial collaboration and demonstrates the capacity to adapt. Modifications generally result from the shared construction of meaning facilitated by an interactive and inclusive team (Lueddeke, 1999). Power dynamics may impede progress and faculty and staff members are more successful navigating innovative environments when they collaborate (Kezar, 2011).

Owen and Demb (2004) used an instrumental case study to examine issues related to transitional processes and found six themes related to power dynamics: tension, turbulence, planning, implementation, cultural change, and barriers. This study identifies the difficult challenges faced by faculty during innovative initiatives and how this process contributes to operational goals. The unrelenting commitment of leadership in its support was cited as the single most significant element of stability that sustains faculty through innovative initiatives. The findings offer a new perspective on how an institution can continue to pursue its goals despite unpredictable outcomes and power dynamics.

The Petroleum Engineering Degree Program at UND

In response to a very apparent need in North Dakota, in 2012 the North Dakota State Board of Higher Education approved a new Department of Petroleum Engineering at the University of North Dakota. “Part of UND’s mission is to serve the state, the country, and the world through teaching, research, creative activities and service” (North Dakota University System, 2012, para. 3). Dr. Hesham El Rewini, Dean of the School of Engineering and Mines stated, “It was created as a timely response to the oil boom in North Dakota” (North Dakota University System, 2012, para. 4). It is anticipated the

students in the program will contribute to research and professional service for affordable, sustainable energy production and environmental protection. The Petroleum Engineering curriculum was designed "together with input from alumni, industry professionals, government officials, and faculty at UND and other institutions" (North Dakota University System, 2012, para. 10). The program maximizes the use of available resources, focuses on future student success by emphasizing hands-on experience in using leading-edge technologies and includes training in "international politics, multicultural communication, business administration, leadership and entrepreneurship" North Dakota University System, 2012, para. 10).

Conclusion

A wide range of literature informs this study as no single body of literature captures the context of higher education program development to meet the needs of industry. This overview of the literature has examined educational reform, higher education response to regional needs, the changing climate of higher education, partnerships and economic regeneration, outreach, engagement and research hubs, development of higher education programs, recommendations for successful partnerships, and leadership in higher education. The chapter concluded with a discussion of the various forms of university-community engagement. The next chapter is about the research methodology.

CHAPTER III

METHODOLOGY

The purpose of this qualitative study is to understand the experiences and perspectives of selected key participants in the development of the Petroleum Engineering program at the University of North Dakota (UND), and to do so within the Innovation System Framework. The overarching research question that guides this study is: How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program?

Method

Research methods or designs provide a template, a plan and a procedure for research and the researcher must make a decision about which plan would be most appropriate for the study of a particular topic. Qualitative research methodology was chosen for this study, as it is appropriate given the complexities of the circumstances encompassing the development of a new degree program in Petroleum Engineering at UND. Qualitative research helps give meaning to social interactions through understanding and interpretation (Lichtman, 2010). Gergen (1985) described qualitative research as a process of exploratory social inquiry that provides an explanation for the world in which people live. Understanding how the University of North Dakota proceeded with establishing a Petroleum Engineering degree program lends itself to a qualitative approach.

A qualitative approach to this research will be provided through a case study. Bogdan and Biklen (2007) define case study as "a detailed examination of one setting, or a single subject, a single depository of documents, or one particular event" (p. 59). Baxter and Jack (2008) note, "Qualitative case study methodology provides tools for researchers to study complex phenomena within their contexts" (p. 554). Stake (1995) and Yin (2003) both approach case studies based on a constructivist paradigm. Constructivists claim truth is relevant to the individual and dependent on each individual's perspective that in turn results in the subjective individual creation of meaning (Crabtree & Miller, 1999). An advantage of case study research methodology is that it allows for close interaction between researcher and participant enabling participants to tell their stories (Crabtree & Miller, 1999). Yin notes case study is a good design choice when the focus of the research is to answer how and why questions within a specific context. Case study research allows the researcher to collect data from many different sources and to integrate the data to articulate the case (Baxter & Jack, 2008). The stories of selected key participants in the development of the Petroleum Engineering program at UND help to understand how the University of North Dakota is contributing to meeting the need for a trained and educated workforce in the state of North Dakota.

Framework for Research Design

The research question for this study is viewed through a constructivist lens. Constructivists believe that there are multiple representations of reality by which researchers may examine how human beings construct knowledge from information generated through their experiences (Berger & Luckmann, 1966). The constructivist lens

relates to this research as I asked selected individuals associated with the development of the Petroleum Engineering program at UND to construct responses based on their experiences. Information generated from the construction of participants' experiences helped to understand the topic, as the information resulted from each individual's activity and constructive reality. Mertens (2014) noted, "What people believe and perceive is shaped by their assumptions and prior experiences and the reality that they interact with" (p. 43). Hammersley (1992) agrees that reality is socially defined; however, holds that it is constructed on the subjective experience of everyday life as understood by the individual. Steedman (2000) notes that most of what is known and even the process of knowing is concerned with making sense of what it means to be human. Therefore, social constructivism is a good lens for examining the nature of reality through qualitative research.

Data Sources

One of the characteristics associated with case study research is the use of multiple data sources; using multiple data sources also supports data credibility (Patton, 1990; Yin, 2003). Data from case study research may include, "documentation, archival records, interviews, physical artifacts, direct observations, and participant observation" (Baxter & Jack, 2008, p. 554). Data from these sources is often amalgamated in the analysis process rather than regarded as an individual entity. Each data source is in essence a piece of a puzzle and each piece contributes to a holistic understanding of the particular case.

In-depth interviews were the primary source of data collected for this research and were supplemented by the review of written documents. Interviews allowed for close interaction with selected key participants associated with the development of the Petroleum Engineering program, and documents provided a record of human activity. Newspaper and magazine articles provided insight into the development of the oil boom in North Dakota, as well as the events leading up to the development of the Petroleum Engineering program at UND. University of North Dakota departmental documents provided insight into the Petroleum Engineering program development process.

Participant Selection

Case studies can focus on one particular instance, event, relationship, experience or process. They can use only one participant or a small group of participants although it is important that the number of participants remain comparatively small (Denscombe, 2004). In qualitative research there is a point of diminishing return on the sample when collecting more data no longer leads to gathering more valuable information. Different participants generally have different experiences and opinions so the sample needs to be large enough to ensure that most or all of the perceptions have been discovered. In the majority of qualitative studies sample size follows the concept of saturation, referring to when gathering new data no longer sheds new light on the study (Ritchie, Lewis, & Elam, 2003). Berkenkotter, Huckin, and Ackerman (1988) conducted a case study with only one participant and a study by Emig (1971) used eight participants representing a diverse cross section of community members. Case studies are likely to be more convincing if they are based on several different sources. Selfe (1985) notes that a combination of

several methods of data collection should be used to collect data in any case study as cross checking data from multiple sources helps provide a multi-dimensional profile of a particular event or situation.

The goal of this study was to have a representation from a diverse cross-section of individuals who were associated with the development of the Petroleum Engineering degree program at UND. In total, twenty-one individuals (all male) participated in the study: twelve from academia and nine from industry. Included in the twelve participants from academia, five were administrators with various roles. One of the administrators participated in an interview over the telephone during which time I did not ask any of the research questions, but rather, just asked him to speak to me about the development of the Petroleum Engineering program. I had no set questions for him and I let him speak freely. Distinctive labels or categories were not created for administrators, because doing so made each more identifiable in the research. Two of the research participants were former faculty members, one is a current faculty member, and four were students in the Petroleum Engineering degree program; two of the students are enrolled in the distance program. I placed all of these participants in a category and titled it *academia,* as each of these participants is part of the milieu or interests of a university. Nine participants were industry executives from the petroleum industry, energy and environmental services, economic development corporations and consulting services operating in the Williston Basin and Grand Forks region. I placed all of these participants in a category and called it *industry executives*. I chose *industry executive* as a title for this category as all of the individuals in the category have managerial responsibility in a business organization.

There are many methods for selecting research participants. One of the most widely used methods in qualitative research is called snowball sampling. Snowball sampling is a method of sampling that helps researchers gather data from difficult to reach or even hidden populations (Biernacki & Waldorf, 1981; Faugier & Sargent, 1997). Snowball sampling served as an entry into a group that I might otherwise have had difficulty gaining entry. The snowball sampling process began with a list of (five) names of individuals associated with the development of the Petroleum Engineering program at UND: a faculty member at UND provided the list. To begin the snowball sampling process contact was initiated with each individual on the list either by telephone or through email. During the contact, I explained the research study and asked the individual to take part in the research. Whether or not the individual agreed to participate in my study, they were also asked to help identify other individuals who may also be willing to participate. By using snowball sampling initial participants helped me gain entry into an unknown population that helped make up the sample (Biernacki & Waldorf, 1981; Faugier & Sargent, 1997). The snowball sampling process was repeated until the sample size was met. Access to potential participants was based on individual willingness to be interviewed.

Criteria used in detecting the right people to participate included, but was not limited to: people with professional experience and knowledge about the circumstances surrounding the development of the Petroleum Engineering degree program at UND. For example, those individuals with personal and organizational commitment as well as diversity of experience in either industry or academia: individuals with different

perspectives, and/or levels of understanding; persons with a demonstrated or vested interest in the development of the program and/or in this study. Some of the individuals who were willing to participate in this study were internal to the university such as Deans, department Chairs, faculty members and students.

Students were considered important to this research because of their organizational commitment having chosen to complete their degree in Petroleum Engineering at the University of North Dakota. Students come with different perspectives and levels of understanding that provide insight into how the program is meeting the needs of students. The NDUS (North Dakota University System) Strategic Plan 2015 – 2020 provides evidence of a significant focus on meeting the needs of students raising the question, "Who's going to want to go to a university that doesn't focus on students (p.2)"? The plan also explains that NDUS cannot achieve its goals without students and mentions the need to meet the needs of North Dakota's workforce. Given the focus on meeting the needs of students and meeting the need for North Dakota's workforce, student participation in the research was deemed important. Moreover, meeting the needs of students was one of the drivers behind the development of the Petroleum Engineering program. Students provided valuable information about their involvement or association with the Petroleum Engineering program at UND. Students were recruited through *Linkedin* after I received IRB approval for the study on October 15, 2015.

Some of the individuals that participated in this study were external to the university and included former faculty members, individuals from industry, donors and champions (individuals who can influence change) (Weyrauch, 2013). This nomination

procedure was conducted over the phone and through email after I received IRB approval for the study on October 15, 2015 (See Appendix A). All participants were informed of the purpose of the study, the research questions and the selection criterion. A copy of the letter or script of the narrative introducing the research to the potential participant is in Appendix C.

Interview Questions

Case study research generally answers one or more how and why questions within a specific context. The questions are aimed at a limited number of events or conditions and their inter-relationships (Yin, 2003). The overarching research question that guides this study is: How did UND proceed with establishing the Petroleum Engineering degree program? Upon the recommendation of my committee, one set of interview questions was created for participants from academia and slightly different set of interview questions was created for individuals from industry. The rationale for interviewing individuals from industry is based on my professional experiences developing programs to meet the needs of industry, as industry professionals invariably play a collaborative role in a program development process. Moreover, the literature is replete with references to industry collaboration with universities (Berman, 2008; Besant & Chandra, 2007; Boersmaa, Reineckeb, & Gibbons, 2008; Edmondson et al., 2012; Gaskell et al., 2003; Hagen, 2002; Homma & Attalage, 2008; Jones & Clulow, 2012; Martin et al., 2005; Meredith & Burkle, 2008; Lundval, 2009; Mowery, 1999; Munyoki, Kibera, & Ogutu, 2011; Pertuze et al., 2010; Prigge & Torraco, 2006; Sandman & Baker-Clark, 1997; Santoro & Betts, 2002; Turk-Bicakci & Brint, 2005).

Below are the broad open-ended questions directed at individuals from academia: questions one and two establish the participants' background and affiliation with the Petroleum Engineering program at UND, while questions three through six are related to the conceptual framework for the study.

1. Tell me about yourself.
2. Tell me about your affiliation, interest, or involvement with the Petroleum Engineering program at UND.
3. What are the factors that contributed to the development of the Petroleum Engineering program?
4. What are the best methods for collaborating with industry to develop a degree program in higher education?
5. In your opinion, what role does the Petroleum Engineering program at UND play in advancing or transferring new technologies and skills?
6. What are your recommendations for higher education program development to meet the needs of industry?

These are the broad open-ended questions directed at individuals from industry: questions one and two establish the participants' background and affiliation with the Petroleum Engineering program at UND, while questions three through six are related to the conceptual framework for the study.

1. Tell me about yourself.

2. Tell me about your affiliation, interest, or involvement with the Petroleum Engineering program something about your background and your interests in the Petroleum Engineering program at UND.
3. What were the most important factors that contributed to the development of the Petroleum Engineering program?
4. How did the interaction between stakeholders influence the development of the Petroleum Engineering program?
5. What role does higher education play in advancing or transferring new technologies and skills?
6. How would you define or measure success in an industry partnership with higher education?

Procedure

The data collection for this research occurred between October 26 and December 9, 2015. Interviews with participants generally lasted up to forty-five minutes. Only two of the interviews were conducted face-to-face in Grand Forks North Dakota, and the rest of the interviews were conducted from my home or office in Manitoba, Canada using electronic means such as telephone, Skype and FaceTime. Prior to the interview each participant received an electronic copy of The University of North Dakota Consent to Participate in Research form for signature and the interviews commenced only after the initialed/signed consent form was returned to me electronically or in hard copy, as was the case with the face-to-face interviews (Appendix B). At the beginning of each interview the purpose of the study and the details of the consent form were reviewed;

participants were also asked if they had any questions regarding the study or participation in the study. Prior to beginning the interview process the audio recording device was turned on; two of the interview participants did not consent to being audio recorded so I took notes throughout the interview. Open-ended interview questions were used for the purpose of expanding the depth of data collection and increasing the informant's information (Yin, 1994).

Following the completion of the questioning, I thanked the interviewee for his participation in the research. Participants were informed that they would receive an electronic copy of the transcribed audio recording within the following week for the purpose of member checking. After reading the transcript and checking it for accuracy, participants were asked to return it electronically with their comments within one week if there were errors. Some of the participants made a few corrections where I had misunderstood the audio recording.

Overall, I was pleased with the outcome of the interviews. Some of the participants were eager to share their stories and experiences, often getting off topic. As a result, it was sometimes challenging to re-direct them to the interview questions. Some current and former faculty members as well as industry executives were a little more difficult to draw out even after encouraging them to elaborate on their responses. I found each of their stories interesting, and I endeavored to understand and learn from their experiences. Part of my enthusiasm and interest emanated from my past experiences in higher education program development to meet the needs of industry. I was unexpectedly surprised to garner the participation of two distance students, and enjoyed hearing about

their personal experiences and career goals. I was impressed by the collaborative behavior of the Petroleum Engineering Advisory Committee as well as the commitment to regional economic development in North Dakota as articulated by industry executives who work at head offices in other states. Table 2 provides an illustration of interview participants and the numerical code that will be associated with that participant throughout the study.

Trustworthiness

Trustworthiness must be addressed in all research studies and consists of four components: credibility, transferability, dependability, and confirmability (Davies & Dodd, 2002; Lincoln & Guba, 1985; Seale, 1999; Stenbacka, 2001). Credibility refers to confidence in the truth of the findings while transferability refers to showing that the findings could have applicability in other contexts. Dependability shows that the findings are consistent and could be repeated in another study and conformability refers to the degree of neutrality, or the extent to which the findings are shaped by the respondents and not influenced by researcher bias (Lincoln & Guba, 1985).

Whittemore, Chase, and Mandle (2001) note the importance of developing a conscious research design including making appropriate decisions about the research, and providing adequate sampling and data triangulation. This research study used member checking to establish credibility and trustworthiness in the research. According to Lincoln and Guba (1985), member checking is a key trustworthiness practice that involves taking the data from the interview transcripts back to the research participants so that they have the opportunity to verify the accuracy of the data. Participants in this study were asked to

Table 2. Participant and Numerical Code.

Participant	Numerical Code
On-campus Student	1
On-campus Student	2
Distance Student	1
Distance Student	2
Industry Executive	1
Industry Executive	2
Industry Executive	3
Industry Executive	4
Industry Executive	5
Industry Executive	6
Industry Executive	7
Industry Executive	8
Industry Executive	9
Former Faculty	1
Former Faculty	2
Current Faculty Member	1
Administrator	1
Administrator	2
Administrator	3
Administrator	4
Administrator	5

verify the accuracy of their transcribed interviews via email and provide feedback regarding the accuracy of what was said during the interview process; they also had the opportunity to correct errors and facts or add additional information. Out of the twenty-one interview participants, eighteen consented to being audio recorded, and only three suggested minor modifications to names and places I had misunderstood from the audio recording.

This study also used triangulation to establish credibility by collecting data from a diverse range of individuals both in industry and academia as well as various print sources. Triangulation reduces the possibility of bias and provides for a better overall explanation of the data (Maxwell, 2013). Triangulation does not automatically increase the trustworthiness of the data as the methods of triangulation (interviews, documents) may be biased and create a false sense of security; any research method is vulnerable to bias (Fielding & Fielding, 1986).

Transferability involves demonstrating that the results of the study could be transferred to other contexts. Transferability is supported through the use of thick description, or rich data meaning that the researcher goes into enough detail so the reader can make their own decisions about whether or not the results of a particular study are transferable to another context. Davis (1995) described thick description as providing explanations that include participants' own interpretations as well as other social or cultural information. Maxwell (2013) explained rich data as showing the complexities of what is being studied and Marshal and Rossman (1989) note that, "Transferability is the responsibility of the person seeking to apply the results of the study to a new context"

(p. 606). The rich data collected for this research helps to develop an understanding of participant experiences in order to accurately represent the testimony of participants.

Dependability supports trustworthiness by way of using overlapping methods, triangulation or multiple data sources (Denzin, 1994). Brown (2005) endorses the use of overlapping methods, or cross-validating data to verify consistency of the data and interpretations over time. Lincoln and Guba (1985) note that dependability or consistency is supported through the use of an audit trail, triangulation and using a reflexive journal. This research study employed multiple data sources garnered through participant selection as well as multiple print sources that were written over a period of time. The study also demonstrates dependability or consistency, as the findings of this inquiry would be repeated if the study were conducted with similar participants in similar contexts.

Confirmability supports the trustworthiness of the research data that is used for interpretations. Specifically, the reader of a research study should be able to examine the data to confirm results and interpretations. Confirmability is further supported by the use of an audit trail or a, "residue of records stemming from inquiry" (Lincoln & Guba, 1985, p. 319). Denzin (1994) noted that confirmability builds on audit trails through record keeping of the data for possible inspection. This research study employed an audit trail by keeping all the records associated with the study so that readers could assess the adequacy of the research. Excerpts from my reflexive journal, the IRB approval, and Consent to Participate in the Research form are included in the Appendices.

Researcher Subjectivity

Maxwell (2013) identified the importance of triangulating sources, conducting member checks, providing thick description of the research data, and the use of a reflexive journal for identifying researcher bias. An outcome of researcher bias may be the selective selection of data to align with the researcher's goals or preconceptions (Miles & Huberman, 1994). Therefore, to accurately represent the voice of participants, participant's actual words are used to describe their thoughts, ideas and experiences; I refrained from interjecting my own words into the text that stem from my personal experiences in higher education program development to meet the needs of industry. Likewise, I avoided siding with the participants by discussing only favorable results, or only results that shed a positive light on me or the participants (Creswell, 2012). This research reports the full range of the findings even when and if they are contrary to my own experiences recognizing that individuals have different and unique lived experiences (Creswell, 2012). Bogdan and Biklen recommend that the researcher write a reflective acknowledgment of their own background experiences that may have a potential impact on the study. Therefore, I identified my personal interest in the study in Chapter 1, and provided vignettes of reflective acknowledgements taken from my reflective journal written during various periods of time during the research (Appendix D).

Researcher Bias

Having been a project manager and curriculum developer in a program development initiative at a post-secondary institution involving government and industry, I was aware and acknowledge the possibility of researcher bias (Cohen, Manion, &

Morrison, 2000). I am aware of the challenges associated with collaborative processes between higher education and industry, and recognize this bias has the potential to manifest itself in my interpretation of the data. Some of the challenges that I have experienced are associated with stakeholder resistance to the program development processes, lack of engagement, and faculty and/or organizational negative attitudes and/or general inertia. While my experiences uniquely position me to develop meaningful research questions, every effort was made not to make assumptions or bring in preconceived beliefs based on my experience. I am cognizant that my experiences are different from those experiences of the participants in the study. Therefore, I was careful to balance my studied knowledge of the topic through my research with the lived experiences of my subjects. I did not interview anyone I was directly associated with through any of my prior experiences as bias can occur during a research study when the situation is familiar to the researcher (Creswell, 2012). Maxwell noted that it is not possible to completely eliminate researcher bias; however, I made every effort to avoid it. Finally, I conducted myself in a professional and respectful manner throughout the research.

The influence that a researcher has on individuals in a particular study is known as reactivity (Maxwell, 2013). Hammersley and Atkinson (2007) note that it is impossible to eliminate the influence of the researcher entirely; however, it is important to understand the power of influence on participants. The authors recommend that researchers avoid using leading questions, understand how they may be influencing what the informant has to say, and how validity is affected as a result of inferences from the

data. I was aware that in the processes of interviewing individuals I have the power to influence participants. Interview questions have the potential to be skewed toward a desirable outcome and such influence poses a threat to validity. Seidman (2006) noted that sometimes an interviewer's experience resonates with that of the participant, and the author cautions against the overuse of sharing experiences as they can distort an interview.

Analysis Techniques

I personally transcribed the raw data from all 18 audio-recorded interviews, and I took notes during the interviews with the three individuals who did not consent to being audio-recorded. Personally transcribing each audio recording took a minimum of three hours per recording, and as a result I became intimately familiar with the data. All 18 interview transcripts and the notes from the three non-recorded interviews were sent electronically to participants for member checking to verify the correctness of the information in the transcript as well as add any further information or correct errors in the transcript. Follow up interviews, electronic communication or correspondence lasted up to 30 minutes during which time participants responded to the transcript of the first interview and verified the correctness of the information. Each of the participants verified the accuracy of their interview transcript and I proceeded on to the next step of analyzing the data. Data analysis did not begin until all the member checking and follow-up interviews had been completed.

All the data for this study was read numerous times for a general sense of the information and then reflected on for meaning, tone, impression, overall depth, credibility

and usefulness (Creswell, 2012). Important areas were highlighted during the first and each subsequent reading. Qualitative research data analysis relies on an organized and systematic process for breaking data down into manageable units; manageable units allow for identifying emergent patterns and themes (Bogdan & Biklen, 2007; Creswell, 2012). Bogdan and Biklen as well as Creswell suggest a process of creating codes for setting or context, participant perspectives, activities, events or relationships. Codes are "tags or labels for assigning units of meaning to the descriptive or inferential information compiled during a study" (Miles & Huberman, 1994, p. 56).

To begin the data analysis process, I manually coded the interviews line-by-line by singling out individual words or little statements of meaning in a process called open-coding (Ryan & Bernard, 2003): open-coding led to identifying and creating categories with similar content (Lichtman, 2010). After I completed coding the interview transcripts, I transferred each individual code to a large sheet of art paper fastened to a wall, which allowed me to view all the codes in their entirety and reflect on them. Next, I created an Excel spreadsheet and transferred the codes from the large sheet of art paper into themed columns or categories on the spreadsheet. After reflecting on the themed columns or categories, I rearranged some of the codes and placed them in more appropriate categories. Finally, I gave each column/category an appropriate categorical title. This process resulted in a final document with 118 codes and twenty categories.

Next, I created a descriptive statement for each category of codes by analyzing the coded content in each individual column, and by reflecting on related statements made by the subjects. Following the creation of descriptive statements, I conducted a cross-

categorical analysis of codes also known as axial-coding that examines the relationships among the open codes (Creswell, 2012). Cross-categorical analysis helps to establish a sense of emergent themes that result from the open-coding categories. Working on my Excel spreadsheet, I used separate color schemes for identifying repetitive as well as similar codes across the four categories to determine what thematic correlation existed between categories. This processes led to the formulation of fifteen emergent themes, which I sorted into four overarching themes for the study. The four overarching themes that resulted from this open coding and cross-categorical analysis were:

1. Regional influencers affected the development of the Petroleum Engineering program.
2. Attunement by UND to regional influencers performed a critical role in developing the program to meet the needs of industry.
3. Students were attracted the Petroleum Engineering program.
4. Industry support was critically important to the development of the academic program.

A schematic of the complete diagrams containing codes, categories, and emergent themes can be found in Appendices E. This data analysis process is consistent with Lichtman's three Cs of data analysis: codes, categories and concepts (Lichtman, 2010).

An open-coding process sorts data into distinct categories, so it is important to link the categories together during further analysis of the research (Birks & Mills, 2011). As I continued to work through the analysis process, I looked for recurring themes across the data set and for emerging overarching ideas that emerged from the data. After careful

consideration four assertions emerged from the research. Each assertion represents an aspect of collaboration, which answers the overarching research question that guided this study: “How did the University of North Dakota proceed with developing a Petroleum Engineering degree program”? The University of North Dakota proceeded with developing a Petroleum Engineering program through collaboration. Therefore, the four assertions that emerged were:

1. The University of North Dakota was responsive to regional needs.
2. University of North Dakota faculty were engaged participants in developing a new degree program.
3. The University of North Dakota developed a program that offered flexible learning to meet the needs of students.
4. The University of North Dakota collaborated with industry when they developed a new degree program to meet the needs of industry

These four assertions are the outcome of the open coding process of sorting data into distinct categories and linking categories together to discover recurring themes across the data set.

A final step in data analysis is asking, “What were the lessons learned” (Lincoln & Guba, 1985)? Chapter 5 will analyze and discuss the findings as presented in Chapter 4 and provide an interpretation of the results to help the reader understand the overall meaning of the study. The chapter will identify practical implications of the research, and place the results of the research into the context of the literature review and conceptual framework for the study. I will describe to what extent and in what ways the Innovation

System Framework helps to explain the development of the Petroleum Engineering program at UND, and draw attention to new questions that need to be asked that were unforeseen at the beginning of the study. Chapter 5 will also make recommendations for further study and provide a conclusion.

Confidentiality and Anonymity

Confidentiality and anonymity are ethical concerns especially when using audio recording for the purpose of participant interviews, transcribing data verbatim, writing up the results of the research and disseminating results (Gay & Airasian, 2000). Due to the nature of this study, the Petroleum Engineering program at the University of North Dakota will be identified in any publications or presentations that result from this research. This means that participants may also be identifiable due to their affiliation with the Petroleum Engineering program even though they will not be named in the research. The University of North Dakota Consent to Participate in the Research consent form states:

> In any report about this study that might be published, you will not be identified, but you should understand that this does not guarantee confidentiality, because the Petroleum Engineering program and the University of North Dakota will be identified in any publications or presentations that result from this study. (University of North Dakota Institutional Review Board: Consent to Participate in Research, Appendix B)

Confidentiality was explained to participants prior to the interviews, and articulated in the narrative of the Consent to Participate form. Recorded interview tapes were labeled with

respondent number only. Interview tapes, transcripts and informed consent documents are kept in a secure location in my home. The tapes and transcripts are kept separately from the informed consent documents. Recorded audio files will be kept for a period of up to three years in case I decide to return to the data at a later date and listen to the tapes again for the purpose of listening for inflection and tone in the participants' response. After a period of three years all the audiotapes will be erased. Transcriptions from the audio recordings will be kept for an indefinite period of time in a locked drawer in my home office.

Ethical Considerations

A major area of concern to be addressed in research is that of ethics. When gathering data for a research study, real participants in real life situations must participate. Ethical considerations are crucial to any research and exist at every stage of the research design, including the research question, purpose, data collection, analysis and interpretation (Creswell, 2012). One of the most central elements around ethical issues concerns participants. Following correct ethical guidelines ensures that everyone, including participants, benefit from the research experience. Gay and Airasian (2000) state:

> Perhaps the fundamental role of ethics is that participants should not be harmed in any way, real or possible, in the name of science. Respect and concern for your own integrity and for your participant's dignity and welfare are the bottom lines of ethical research. (pp. 100-101)

This research study was designed to address two ethical considerations: protecting the participants from undue harm and informed consent (Bogdan & Biklen, 2007). DePoy and Gitlin (2005) as well as Creswell (2012) identify three main areas that are important to consider in the research process. First, the researcher must offer participants full disclosure of the research methods that will be used, the basic facts surrounding data collection, and the nature of the research. The letter or telephone conversation introducing the research to the potential participant (Appendix B) and The University of North Dakota Consent to Participate in Research form (Appendix B) provide full disclosure of all these considerations in this research study. Second, participants were assured that the information they share would be kept confidential. The participant consent form for this study clearly identifies that I will remove any specific identifying information; however, this will not guarantee confidentiality, because the Petroleum Engineering program and UND will be identified in any presentations or publications that result from this study. Thirdly, participants understood that were under no obligation to participate in the study. The informed consent form (Appendix B) clearly identifies all three ethical considerations.

Delimitations

This study confined itself to interviewing selected individuals associated with the development of the Petroleum Engineering program at the University of North Dakota.

Limitations

The possibility that some participants could be identified could be a limitation in this study. Even though I removed any specific identifying information associated with

research participants, and confidentiality was maintained by means of coding procedures, this does not guarantee anonymity or confidentiality. As a result, some participants may not have spoken as freely as they otherwise might have. When a person does not have anonymity there is a limitation to getting reliable data. This threat to reliability was addressed to the best of my ability by being transparent about the research process and informing participants that even though they will not be identified in any report or publication relating to the study, they should understand that this does not guarantee confidentiality, because the Petroleum Engineering program and the University of North Dakota will be identified. The level of anonymity is preserved at the level of specific statements and points of view not being identified with any particular participant. Much information already exists in the public arena in newspaper and magazine articles about the participants involved in the partnership with the University of North Dakota.

As anticipated, there were time constraints on the collection of data for this research due to the fact that I live in Canada, two and a half hours away from UND, and I have full-time professional responsibilities. Furthermore, as anticipated the interview participants from both industry and academia (who resided throughout North Dakota and elsewhere in the United States) also had time constraints due to their professional responsibilities. My available time to collect the data for this research was initially primarily limited to evenings and weekends, and it proved difficult to solicit participation from potential participants during this time due to participant's academic and professional commitments. Ultimately, I arranged my schedule to accommodate the daytime availability of participants. It was not possible to calculate an exact response rate

to this research, as the given pool of potential participants was small which has the potential to result in less narrative and thick or rich descriptions. This case study takes place in a specific context that includes a specific state, university, time period, and political, social and cultural context. A repetition of this study to another university in a different geographical location, time period, political, social and cultural context and with different participants may identify additional or different aspects of higher education program development to meet the needs of industry.

Summary

This chapter has provided an overview of research methodology considerations with a focus on qualitative research methodology. The practical aspects of the study have been presented such as the framework for the research design, potential data sources, participant selection, interview questions, the research procedure and data analysis techniques. The chapter has also explained procedures for ensuring validity, reliability, confidentiality, anonymity, ethical considerations, researcher reflexivity and research limitations. The next chapter will identify the research findings and prominent themes that emerged.

CHAPTER IV

FINDINGS OF THE STUDY

This chapter includes the findings on higher education program development to meet the needs of industry. The purpose of this study was to understand the experiences and perspectives of selected key participants in the development of the Petroleum Engineering program at the University of North Dakota, and to do so within the Innovation System Framework. The overarching research question that guided this study was: How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program? Six broad open-ended questions were directed at individuals from academia and industry. Participants from academia were asked:

1. Tell me about yourself.
2. Tell me about your affiliation, interest, or involvement with the Petroleum Engineering program at UND.
3. What are the factors that contributed to the development of the Petroleum Engineering program?
4. What are the best methods for collaborating with industry to develop a degree program in higher education?
5. In your opinion, what role does the Petroleum Engineering program at UND play in advancing or transferring new technologies and skills?

6. What are your recommendations for higher education program development to meet the needs of industry?

Questions one and two established and confirmed appropriate research participation criteria, and questions three to six were linked to the conceptual framework for the study, the Innovation System Framework. Participants from industry were also asked six broad open-ended questions:

1. Tell me about yourself.
2. Tell me about your affiliation, interest, or involvement with the Petroleum Engineering program at UND.
3. What were the most important factors that contributed to the development of the Petroleum Engineering program?
4. How did the interaction between stakeholders influence the development of the Petroleum Engineering program?
5. What role does higher education play in advancing or transferring new technologies and skills?
6. How would you define or measure success in an industry partnership with higher education?

This chapter presents the four overarching themes supported by sub-themes that resulted from the research questions, interview transcriptions and subsequent data analysis. Each theme was generated from an open-coding process followed by axial coding. The audit trail in Appendix E shows how I moved from open coding to axial coding to form categories, emergent and over-arching themes based on the initial coding process.

Theme 1: Regional Influencers Affected the Development of the Petroleum Engineering Program

During the period of rapidly expanding oil extraction in western North Dakota that began around 2006, members of the oil and gas industry along with various sectors of the business community in North Dakota noted an increased need for petroleum engineers. The increasing need for petroleum engineers produced a perceived urgency to educate local individuals with the appropriate skills for petroleum engineering. Administrator #4 noted:

> The urgency to create a Petroleum Engineering program in North Dakota was further intensified by the discovery that some individuals from the tri-state area, specifically, North Dakota, South Dakota and Minnesota were going to other post-secondary institutions such as the Colorado School of Mines, or Montana Tech to receive training appropriate for petroleum engineering. It would be better to keep these students in North Dakota rather than have them attend programs in other states.

In light of the knowledge that some local individuals were leaving the state for training in Petroleum Engineering programs in other states, administrator #4 reported, "Establishing a Petroleum Engineering degree program at UND became an easy decision".

Assumptions About Recruiting Locally

The research findings noted that the oil and gas industry in North Dakota had been experiencing difficulty filling their petroleum engineering hiring quotas, and this was exacerbated by frequent turnover associated with hiring petroleum engineers from

southern climates for whom North Dakota was a cold, harsh and remote experience. Former faculty member #1 noted:

> Some members of the University of North Dakota alumni and industry executives informed faculty at the University of North Dakota about the difficulties associated with recruiting and retaining graduates from Texas A & M to North Dakota, because of the remoteness, the cold winter and isolation: there was a growing perception that training locals would provide a solution to frequent human resource turnover in petroleum engineering.

The data indicated that prior experiences had shown industry that workers from Texas, Louisiana or Mississippi demonstrated no intention of putting down roots in the state, and these experiences or perceptions contributed to industry's growing interest in training local people for whom North Dakota is home. Industry executive #4 noted, "North Dakota has quite an unforgiving climate. When you hire locals, you can get people who are more invested, more willing to put down roots". Evidently, there was a growing perception in the industry that recruiting individuals who had grown up in North Dakota would result in greater long-term employment stability in the oil and gas industry.

In addition to industry's perception that the cold weather in North Dakota was a deterrent to recruiting petroleum engineers from elsewhere, and that local graduates would already be acclimatized to the weather, there was also a perception that local graduates are exemplary in other ways. Faculty member #1 notes, "Industry recruits a lot of our students and notes a difference in work ethic, farm background, family values and morals. So companies like recruiting our students, because they know they are going to

work hard". Similar perceptions as well as assumptions were noted by former faculty members, administrators, as well as industry executives: administrator #4 echoed, "Industry wants to hire graduates from North Dakota, because students from North Dakota are used to the cold winter". Administrator #3 noted that companies acknowledge, "A different work ethic up here in the mid-west than compared to a lot of schools down south". The combination of already being acclimatized to North Dakota's weather and perception about work ethic contributed toward an emphasis on training and recruiting home grown graduates of a petroleum engineering program at UND.

With the oil boom in the Williston Basin, difficulties attracting and retaining out-of-state petroleum engineers, and the perception that hiring locally trained petroleum engineers would contribute towards alleviating a human resource deficit, developing a Petroleum Engineering degree program at UND seemed like a logical decision and an investment in North Dakota. Industry executive #7 noted, "Hiring professionals from North Dakota is an investment in the future of the state". The research findings noted a pervasive assumption that students from North Dakota who want to be petroleum engineers would most likely want to live and work in North Dakota, and not just gain a couple of years of experience for greater career mobility. The perceived advantage of recruiting students from North Dakota was that home grown petroleum engineers would be more likely to put down permanent roots and contribute to the growth of the state.

Administrators, faculty, as well as industry executives noted that in industry you have to attract the right kind of people to where the work is and keep them there. There is a perception that since the Petroleum Engineering program at UND resides in Grand

Forks, North Dakota, it has the potential to attract an available base of students who already call North Dakota home, and these students are likely to stay and work in the area. Industry executive # 5 noted:

> UND has a quality Petroleum Engineering degree that has a local base, and it is going to attract the people that see North Dakota as home. As a result they are more likely to stay and work in North Dakota.

Industry executive #1 also noted that, "A lot of local kids want to stay in North Dakota". These perceptions and assumptions were pervasive in the research findings as was the notion, or prevalent belief concerning stereotypical motifs about the North Dakota work ethic, and these perceptions contributed to a focus on training and recruiting locally. Industry executive #5 stated, "North Dakota people are smart, people work hard, and people are committed. The types of characteristics that come out of this part of the country make it exceptional to be right here". Apparently as the oil boom gained momentum, many individuals clung to popular perceptions about people from North Dakota making assumptions about graduate student employment preferences.

The research found that participant responses recurrently centered on values industry associates with students who grew up on farms, ranches and in small towns in rural North Dakota. There was a prevailing perception among industry that associates certain intrinsic attributes such as authenticity, humility and leadership potential with individuals that come from rural situations in North Dakota. Industry executive #2 notes:

> We look at what the new students can bring to a team, especially to a field office. When you come from a small town it allows you to stay humble, and stay within

> yourself. A lot of leaders and leadership ability comes naturally from personality. There are not a lot of ways you can learn leadership, it is not an easy process, and often times there are major roadblocks.

There is a perception in industry that assembling local people [Petroleum Engineers] with that small town humility, will provide industry with individuals who possess the intelligence and the acumen to deport themselves as leaders in the industry while still being able to deal with the lay people on the ground who, "get their boots dirty and go home every day stinking of oil" (Industry executive #2). Industry executive #3's perception harmonized with Industry executive #2 noting, "These are the attributes that industry is hoping to garner by hiring local home grown graduates of the Petroleum Engineering program at UND: specifically, better-rounded engineers".

Growing Momentum to Develop a Program

In addition to the expressed wishes from industry to develop a Petroleum Engineering degree program at the University of North Dakota, there was also a push from alumni, in particular alumni associated with the oil industry, and there was a substantial gift early on from an alumnus. Former faculty member #2 notes:

> Bob Solberg, a former alumnus, put a million dollars in a pot many years ago, and was promised through a previous Dean that there would be some kind of petroleum thing going on. The money sat around for a while. However, there was a lot of nudging as the Bakken formation was really starting to take off.

Interest and feedback from alumni and industry stimulated faculty interest in regards to developing a degree program in petroleum engineering. However, former faculty member

#2 reports that faculty had already begun to engage in active research concerning the possible development of a petroleum engineering program due to the accelerating oil production activity in the Bakken, and some faculty members in the Geology Department had petroleum engineering backgrounds. The state also had an interest in developing a petroleum engineering degree program, and a Petroleum Centre of Excellence already existed within the state. Administrator # 4 noted, "Several different forces were coming into line pretty much all at the same time. The timing was right, the support was right; we structured things to create the program and it happened".

A Missed Generation of Training Petroleum Engineers in North Dakota

There were also a large number of stakeholders and executives in the oil and gas industry that had come through the University of North Dakota, who, in the light of the oil boom in the state, felt that UND's decision to discontinue the Petroleum Engineering program in the late 1980s had been a major mistake: an entire generation had missed the opportunity for training in petroleum engineering and another segment of the sector was at or near retirement age. Industry executive #8 commented:

> This realization drove the discussion and really spurned the interest and the understanding of the long-term demand for more petroleum engineers, and where better to do it than in North Dakota where they can get the knowledge and the experience.

A Petroleum Engineering program first appeared in the UND catalogue in 1952, and it appeared again for the last time in 1992 (Elwyn B. Robinson Department of Special Collections, University of North Dakota, April 8, 2016). The research findings noted that

due to the absence of a petroleum engineering program in the state for nearly a generation, and the perceived long-term demand for petroleum engineers in North Dakota, there was also a perception that it was the right time to develop a petroleum engineering program in the state.

Significance of Engagement in Regional Needs

The North Dakota economy is very dependent on the Bakken, which is the second largest oil producer in the United States. The research data indicated that graduating students who are skilled petroleum engineers is really important to the future of North Dakota. Faculty member #1 noted, "If students graduating from the Petroleum Engineering program are of good quality, they will help the state to grow in terms of technology which will have a direct impact on the economy of the state". The perception based on the research data is that producing practical graduates is essential for helping to advance oil recovery in the state through research and developing more cost-effective drilling methods, and this will have a direct impact on the economy of the state. Since the resources in North Dakota are unconventional, the process of extracting the oil is fairly new technology. Therefore, "the university plays a key role in helping to develop new ideas and new technology to improve the extraction of oil recovery and finding different ways to improve efficiency" (Administrator #4). The research findings note that graduating students who are skilled petroleum engineers is really important to stakeholders, as the new graduates will be the future of the state: there is also an assumption that graduates of the program will remain in North Dakota.

One of the roles of universities is to contribute to the economic development of the state; this includes providing resources so that industry can improve and become more profitable and efficient. North Dakota's Roundtable on Higher Education is committed to fostering job training and workforce development to enhance the economic vitality of the state. Therefore, part of the role of faculty is to support innovative program development, technology transfer and economic development. Administrator #1 notes:

> I think the innovations need to come from faculty that is immersed in their subject. You need a team of people who are diligent, a team of people who want to dig in, they want to challenge the status quo, challenge current thinking, and that's really where innovation comes from.

The research findings also noted the importance of staying abreast of the challenges in industry such as issues related to limitations on oil production, the ability to drill, and how industry thinks about what they do. The data indicated that it is the university's role to challenge current thinking and come up with ways to answer industry's questions, advance science and develop a better understanding of unconventional methods for oil extraction. Administrator #1 noted, "We want to get more oil out of shale; how can we fracture better? How can we open the pores better? How can we mobilize that oil and gas"? The research findings note that the Petroleum Engineering program at the University of North Dakota has the potential to contribute to the development of new ideas and new technology that may help improve oil extraction methods specific to the challenges in North Dakota.

Theme 2: Attunement by UND to Regional Influencers Performed a Critical Role in Developing the Program to Meet the Needs of Industry

During the time (around 2006) when unconventional oil production in the Bakken was booming, the Dean of Engineering and Mines together with other leaders from UND visited the Williston region where they received requests from industry leaders in the community to consider the development of some kind of Petroleum Engineering program. Initially, industry requested a Petroleum Engineering concentration, or Petroleum Engineering minor within the Geological Engineering degree program. Initial plans were made to offer three to five courses specific to petroleum engineering and later the request changed to a Bachelor of Science degree in Petroleum Engineering. The request kept changing over time so former faculty members researched the status of other Bachelor of Science programs in Petroleum Engineering to review the content of those programs (Former faculty member #1). Former faculty member #2 noted that "each of the existing Bachelor of Science degrees in Petroleum Engineering was overloaded and enrollment was huge". The University of North Dakota perceived that the demand for a Petroleum Engineering program was really high so they continued to corroborate with industry and other constituents.

The research findings discovered that the initiative to develop a Petroleum Engineering degree program at the University of North Dakota came from people who recognized the optics of no Petroleum Engineering degree program in the state of North Dakota with the oil boom in the Williston Basin did not look good (Administrator #4). Administrator #4 referred to the decision to develop a Petroleum Engineering program at UND as a "no-brainer" since oil production in the state had increased, and was expected

to continue to increase. Former faculty member #4 noted, “We had a start-up team of faculty members, and then other individuals were added as we progressed”. Administrator #1 noted the start-up team received some initial funding from industry groups such as Whiting Petroleum and Marathon with additional sponsors contributing over time.

The Petroleum Engineering Advisory Board

The series of sponsors that came through to support the development of the Petroleum Engineering program was attributed to the development of the Petroleum Engineering Advisory Board. Administrator #1 notes:

> If I had to identify one of the most important things we did, it would be the development of the advisory committee. We got leaders from industry [names omitted intentionally] in North Dakota to come in and participate in advising us how to develop the program, tell us what they wanted in graduates. They opened their checkbooks to us with funding. This is before Harold Hamm, before Hess funding.

The research found that there were a lot of little pockets of funding that occurred prior to the more familiar funding provided by Harold Hamm. Administrator #1 referred to the providers of the early funding as, “unsung heroes meeting the day-to-day need, as we had to hire some faculty”. The series of initial sponsors together with the development of the Petroleum Engineering Advisory Board played valuable roles in contributing much needed financial resources as well as support and guidance in developing a program.

The significance of the role of the Petroleum Engineering Advisory Board is a recurring theme in the research findings. The Petroleum Engineering Advisory Board comprises alumni and leaders from industry in North Dakota who come to campus and participate in advising faculty on how to develop the program as well as provide feedback on what they want in terms of skilled graduates. In addition to providing a lot of insight into what they are looking for in graduates they also provide financial support (Administrator #1). Administrators as well as current and former faculty members noted the importance of seeking advice and input from industry particularly in regards to feedback on what they are seeking in the ideal graduate, staying abreast of industry problems, and dialoging with industry about collaborative ways to help solve industry problems. Former faculty member #2 noted the significance of having a Petroleum Engineering Advisory Board:

> The Industry Advisory Board was exactly how I would picture an industry advisory board: actual people from industry who were making decisions that we listened to. This advisory board was really impactful; they listened . . . that's exactly how I would want an advisory board to work.

As with anything that starts up, it is important to have solid promotion through participation from key people. The research findings indicated that the Petroleum Engineering Advisory Board played various participatory roles contributing to the development of the Petroleum Engineering program.

Industry On-Campus

In addition to the significant positive presence of the Petroleum Engineering Advisory Board, the research found that welcoming industry into the classroom to do some teaching was considered a valuable collaborative enterprise. Faculty member #2 commented, "Let them [Industry professionals] be part of courses; let them be part of projects". It was the perception of certain interviewees that some of the best collaboration between industry and academia is just inviting industry in to the classroom to give some talks. Former faculty member #4 noted:

> Having that polo shirt with the person's logo walking down the halls in our department at least once a week. Just talking to industry about projects that may have been sitting on the back burner; for example, the projects that no one has wanted to think about. Such as, "Why is this pump sanding when the one over there has not had any sanding occur"? No one, except for five petroleum engineering seniors may want to figure that out.

The research discovered there was a significant emphasis on the valuable presence of having industry on-campus to participate in courses, projects and discussions concerning research.

Bridging the Gap Between Advanced Technology and Industry

There is a perception that the University of North Dakota has developed a very good Petroleum Engineering program that is bridging the gap between advanced technology and the industry in North Dakota. Due to the unconventional Bakken formation, advanced technology for horizontal drilling combined with hydraulic

fracturing is needed. There is also the perception that the Petroleum Engineering program at UND has the opportunity to gather new advances in the petroleum industry and to teach students with the most advanced technology. Former faculty member #2 noted, "It is important to provide students with a solid foundation in fundamentals, because there comes a time when they have to get out on a drill rig and be part of the real world experience". Former faculty member #2 also notes that academia communication with industry is essential because, "you're not going to know what industry wants until you go and talk to industry. Industry is not going to pay for anything new unless you can prove to them that it's going to add to the bottom line". The research noticed the perception that adding to the bottom line means contributing to the development of advanced technology for horizontal drilling and hydraulic fracturing.

Rationale for Starting a New Program

Administrator #5 at the University of North Dakota notes three essential elements associated with starting a new program:

1. A trustworthy campus champion who has credibility with various constituencies, faculty, staff, administrators and alumni: someone who is solidly behind the program and can advocate for the new program in a compelling way.
2. A core of expertise within the department or college who have the skills and training to contribute to the development of a new program.
3. Alignment with the university mission and priorities.

Administrator #5 notes the Department of Geology and Geological Engineering already had faculty with skills and training that were expandable into petroleum engineering, and these faculty provided the opportunity to proceed with the development of a new program. Administrator #5 emphasizes that taking advantage of an opportunity that presents itself is great, however:

> The opportunity must fit into the mission of the university: particularly at a research university like UND, the proposed program must have legitimacy from the very beginning. Leadership is really important, and the leader can also be the campus champion.

Administrator #5 notes that ideally the champion is going to be someone who is connected to the unit developing the new program as with petroleum engineering where the champion was connected to the School of Engineering and Mines as well as the Dean's office.

Internal drive for developing a new program is really important, as you cannot successfully launch a new program if the impetus is entirely external (Administrator #5). Administrator #5 notes:

> There are situations where external entities exert interest and/or pressure for developing a new program that does not align with the university vision and/or mission and that seldom works. There has to be a reason internally within the university that is driving the interest in developing a program.

Moreover, if there is a lot of discussion about starting a new program, people need to come up with the funding. Administrator #5 notes:

> With petroleum engineering, in many ways it was the key donors during the capital campaign who were driving the proposal. However, the college had an idea of what could be accomplished and they tied that into donor interest, sustainability and the mission of the university.

Administrator #5 acknowledged that the multiple drivers behind the development of the Petroleum Engineering program were similar, and the support helped drive the development of the program: the external drive however, was not the impetus for the development of the program.

In today's economic and political climate programs have to be financially sustainable, and it would be unwise to proceed with a new program proposal based entirely on the premise of generating new resources through industry and alumni support or tuition (Administrator #5). According to administrator #5:

> In order to develop a new program there must be a clear path to sustainability or self-sustaining revenue. The Petroleum Engineering program appeared to have all the resources to be self-sustaining right from the very start with two important factors supporting self-sustainability: enrollment and connections to industry and state. While support helped drive the development of the Petroleum Engineering program, the support was not the impetus for program development.

First and foremost, the proposed program needs to be able to demonstrate financial stability and in the case with petroleum engineering, that was accomplished through "the belief that industry would find a petroleum engineering program a good investment and therefore support it" (Administrator #5). According to administrator #5, this is in fact

what happened with considerable support coming from the State Industrial Commission. Administrator #5 adds that what the petroleum engineering program development initiative discovered is that, “Industry had no interest in seed money, or money to get a program started, however; they were willing to invest in a high quality operation providing the seed money came from elsewhere”. Administrator #5 concedes that if these supports had not materialized, the university would have reconsidered the viability of the program. Administrator #5 notes:

> Today with oil at 19 dollars a barrel the program would not be considered viable. However, it was the perfect time to develop the program, and it was a principled decision that fit into the College and UND missions.

Administrator #5 notes that the development of the Petroleum Engineering program has been very successful, it was timed perfectly to coincide with the oil boom in the state and UND caught the wave.

It was the perception of some of the interviewees for this study, particularly those from industry that UND is still searching for its niche with its Petroleum Engineering degree program. However, administrator #5 views the situation as a symbiotic relationship in which industry has a need for what the university can provide, and only the university can provide the quality of what industry needs. “In such a situation it is in everyone’s best interest to go forward” (Administrator #5). Administrator #5 notes:

> North Dakota has a long history of its highest trained people leaving the state to advance their career opportunities. However, training people who already have a commitment to North Dakota, and have reasons to stay in the state, is likely to

> provide longer term stability rather than bringing in external professionals to work in the oil industry.

While it is not necessary to acquire oil rig personnel locally, as that is a very mobile labor force, it is necessary to train professional, middle management and higher level individuals to align with the needs in the oil and gas industry, and this need in the industry aligns with UND's interests (Administrator #5).

Collaboration With Industry

It is important to get industry involved from the very beginning when developing a program, as developing a program without industry input does not foster confidence in the quality of the program. Administrator #4 noted, "It is not good to bring industry in at a late stage". There is a perception that by involving industry from the very beginning and inviting industry input during the development of foundational program requirements will result in greater industry participation in the program development process. Administrator #3 notes:

> It is very important to know what is good for students, and keep abreast of what the world would like to see in graduates. Students will need soft skills to deal with individuals in different geographical locations, as they have to interact with industry.

Administrator #3 continued to explain that it is important to make certain that students have a strong education in the fundamentals so they have a solid background or platform to grow on once a company hires them. Most industries want to hire individuals with a solid foundation as opposed to specialized training since they can provide the specialized

training later. If students are strong foundationally, they should be capable of learning the specialized training later. Administrator #3 continued to explain the importance of training students to be good critical thinkers and problem solvers; to expose them to modern tools and technology, to keep up with technology used for teaching, and be mindful that internships are a critical part of the education process.

The research findings noted the importance of understanding what industry wants and speaking their language as opposed to using academic terminology for communicating. Industry's primary objective is measured in dollars per day, so it is important not to become discouraged or give up if they are difficult to reach or seldom reply to solicitation for participation. Administrator #4 noted, "Don't think that they don't reply because they don't care. They don't reply because they are busy, they forget . . . that's the nature of the industry". Administrator #4 also mentioned that academia is aware that industry does not share academia's fervor for university/industry research partnerships as industry generally has its own internal research facilities. Nevertheless, departments should aspire to building up a team of individuals at the faculty level that comprehend the research needs of the industry, and then work with leadership to prioritize needs, and then connect those needs back to the needs of state industry. Administrator #4 emphasized the importance of checking in with faculty on a regular basis to make sure they are doing work for industry.

In collaborating with industry administrator #4 noted the importance of understanding industry culture and speaking to industry in their language. For example,

"Don't talk about long-term projects, don't disturb them too much, and don't take too much of their time". According to administrator #4:

> Connecting with industry for one hour a month is sufficient to get some ideas otherwise industry can get distracted, because one hour of drilling is huge, a lot of cost, so they don't want to get distracted. Industry wants something that is relatively immediate, practical and applied.

According to administrator #4, industry is pre-occupied with a quick return on investment.

Faculty involvement with projects related to the needs of industry has its controversy. Former faculty member #2 noted, "Since everybody is going for tenure . . . a lot of faculty won't go down the path of working closely with industry . . . getting a project from industry should be equally as important as getting a project from NSF [National Science Foundation]". Specific reasons for faculty reluctance to work on research projects related to industry were noted by former faculty member #2 as, "The confidential nature of certain projects with industry and getting credit where credit is due". As a result of faculty reluctance to work on projects for industry, questions arise about how to best connect faculty to the needs of North Dakota in the energy sector. Lessons learned from conducting research for industry and reporting on research results have shown:

> Industry does not have time to read lengthy reports; they want to cut to the chase. You might be able to do just the greatest academic work, but it might be a riffle shot on what the industry needs and you need to translate what they need back to

them . . . you have to understand that they have two things in mind: 1) How can you help them make money; and 2) How can you help them save money. Maybe three; How can you help them meet environmental regulation? (Administrator #4)

Administrator #4 noted the disconnect between faculty members who are trained, focused, and take satisfaction in producing scholarly research and writing academic papers while industry only wants an abridged version.

Administrator #4 noted that developing effective communication with industry is really just as important as developing effective communication with faculty members. The objective with faculty members is to instill the significance of responding to opportunities in industry in a way that is encouraging to all faculty members, and to be able to get them excited about working in these areas. Former faculty member #2 notes:

> Sometimes petroleum doesn't seem that exciting, but it's actually really fascinating, and then working with industry is fascinating, building partnerships, building consortia, building all sorts of things.

The research findings noted that all of these convictions are really important to instill on faculty members.

Developing a new program in higher education to meet the needs of industry requires the participation of diverse constituents in order to create a vision large enough to meet the short-term local demand for petroleum engineers as well as long-term global demand (Former faculty members 1 & 2). Former faculty member #2 notes that the process of program development is well served through the participation of a diverse group of alumni, but then diversifying:

> So there's only a few alumni that are part of the program. You want people who are friendly to what you want to do. But then you want to scale out from there to make sure that you are also getting some of the people that might not fully agree with what you're doing, because that diversity is important to have in the group; that way you're not in an echo chamber.

Former faculty member #2 notes the significance of having the naysayer participate in the program development process: however, you do not want them participating when you first start out. Furthermore, before you bring naysayers into the group, you want to make sure the preliminary group understands why you have invited naysayers to participate.

The research discovered that when developing a new program to meet the needs of industry it is essential to include the Industry Advisory Board and people from industry who have an understanding for what you are trying to do. In choosing people from industry to participate, former faculty member #2 recommends refraining from inviting low-level individuals in industry who do not have any authority to make decisions:

> You want to have VP's sitting next to you, exchange business cards, and be able to make decisions in the moment. You want to be sitting next to decision-makers, but you don't want someone who is up too high; they won't know what's going on, or they'll just tell other people to do stuff; maybe someone in the middle – that nice middle area.

The research findings noted the value and importance of engaging individuals who have an understanding for the program development process as well as the authority to make influential decisions.

Theme 3: Captivated Students Explore Academic Options, Distance Learning, and Collaborative Activities

Industry executive #8 perceived Harold Hamm's influence on the development of the Petroleum Engineering program at UND significant, not only in terms of his financial contribution to the geological program, but also his direct impact on stimulating student interest for a career in petroleum engineering. Industry executive #8 relates Hamm speaking to students in Grand Forks on a Friday afternoon:

> There was a hockey game scheduled for that evening; now put yourself in the position of competing for an audience with a hockey game in Grand Forks! The room was just jam-packed with students and you could have heard a pin drop, they were so intrigued, so interested in the opportunities before them . . .
>
> To listen to someone who had a successful career in the gas and oil industry, and who had made a large contribution not only in terms of financial resources, but also in terms of involvement in developing the Petroleum Engineering program at the University of North Dakota made an enormous impression on students.

The research findings noted that Harold Hamm's well-attended speaking engagement in Grand Forks, his financial contribution, as well as his successful career in the oil and gas industry made an imprint on students and other attendees.

Exploring Academic Options in Petroleum Engineering

One of the on-campus students that participated in this research expressed that he initially began his education at UND in another engineering program, but decided to switch to petroleum. On-campus student #2 stated:

> I had an open class in my schedule and decided to take a geology course that happened to be under petroleum engineering and I loved it! I met the right people and decided to go for this exciting degree.

On-campus student #2 described his enthusiasm towards completing a degree in petroleum engineering at the time of the oil boom: "I thought it was an adventure and I wanted to go and explore that". On-campus student #2 became involved in the Society for Petroleum Engineers, contributed to providing opportunities for students to attend conferences, played a role in bringing industry companies to campus to provide presentations, and attends Advisory Board Meetings to be a student ambassador for the program.

Another on-campus student also confessed to initially being in a different program at UND, but then switched to start learning about petroleum. On-campus student #1 stated:

> I feel that petroleum has a mystical element to it. You can have all the science, all the technology behind it, and at the end of the day you don't know for certain what is going to happen when you stick that pipe into the ground. A similar kind of process would be fishing.

Both of the on-campus students that participated in this research switched over to the Petroleum Engineering program without regret.

Distance Learning

A distance student living in another state has a family and a life that make it difficult to go back to school. Distance learning has provided him with an opportunity to pursue career goals he may not have otherwise had. Distance student #1 notes:

> UND is the only university that has a distance engineering program, so finding the Petroleum Engineering distance program is advantageous for what I want to do. Right now I'm doing school full-time; the distance program works out very well for me.

Distance student #1 enjoys the recorded lectures, the communication with other students on the discussion board, and is satisfied with the interaction he is receiving from his professors. The research findings noted that the online program has important advantages for distance students; for example, distance student #1 noted, "By doing the degree online I also have the flexibility to help care for my daughter".

Another distance student originally from outside of North Dakota had no interest in petroleum engineering until he retired from another career in 2013. Distance student #2 notes, "I found out about UND's online Petroleum Engineering degree program, and that's kind of how I started as a distance student". Although distance student #2 now resides in Grand Forks, he continues to take at least one online course per semester even though he is now an on-campus student. The reason for that is, "arranging all the classes I am supposed to take in a given semester almost never works out with my schedule"

(Distance student #2). The student has taken at least one online course each semester even as an on-campus student.

Student Views on Collaborating With Industry

Students noted the formation of the Petroleum Engineering Advisory Board as one of the best collaborative actions for developing a new program. Students spoke freely about the value of collaborating with industry on actual projects, or using real-life project data from industry in lectures and group work. Primarily, students expressed interest in having industry companies come to UND to provide them with the opportunity to become acquainted; students are eager for research opportunities, internships and any other activity or opportunity that helps them advance their careers. Students expressed the need for frequent contact between academia and industry, and open channels of communication, as universities need to understand what industry is actually looking for when they hire graduates. Distance student #2 noted, "As a major university, we should be following the directive of the major producers in the oil field". Generally, the interview narratives discovered that students place considerable value on collaborative activities between the university and industry, particularly on collaborative activities that lead to career opportunities for graduates.

The research found that students view themselves as vehicles for advancing or transferring new technologies and skills. On-campus student #1 noted, "You hone in on new technologies through the university; once you go out in the field you experiment to find real-world application". The findings discovered that students perceive it is important to have reciprocal communication between the university and industry to have

ideas flowing both ways to support the advancement and transfer of new technologies and skills. On-campus student #2 noted:

> It is very exciting for me being an engineer at this point and time, because now engineers are being challenged within the petroleum landscape to really drive that cost advantage. New skills are really what is going to keep the oil industry going through the downturn.

On-campus student #1 noted:

> I think what is special about this program is to understand the Bakken in western North Dakota. UND can improve their research to gain a greater understanding of this field so students are prepared to work in the Williston Basin.

The findings indicate that students are significantly preoccupied with making the right choices as well as connections that will open doors for future employment. Moreover, students see themselves as playing a key role in advancing or transferring new technologies and skills in industry.

The research data indicated that students would like to see more industry professionals come into the classroom and talk to them about what is happening in industry as well as what they expect from graduates. On-campus student #1 noted:

> I know there is a large disconnect; many people in the industry will say that graduates from any school don't immediately have the skills that are required for the job. Many new hires have to do rotation programs in these companies to get trained in skills they probably should have had when they graduated.

Students spoke readily about their concerns regarding employment readiness. On-campus student #2 noted:

> It's not just about the hard skills, like being able to do a bunch of mathematical calculations; it's the soft skills that most companies say that are lacking. When they're hiring engineers, they are also looking for soft skills.

The research discovered that students are eager to acquire the appropriate combination of skills that will help them to successfully launch their careers. They are especially keen to have opportunities to participate in field experiences such as internships realizing that, "kids that get internships are light years ahead" (On-campus student #2) when it comes to getting hired after graduation. Overall, the data affirms student interest in petroleum engineering as an academic option and anticipated career choice. Some students are working towards their career choice though distance learning options, and all the students are interested in collaborative activities especially those that will help to advance their career options.

Theme 4: Industry Support Was Critically Important to the Development of the Academic Program

Several of the industry executives that participated in this research are affiliated, interested or involved with the Petroleum Engineering program at the University of North Dakota as a result of being involved with the Energy Environmental Research Center (EERC), serving on various boards at the School of Engineering and Mines, or on the Petroleum Engineering Advisory Board: others have donated resources to the Collaborative Energy Center, or are alumni. When the activity in the Bakken began accelerating, several executives in the oil and gas industry that had come through the

University of North Dakota felt that when the university discontinued their Petroleum Engineering program in 1992 it was a big mistake. The absence of a Petroleum Engineering program in North Dakota in light of the oil recovery activity in the Bakken was considered an indicator of the need for a Petroleum Engineering program in the state. Several of the industry executives from oil and gas companies disclosed that they are continually looking for ways to connect with local post-secondary institutions.

Universities are key partners for economic development organizations, and they want to ensure that higher education is aligned to economic needs in the Grand Forks region. Economic development organizations are especially concerned about providing well-paying jobs for graduates within the region so they remain in the state. Industry executive #7 noted:

> We want them to stay here. We have a real shortage of people who stay in North Dakota; that's probably the largest impediment to growth. We're not going to attract people from the rest of the country. It's very difficult because of our climate and the perception that the rest of the US has about North Dakota. So you have got to grow from within.

The Petroleum Engineering degree at the University of North Dakota is of particular interest to economic development organizations due to the shortage of petroleum engineers in the state. Industry executive #4 appreciated that the University of North Dakota has matched the need for trained professionals in the state's oil and gas industry with the need to provide well-paying jobs for UND graduates and keep them in the state. Industry executive #4 noted:

> We have found that it is difficult to get engineers who are willing to put their time in the field and learn everything they need to learn as well as deal with North Dakota's harsh winters. When people get into petroleum engineering they dream of a desk job somewhere sitting in an office in a high rise in a big city and nice climate, and North Dakota doesn't have a lot of that.

Industry executive #4 explains that not many oil and gas companies provide long-term field opportunities for engineers where they can develop with the company while staying in the field. Many companies offer only one or two years in the field, and then engineers are required to move to a corporate office or a primary location far from the field. It is industry executive #4's perception that, "Many local kids do not want to move to Oklahoma City, Denver or Houston". Industry executive #4 serves on the Petroleum Engineering Advisory Board at the University of North Dakota, and is interested in the Petroleum Engineering program at UND from a mutually beneficial perspective as a result of the way the company he works for operates globally. Industry executive #4 notes, "We want to be a trusted valued partner. To be a trusted valued partner you've got to behave in a very open and ethical manner; you have to develop the people in the country that you're in". Industry executive #4 continues to explain that in order to ensure that his company's presence in a state or country actually results in more than just the efficient development of resources, the company also focuses on the overall improvement of communities through the development of people by developing their skills so that the community is a good place for everyone to live. Industry executive #4 also notes, "At the company I work for we want to attract people who have the skills and temperament to

handle the weather; we are very interested in workforce development in North Dakota's oil and gas industry". What this industry executive is really interested in is being able to fill jobs within the oil and gas industry in the state, and ideally do so with people who are home grown, or who will come to the state, bring their families and stay.

Lost Generation of Petroleum Engineers in North Dakota

Industry executive #8 noted that one of the key features during the collaboration between stakeholders leading up to the development of the Petroleum Engineering program at the University of North Dakota was, "Beginning to grasp the magnitude of not having had a lot of students go into petroleum engineering across the country for nearly a decade". During these early deliberations various key speakers presented at stakeholder meetings: for example, the president from Whiting Petroleum informed stakeholders that North Dakota had lost an entire generation of people who were trained as petroleum engineers. As a result of this realization, stakeholders began to develop a clearer understanding of the future demand for petroleum engineers, and the incredible opportunities for development when you lose an entire generation of people in a sector, and the other group in that sector is at retirement age. As a result of the speakers brought in by stakeholders, there was a collective realization that if you could bring cohorts of students through a petroleum engineering program, they would immediately have incredible opportunities for rapid career advancement due to the lack of petroleum engineers in North Dakota.

Various Forms of Collaboration

Collaboration between stakeholders has taken various forms since the onset of the oil boom. Industry executive #5 noted effort to bring communities from western North Dakota together with the Grand Forks region to discuss the challenges associated with attracting, retaining and developing a skilled workforce. According to the industry executive, some of the participants coined the initiative East Meets West. However, upon further investigation it is more likely that the industry executive was referring to a marketing campaign known as "Access the Bakken – Expand East. Do Business West" (Access the Bakken, 2015). Access the Bakken brought together private and public sectors in the region including:

> The City of Grand Forks, The Chamber of Commerce, the Grand Forks Region Economic Development Corporation (EDC), The Energy & Environmental Research Center (EERC), and AE2S [an Environmental and Civil Engineering Consulting firm in Grand Forks], with support from the Greater Grand Forks Convention and Visitor's Bureau and the University of North Dakota. (Access the Bakken, 2015)

The Access the Bakken campaign brought together leaders from the Grand Forks region and western North Dakota to identify opportunities for business interaction between Grand Forks and the Bakken. The campaign focused on the need for expanding the workforce in western communities and the importance of training programs at the University of North Dakota that contribute to a skilled workforce. Industry executive #5 described that as a result of bringing these communities together, further interest

developed for having the university and the community, “really seize the day and grasp the opportunity that was before them”. Industry executive #5 continued to describe that bringing these two separate communities and diverse groups of stakeholders together was considered a “great success story”. Industry executive #4 also commented on the success of Access the Bakken noting the expediency with which the two diverse communities collaborated to focus on positioning Grand Forks and the University of North Dakota at the forefront of providing an educated and talented workforce.

Preliminary efforts in the development of the Petroleum Engineering program were focused on what stakeholders wanted to see being developed, and on how ambitious the program should be in terms of student capacity; there was a lot of debate about getting the appropriate advice. Industry executive # 7 commented:

> This past year we have had new leadership that has a very clear vision about where to take the degree . . . I think I’ve seen an improvement with the vision; there’s clarity and an energy that was not there a year ago.

The research discovered that clear vision and energy in regards to the Petroleum Engineering program is important, as industry wants to recruit the best talent, and wants a program that is going to recruit good students. Industry executive # 4 notes, “Academia needs to focus on generating high quality students and this can be accomplished by tuning in to the needs of industry”. It is industry’s perception that when you have large corporations, for example, Hess Corporation contributing to facilities and to the program, the impact is going to be huge in terms of rewards regarding the development of the right kind of program that produces high quality graduates. The findings also noted that a

company that operates in North Dakota is naturally going to look to UND for new graduates and academia's collaboration with industry is critically important. Industry executive #4 noted, "It's suicide not to collaborate! Focus on collaborating with all stakeholders. Focus on participating with the Petroleum Engineering Advisory Board". The findings noted the interaction between stakeholders is perceived as being one of the biggest positives in terms of higher education program development to meet the needs of industry.

Industry Attentiveness to the Transfer of Knowledge

The research findings noted that higher education is one of the fundamental underpinnings for advancing or transferring new technologies and skills within regions and the medium for research to contribute to more efficient oil recovery in the state. Industry executive #8 notes:

> Advancing or transferring new technologies and skills is incredibly valuable and that is why you have to keep investing in these programs to make sure that colleges have the best technology available and the best labs. Industry does not like to build a building, that is the responsibility of the state and general taxation, but they are always supportive of providing assistance to buy laboratories and equipment, which help support the advancement of new technologies and skills.

The research findings note the significance of higher education program development and the production of skilled graduates that ultimately results in enhanced participation in advancing or transferring new technologies and skills in the regions in which the university is situated.

Program Development Resources

Industry executive #8 ventured that even though the University of North Dakota has placed a lot of emphasis on the development of a robust curriculum that provides a specific focus on unconventional oil recovery, and that this specific focus is further enhanced by the Wilson M. Laird Core and Sample Library as well as the Energy & Environmental Research Center (EERC), UND is still gauging how to most effectively leverage its niche.

The Wilson M. Laird Core and Sample Library at the University of North Dakota stores soil and rock samples and approximately 34,000 boxes of drill cuttings representing 75% of the core cut out of North Dakota's Williston Basin (Burleson, 2014). The library is significant to energy development in North Dakota and its location next to the Harold Hamm School of Geology & Geological Engineering (HHSGGE) supports "the integration of this asset into the education of the workforce to support energy development in the state" (University of North Dakota, 2014). Students at UND use the library for petroleum related studies and it is central to generating further interest to support the needs of energy use in the state. It is expected that the library will revolutionize how students learn about rock formations since the library brings the rocks below the surface of North Dakota to life through a virtual tour of the subsurface of the Williston Basin. Students are also able to analyze scanned core in a way that was previously not achievable (North Dakota University System, 2014).

The Energy and Environmental Research Center (EERC) in Grand Forks is a research, development, demonstration and commercialization facility for energy and

environment technology development (Energy and Environmental Research Center). The Center is recognized as one of the world's leading developers of cleaner, more efficient energy and environmental technologies to protect and clean our water, soil and air (Energy and Environmental Research Center, 2015). The EERC is a high tech applied research facility operating as a non-profit division of the University of North Dakota. The Center operates like a business pursuing an entrepreneurial, market-driven approach to research and development for the purpose of successfully demonstrating and commercializing innovative technologies (Energy and Environmental Research Center, 2015).

While the EERC has been mostly self-sustaining in its work with environmental technology, on May 30, 2014 Gerald Groenewold, who had led the EERC since 1987 was terminated (Burleson, 2014). As far back as 2008, the EERC had listed an annual deficit of over $1million. Groenewold attributed the center's financial problems to disputes over intellectual property that began in 2004 and ended up in court. Although the dispute was settled a year later the deficit was blamed on changing government interest in the center resulting in reduced funding (Burleson, 2014). According to the North Dakota Legislative Management minutes of the Energy Development and Transmission Committee in the fall of 2014, the EERC was reported to be $1.6 million in debt attributed to reduced focus on vision (North Dakota Legislative Council, 2014). In March, 2015 the *Grand Forks Herald* reported that the deficit had reached $2.7 million. The same report noted the need for the center to have a closer relationship with UND, as it had been very separate under Groenewold's leadership. Alice Brekke, Vice President for Finance and Operations at

UND reportedly recognizes it will take some time to steer the Center back on track, but is hopeful progress can be accomplished through prioritization (Burleson, 2015).

During the 2015 fiscal year the EERC received $28.4 million in new awards and Director Tom Erikson identified a $32 million goal for the coming year (Burleson, 2015). A report by Huron Consulting Group as cited in the *Bismarck Tribune* noted that the EERC is well positioned to benefit in terms of additional revenues by embracing a closer relationship with UND (Burleson, 2014). Industry executive #1 acknowledged the need for continued exploration as to UND's niche in the higher education landscape and its association with the EERC. The Wilson M. Laird Core and Sample Library with its extensive laboratory space and sample collection compliments the Petroleum Engineering program, however, there is a perception that it is yet to be defined just where UND fits in, in terms of helping the oil industry find solutions to problems associated with unconventional oil recovery. Industry executive #1 noted, "Most companies rely on their internal Research & Development departments to kind of solve problems for them". Industry executive #1 continued to explain that what has been distinct is:

> The need for a strong relationship between UND and the EERC, as the EERC is recognized within the region as the go-to facility to do things. They have projects and consortiums coming out of their ears that have industry involvement, and we are encouraging them to continue to collaborate closer together so that students can get exposure.

Industry executive #4 noted that industry "doesn't have the opportunity to invest a lot of time in research projects". Industry executive #2 attributes this to the fact that

"technology in industry changes very rapidly, and certain aspects of the work change every few months". The findings noted that the university might actually be at a disadvantage in not being aware of industry's needs on a daily basis. Industry executive #2 noted, "Academia needs to acquire more of an industry mindset as what students hear in the classroom may not be the same as what is heard from someone who is working it every single day". Industry executive #5 recognized, "The knowledge associated with the use of cutting edge technology in industry is a little difficult to get quickly transferred to educational programs, because so much is happening in industry".

For many of the industry executives that participated in the research, the most basic element associated with the development of the Petroleum Engineering program is the quality of people that are graduating. Industry executive #3 noted, "I think everybody generally agrees that what we are looking for is quality. You need students who are problem solvers, people who are very adaptable; they have to have a very clear understanding of what business is about". Executives from industry also noted a very strong selection criterion for hiring petroleum engineers. However, at the basic level, the findings noted it is all about graduates' ability to be adaptable, flexible, and the ability to solve problems.

How Industry Measures Success

According to industry executive #7, "Defining or measuring success in an industry partnership with higher education would depend on what you had identified when you started the partnership; what your goals were to begin with". The research noticed that partnerships between industry and education have a business underpinning

and goals are set in terms of the business, depending on the nature of the opportunity. According to industry executive #6's perspective, "Bringing industry and academia together is going to take a little bit of finessing as many industries only ever talk to the academic institutions for the purpose of recruiting". Industry executive #5 notes a successful partnership with the university is, "More about how well the university, or how well the department looks to partner with industry". Industry executive #1 advises UND against trying to emulate the Colorado School of Mines, Texas A & M or the University of Texas at Austin, and find their niche in their geographical advantage. It was conjectured that not a lot of other universities are delivering lectures or holding discussions about unconventional oil recovery. Therefore, developing its geographical advantage with the Core Library research facility is how UND can leverage its strengths.

In the short term, industry executive #4 notes that success is all about how many students are completing the program, and of the numbers that complete the program, how many are able to:

> Identify problems, solve problems, come up with possible solutions and then implement them. In the long term, are they able to do some research that benefits industry and benefits the state.

Measuring success was frequently described as having a program where there is a very high hiring rate for the petroleum engineers from that program, in this case UND. Industry executive #5 noted, "I think employment would be a big thing, and I think success would be how the industry looks at hiring those graduates". For industry executives # 4 and #9 the definition or measure of success is producing graduates who

are problem solvers as "a lot of problems come up when you are drilling a well – a lot, a lot of problems. You have to be part of a team effort to solve that at the rig" (#9).

Summary of the Findings

In this chapter I have presented the themes that resulted from the research questions, interview transcriptions and subsequent data analysis. The interviews for this research provided an abundance of information surrounding the decision to develop a Petroleum Engineering degree program at the University of North Dakota. Events leading up to the decision involved the oil boom in the Williston Basin in the western part of North Dakota, which subsequently resulted in a shortage of trained professionals, specifically, petroleum engineers to work in the field. Pivotal moments and events contributing to the decision to develop a petroleum engineering program at the University of North Dakota appear to have involved stakeholder realization that petroleum engineers had not been trained in the state of North Dakota since 1992. Affirmative statements about North Dakota heritage, values and work ethic resound throughout the interviews, as do the implications for training and recruiting local students. Similarly, constructive remarks from interview participants acclaimed the value of forming the Petroleum Engineering Advisory Board early on in the program development process. In the next chapter, I will analyze the findings and make recommendations.

CHAPTER V

ANALYSIS, DISCUSSION, AND CONCLUSIONS

Introduction

In the previous chapter, I reported the findings about participant's views on the development of the Petroleum Engineering program at the University of North Dakota. In this chapter, I will discuss the findings in light of the research questions, provide recommendations, and reach some conclusions based on the findings of this study. The purpose of this study was to understand the experiences and perspectives of selected key participants associated with the development of the Petroleum Engineering program at the University of North Dakota, and to do so within the Innovation System Framework. The overarching question that guided the study is: How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program? Some additional questions that guided this study are:

1. How do key participants describe their experiences and perspectives about the development of the program?
2. What light to key documents shed on the development of the Petroleum Engineering program?
3. To what extent and in what ways does the Innovation System Framework help explain the development of the Petroleum Engineering program?

This chapter answers the research questions with results from the study, and links the results of the study to the literature.

How the University of North Dakota Proceeded With Establishing a Petroleum Engineering Degree Program

The overarching research question that guided this study is: "How did the University of North Dakota proceed with establishing a Petroleum Engineering degree program"? The research findings noted that UND proceeded with establishing a new degree program in Petroleum Engineering by responding to an expressed need in the community to develop a program. The University began proceeding with the development of a program by engaging in active research to explore the components of Petroleum Engineering programs at post-secondary institutions in other states. Administrator #5 noted that "internal drive within the university" was significant in proceeding with the development of a new program, and "leadership in the form of a campus champion … advocate[d] for the new program in a compelling way". Therefore, establishing the new program proceeded as a result of faculty response to regional needs, followed by faculty engagement in research to determine the components included in a petroleum engineering program, and these initial activities were supported by leadership.

The research revealed that the movement to establish the new program was driven by a start-up team and subsequently joined by other individuals as program development progressed. A core of expertise already existed within the Department of Geology and Geological Engineering, and this core of expertise had the skills and training to contribute to the development of a new program in petroleum engineering. The startup team received some funding through various sponsors in the oil and gas industry as well as

alumni. The core of existing expertise within the department ensured that the start-up team had a foundation on which to begin developing a program, and financial sponsorship helped to cover the day-to-day expenses of developing a new program that included hiring additional faculty members. The internal drive evidenced by the start-up team, the existing core of expertise, and financial sponsors supported proceeding with the development of the Petroleum Engineering degree program.

The findings indicated that if there is discussion about starting a new program, people need to come up with the funding, and with Petroleum Engineering it was "key donors during the capital campaign who were driving the [program development] proposal" (Administrator #5). The School had an idea of what could be accomplished in developing a new program, and they connected their ideas to donor interest, long-term sustainability, and the mission of the university. Administrator #5 noted the importance of principled opportunism that "fit[s] into the mission of the university". The support of various sponsors and alumni was attributed to the development of the Petroleum Engineering Advisory Board, and the development of the Advisory Board was identified in the research as one of the most important actions that occurred during the initial stages of developing the new degree program. Proceeding with the development of a new program requires the assurance of funding, a conceptualization of what can be accomplished with the development of a new program, the formation of an advisory board, and alignment with the university mission.

Multiple external drivers propelled the development of the Petroleum Engineering program, however, the external drive was not the impetus for the ensuing development of

the program. Administrator #5 noted, “First and foremost a proposed program needs to be able to demonstrate financial sustainability and this was accomplished through the belief that industry would find the program a good investment and support it”. A plan was put in place that would have five people enrolled in the first year of the program and fifteen in the second year. While there were five people enrolled in the program the first year, there were 102 in the second year. The higher than anticipated enrollment during the second year of the program is an indication of student interest in petroleum engineering as a profession, the job market in North Dakota and future employment prospects. While external drive plays a key role in launching the development of a new program in higher education, a new program needs to provide assurance of financial sustainability and industry support.

The findings established that responding to industry’s request to develop a new program at UND was well served by an enthusiastic start-up team and the new program request aligned with the university’s mission. Moreover, the initiative was supported by a campus champion who advocated for the development of the new program in a convincing way. It is important to note that if there is discussion about starting a new program there must be available funds, and a capital campaign at UND provided a logical plan for raising money to launch the development of a new degree program. One of the key features attributed to the success of establishing the Petroleum Engineering program was the formation of a Petroleum Engineering Advisory Board. All of these drivers were incentives behind the innovation, or decision to proceed with the development of a Petroleum Engineering program at UND.

The literature noted that university collaboration with industry can take various forms and include different methods of engagement (Martin, 2000), and that a shared vision brings people together, although productive collaboration requires a joint effort for sustained results (Nichols et al., 2014). The literature review, however, found only a scant body of empirical research on higher education program development to meet the needs of industry. This research fills a gap in the literature by discovering how the University of North Dakota proceeded with establishing a new degree program to meet the needs of industry in petroleum engineering. The results of the research resonate with the literature on regionally engaged institutions of higher education, and their potential to be significant advocates for local economic development in their respective region (Chatterton & Goddard, 2000). The research has shown that the University of North Dakota is a regionally engaged university and proceeded with developing a new degree program in response to an expressed request from the community to develop a new program that would produce petroleum engineers for the oil field in western North Dakota.

The results of the research findings also resonate with Laredo (2007) who noted the importance of the university's role in fostering employability skills for the purpose of contributing to the community. Duke (1998) and Kerr (1963) encouraged innovative ways of thinking about regional environments and collaborating with stakeholders across university boundaries to develop learning opportunities in regions; that the purpose of the university is to serve the community. The research has shown that the University of North Dakota is innovative in collaborating with stakeholders across university

boundaries to engage in program development to meet the needs of local industry. Throughout this study the data has demonstrated that the University of North Dakota proceeded with establishing the Petroleum Engineering degree program by responding to regional needs, and the regional needs aligned with UND's mission. Program development was driven by a start-up team, championed by a key leader, and financially supported by donors.

Key Participants Describe Their Experiences and Perspectives

One of the additional questions that informed this study was, "How do key participants describe their experiences and perspectives about the development of the Petroleum Engineering program"? The research findings discovered that participant's experiences as well as perspectives associated with the development of the program varied depending on each person's subjective experience. Some of the participants played an active leadership role supporting program development, and others functioned as members of the start-up team or faculty. Some of the participants in the research provided financial support while others had a keen interest in economic development and regional growth, or concern over the talent gap in North Dakota, specifically, the need for petroleum engineers. Some of the participants in this research were end users of the product, or curriculum developed for the Petroleum Engineering program.

Administrators and Faculty Experiences and Perspectives

Administrators play integral roles in planning and managing initiatives in higher education. Administrator #1 noted that he regularly plays a role in supporting the development of education and research programs as part of his role at UND.

Administrator #1 became involved in planning and managing aspects of developing the Petroleum Engineering program and described his experiences and perspectives as follows:

> The Dean of Engineering found out through industry partners that they really want to start a Petroleum Engineering Department at UND. So that is where it initiated, and then there was a team that wrote the proposals to the State Board of Higher Education, got that approved, and then started getting the program set up. My background fit very well with where the program needed to go.

Administrator #1's experience and perspective concerning the development of the Petroleum Engineering program was influenced by his background experience as well as his role as a participant in the start-up team and trying to "start a program without any money". According to the administrator, money trickled in from research and development funding, the President's office and the Dean's office. Money also began to come in from various industry groups, and Administrator #1 attributes financial support from industry to the development of the Petroleum Engineering Advisory Board. What is really noteworthy about Administrator #1's experiences and perspectives is that obtaining resources for the development of the new program was a challenge prior to the well-known and publicized Harold Hamm and Hess Funding. The key issue here is that this administrator became involved in developing the new degree program based on his background experiences, and his involvement with supporting the development of the new program was permeated with concerns regarding financial support for the initiative. Moreover, Administrator #1's experiences and perspectives were influenced by the

formulation of the Petroleum Engineering Advisory Board and the Board's contribution to improved financial support.

Administrator #2's experiences and perspectives were influenced by industry's interest in recruiting students from UND, remarking that "oil and gas companies were approaching UND for the purpose of hiring petroleum engineers". Administrator #2 described his experiences and perspectives as follows:

> I was part of a task force to look at what a program would look like, how it should be structured, and what kind of resources we need to put together. I sort of helped out at the very beginning putting the program together, and played a role in creating key documents.

Administrator #2 recounted industry's interest in recruiting students from UND due to a "noted difference in work ethics, background, family values and morals". The research found that a focus on these attributes was frequently associated with students graduating from UND. Moreover, throughout the research there was an assumption that petroleum engineering graduates from UND would most likely be from North Dakota, or at least the tri-state area, and they would want to stay in North Dakota, where they already have roots, to build their own families. It is important to note that this administrator, who held a supportive role in the development of the program, recounts industry's emphasis on recruiting students from UND based on industry's assumption about certain attributes intrinsic in North Dakota locals.

The similarity between administrator #1 and administrator #2's experiences and perspectives is that they both played a supportive role at the very beginning of

establishing the Petroleum Engineering program. Administrator #1 had a background that "fit very well with where the program was supposed to go" and Administrator #2 "was part of the task force" and "helped create key documents". The differences between the two participant's experiences is administrator #1 spoke largely about the start-up team, challenges associated with starting a new program without adequate funds, the missed generation of training petroleum engineers at UND, and North Dakota's talent gap in petroleum engineering. Administrator #2 spoke about rapid expansion in the oil industry, industry's difficulty filling their engineering hiring quotas, challenges retaining out-of-state petroleum engineers, and industry's interest in hiring home grown grads due to the perceived qualities associated with home grown North Dakota grads such as "hard working, family values and morals, [and] farm background". The similarities in these administrator's experiences may stem from their seniority and accumulated professional experiences that lent itself to functioning in supportive roles involving the creation of key program documents. The differences being administrator #1's focus on financial issues associated with program development, and administrator #2's focus on recruiting locally may be associated with the specific nuances of each administrator's role[s] and responsibilities. Both of these administrator's experiences and perspectives are important to note as they shed light on the diversity of participant experiences. Moreover, participant experiences and perspectives are most likely influenced by a myriad of factors such as professional experiences, roles and responsibilities.

Of the current and former faculty members who participated in this research, no participant's experiences and perspectives were so noteworthy as former faculty member #2 who noted:

> The development of the Petroleum Engineering program is both a star to me, as well as the indication of just how crazy life can get. I mean it was fun, it's exciting, all the different people I got to meet. But at the same time it was challenging within the university to just even get the thing off the ground. I'm glad I was part of it.

None of the other participant experiences and perspectives discovered through the interview process and data analysis bore any resemblance to the expression of emotion in former faculty member #2's response. The response denotes an indication of pride in accomplishment, yet it has undertones of challenges associated with the development of a new program. While the other current and former faculty that participated in this research held their experiences and perspectives close to their vest, former faculty member #2 shed a valuable light on providing evidence that the program development process experienced its highs and lows.

Student's Experience and Perspectives

The involvement of two distance students among the research participants was an unexpected, but welcome surprise given my extensive experience with developing and facilitating distance education. What is noteworthy about distance student #1 is that he lives in another state that is associated with the oil industry so he is near some of the larger institutions that offer education in petroleum engineering. Due to his

circumstances, attending face-to-face classes was not an option, so discovering a distance program in petroleum engineering at UND helps him attain his career goals. Distance student #2 had no interest in petroleum engineering until he retired from another career in 2013. Shortly thereafter, he found out about UNDs online degree in petroleum engineering and enrolled in the program. Although the student was living in another state at the start of his program, he now resides in Grand Forks where he continues to take at least one online course per semester. Distance student #2 attributes a number of reasons for choosing to take online courses. However, identifies that the main reason is related to scheduling. Arranging all the classes he is required to take as part of his program and fitting them into a timetable is challenging. Therefore, taking at least one online course per semester alleviates challenges with scheduling.

The similarities between these two distance students stem from the fact that they are both older than the typical student embarking on a university degree: they already both have an under-graduate degree and extensive life experience. The differences between these two students are that distance student #1 mentions the responsibility of taking care of a small child and returning to work as soon as possible. Distance student #2 is in essence no longer a distance student since he now resides in Grand Forks; however, I categorized him as a distance student. The fact that the University of North Dakota offers the Petroleum Engineering program as an online option demonstrates that UND is committed to serving the needs of the wider community and society.

The two on-campus students that participated in this research both have one thing in common: both were initially enrolled in other programs at UND before switching to

Petroleum Engineering. On-campus student #1 had previously enrolled in another program associated with engineering, while on-campus student #2 had previously enrolled in a program entirely unassociated with engineering. On-campus student #2 describes a mystical element associated with petroleum engineering, and given that both on-campus student #1 and on-campus student #2 were drawn from other departments and fields of study into petroleum engineering, there may be an element of truth in on-campus student #2's observation. It is important to note that the experiences of both of these students may very well be summed up by on-campus student #1 who noted, "I met the right people and decided to go for this exciting degree". Of key significance in this students' statement are the words, "I met the right people". It would be interesting to further explore what the student associated with his concept of "the right people". On-campus student #2 is originally not from North Dakota, and also seems to have made the sort of connections with petroleum engineering that caused him to switch from a course of study completely unrelated to petroleum engineering. It is important to note that both of the on-campus students interviewed for this study were initially in other programs at UND, but switched to petroleum engineering as a result of being attracted to the degree and meeting supportive individuals.

The literature review for this study drew attention to the need for regional development in higher education, and "flexible structures for learning" (Chatterton & Goddard, 2000). Distance learning options for a program like petroleum engineering more traditionally associated with face-to-face instruction is an example of how UND has poised itself to serve the needs of the wider community as well as individual needs of

students within regions. Chatterton and Goddard (2000) noted, "Responding to regional needs is not a clear cut process for higher education institutions" (p. 491) and Duke (1998) noted that what is needed is a new way of thinking about enriching learning within regions.

The literature review for this study did not include a review of literature related to flexible learning options, or distance learning for students in a program associated with engineering, or otherwise traditionally associated with face-to-face program delivery, as I was not anticipating the participation of online distance students in this study. A review of the literature map in Figure 2 may suggest that literature related to student experiences and perspectives specifically associated to online learning may fit in the category titled, "Changing Context of Higher Education". The results of this study will add to the empirical literature on student experiences with online learning in a program of study traditionally associated with face-to-face instruction.

Industry Executives Experiences and Perspectives

Industry executives had various experiences and perspectives based on the context of their individual situations, however, one factor, preoccupation or perspective bound them all together single-mindedly: that single-minded preoccupation was the focus on training and recruiting locally grown North Dakota graduates, as there is a pervasive perception that North Dakota's climate and remoteness is a deterrent to people from elsewhere. Industry executive # 1 spoke about the development of the Petroleum Engineering program as follows:

> This thing needed to happen. One of the things we have pushed for was the advertisement of the program . . . let's face it, people not from this area don't typically get too anxious to move to North Dakota, not if they're from Texas, Colorado, or Florida. If we can educate people that actually want to be here . . . the industry has a need for people that want to be here.

It is evident from industry executive's #1 experiences and perspectives that the development of the Petroleum Engineering program by his estimation was greatly anticipated. The development of the program appears to have been greatly anticipated due to the perception that people who are not from North Dakota do not want to live and work in the state. Industry executive #1 acknowledges a real need for people [petroleum engineers] who want to be in North Dakota. Since industry seems to be pre-occupied with recruiting people who want to be in North Dakota, there must be an explanation for this reiterative concern: the concern may be grounded in industry's preceding experiences associated with hiring out-of-state petroleum engineers, and hiring locally grown petroleum engineers may be perceived as the best possible solution to the problems associated with out-of-state hires. The key issue here is that industry executive #1's experiences and perspectives stem from his anticipated need for the program, and his concern about marketing the program favorably to attract individuals who want to be in North Dakota.

Industry executive #2 noted that as oil production in the state increased, increasingly more companies were looking to hire local people. Similar concerns were

identified by industry executive #3 who added that one of the challenges associated with the oil and gas industry is:

> Attracting the right kind of people to where the work is and keeping them there. Since the Petroleum Engineering program exists at UND, it attracts an available base of students from North Dakota, South Dakota and Minnesota who are likely to stay and work in those areas. That is a big consideration, we can attract a lot of people, but retaining them working in Williston for a longer period of time, and getting them settled there with families is quite challenging.

Industry executive #4 notes, "We want to be able to fill jobs ideally with people who are home grown or who will come to the state, bring their families and stay". This industry executive alludes to being amenable to filling jobs with non-North Dakota persons providing they come to the state, put down roots and stay. The emphasis on hiring local people may stem from the perception that local people are less likely than out-of-state people to pursue job opportunities or career advancement elsewhere, resulting in less human resource turnover. The key issue here is that as oil production in the state increased, more companies looked to hire locally with the assumption that hiring locally would result in greater human resource stability.

Industry executive's experiences and perspectives associated with the development of the Petroleum Engineering program stem from various situations. For example, industry executive #8 has been associated with the North Dakota Petroleum Council for many years, and his standpoint regarding the development of the Petroleum Engineering program stemmed from the discontinuation of the program in 1992, noting,

"it was a major mistake when they stopped the program". Industry executive #8 noted that:

> Any petroleum engineer in the world would want to experience working in the Bakken, so it was a great opportunity for the university and a great opportunity for industry. We hope we can train them and keep them at home. That's critical, because once they gain experience they sometimes ship off to the rest of the world.

It could be argued that there is an underlying assumption that all, or the majority of students in the Petroleum Engineering program at UND are North Dakota locals who want to live and work in North Dakota after graduation. The key issue here is that a long standing member of the North Dakota Petroleum Council affirms the need for a petroleum engineering program in the state as well as the perceived need to retain trained people in the state.

Industry executive # 7 views universities as key partners in economic development, and he is concerned that universities as well as technical colleges are aligned with the needs of the region. This industry executive describes his experiences and perspectives as follows:

> We'd like to provide well-paying jobs for graduates of our institutions in our region, so they don't move . . . keep them here if we can. We want them to stay here . . . to grow our economy. We have a real shortage of people who stay in North Dakota, and that's probably the largest impediment to growth. We're not going to attract people from the rest of the country, it's very difficult because of

> our climate and the perception that the rest of the world has about North Dakota. So we've got to grow from within. Petroleum is of particular interest to us . . . even with the downturn in the oil patch, there are still some great opportunities for graduates.

Industry executive #7's point of view from an economic development perspective is concerned about growing the economy through retaining local graduates as opposed to having local graduates leave the region to pursue careers elsewhere. This means that in order to retain local graduates it is important to have well-paying jobs within the region. The key issue here is that industry executive #7 is concerned that university and college programming is aligned with the needs of the region, so graduates from local post-secondary institutions have well-paying career opportunities that align with the needs of the region which ultimately contributes to sustaining populations within regions.

Industry executive #9 is very interested in recruiting locally as a result of the difficulty associated with retaining out-of-state engineers after they experience a North Dakota winter. This executive notes:

> We have found it is difficult to get engineers who are willing to put in their time and deal with North Dakota's harsh winters. When people go into engineering, especially petroleum engineering, they dream of a desk job sitting in an office in a high rise in a big city, nice climate, and North Dakota doesn't have a lot of that.

It could be argued that this is a subjective point of view and that not everyone studying petroleum engineering dreams of a desk job in a nice climate. What the research findings cannot ignore is the pervasive pre-occupation with training and recruiting home grown

petroleum engineers. Due to the recurring theme to train and recruit locally it is fair to make an assumption that there must be elements of truth related to the problems industry associates with hiring out-of-state petroleum engineers. The key issue here is that industry repeatedly identifies problems associated with retaining out-of-state petroleum engineers, and attributes this problem to the North Dakota climate. Industry perceives that training and hiring local North Dakota born and raised graduates will contribute to greater human resource stability in the oil industry and this will help the state to grow.

The findings associated with participant's experiences and perspectives about the development of the Petroleum Engineering program align with the body of literature that notes the importance of training individuals to serve the needs of the community. For example, participant's experiences and perspectives align with Etzkowitz et al., (2007) as well as Vorely and Nelles (2008) who noted the increasing awareness of the function of higher education in serving the needs of the community. The results of the study also fit alongside Laredo (2007) who drew attention to the importance of the university's role in fostering regional employability skills. Finally, the findings on participant's experiences and perspectives align with both sets of authors who note the importance of the university's role in addressing the needs of the local population through shaping curricula towards topics related to local employment.

Key Documents

The second additional question that informs this study is, "What light do key documents shed on the development of the Petroleum Engineering program"? Key documents including Stage I and Stage II Petroleum Engineering Program Request were

used in this study to serve as a record of human activity. The documents are important as they provide insight into the program development process contributing to an enhanced understanding of the complexities of the circumstances encompassing the development of a new program. The documents give meaning to social interactions (Lichtman, 2010) and provide an exploration of the world in which people [academia] live(s) (Gergen, 1985).

The North Dakota University System has policies and procedures in place for developing a new program. Campuses are required to announce their intention to develop a new academic program before making a significant investment in developing the program. The announcement must address the, "Type of funding necessary to implement the proposal, [the] relationship of the proposal to the campus mission, a one-line description of the program, [and] a short paragraph on relationship to the Roundtable" (North Dakota University System, 2012). The System Office logs the academic request in the "Programs Under Consideration" log, and the system office academic staff reviews the program proposal. Following the review from the system office the request enters into Stage I. The purpose of Stage I is to announce the intention to develop a formal academic program prior to making an investment in developing the program (North Dakota University System, 2012).

Petroleum Engineering Stage I Program Request

Stage I New Program Request documents dated October 21, 2008 identified the new program as a Bachelor of Science in Petroleum Engineering. The program description indicated that the development of the program was in response to the regional need for graduates with petroleum engineering skills for the oil and gas industry. The

Mission Statement expounded on equipping students for careers in petroleum engineering, conducting research, and pursuing advanced studies to help maximize oil recovery while minimizing environmental impact. The Roundtable Recommendations in the document included six cornerstones focusing on economic development, education excellence, a flexible and responsive system, accessibility, funding and rewards, and sustaining the vision. A section on Employer Demand expounded on the rapid development of petroleum resources in the state, and the severe shortage of petroleum engineers, declaring that employment opportunities in petroleum engineering would continue to grow in both the state and nation. The new program proposed to use many of the existing courses delivered by faculty in the Department of Geology and Geological Engineering with the initial addition of four new courses specifically targeted at petroleum engineering, and anticipated subsequent course development as the program developed. New laboratory and computer simulation experiments were to be developed using new equipment and software provided by a $3 million award from the state for the purpose of establishing a Petroleum Research, Education and Entrepreneurship Center as well as by a $1 million award from the Department of Energy for geochemical research focusing on the Bakken formation. The proposal document acknowledged a donation from Mr. Bob Solberg, however, does not identify an amount. The new program proposal also indicated the plan to use the physical facilities in Leonard Hall that houses the Department of Geology and Geological Engineering (University of North Dakota, 2008).

Petroleum Engineering Stage II Program Request

The process enters into Stage II of the formal request through the submission of an electronic version of the new program request to the Academic Affairs Council (AAC) in a proposal format that includes a one page executive summary addressing:

> The need for the program, program objectives, cost and funding resources for implementation and maintenance of the program, accreditation information if applicable, relationship of the program internally and externally to the campus, articulation opportunities, viability and plans for assessment of the program. (North Dakota University System, 2012).

All program requests must identify the relationship of the proposed program with the 2000 Higher Education Roundtable recommendations. The minimum requirements for a complete program proposal include:

1) Program objectives including any specific strengths or unique features: program objectives are expected to relate to institutional mission.
2) Cost and resources associated with implementing and maintaining the program including existing resources such as equipment, facilities, library materials and personnel: additional required resources must also be declared.
3) Accreditation requirements must be addressed if the institution plans to seek approval of a professional accreditation association.
4) The relationship of the program to existing programs at the institution, or other system institutions, or the region must be identified (North Dakota University System, 2012).

New program requests are also required to identify the relationship of the proposed program to six Roundtable Recommendations incorporating an explanation of the following:

1) Economic development connections or how the program contributes to economic growth, career opportunities and workforce needs.
2) Clarification of education excellence and skill development opportunities that prepare students to be successful and advance in their careers.
3) Evidence of a flexible and responsive system that responds to the needs of clients within the economy of the state.
4) Verification of an accessible system that seeks students from outside the state with a focus on who is being served by non-traditional means such as non-resident, part-time and place bound learners.
5) Guarantee of funding and rewards that assure quality and links to the priorities and expectations of the University System.
6) Pledge to sustain the vision remaining connected to the needs of the university system, the state, and its citizens (North Dakota University System, 2012).

New program requests are required to list the program course requirements and provide an estimated number of students who will enroll as well as complete the program each year. Requests are required to describe the plan for evaluating the success of the proposed program, and describe the plan for delivering the program (North Dakota University System, 2012).

The Roundtable with its six cornerstones is what guides the development and approval of program proposals. The Roundtable on Higher Education within the North Dakota University System was created in 1999 through the collaboration of "61 state leaders – 21 legislators and 40 private sector, government, and education representatives" (The North Dakota University System, 2015). The goal of the Roundtable is to, "To enhance the economic vitality of North Dakota and the quality of life of its citizens through a high quality, more responsive, equitable, flexible, accessible, entrepreneurial, and accountable university system" (The North Dakota University System, 2015). The six cornerstones reflect issues identified at the ninth meeting of North Dakota's Roundtable on October 8, 2008, comprising of sixty participants including the "Legislative Interim Higher Education Committee, private sector stakeholders, the State Board of Higher Education . . . representatives of k-12 education, state government, and North Dakota colleges and universities" (The North Dakota University System, 2015). The six cornerstones established by the Roundtable on Higher Education were deemed vital to the future of the state, and the intent was to provide broad policy directions for the North Dakota University System.

The Stage II Program Request is the University of North Dakota's rationale for why the North Dakota University System should approve such a program. In a letter to Dr. Hillman, Vice Chancellor for Academic Affairs, dated February 16, 2010, Paul LeBel, Provost and Vice President for Academic Affairs at the University of North Dakota sought approval for a Bachelor of Science in Petroleum Engineering. Attached to the letter was an executive summary and program proposal intended for distribution to all

Academic Affairs Council (AAC) members. The program request reiterated the need for the program as a result of growing oil production in the state and identified that North Dakota, among the top 10 oil producing states, was the only state without a Bachelor of Science in Petroleum Engineering degree program. The Stage II Program Request also identified that new funds would be needed to implement and maintain the program. For example, to implement the first three years of the program, three full-time faculty members, including two new hires with start-up budgets, and one current faculty with re-allocated salary were required. In addition, support was required for Graduate Teaching Assistants (GTAs) and Graduate Research Assistants (GRAs) to help with operating labs, grading and other support duties. One instructional lab with low-cost teaching instruments, and one PC lab had already been obtained through the current faculty's research funds: one secretary, one lab technician, and possibly two adjunct faculty would also be required (University of North Dakota Stage II Program Request, 2010, personal communication). New laboratory and computer simulation experiments would need to be developed and would be covered by:

> A $3 million award from the State to establish a Petroleum Research, Education and Entrepreneurship Center (PREEC) and by a $1 million award from the Department of Energy for geomechanical research on the Bakken Formation, together with other smaller research funds including $200K from state and industry and $100K of the current faculty's start-up funds. (University of North Dakota Stage II Program Request, 2010)

To maintain the program between years four and eight, it was anticipated that the program would require salaries for three faculty members, continued support for GTA/GRAs, one secretary, one lab technician, up to two adjunct faculty members (depending on enrollment) and other routine supplies to support an engineering program. The Stage II Program Request also included details about accreditation and reiterated UND's mission proposing how the Petroleum Engineering program would enhance the mission to "serve the state, the country and the world community through teaching, research, creative activities, and service" (University of North Dakota Stage II Program Request, p. 6). The Stage II Program Request also described program delivery, viability, and promised not to duplicate any other program in the North Dakota University System (NDUS) (University of North Dakota Stage II Program Request, 2010, personal communication).

The University of North Dakota Stage II Program Request responded to the program's relationship to the Roundtable by identifying North Dakota as the fourth largest oil producing state in the USA, and petroleum being the state's primary industry creating jobs and revenue. It was identified that the Petroleum Engineering program would produce petroleum engineers to meet the request from oil companies. The Petroleum Engineering curriculum was created to follow UND's Essential Studies and ABET (Accreditation Board for Engineering and Technology) requirements. The program proposed to make use of existing resources and focus on students' future success. The Petroleum Engineering program would integrate teaching, research and skills application offering students an outstanding educational experience and faculty

members would work as a team in a research consortium setting. Funding would be sought from federal, state and private sectors as had been successfully practiced since 2005 in UND's current Petroleum Engineering Lab (p. 7).

Traditionally, Petroleum Engineering programs focused on preparing students to be petroleum engineers who are able to "produce oil, gas, and other fluid resources from the earth" (University of North Dakota Stage II Program Request, p. 19). While this is still the central focus of the discipline, the Stage II Program request acknowledged that future petroleum engineers will be faced with more challenges requiring the ability to "work, communicate and lead in an international and multicultural environment" (p. 19). The proposed Petroleum Engineering curriculum would offer students opportunities to learn the traditional fundamental principles of science and engineering as well as "learn skills in business administration, leadership, international and multicultural communication, and entrepreneurship" (p. 19). Essential studies would include "a minimum of 39 credits, including 9+ from Communication, 9+ from Social Sciences, 9+ from Fine Arts and Humanities, 9+ from Mathematics, Science, and Technology, and 3 from a 400 level capstone course taken in the senior year" (p. 20).

The Stage II Program Request indicated letters and emails in support of the proposed Petroleum Engineering program had been received from 24 different sources some of which included the Office of Enrollment Services, 24 departments, for example, the Department of Chemical Engineering, Department of Entrepreneurship, and Department of Political Science and numerous students. In addition to the letters and

emails of support, many people had also expressed their interest and support orally (p. 24).

Curriculum Development Plan

A Curriculum Development Plan for the Petroleum Engineering Program (Spring, 2011) outlined curriculum development and related needs for the Petroleum Engineering program at the University of North Dakota's School of Engineering and Mines. The goal was to ensure the development of courses in a sequence to allow for students already enrolled in the program to complete their requirements by May 2013. At that time there were six students enrolled in the program, most of which were transfer students who had already completed a considerable portion of their degree requirements with the exception of those courses that still required development; there were nine courses still in need of development. A shortage of faculty at that time was affecting curriculum development. However, the faculty search was underway with the anticipation that the new position would be filled by fall, 2011. At that time, teaching loads were a significant issue for both the Geological Engineering program as well as Petroleum Engineering. There were lab facilities that needed to be purchased, installed and tested as well as laboratory modules to be developed. A lingering concern was time for faculty to engage in training workshops and site or facility visits to stay abreast of the new advances in technology in the industry (University of North Dakota, 2011).

Creation of a New Department

Almost two years later (November 14, 2011) in another letter to Dr. Hillman, Paul LeBel requested approval to establish a Department of Petroleum Engineering. LeBel

attached a detailed proposal for review and noted that the proposal was being distributed to all ACC members. Attached to LeBel's letter was an executive summary identifying the need for the department given the expansion of oil production in the state. Requested details included department objectives to educate future generations of petroleum engineers, cost and resources (no new resources were needed), relationship of the Department to the Campus Mission, viability (the program had 24 students plus 7 distance students and was growing rapidly), duplication (the new Department would not duplicate any department in the North Dakota University System), and relationship to the Roundtable (The University of North Dakota, 2011).

The North Dakota State Board of Higher Education approved a new Department of Petroleum Engineering at the University of North Dakota in 2011. The financial contribution by Harold Hamm and the ND Industrial Commission supported the recruitment of additional faculty and students in petroleum geology within the new Harold Hamm School of Geology and Geological Engineering, now part of the *College* of Engineering and Mines (North Dakota University System, 2012). These resources supported coursework and activities for students in the Petroleum Engineering Department, as well. A proposal titled *Petroleum Engineering Program Faculty Start-Up* identified that the UND Petroleum Engineering Program sought to hire a faculty member to fill a tenure track position as assistant/associate professor. The availability of the position being attributed to the growing need for petroleum engineers regionally, nationally and internationally. The incumbent was expected to have the ability to educate future generations of petroleum engineers, perform research and contribute to sustainable

energy production and environmental protection. The *Petroleum Engineering Program Faculty Start-Up* proposal noted that the newly initiated program within the School of Engineering and Mines would be developed through a collaborative effort involving faculty members with a proven track record of successful teaching and research (The University of North Dakota, n.d.).

This examination of key documents is important because they serve as a record of human activity, provide insight into the program development process and contribute to an enhanced understanding of the complexities associated with developing a new program. Ultimately, the documents give meaning to the context in which academia operates in developing new programs. The documents show that the program development process aligns with and confirms Administrator #5's essential elements for starting a new program such as involving a campus champion, including a core of expertise and alignment with university mission and priorities. The documents provide evidence of program objectives which also align with Administrator #5's assertion that it is essential to know what you are going to do and what you are not going to do. The documents show how the Petroleum Engineering program meets the Roundtable Recommendations for supporting economic growth, contributing to skill development, and provides flexible learning options for out-of-state students. The examination of documents add value to the study and contribute to the literature as there is a scant body of literature connecting the needs of the university system to the needs of the state through program development to meet the needs of industry.

The Innovation System Framework

A third additional question that informed this study was, "To what extent and in what ways does the Innovation System Framework help explain the development of the Petroleum Engineering program"? In Chapter I, four problems were identified which the research has addressed: (i) how the development of the Petroleum Engineering program at the University of North Dakota progressed, (ii) the relationship between the drivers of the program development initiative, (iii) the interaction between various stakeholders, and (iv) the process of developing a new degree program. There is a shortage of empirical literature focused on higher education program development to meet the needs of industry and the relationship between the drivers of program development initiatives, the interaction between stakeholders, and the process of developing a new degree program. The findings associated with this study considered within the conceptual framework that guided the research provide formal articulation of the drivers behind innovation, the interaction between stakeholders, the innovation, and innovative behavior. All four research problems were linked to the conceptual framework in Chapter I, and are reviewed in this segment within the formal research data collected for this study.

Driver Behind Innovation

The expansion of the petroleum industry in western North Dakota's Williston Basin, talent and skills needed for the workforce in North Dakota's oil industry, interest from community leaders in the Grand Forks region and Williston Basin area, industry executives concerned about hiring locally, and faculty interest at the University of North Dakota drove the development of the Petroleum Engineering degree at UND. There was

also a push to develop a petroleum engineering program from alumni, especially from those who were in the oil industry. For example, there was a substantial gift early on from an alumnus who provided initial financial support for program development related to petroleum engineering. Moreover, the state had an interest in developing a petroleum engineering degree program, as a Petroleum Center of Excellence already existed in North Dakota. A large number of stakeholders and executives in the oil and gas industry had always felt that when UND discontinued their petroleum engineering program in 1992, it had been a major mistake. The impetus to develop a petroleum engineering program at the University of North Dakota was a great opportunity for industry, the community and UND.

Interaction Between Stakeholders

Chapter one noted that funding for the development of a new program in petroleum engineering at the University of North Dakota came from Harold Hamm, North Dakota's Industrial Commission and Gas program, Hess Corporation, and the North Dakota Education Challenge Fund. The findings in Chapter Four identified there were other pockets of funding prior to the well-publicized larger donations frequently associated with Harold Hamm and Hess Corporation. The initiative to start a petroleum engineering program at the University of North Dakota also came from the interaction between individuals who realized that the optics of no petroleum engineering degree program in the state amidst the oil boom in North Dakota did not seem appropriate. The innovation, which was about to manifest itself in the development of a new program,

occurred as the result of a complex set of relationships between stakeholders to produce and distribute knowledge.

The process to develop a petroleum engineering program at UND began with a start-up team and then other individuals were added as the team continued towards their goal. The development of the Petroleum Engineering Advisory Board comprised of leaders from industry was noted as one of the most important factors in the development of the program. The interaction between stakeholders provided useful insights into what industry was looking for in graduates, and the participation of financial sponsors helped to support the day-to-day need for program development such as hiring additional faculty. The results of innovation are dependent on how stakeholders relate to each other as part of a collective system.

Innovation

The third phase of the Innovation System Framework illustrates that innovation, or using knowledge to solve problems, train specialized professionals or produce skilled workers is the outcome of the interaction between stakeholders as a result of the drivers behind innovation. During the interaction between stakeholders leading up to the development of the Petroleum Engineering degree at UND, stakeholders from the oil industry articulated how North Dakota had lost an entire generation of petroleum engineers as a result of the program being discontinued in the state in 1992. As a result of this insight, stakeholders developed a clearer understanding of the need for trained skilled professionals in petroleum engineering in North Dakota. Similarly, the Access the Bakken campaign mobilized businesses in Grand Forks and the Bakken resulting in

further interest to take advantage of developing a petroleum engineering program to meet the needs in the state for specialized trained professionals in petroleum engineering. The development of the Petroleum Engineering Advisory Board comprised of alumni and leaders from industry in North Dakota who assembled at UND to participate in advising faculty how to develop the program as well as provide feedback on what they wanted in terms of skilled graduates was a reoccurring theme throughout the research in being identified as the most collaborative action during the development of the petroleum engineering program.

Innovative Behavior

The outcome of innovation in this study is the innovative behavior, or the development of the Petroleum Engineering program at the University of North Dakota. The Stage I New Program Request documents from October 21, 2008 identified the program as a Bachelor of Science in Petroleum Engineering. The program description stated that the program was being developed in response to the need for trained skilled professionals in petroleum engineering for North Dakota's gas and oil industry. The proposed program intended to focus on economic development, education excellence, flexibility, accessibility, funding and rewards as well as sustained vision. The New Program Request documents noted the rapid development of petroleum resources in the state, and the severe shortage of trained specialized professionals in petroleum engineering that was expected to continue to escalate in North Dakota.

The Innovation System Framework is an appropriate conceptual framework for examining the development of the Petroleum Engineering program at the University of

North Dakota. The framework served useful for identifying and reviewing the drivers behind the innovation, the interaction between stakeholders, the innovation, or using knowledge to train specialized professionals for the oil industry, and the innovative behavior, or the development of the Petroleum Engineering program at the University of North Dakota. The framework helps to conceptualize the process, or progression of events leading up to higher education program development to meet the needs of industry. The framework guided the exploration of the relationships between many stakeholders in a system comprised of many individuals with vested interests.

Practical Implications of the Research

A research study needs to identify why and how the analysis and interpretations that were made during the inquiry are important (Stainback & Stainback, 1988). This segment presents four major implications of the findings in this study: (i) the importance of higher education sensitivity to regional needs; (ii) the significance of successful collaboration between stakeholders; (iii) innovation alignment with innovation driver, and; (iv) the innovative behavior or end result.

Importance of Higher Education Sensitivity to Regional Needs

The discussion of the findings in this study highlighted the expressed need from industry executives to produce talent and skills for North Dakota's workforce in petroleum engineering. Furthermore, industry highlighted the perceived need for a locally trained work force comprised of North Dakota locals. Alumni, industry and various sponsors demonstrated their sensitivity to regional needs in North Dakota by contributing financial resources through large sums of money for the development of human resources

in petroleum engineering, and by participating in the Petroleum Engineering Advisory Board. The University of North Dakota's sensitivity to regional needs through the development of the Petroleum Engineering program to meet the needs of industry demonstrates the importance of higher education's understanding of regional needs.

Since universities and colleges are located within regions it is important for them to be sensitive to regional economic needs and development. The distribution of knowledge and skills within a region are significant to the region and regionally engaged institutions of higher education have the potential to become key sponsors of regional economic development. As key sponsors of regional economic development, higher education has the capacity to make significant contributions to knowledge creation as well as the distribution of knowledge transfer; knowledge transfer can occur through human resource development, graduate employment in a region, and supporting community expansion (Chatterton & Goddard, 2000; Duke, 1998).

Significance of Successful Collaboration Between Stakeholders

The discussion of the findings in this study noted the significance of successful collaboration between stakeholders. As stakeholder groups began to develop an understanding of the future demand for petroleum engineers in North Dakota, and the void of trained, skilled professionals in the petroleum engineering sector, community initiatives began to take advantage of, and support initiatives that would ultimately benefit Grand Forks, the Bakken and North Dakota. The Petroleum Engineering Advisory Board is an example of successful collaboration between stakeholders in an effort to develop a program with higher education to meet the needs of industry. The

research findings demonstrate that the successful collaboration between stakeholders had a significant influence on the development of the Petroleum Engineering program.

Successful collaboration between stakeholders is dependent on the context of the environment and how individuals within that environment relate to each other. Innovative initiatives in higher education are the result of numerous environmental factors such as resources, mutual interest and leadership (Albulescu, Litra & Neagu, 2014). Universities are obliged to respond to the requests from regional stakeholders, and can leverage their individual strengths by serving as foundations of expertise in their region leading stakeholders in the process of creating programs to foster skills development and future employability (Burton & Dlouha, 2011). Universities have a direct impact on the local populations they serve; therefore issues related to local employment, employability and the successful collaboration between stakeholders are important topics for consideration and practice implications of the research.

Innovation Alignment With Innovation Driver

Innovation alignment with innovation driver is an important practice implication of this research. Specifically, how well does the innovation, or using knowledge to solve problems, and train specialized professionals to produce workers for the oil industry align with the driver behind the innovation: in this case the boom in the oil industry in western North Dakota. The link or the catalyst ensuring innovation alignment with the innovation driver in this case study is the Petroleum Engineering Advisory Board. Nearly every interview participant noted the significance of the role, and presence of the Advisory Board in helping to guide and shape the curriculum for the Petroleum Engineering

program at UND. The formation of an industry advisory board early on in the program development process is an important practice implication of the research for higher education program development to meet the needs of industry.

If the employability of future graduates is significant to local economies, then it is important to develop professional degrees that are relevant to the local economy. The development of professional degrees that are relevant to the local economy is the, "First layer of interaction between the university, the region, and the established representations of industry" (Laredo, 2007, p. 10). Linking back to the region is commonly at the very center of regional economic specialization where universities are located, and the geographical positioning serves to support the valorization of the knowledge produced at the university, and subsequently potential future employment within the region. Therefore, innovation alignment with the innovation driver is an important practice implication in this research.

The Innovative Behavior or End Result

The innovative behavior or end result is also an important practice implication in this research. The Stage I Program Request documents indicating the need for graduates with petroleum engineering skills for the gas and oil industry in western North Dakota is the verification of innovative behavior in the manifestation of a bona fide program. The materialization of a bona fide program in petroleum engineering at the University of North Dakota is an indication of higher education program development to meet the needs of industry. The program proposal document acknowledged the availability of financial resources to support the program as well as the available space for classrooms.

At the very foundation of the New Program Request was a specific focus on economic development and the need to grow the petroleum engineering program within the state. The innovative behavior itself, or the development of the Petroleum Engineering program is an important practice implication in this research.

Recommendations for Program Development to Meet the Needs of Industry

The following recommendations stem from the responses to the research questions gathered through data collection.

1. Recruit faculty with a specific interest in participating in the program development process.
2. Promotion and tenure at the university ought to recognize the value and importance of attaining a project from industry that results in the production of a valuable outcome that contributes to the community, region or society.
3. Foster communication and collaboration with industry as early as possible in the program development process. Consider differing opinions from industry, receive feedback and incorporate suggestions.
4. Form an industry advisory board for the new program.
5. Develop and maintain strong communication and collaboration with industry to support the conveyance of knowledge for the program development team.
6. Establish a mutual understanding between stakeholders regarding Key Performance Indicator's (KPI's).
7. Establish KPI's for defining and measuring success.

8. Include diverse groups of individuals in the program development process. Ensure that individuals with differing opinions are represented and contribute to a well-rounded final product.
9. Connect with professional societies in the industry to solicit champions.
10. Ensure that the program under development is comprised of a strong foundation in the fundamentals so that students have a solid foundation to grow on.
11. Provide professional networking opportunities for students and industry.
12. Generate co-op and internship opportunities for students in petroleum engineering companies.

Recommendations for Further Research

The results from this study are not comprehensive. Consequently, they do not articulate the experiences of all individuals engaged in higher education program development to meet the needs of industry. Therefore, at the close of this study, I suggest a number of considerations for future research.

1. More research should be conducted on other collaborative endeavors in North Dakota and elsewhere between higher education, the community and/or industry.
2. A study of prospective regional drivers in North Dakota or elsewhere that have the potential to result in higher education program development to meet the needs of industry.

3. Very little research has been done on the impact of higher education program development to meet the needs of industry. The reactions and perceptions of other individuals involved in such endeavors should not be discounted, especially when skill development for regional economic development is directly related.
4. More research needs to be done on the role of industry advisory boards and higher education program development to meet the needs of industry.
5. Now that there is data on the development of the Petroleum Engineering program at the University of North Dakota, it would be useful to have observational data from the industry advisory board meetings. Questions deserving further research are (i) how do industry roles play out during industry advisory board meetings; (ii) what kind of situations between industry executives and faculty members stimulate or support changes; (iii) are there ideal industry advisory board members; (iv) are there specific skills or attributes an industry advisory board member should have; and (v) should there be a limit on the number of advisory board members and/or duration of participation on the advisory board?
6. More research is needed concerning what industry advisory board members have to say about collaborating with higher education, or what faculty members have to say about collaborating with industry.
7. A more in-depth study of the Access the Bakken campaign in the Grand Forks region could add value to the current study.

8. A study on the effect of leadership of industry advisory boards could support or enhance this case study.
9. Longitudinal research on whether or not the development of the Petroleum Engineering program at the University of North Dakota contributed significantly toward the void in skilled engineering professionals in the state.
10. A longitudinal study on hiring trained North Dakota locals to work in the oil industry, and whether or not they remain in the state over the course of their career.

These are just a few of the many research studies that could be conducted to support or enhance the findings of this study.

Conclusion

This study sought to understand the experiences and perspectives of selected key participants in the development of the Petroleum Engineering program at the University of North Dakota. The overarching question that guided this study is: How did the University of North Dakota proceed with developing a Petroleum Engineering degree? Questions that guided this study were:

1. How do key participants describe their experiences and perspectives about the development of the Petroleum Engineering program?
2. What light do key documents shed on the development of the Petroleum Engineering program?
3. To what extent and in what ways does the Innovation System Framework help explain the development of the Petroleum Engineering program?

The conceptual framework that guided this research is the Innovation System Framework.

It is evident that the participants in this study described various experiences and perspectives about the development of the Petroleum Engineering program at the University of North Dakota. The participant's experiences and perspectives indicated the need for a petroleum engineering program in the state for the purpose of developing human resources. The need for human resources for North Dakota's oil and gas industry, and a petroleum engineering program in the state of North Dakota resulted in the collaboration of various stakeholders in academia and industry to develop a Petroleum Engineering program at UND. It is apparent that the Innovation System Framework provides an appropriate framework for this study in helping to understand the innovative process and knowledge flow between stakeholders contributing to regional economic development. The study demonstrates that innovation is of key importance in reaching developmental goals to promote regional economic growth; regional economic growth is vital to the future prosperity of North Dakota. It is hoped that this research will provide guidance to other institutions of higher education that may be interested in developing a degree program to meet the needs of industry. Likewise, it is hoped that this research will also guide industry leaders seeking to partner with higher education for the purpose of program development. Both industry leaders and academia have the potential to benefit from the findings of this study.

APPENDICES

Appendix A
University of North Dakota IRB Approval

UNIVERSITY OF NORTH DAKOTA

DIVISION OF RESEARCH & ECONOMIC DEVELOPMENT

UND.edu

Institutional Review Board
Twamley Hall, Room 106
264 Centennial Dr Stop 7134
Grand Forks, ND 58202-7134
Phone: 701.777.4279
Fax: 701.777.6708

October 19, 2015

Principal Investigator:	Rosemary Vogt
Project Title:	Academia Meeting the Needs of Industry: A Case Study of Developing a New Degree Program for Petroleum Engineering
IRB Project Number:	IRB-201510-102
Project Review Level:	Expedited 6, 7
Date of IRB Approval:	10/15/2015
Expiration Date of This Approval:	10/14/2016
Consent Form Approval Date:	10/15/2015

The application form and all included documentation for the above-referenced project have been reviewed and approved via the procedures of the University of North Dakota Institutional Review Board.

Attached is your original consent form that has been stamped with the UND IRB approval and expiration dates. Please maintain this original on file. ***You must use this original, stamped consent form to make copies for participant enrollment. No other consent form should be used.*** It must be signed by each participant prior to initiation of any research procedures. In addition, each participant must be given a copy of the consent form.

Prior to implementation, submit any changes to or departures from the protocol or consent form to the IRB for approval. No changes to approved research may take place without prior IRB approval.

You have approval for this project through the above-listed expiration date. When this research is completed, please submit a termination form to the IRB. If the research will last longer than one year, an annual review and progress report must be submitted to the IRB prior to the submission deadline to ensure adequate time for IRB review.

The forms to assist you in filing your project termination, annual review and progress report, adverse event/unanticipated problem, protocol change, etc. may be accessed on the IRB website: http://und.edu/research/resources/human-subjects/

Sincerely,

Michelle L. Bowles, M.P.A., CIP
IRB Coordinator

MLB/jle
Enclosures

Cc: Dr. Daniel Rice

Appendix B
Consent Form

THE UNIVERSITY OF NORTH DAKOTA
CONSENT TO PARTICIPATE IN RESEARCH

TITLE:	**Academia Meeting the Needs of Industry: A Case Study of Developing a New Degree Program for Petroleum Engineering**
PROJECT DIRECTOR:	**Rosemary Vogt**
PHONE #	**204 943 3594**
DEPARTMENT:	**Educational Leadership**

STATEMENT OF RESEARCH

A person who is to participate in this research must give his or her informed consent to such participation. This consent must be based on an understanding of the nature and risks of the research. This document provides information that is important for this understanding. Research projects only include subjects who choose to take part. Please take your time in making your decision as to whether to participate. If you have questions at any time, please ask.

WHAT IS THE PURPOSE OF THIS STUDY?

You are invited to be in a research study about the development of the Petroleum Engineering program at the University of North Dakota.

You are being asked to participate in this study due to your professional experience and knowledge about the circumstances surrounding the development of the Petroleum Engineering degree program at UND.

The purpose of this research study is to understand the experiences and perspectives of the key participants in the development of the Petroleum Engineering degree program at UND.

HOW MANY PEOPLE WILL PARTICIPATE?

It is anticipated that approximately 20 people will participate in this study: 10 people from academia and 10 people from industry and/or government. It is anticipated that the research will take place at the University of North Dakota and Grand Forks area.

HOW LONG WILL I BE IN THIS STUDY?

Your participation in the study will last for two interviews that will take about two hours total.

Approval Date: OCT 15 2015
Expiration Date: OCT 14 2016
University of North Dakota IRB

Date: _____
Subject Initials: _____

WHAT WILL HAPPEN DURING THIS STUDY?

You will participate in two interviews. The first interview will last up to one hour and the second interview will last up to 30 minutes. The purpose of the second interview is to provide you with an opportunity to respond to the transcript of the first interview and to verify the correctness of the information in the transcript as well as add any further information or correct errors in the transcript. The time and place of the face-to-face interview will be determined by mutual convenience. If meeting face-to-face is not possible due to a conflict, an alternative means such as the telephone, Skype or FaceTime will be used.

WHAT ARE THE RISKS OF THE STUDY?

There are no foreseeable risks to participating in this study. If, however, you become upset by questions, you may stop at any time or choose not to answer a question.

WHAT ARE THE BENEFITS OF THIS STUDY?

The researcher will not benefit personally from being in this study. However, in the future, other people might benefit from this study as a result of having a greater understanding of higher education program development to meet the needs of industry.

WILL IT COST ME ANYTHING TO BE IN THIS STUDY?

There are no foreseeable costs associated with participating in this study.

WILL I BE PAID FOR PARTICIPATING?

You will not be paid for being in this research study.

WHO IS FUNDING THE STUDY?

The University of North Dakota and the research team are receiving no payments from other agencies, organizations, or companies to conduct this research study.

CONFIDENTIALITY

The records of this study will be kept private to the extent permitted by law. In any report about this study that might be published, you will not be identified, but you should understand that this does not guarantee confidentiality, because the Petroleum Engineering program and the University of North Dakota will be identified in any publications or presentations that result from this study. This study record may be reviewed by Government agencies, the UND Research

Approval Date: OCT 15 2015
Expiration Date: OCT 14 2016
University of North Dakota IRB

Date: _____
Subject Initials: _____

Development and Compliance office, and the University of North Dakota Institutional Review Board.

Any information that is obtained in this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of coding procedures. All information received from you will be stored digitally by pseudonym on a computer to which only the researcher involved in the study will have access. The informed consent sheet containing your name will not be kept with the interview data, and will be stored in a locked drawer in the researchers' office where only she has access to it, avoiding the possibility of connecting your name to any information you have given.

If the researcher writes a report or article about this study, she will describe the study results in a summarized manner so that you cannot be identified.

During the interview process a high quality digital voice recorder will be used to record the interview and a professional transcriptionist may be hired to transcribe the data verbatim. You will have the opportunity to review the interview transcripts for accuracy. Recorded audio files will be kept for up to three years in case the researcher decides to return to the data at a later date and listen to the tapes again for the purpose of listening for inflection and tone in the participants response. After three years all the audiotapes will be erased. Transcriptions from the audio recordings will be kept for an indefinite period of time in a locked drawer in the researcher's home office.

IS THIS STUDY VOLUNTARY?

Your participation is voluntary. You may choose not to participate or you may discontinue your participation at any time without penalty or loss of benefits to which you are otherwise entitled. Your decision whether or not to participate will not affect your current or future relations with the University of North Dakota.

CONTACTS AND QUESTIONS?

The researcher conducting this study is Rosemary Vogt. You may ask any questions you have now. If you later have questions, concerns, or complaints about the research please contact Rosemary Vogt at ***204 943 3594 or Rosemary's advisor Dr. Daniel Rice at 701 777 3431.*** If you have questions regarding your rights as a research subject, you may contact The University of North Dakota Institutional Review Board at **(701) 777-4279**.

- General information about being a research subject can be found by clicking "Information for Research Participants" on the web site: http://und.edu/research/resources/human-subjects/research-participants.cfm

Approval Date: OCT 15 2015
Expiration Date: OCT 14 2016
University of North Dakota IRB

Date: _____
Subject Initials: _____

I give consent to be audiotaped during this study.

Please initial: ____ **Yes** ____ **No**

I give consent for my quotes to be used in the research; however I <u>will not</u> be identified.

Please initial: ____ **Yes** ____ **No**

Your signature indicates that this research study has been explained to you, that your questions have been answered, and that you agree to take part in this study. You will receive a copy of this form.

Subjects Name: _____

_____ _____
Signature of Subject Date

I have discussed the above points with the subject or, where appropriate, with the subject's legally authorized representative.

_____ _____
Signature of Person Who Obtained Consent Date

Approval Date: OCT 15 2015
Expiration Date: OCT 14 2016
University of North Dakota IRB

Date: _____
Subject Initials: _____

Appendix C
Letter or Telephone Conversation Introducing the Research to the Potential Participant

Dear/Hello Participant,

My name is Rosemary Vogt, and I am a PhD candidate in Educational Leadership at the University of North Dakota. I am currently working on my dissertation, and am seeking your help in the completion of my study on the development of the Petroleum Engineering degree program at the University of North Dakota. Currently, I am contacting selected key individuals to let them know about the research and invite participation. The purpose of this study is to understand the experiences and perspectives of the key participants in the development of the Petroleum Engineering program at UND. I am willing to share the findings of my research with those who participate in the study. Your role in the study could add valuable information and insights. However, you are under no obligation to participate in this study; it is your decision.

Your participation in this study is voluntary. You should know that the study will identify the Petroleum Engineering program at UND; even though participants will not be named in the research, there is no way to guarantee confidentiality. Your identity will be protected to the best of my ability: confidentiality will be maintained by means of coding procedures. If you decide to participate I would like to interview you twice. The first time may take up to 45 minutes and the interview will be audio recorded; the second interview may take up to twenty minutes. The purpose of the second interview is to respond to any questions or more information you may have after you have had an opportunity to review the transcription from the first interview. If you are interested in participation in this

study please let me know the best way I can communicate with you. If you are not interested in this study I will not contact you any further.

Thank you for your consideration.

Rosemary Vogt, Doctoral Candidate, University of North Dakota

Daniel Rice, Ph.D., Doctoral Advisor

Appendix D
Reflective Journal

July 22, 2014

I am a Canadian completing doctoral study at an American university: my dissertation topic is higher education program development to meet the needs of industry. My topic and my interests do not resonate with the other students in my cohort, and I perceive that many people (Canadian and American) are puzzled by my interest in the development of the Petroleum Engineering program at UND. I tried to find a context for this research (higher education program development to meet the needs of industry) in Manitoba Canada, but that did not work out. The only situation(s) I was aware of in Manitoba were those I had been personally involved in, and I did not want to base my studies or dissertation on those, as I had been very personally involved. Besides, I am really excited about the opportunity to conduct research in a different country. That sounds really strange because I have lived near the Canadian U.S. border all my life and have not really thought of myself as "the other".

October 29, 2015

In a recent interview a former faculty member commented on his involvement in the development of the Petroleum Engineering program as, "Its both a star to me as well as an example of just how crazy life can be". This participant's comment resulted in further reflection on my own experiences in program development to meet the needs of industry as well as my own role or stance in this research. Although the interviewee did not elaborate on his comment, I could easily identify with the brief statement he made.

For example, looking back at a five-year program development initiative that I played key and multiple roles in, I can also say the product that we, or my team developed is both a star to me as well as an example of how crazy life can be, because program development generally involves many stakeholders with differing opinions and expectations. Based on my own experiences and world view, and reading between the lines spoken by my interviewee, I surmised that the process of developing the Petroleum Engineering program had extraordinary moments, and the result of having a final product was gratifying, but the in between parts featured highs and lows. As I found myself identifying with what the interviewee was saying, I realized that I am not a neutral participant in this research, I have my own conceptual baggage based on my own experiences with which I am making a judgment on the interviewee's experience. Since the goal of qualitative research is to seek to understand meaning, I should not assume that meanings are fixed or stable, or that the interview participants' experience bore any similarity in meaning to my own experience. It is interesting to think about how meaning is produced, because individual meaning making is influenced by context, gender and race as well as other characteristics. Since I perceive to identify with this interviewee's experience, my perception is shaping the construction of meaning in this research resulting in researcher bias in my own construction of meaning. I wondered if I would have taken note of this interviewee's comment at all if I did not have any experience or reference points with the subject. I realize it is important for me as a researcher to be aware of my own biases and lack of neutrality to avoid making unintentional incorrect assumptions about the research. In hindsight I should have asked the interviewee to

explain the comment, but a challenge I was experiencing with this participant is capturing an appropriate moment to interject to ask a question.

November 3, 2015

Today I conducted another interview: the last two interviews have taken place via SKYPE as opposed to face-to-face. I realize that I am not an entirely neutral person in my research study. I have issues about higher education program development to meet the needs of industry. These issues stem from the challenges I faced as a project manager in an initiative between post-secondary education and the provincial government to develop courses and programs to meet the needs of industry. During this time I experienced that stakeholders were all over the map in regards to the objectives of the project, and no one really had a clear understanding of how we were going to proceed; it was as though we were constantly proceeding along a long hallway in a fog, trying to feel the walls on each side as reference points. I have the strong/distinct impression that stakeholders involved in the development of the Petroleum Engineering program at UND were more in unison in working collaboratively with each other. As I proceed with my research I will make certain not to speak about my negative, or disappointing experiences with any of my interview participants. I will make certain to remain neutral during the interview process.

November 10, 2015

No, I'm not entirely neutral in this interview/research study process, and I am wondering if it is possible for a researcher ever to be completely neutral, since researchers generally choose a topic, or subject that resonates with the researcher in some way, so clearly the researcher is going to have some prior knowledge of, or experience

with aspects that feed into the research topic. For example, a participant I interviewed recently spoke about regional economic development in the Grand Forks region, and stakeholders interest in ensuring there are well paying jobs within the region for graduates from UND, so graduates are not leaving the state in search of well paying jobs elsewhere. This concern has similarities to my own experience in Manitoba where it has often been said, as well as documented, that the brightest young people leave Manitoba for other provinces, specifically Alberta, British Columbia or southern Ontario. In Manitoba it is unclear what makes people leave, which makes me think this topic would make for a great research study. Speculation suggests that young people who leave gravitate toward larger cities like Vancouver or Toronto, and from my experience these people often return to raise families in Manitoba. While Manitobans complain about the weather, long winter and isolation (which is similar to North Dakota), the weather is generally not associated with attracting and retaining skilled professionals in the province. What draws a lot of people here (to Manitoba) is the fact that the lower cost of living allows people to purchase more affordable housing and then travel to warmer destinations for vacation more frequently. What I see as a concern in Manitoba is the fact that it is a small geographically populated area and career opportunities in some professions are not that easily attainable. For example, careers in higher education for people with PhD's are not that readily available. Therefore, I can appreciate the fact that individuals in North Dakota, specifically the Grand Forks region who are invested in regional economic development are concerned with well paying jobs for graduates from UND. It would be interesting to conduct a study on individuals from UND who leave the

state to determine what factors come into play to influence the decision to leave. Is it wages or employment opportunities in general? So no, I am not neutral in this study, I completely understand, and/or agree with North Dakota/Grand Forks initiatives associated with ensuring that graduates from UND have interesting/engaging career choices that offer attractive financial remuneration.

November 15, 2015

A recent interview participant from academia spoke about industry culture and the importance of speaking to industry in their language as opposed to using academic jargon. Apparently, this premise also applies to writing reports for industry, as industry, according to my interview participant, does not have time to read long detailed reports full of academic verbiage. This insight resonated with my own experience and I realized again that I am not entirely neutral in this study. For example, in my own experience working on higher education/industry/government program development, I have written lengthy reports for industry/government, and I have written these reports with my academic hat on priding myself in sourcing/referencing my material, as I would do in academia only for industry/government stakeholders to request an abridged version. I wish I had known these nuances about industry culture at the time, or that someone would have told me. However, no one else on my team from higher education pointed that out to me, which makes me believe they were as inexperienced as I was in collaborating with industry/government. So, as I listened to my interview participant, I realized that I was not entirely neutral in the research, and I had biases stemming from my own experiences. Being really curious about research bias, I conducted a Google

search and found an article by Rebecca Sarniak, a moderating services specialist for a Denver research firm. Sarniak says that bias can find its way into any research and it is naïve to think that any research can be totally free from bias. Knowing that I wondered how then to proceed as a researcher, and if all research is biased to some extent when does it become a serious problem? Continued exploration on researcher bias confirmed what I already know, specifically, that bias in qualitative research has the potential to distort results. So, it is important to strive to be as objective as possible keeping an open mind as to not skew reporting. I don't believe that my reporting of the findings will alter the reality of what the research participant reported, however, the experience made me realize once again that I am not entirely neutral in this study.

December 1, 2015

Over half way done reaching my goal of interviewing 20 individuals for this study. I have been thinking a lot about a researcher's baggage, in this case my baggage. When I listen to research participants tell me about their experiences or interest or role in the development of the Petroleum Engineering program at UND, I can't help but think that this does not bare any similarity or likeness to my own experiences. My own experience was riddled with setbacks, one tiny step forward and two giant steps backward; the target kept changing. I'm sure there are aspects of the situation here that I will never be apprised of, but overall, there is a momentum in this situation that does not bare any likeness to my own previous experiences.

December 8, 2015

Interviewed another participant today. I am reflecting again on my personal experiences and biases related to higher education program development to meet the needs of industry. It is evident that the Petroleum Engineering Advisory Board played a significant and positive role in the development of the petroleum engineering program at UND. Advisory boards from my own personal experiences were fraught with conflict and had a tendency to evaporate; best-case scenario the advisory board needed constant CPR. I have so much more to learn about these processes as I hope that in some way, shape or form my future work will in some small way entail developing programs to meet the needs of industry.

Appendix E
Open-Coding: Categories and Codes

Theme 1: Regional influencers affected the development of the Petroleum Engineering program.

Over-arching theme	Emergent Themes	Category	Codes
Theme #1: Regional influencers affected the development of the Petroleum Engineering program.	• Increased need for Petroleum Engineers in North Dakota • Assumptions about recruiting locally • Growing momentum to develop a program • Significance of engagement in regional needs	• Rapidly expanding oil extraction • Urgency to develop a petroleum engineering program • Emphasis on training and recruiting local people • Difficulty filling positions with out of state hires • Harsh climate/cold weather • University and stakeholder interest	• Williston Basin • Increased oil production • Urgency to hire petroleum engineers • Opportunity for employment • Desire to train locally • Long-term demand for Petroleum Engineers • Difficulty hiring petroleum engineers who stay in North Dakota • Stabilize Growth in North Dakota • Some students going out of state for training • Work ethic in North Dakota • Industry wants home grown grads • North Dakota culture/heritage

			• Negative view of North Dakota • Unforgiving climate • Constant Influx-outflux of Petroleum Engineers • Farm kids • Ranch kids • Alumni • Funding • Bob Solberg • Accelerate oil production • Petroleum Centre of Excellence • Stars aligning • Collaborate • No Petroleum Engineering program in North Dakota • Lost generation of petroleum engineers in North Dakota • Growth of North Dakota • Impact the economy • Advance oil recovery • Role of the university • Innovation

Theme 2: Attunement by UND to regional influencers performed a critical role in developing the program to meet the needs of industry.

Over-arching theme	Emergent Themes	Category	Codes
Theme #2: Attunement by UND to regional influencers performed a critical role in developing the program to meet the needs of industry.	• The university begins to mobilize to meet local need • Petroleum Engineering Advisory Board • Bridging the gap between advanced technology and industry • University collaboration with industry	• Requests from industry • Stakeholder collaboration • Advancing technology • Essential elements for developing a program • Program development	• Bakken • Initial plans • Curriculum • Collaborate • Faculty • Leadership • Easy decision • No Brainer • Startup team • Unsung heroes • Day-to-day need • Sponsors • Little pockets of funding • Harold Hamm • Skilled graduates • Finances • Solve problems • Participatory roles • Teaching • Courses • Polo shirt • Projects • Credibility • Opportunism • Mission • Champion • Multiple drivers • Symbiotic relationship • Critical issues • Controversy • Tenure

Theme 3: Students were attracted to the Petroleum Engineering program.

Over-arching theme	Emergent Themes	Category	Codes
Theme # 3 Students were attracted to the Petroleum Engineering program.	• Exploring academic options in Petroleum Engineering • Distance learning • Students views on collaborating	• Harold Hamm influence • On-campus student • Distance learning • Student ideas about collaborating • Concerns about employment readiness	• Stimulating student interest • Harold Hamm • Opportunities • Successful career • Enormous impression • Another Engineering program • Switch • Petroleum Engineering adventure • Exciting degree • Mystical element • Advisory Board • Difficult to go back to school • Another state • Opportunity I would not otherwise have had • Flexibility • Distance student • On-campus student • Industry lectures • Internships • Flexible learning • Job placement • Interaction with industry • Light years ahead • North Dakota talent gap • Need for Petroleum

			Engineers in North Dakota • Advance technology • Stay abreast with industry

Theme 4: Industry support was critically important to the development of the academic program.

Over-arching theme	Emergent Themes	Categories	Codes
Theme #4: Industry support was critically important to the development of the academic program.	• Various forms of collaboration • Transfer of knowledge • Program development resources • How industry measures success	• Recruiting local • Stakeholder insight • Student reflections • Collaborative endeavors	• Activity in the Bakken • Industry stakeholders • Regret/discontinued Petroleum Engineering program • Indicator of the need for a program • Universities as key partners • Well-paying jobs for graduates • Shortage of people who stay in North Dakota • Local kids/farm kids • Climate in North Dakota • Negative impression of North Dakota • Investing in skills • Invest in locals • Grasp the magnitude • Nearly a decade • Lost generation • Future demand • Career advancement • East Meets West • Access the Bakken • Cohorts • Advancing/transferring technologies and skills • Core & Sample Library • EERC • Quality students

			• Key Performance Indicators • Regional situatedness • Finding niche • Geological advantage • Attracting and Retaining • Companies operating in North Dakota look to UND for new grads • Suicide not to collaborate

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