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Fundamental Factors for Success: Engineering Faculty and Industry Partners

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By

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FUNDAMENTAL FACTORS FOR SUCCESS: ENGINEERING FACULTY AND INDUSTRY PARTNERS

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A DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF EDUCATIONAL DOCTORATE IN EDUCATIONAL LEADERSHIP

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ABSTRACT

Partnerships and collaborations between higher education and industry have a long history in the United States. Numerous partnerships have contributed to advancements in the economy, education and training, humanity, and innovation. The subject areas of science, engineering, and technology are fields in which many of the collaborations occur, and many of the partnerships are often initiated and led by a faculty and a member of industry. Yet, it remains unclear how academia and industry achieve successful partnerships when the goals, language, culture, and organizational structures significantly differ from one organization to another. This study examined whether partnerships among engineering faculty perceive the core factors of successful collaborations similarly to how business and industry perceive the core successful collaborations with academia. This research sought to identify the core set of factors necessary to establish and maintain successful partnerships between higher education and industry. Data was solicited through surveys from engineering faculty in the Minnesota State University and College system and business and industry leaders throughout the state of Minnesota.

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Chapter I

Introduction

The words *partnership* and *collaboration* are repeatedly expressed within institutions of higher education and within business and industry. Many partnerships, although complex, have resulted in a variety of successful joint ventures between universities and industry. The collaborations yield positive outcomes with advancements in the economy, education and training, humanity and in the organizations with shifting culture, structures and perceptions for universities and industry alike. Yet, it remains unclear how universities and industry achieve successful partnerships when the goals, language, culture, and structures significantly differ from one organization to another.

History of Higher Education & Partnerships

In the early half of the nineteenth century, higher education in America was a way “to educate an elite group of young men for the learned professions and positions of leadership in society” (Bok, 2013, p. 28). However, during the second half the nineteenth century, the objective of universities and colleges began to shift. American colleges and universities responded to America’s rise of industrialization and the growing economy by modifying the goals and focus of higher education to respond to the economic demands. The emphasis on research and practical training emerged.

Congress, observing the growth of the Industrial Revolution, recognized the importance of the evolving focus areas of higher education in America and passed the Morrill Act of 1862. The Morrill Act created land-grant colleges by transferring US government land to the states so that proceeds of the sale would be used for the establishment of colleges to teach practical training in science, primarily agriculture and the mechanical sciences (Atkinson & Blanpied, 2008). Faculty at these institutions were also expected to conduct research in their areas of study and produce outreach programs to disseminate the results of their research (Atkinson & Blanpied, 2008). As a result, partnerships between institutions of higher education, private enterprises, and non-profit organizations began to appear in a variety of ways to support the new priorities and redirect the focus of higher education (Prigge, 2005).

Research became a valuable opportunity for universities to demonstrate their contribution and support the growing American economy. Utilizing a German model of university research, Harvard University, in the early 1870s, established the Jefferson Physical Laboratory, the first physical laboratory in America exclusively devoted to research and teaching (Atkinson & Blanpied, 2008). Johns Hopkins University led the way in 1876 as the first American research university and the first graduate university, dedicated to research and training for scientific inquiry (Bok, 2013). Shortly thereafter, other universities adopted research as their focus and established their credentials as research institutions.

The start of the twentieth century saw an uptick in scientific research. Universities, private, non-profit institutions, and federal organizations partnered to conduct scientific research during World War I and thereafter (Atkinson & Blanpied, 2008). World War II triggered a large shift in academic research when the National Defense Research Council, and the Office of Scientific Research and Development were created. Both commissions were comprised of experts in academia and research coming from prestigious universities like Massachusetts Institute of Technology and Harvard University (Atkinson & Blanpied, 2008). The partnership between the US government and the various institutions of higher education led to the creation of additional agencies like the National Science Foundation and the National Institute of Health to support scientific research. This resulted in a rapid expansion of federal support for the American academic research system throughout the 1950s through the 1970s.

Due to the rapid expansion of federal support, many collaborations between university and industry were abandoned. Industry collaboration was no longer a priority. Institutions of higher education shifted their focus and merely concentrated on meeting the needs and expectations of the federal government partnerships since they were contributing financially. As a result, many relationships with industry dissolved. Yet, in 1980, the Bayh-Dole Act was passed, granting rights to universities to keep their patent rights and for private firms to share the rights to research results with potential university partners (Pelfrey & Atkinson, 2010). In turn, research universities offered support for faculty to help with the patent process of their work. They also encouraged faculty to create external partnerships, and start companies that would develop, and market new products based on their research discoveries (Bok, 2013). Currently, almost every major American university declares research as part of their mission (Bok, 2013), and as the Morrill Act of 1862 required, research findings are distributed to connect with external outreach programs, building additional bridges for engagement and collaboration.

The other area of emphasis to emerge in higher education was the applied training of students in response to the demand for skilled and qualified employees. Public universities began offering courses in domestic science, engineering, business administration, teacher training, sanitation, and public health. Private universities also responded by adding programs in business and strengthening their professional schools of law and medicine (Bok, 2013). The demand for elite university educated men were no longer relevant. Rather, the booming American economy needed a skilled labor force to continue advancing America's economic growth and garner prosperity.

The close of the Civil War called for "individuals with scientific training and verifiable competencies who, upon mastering a set body of knowledge, could develop and manage complex tasks and processes" (Sorber, 2018, p. 16). One notable area was the changes in engineering education in the United States of America. Overseas, engineers were trained through apprenticeship by working with a practicing engineer before becoming an independent engineer. Training with a skilled apprentice was an opportunity to cultivate new engineers, however, with America in its infancy, there were not enough apprentices to educate new emerging engineers.

Indeed, America's rapid growth called for more engineers to build the infrastructure and the foundation of the United States. Yet, the American college and University system was not prepared to produce skilled and qualified engineers. As Reynolds (1992) states, "The growing need for engineers to plan and build roads, canals, and railroads came while American colleges faced criticism for being elitist and irrelevant to American conditions" (p. 462). With the rapidly expanding national transportation networks the traditional apprenticeship model for training skilled engineers was not able to meet the demand. Consequently, American colleges had to shift their areas of focus and begin to train engineers (Reynolds, 1992).

Thus, when the Morrill Act was passed the number of schools offering engineering education increased from six to seventy between 1862 and 1872 (Reynolds, 1992). However, there was not a standard for organizing college-level engineering instruction since "no public consensus existed about how engineering training should be conducted, and no public agencies or institutions had the power to promote or enforce uniformity" (Reynolds, 1992, p. 462). Historians have since concluded that engineering education was designed to serve American corporate interests "due to the invisible hand of the market that operated alongside state investments and policy in the development and governance of the U.S. system of engineering education" (Akera, 2017, p.1835).

Perhaps because of these invisible forces, engineering education went through many revisions. The Morrill Act was instrumental in providing the basic structure for engineering education as much of the curricula, standards and policies were guided by scientists and scholars (Sorber, 2018). Further curricular structure was being investigated by the Society for the Promotion of Engineering Education (SPEE, today known as the American Society for Engineering Education) which was formed as the first academic society dedicated to establishing a system of training (Akera, 2017). From 1893 to 1929, SPEE partnered with external investigators from The Carnegie Foundation for the Advancement of Teaching and AT&T, who created similar reports emphasizing the fundamentals, science, professional training, and liberal arts. However, the report from William Wickenden from AT&T, after observing the emerging system of regional accreditation for U.S. institutions of higher education, called for engineering degree programs to become accredited (Akera, 2017).

The call for accreditation was supported by state engineering license boards, however, SPEE had concerns about the idea. As such, the Engineers' Council for Professional Development (ECPD) was created. ECPD, along with delegates from SPEE and the National Council of State Board of Engineering Examiners, began the process of evaluating individual degree programs, and they allowed new engineering degree programs to apply for evaluation, resulting in "a wide array of emerging subdisciplines such as aeronautical engineering and agricultural engineering" (Akera, 2017, p. 1838). The process of accreditation continued while the American Society for Engineering Education (ASEE; formerly known as SPEE until 1946) continued to research and publish reports on engineering education.

In 1980, ECPD changed its name to the Accreditation Board for Engineering Technology (ABET, Inc.) "to more properly reflect the scope of its major activities" (Akera, 2017, p. 1840). ABET, ASEE, and other organizations like the National Science Foundation continue to collaborate on the criteria needed for the current ABET accreditation process that engineering education is known for today. The accreditation and the discipline of engineering education differs for each engineering department, so criteria are often discussed and revised to reflect the current research and societal needs. Moreover, the basic structure of engineering education continues to be deeply rooted in the Morrill Act and the "science, fundamentals, and breadth, as well as the parallel system of liberal and professional training" (Akera, 2018, p. 1838).

Synergies of Partnerships

As noted, partnerships between universities and industry have, historically, been used to enhance economic development locally, regionally and nationally (Eddy, 2010), and provide students with the knowledge and skills required by the respective industry, specifically, to enhance the employability of undergraduates and leverage resources (Nathan et al., 2013). From the university perspective, partnerships are ubiquitous. They are observable among faculty and staff, between students, alumni, community, industry, and stakeholders. The focus and establishment of partnerships vary from department and program, special initiatives, projects, funding, and student outcomes. Some partnerships are established to address the following, but not limited to: (a) effect educational reform, (b) provide regional economic development, (c) allow dual enrollment for K – 12 students or to encourage transfer between community college and four-year universities, (d) improve student learning, (c) save on resources, (d) obtain a shared goal or vision, and/or (e) create international partnerships (Eddy, 2010).

Yet, creating successful partnerships between universities and industry is a challenge. Multiple factors impact the relationship of partnerships and many partners do not recognize that partners exist in distinctive situations where roles and expectations differ (Lefever-Davis et al., 2007). Previous partnerships, objectives, goals and strategic plans, and communication all contribute to the structure of partnerships. The differences in the structural dynamics, modes of operation and strategic objectives of each of the partners contribute to the complexity of the partnership network, resulting in the possibility of the potential for conflict, tension, and power struggles. (Kruss, 2006). Additionally, individuals often serve as the initial champions for partnerships, laying the foundation of the partnership with their own connections and involvement areas of interest. It is often the faculty members who determine how the partnership will evolve (Eddy, 2010).

As the global demand for a skilled science, technology, engineering, and mathematics (STEM) workforce continues, faculty are developing partnerships with industries to better prepare students for their professional careers in STEM. The partnerships have been arranged to introduce students to the daily activities, responsibilities, and future roles as practicing professionals (Smith et al., 2018). Engineering faculty also build upon their research as they develop relationships with partners in industry. The opportunities to work with industry permit faculty to contribute to an additional transference of knowledge from academia to the industrial sector ultimately benefiting and impacting more people than just the engineering students at the University (Paige, 2005).

Industry partners also benefit from these partnerships with engineering programs because of the professional relationships built within the university, department and with the students. In fact, business and industry partnerships are common strategic initiatives that are utilized to help lower costs, increase service, and improve competitive advantage (Tuten & Urban, 2001). Coupling that with a partnership with a university, industry can benefit through access to expertise they do not have in house, aid in the renewal and expansion of their technology, put them in contact with students as potential employees, expand pre-competitive research and leverage internal research capabilities (Prigge, 2005).

With the understanding of the impact, government has increased its efforts to encourage universities to collaborate with more industry. As a result, academia has embraced the idea by participating in outreach programs to advise local businesses, collaborate on research, develop new products, and create new companies (Bok, 2013). Business and industry have increased their accessibility by hiring more interns or co-op students, and by participating in mentorship networks, mock interviews, and college industry advisory boards (Veenstra, 2014).

However, research suggests that the greatest barrier to collaboration between industry and higher education lie in a lack of understanding by the different partners of university, corporate or scientific norms and environments (Siegel et al., 2003). The ambiguity of the word ‘partner’ and ‘partnership’ leaves many institutions of higher education with questions, inconsistencies in collaborations, failed professional relationships, and missed opportunities throughout the years.

The nuances in the definition of partnership or collaboration are apparent in how the overarching objectives of the partnership frame and define the language used to describe the group process (Eddy, 2010). In fact, the word partnership is defined as “the state of being a partner” and the word partner is defined as “one associated with another especially in an action,” (Merriam-Webster, 2020). The lack of clarity hinders impactful and successful collaboration causing the already complex and intricate nature of partnerships more challenging. Better understanding of the definition of partnerships from the engineering faculty and external contributors from business and industry can result in more effective, explicit, and ultimately successful relationships and joint ventures.

Purpose Statement

The purpose of this study was to examine whether partnerships among engineering faculty at institutions of higher education define successful collaborations similarly to how business and industry define successful collaboration with engineering departments in American institutions of higher education. This research sought to identify the core set of factors necessary to establish and maintain successful partnerships between higher education and industry. Data was solicited through surveys from engineering faculty in the Minnesota State University and College system and business and industry leaders throughout the state of Minnesota.

Hypotheses

Higher education in the United States has a variety of different goals and objectives linked to the mission statements of each institution. Each department within the institution also has objectives and distinct pedagogical approaches to research, teaching and learning, that often include collaboration with external partners and stakeholders within business and industry. Yet too often the expectation and reality of the partnerships differ leaving the partnership contributors upset and reluctant to pursue additional collaborations. Thus, testing three predications between the successful definitions of partnerships between institutions of higher education in the United States, specifically, Engineering departments and industry was recommended.

Hypothesis 1. It is hypothesized that engineering faculty will identify a core set of factors necessary for successful industry partnerships.

Many of the faculty in engineering departments at institutions of higher education collaborate with industry partners. Faculty are experts in their discipline. However, faculty are not provided training, insights into the internal policies of the business or guidelines in the best approaches to engaging with partners. Therefore, it was recommended to explore how engineering faculty identify successful partnerships with their departments and industry.

Hypothesis 2. It is hypothesized that industry leaders will identify a core set of factors necessary for successful industry partnerships.

Industry leaders often look to institutions of higher education for opportunities to partner as a means for further research and development, access to recruit students, and impact the educational knowledge and training in the professional discipline. Yet, industry leaders are not aware of the internal policies, bureaucracies, or objectives of the institution or faculty member. Therefore, it was recommended to explore how industry identify successful partnerships with engineering departments and their industry.

Hypothesis 3. It is hypothesized that engineering faculty and industry leaders will identify a shared core set of factors necessary for successful partnerships.

Engineering faculty and industry leaders' partnerships can lead to significant advancement for the University, students, faculty, industry, business, and employees. The impact of a successful partnerships can fundamentally change every aspect of an institution and an industry. Therefore, it was recommended to explore how engineering faculty and industry leaders identify successful partnerships.

Significance of Research

Partnerships can fundamentally change organizations, institutions of higher education, and the people who participate in the collaborations. Yet, partnership research ranging from the core set of factors for success, the effectiveness of partnerships, and even the process for which partnerships are built have not kept pace (Bullough & Kauchak, 1997), and remain subjective to the past experiences and definitions of the collaborators. Subsequently, partnerships fail to meet expectations, relationships weaken, the collaboration ceases, and the outcomes of the partnership are lost.

In recent projection modeling, the Minnesota State Demographic's office (2020) predicts that the number of retires within the state of Minnesota will outnumber upcoming workers for the first time in Minnesota's history, which will "cause government expenditures to continue to shift away from education and toward healthcare and other support services for the aging population" (Dayton & Lee, 2020, p. 18). As history as pointed out, shifting government expenditures is common, however, the shift does result in more institutions of higher education partnering with business and industry.

Additionally, as more workers retire from the workforce, there is a growing demand for educated, prepared, and qualified employees. As this trend continues to increase, industry has become more actively involved in supporting education and providing feedback (Veenstra, 2014). Furthermore, the United States infrastructure is also ageing. The once vibrant U.S. infrastructure that built America and impacted the United States higher education system is once again in need of skilled and qualified workers, specifically, scientists and engineers to tackle complex problems and rebuild America's infrastructure (Saner, 2019).

Partnerships between higher education and industry are and will continue to be imperative, especially in engineering as innovation, research, and training remain essential for the United States. Too often, partnerships are made in an ad hoc, fragmented manner, however, understanding whether partnerships among engineering faculty define successful collaborations similarly to how business and industry define successful collaboration with engineers in American institutions of higher education begin to identify if there are a core set of factors necessary to establish and maintain successful partnerships between higher education and industry.

Definition of Key Terms

Partnerships and Collaboration. For the purpose of this study, *partnerships* and *collaboration* will be used synonymously. Mattessich & Johnson (2018) defines it as "a mutually beneficial and well-defined relationship entered into by two or more organizations to achieve common goals" (p. 5).

Engineering Faculty. Engineering faculty are defined as professional educators at four-year universities instructing students in the application of scientific principles in engineering.

Business and Industry. For the purpose of this study, *busines*s and *industry* will be used synonymously. Business and industry is defined as organizations, and companies that exist outside of the institution of higher education.

ABET. ABET is an acronym for Accreditation Board for Engineering Technology. ABET is the accrediting organization for college and university in engineering education.

STEM. STEM is an acronym for Science, Technology, Engineering and Mathematics.

ASEE. ASEE is an acronym for American Society for Engineering Education. It is an organization made up of individuals and institutions committed to advancing engineering and engineering technology education by promoting excellence in instruction, research, public service, practice, and global leadership (ASEE, n.d.).

Chapter II

Literature Review

Partnerships between higher education and industry have many parts that are specific to each collaboration. An overview of the partnerships among institutions of higher education and business and industry must be provided to understand the current state of partnerships among engineering faculty and business and industry in the United States. Specifically, the evolution of higher education and the different classifications of institutions, as well as the industrial and economic forces and the factors that have led to success in previous partnerships, must be explored in order to gain a foundation of knowledge to explore the current factors of successful partnerships between engineering faculty in higher education and industry.

This review of the literature will begin with an overview of the formation and evolution of the diverse institutional classification within higher education in the United States. The review will include a highlight of the common partnerships found between institutions of higher education and industry. Exploration of industrial and the economic forces that led to industry engagement and collaboration with higher education will then be discussed. Finally, the literature review will examine the successful factors of partnerships and collaborations from the lens of industry and higher education to clarify the importance of this research.

The Evolution and Classification of Higher Education Institutions

Higher education in the United States began in the early seventeenth century. The belief that education was essential was brought to the United States from settlers, many of whom were University of Cambridge and University of Oxford graduates. This greatly influenced the design of American higher education since "…the "collegiate system" of mixing living and learning was at the heart of the Oxford and Cambridge pedagogy, and this vision was seminal in the plan for higher education that college-founders pursued in the American colonies" (Thelin, 2011, p. 8). Their idea of education and insistence on an educated civil leadership and clergy founded Harvard College in 1636 (Thelin et al., n.d.). Shortly thereafter, additional colleges and seminaries were established focusing on educating future leaders and professionals in society (Bok, 2013). These historical and colonial colleges also became an important partner during the larger events of social and political history. During the Revolutionary War many of the college's played a large role as classrooms were transformed into "sites of legendary patriotic oratory" (Thelin, 2011, p. 1), and "dormitories were pressed into service as hospitals and barracks for troops" (Thelin, 2011, p. 1).

After the Revolutionary War, the development and expansion of the United States and higher education continued. During the first half of the nineteenth century, colleges expanded their focus to include Greek, Latin, ethics, logic and ancient history, and the sciences began to be taught, as moral science and mathematics courses emerged (Geiger, 2000). With the start of the Civil War, and the passing of the Morrill Land Grant College Act of 1862, many additional changes were beginning to emerge within higher education. Colleges in the South saw many students and faculty join in the war, depleting the student body and faculty, and by 1865, many campuses abandoned instruction due to the physical damage from battles or the campuses were once again transformed into hospitals and shelters (Thelin, 2011). Other colleges across the United States began to create new programs to provide scientific training. With the aid of the Morrill Land Grant College

Act of 1862, land grant universities began to form and focus on agriculture and engineering education to benefit the states' economies (Geiger, 2000).

At the close of the Civil War, there was a need for scientific training and competencies so employees would be knowledgeable and able to develop and manage complex tasks and processes (Sorber, 2018). This was due to the rise in America's industrialization and the growing economy. The mission of the first colleges in the United States shifted. Higher education began by modifying their goals and focus to respond to the changing demands of society and the economy. The emphasis on research and practical training emerged, as well as engagement and collaboration with business and industry.

Today, there are roughly 4,000 accredited college and universities throughout the United States (Moody, 2021) that serve more than 20 million students, and are home to 1.4 million faculty members (Bok, 2013). These institutions currently characterized by diverse goals, missions, and functions that are significantly more elaborate than the traditional goals, missions, and functions that have been historically assigned to the institution (Dereń & Skonieczny, 2016).

Colleges and universities also contribute to the economy in multiple ways (Sorber, 2018). They contribute to a skilled workforce and respond to labor market needs, but they also contribute a large amount of money to local economies. In fact, institutions of higher education exceed 400 billion dollars in combined annual expenditures (Bok, 2013). Areas that are close to institutions of higher education utilize the local workforce by providing employment for services offered on campuses. Institutions with sports or programming that draw in crowds also increases the local economy because of tourism and hospitality. Indeed, higher education institutions are viewed as critical to a state's economic and cultural development, and vital to the United States infrastructure (Thelin, 2011).

Colleges and universities are intricate organizations that emphasize different purposes and impact several facets of social and economic life. As a result of the varying purposes within universities and colleges, the Carnegie Classification framework was established (Carnegie, n.d.). The Basic Carnegie Classification framework is widely used to help recognize and describe the higher education institutional diversity in the United States (Carnegie, n.d.). The framework categorizes colleges and universities based on the type of conferred degrees (i.e., doctoral universities, master's colleges and universities, baccalaureate colleges, associate's colleges), as well as special focus institutions (i.e., faith-related institutions, engineering schools, health professions) and tribal colleges. These classifications are conducted every three years and group the universities according to program offerings and research and development expenditures (Mendenhall, 2018).

Although the Basic Carnegie Classification is valued and widely used by higher education institutions and special interest groups like the Department of Education and *U.S. News and World Report* (Mendenhall, 2018), other forms of institutional groupings can be found within Carnegie's classifications in their Custom Listings (https://carnegieclassifications.iu.edu/lookup/custom.php). The additional categories provide a constructed list of similar institutions based on classifications ranging from undergraduate instructional program, enrollment profile, community engagement, undergraduate profile, and size and setting. The added categories and classifications provide more insight into similarities among institutions (Carnegie, n.d.) and provide better understanding into the institutional needs that correlate to the types of external partnerships and collaborations that are regularly established, supported, and sought after.

The Research University

Research universities in the United States account for many partnerships between higher education and industry today. The beginning of the research university was due to the creation of the Morrill Land Grant College Act of 1862, which was an agreement that land belonging to the US government would be given to the states if proceeds from the land were used to establish colleges or later universities. The act also encouraged a focus in science, specifically, in agriculture, and engineering (Geiger, 2011). Faculty were also expected to conduct research and create outreach programs to engage with local farmers (Atkinson & Blanpied, 2008).

After the Civil War, the role of US colleges and universities expanded. Research and scientific discovery became an essential piece of the research university's foundation in the United States. Universities established after the Civil War dedicated their mission to research. Johns Hopkins University became the first research university in the United States and soon after several state universities established their credentials as leading research institutions after the turn of the century, including the universities of California, Michigan, Wisconsin, Minnesota, and Illinois (Atkinson & Blanpied, 2008).

With the start of World War I, research universities partnered with federal government laboratories to conduct scientific research. However, after the end of World War II, "American higher education rapidly expanded and became an engine of opportunity and a model for the world" (Tierney, 2021, p. 1). This was a result of the quality partnerships that colleges and universities established with government and the military during the war. “Indeed, the work that academic researchers undertook during the war led in part to the creation of agencies such as the National Science Foundation and the National Institutes of Health” (Tierney, 2021, p. 2). The partnerships illustrated how responsive and resourceful higher education was and showed the concrete ways in which government, military and higher education could work together to support the country (Tierney, 2021).

From the 1950s through the mid-1970s, federal support for academic research increased quickly. The support resulted in the creation of the American academic research system that is known today, but it also generated a decline in industrial support and industrial research collaboration (Atkinson, & Blanpied, 2008). With growing concerns as to the limited number of collaborations between academia and industry, federal agencies created programs in the 1970s to encourage university-industry research collaboration and restore the partnerships between universities and industry (Atkinson & Blanpied, 2008).

Today, industry provides more than half of the total national R&D expenditures, while the federal government provides a little over a quarter of R&D expenditures at universities (Atkinson & Blanpied, 2008). There are approximately two hundred research universities (Bok, 2013), and they are well known for their contributions to science, innovation, and advancement through their academic research. Bachelor’s degrees, master’s degrees, and doctoral degrees are conferred at research universities, but many of the research institutions are well known for producing the highest number of graduates in law and medicine. Criticism of research universities is commonly expressed regarding the lack of engagement between faculty and undergraduate students. This is seen because of institution's mission and the requirement for faculty to actively pursue and focus on academic research (Cutright, 2002). The research university operates on a substantial budget and has access to large endowments due to contributions from supporters and advocates of the academic research.

The Private and Faith-Based College and University

Private, faith-based colleges and universities date back to the very start of higher education in the United States. Harvard University, known as Harvard College at the time, was the first higher education institution in the United States (Thelin, 2011). Historically, these institutions were started with some religious affiliation and concentrated primarily on liberal arts studies, guided by missions motivated by the faith, and connected with service and community engagement (Daniels & Gustafson, 2016). However, as the demand for qualified and skilled workers took hold throughout the United States, more students looked for colleges and universities offering career preparation. Private colleges and universities had to pivot away from the exclusive liberal arts focus and offer programs to support career readiness, and practical skills and training.

Today, private institutions continue to offer strong liberal arts programs, but they also offer an assortment of academic programs to support career readiness. There are an estimated 1,660 private institutions (Moody, 2021). These institutions remain highly competitive and elite by only admitting a select number of students each year to support their offering of small class sizes to provide students with personalized attention. The private institutions are also viewed as being in distinct positions that allow "them to address social issues, engage in service to the local and global community, and to involve students, faculty and administrators in this shared purpose" (Daniels & Gustafson, 2016, p.7).

The private institutions also continue to have large engagements and financial support from their alumni. The large endowment permits private colleges and universities to be finically secure, highly successful, and competitive (Bok, 2013). Since private institutions rely on tuition, endowments, and donations rather than state taxes, an emphasis at the colleges and universities is to gain loyalty and support early from students, families, and external private stakeholders (McClure, 2019). Educational fundraising and stewardship have led to many of the private institutions having and growing substantial endowments.

The Comprehensive University

A comprehensive university is a state institution that enrolls many undergraduates and offers an array of master's degrees and sometimes a small number of doctoral degrees (Nietzel, 2019). Comprehensive institutions serve a more diverse student body terms of age, ethnicities, part-time status, first generation-college students, campus commuters, and socioeconomic background, compared to the student populations of research universities or private liberal arts colleges (Bok, 2013; Nietzel, 2019). They have broadened the opportunity to access education by lowering obstacles to admission and valuing teaching and student-focused programming over research (Orphan, 2018).

Comprehensive universities were founded as technical colleges, veterans' educational centers, or teacher colleges also known as "normal schools," (Bok, 2013). However, as education evolved, many of the universities that were in metropolitan areas began to shift their focus on the needs of the surrounding cities and communities, changing the program offerings to match employment opportunities. Today, research and service are often a focus for comprehensive universities as they work to solve problems for local public schools, businesses, and other local entities within the community (Bok, 2013).

Currently, there are more than four hundred comprehensive universities that provide “access and opportunity” to students while focusing on educating students in the communities and region where they are located. About 40% of historically black colleges and universities are also regional comprehensive universities (Orphan, 2018). Comprehensive universities account for more than 70% of all undergraduates enrolled at four-year schools (Nietzel, 2019), and they are often recognized for providing access to higher education, while supporting regional economies and civic and cultural life, (Orphan, 2018).

The Two-Year College

Two-year college refers to all institutions where the highest degree awarded is a two-year degree (Trainor, 2015). Two-year colleges can also be referred to as encompasses community college, junior college, and technical college. Community colleges were originally named junior colleges. The first junior college in America was founded in Joliet, Illinois in 1901, based on the ideas of a group of university presidents, who believed “the first two years of college are not necessarily part of a university-level education,” (Drury, 2003, p. 1). Rather, the idea that the first two years of postsecondary education should be an extension of the high school to better prepare students began to circulate among higher education institutions. Yet, the growth and adoption of community colleges was slow to start.

However, large social, political, and economic factors began to influence to development and adoption of community colleges. The most influential factor was the need for trained workers to operate the nation's expanding industries. Furthermore, society perceived education as an opportunity to create upward mobility and contribute to society. Advanced schooling was thought to benefit society, therefore, families from farms, shop owners, and other workers influenced the growth of community colleges due to pride in the creation of a college that belonged to the community and was available to all (Drury, 2003).

The Great Depression sparked an increase in enrollment at the community colleges as many young adults were unable to find work. During this time, the two-track curriculum was introduced. The two-track curriculum provided students the option to transfer to a 4-year institution or the option to remain on a terminal track, also known as a vocational track, to gain the skills and training necessary to enter the workforce upon graduation from the community college (Drury, 2003). The vocational track was created during this time with guidance from advisory committees, made up of local business representatives who discussed the vocational needs of their employees (Drury, 2003). The vocational and technical training programs included handicrafts and manual arts, as well as business, nursing, and marketing (Trainor, 2015).

Currently, there are more than one thousand two-year institutions offering studies in liberal arts, vocational and technical training programs, and courses for specific job training developed in collaboration with local employers and the two-year institution

(Bok, 2013). The institutions offer vocational training and diplomas, technical certificates, and two year programs leading to an associate degree (Ratcliff, 2021). They currently enroll over seven million students and faculty at the community college are increasingly “from industry, brining practical skills they can teach to students in vocational programs, (Bok, 2013, p. 12).

The For-Profit Institution

More than thirteen hundred schools are classified as for-profit institutions with about half of the institutions awarding colleges degrees and the other half granting certificates for completing training programs (Deming et al., 2021). The small proprietary schools that responded to the demand in the late nineteenth and twentieth centuries for vocational, technical, and applied subjects in business, managerial, and secretarial skill morphed into the for-profit institutions that exist in U.S. higher education today (Deming et al., 2012). From the 1970 to 2009, the success of the for-profit institutions grew faster than any other of higher education institution in the United States (Deming et al., 2012).

However, for-profit institutions have recently seen a decline in enrollment due to negative publicity about low graduation rates, high default rates on student loans, and recruiting misconduct (Bok, 2013). Yet, the for-profits reach a different student body as many of their typical students are often employed and looking to obtain skills to qualify and acquire a higher paying position (Bok, 2013). They also have been aggressive in their pursuit of online offerings and have focused their programming and offerings on the needs of the working adult students. The for-profits rely almost entirely on tuition payments as a source of revenue, and with only focusing on the essentials for service, rather than research, extracurricular activities and athletics, for-profits can charge competitive tuition while still gaining revenue (Bok, 2013).

Competition among Institutions of Higher Education

American higher education is an elaborate and intricate system. The institutional classifications and the varying goals present an abundance of opportunities for engagement and impact. Similarly, the varying goals and classifications present opportunity for confusion for external stakeholders, and competition among the institutions. Nonetheless, education and research have been viewed as vital to economic growth and leaders from around the world have examined the United States model of higher education in attempts to replicate their own structure of higher education (Orphan & Broom, 2021). This is because of the robust opportunities higher education offers, as well as the awareness that a country's effective higher education system produces a dominant military and is an essential piece to a strong economic global standing (Orphan & Broom, 2021). Moreover, Bok (2013) echoes the impact that colleges and universities have on innovation and economic development:

> The multitude of colleges and universities and the degree of autonomy they enjoy provide many centers of initiative and hence encourage innovation and experimentation. In recent decades, for example, this entrepreneurial spirit has led American universities to respond quickly to government encouragement by helping professors to work with business and launch companies to produce new products, sometimes fostering the economic development of entire regions, such as Silicon Valley in California and the great Boston area. (p. 22)

Yet, the ability for an institution to self-govern and select areas of research and innovation can increase stress as institutions compete against one another. With the influence of highly publicized college rankings, the number of quality students and faculty, college sports, and fundraising, many institutions “try all the harder to reach a higher rung on the ladder,” (Bok, 2013, p. 19), and advance their Carnegie classification, ranking, and overall superiority. This rivalry creates inconsistencies within the higher education system as colleges and universities respond to opportunities through a competitive lens, rather than a mission driven lens. For example, external groups could influence institutions to make choices, change protocols and/or lower standards to remain ahead of the competition (Bok, 2013).

Regardless, each university and college has their own perception of who they serve, and the role in which they play in society and the economy. Each of the institutional classifications provides a guide as to the type of engagement and partnerships certain institutions would theoretically be involved with (Bowers, 2011). However, there is nothing explicitly stated within the institutional classifications that explains the best partnerships. This lack of clarity can create additional competition within the institutions, as we all create a barrier for industry to access academia and gain valuable, and impactful partners.

Historical and Common Partnerships

Despite the lack of clarity, partnerships and collaborations between industry and institutions of higher education have been highly successful. Although, industry and institutions often have their own perceived idea of the type of partnership they are seeking when they start in development conversations regarding collaboration, successful partnerships emerge based on the foundational pieces of the common partnerships. Several forms of partnerships have been used throughout industry and higher education for many years, and often have been the start of engagement because of their historical success in collaboration. The classification of partnerships can be conceptualized within three types: (1) External Engagement (Workplace Learning), (2) Internal Engagement (Applied Learning), and (3) Research.

External Engagement (Workplace Learning)

External engagement between universities and industry is a partnership primarily occurs outside of the institution and is housed at the industry's location. The most common external engagement partnership is workplace learning. Workplace learning is based on the premise that the experiences gained at work is considered the most important aspect in all teaching and learning (Karim, et al., 2007). Industry partners with higher education institutions to host students as they gain experience at the business and engage in their work-based learning program.

The earliest form of engineering education in the United States was workplace learning through apprenticeships. Apprenticeship training was widely used in Europe to train engineers (Gordon & Schulz, 2020) and as migrants came to the United States, they sustained the European model of apprenticeship for engineering. Training with a skilled apprentice was an opportunity to cultivate new engineers, however, the United States did not have enough apprentices to educate new emerging engineers, and the education and training through apprenticeships did not support the demand for more engineers.

Today, apprenticeships still thrive in Europe. However, in the United States, apprenticeships are run much differently. Currently, apprenticeship in America is a government credentialing system for developing and recognizing specific skills, competencies, and accomplishments (Fitzpayne, 2018). Construction and manufacturing trades as well as trades, electronics, and health care are some examples of apprenticeship programs. The apprentice will make progress toward learning all facets of the target occupation. The progress is recorded and matched with the approved, written training outline that describes what functions must be learned, for how long and where (Fitzpayne, 2018).

The length of an apprenticeship varies depending on the occupation and the industry standards. Apprentices obtain wages at about half of what a trained worker receives. However, wages increase every six-months until the training is completed. “In today’s competitive global workplace, the apprenticeship model is more likely to provide well-paying jobs- sustainable careers for workers that meet employers’ needs for highly skilled, highly motivated and well-trained employees,” (Gordon & Schulz, 2020, p. 10).

The on-the-job training is conducted under close supervision of a skilled and experienced craft worker. Through the work experience, apprentices learn the practical skills needed as well as the theoretical side of their jobs in technical classes that they usually attend after work. After all phases of the training are completed a certificate of completion is provided to the apprentice (Gordon & Schulz, 2020).

The other opportunities for workplace learning differ from the apprenticeship model, as students must be enrolled in an institution of higher education in order to participate. “Work-integrated learning, particularly in the form of co-ops and internships, has been an integral part of many engineering programs” (Liu et al., 2018, p. 1). Co-ops are generally full-time employment for a student throughout a semester. Co-ops are typically offered by large corporations focused on engineering and technology and offer paid positions that range from 3 months to 12 months of dedicated work.

Similarly, internships provide students with experience working in their designated fields. The internship program requires weekly hours but provides students and the employer more flexibility, as internships require less time commitment as many students continue to take classes, are often completed over the summer months, and are paid or unpaid.

There are benefits to all forms of workplace learning. The learning is viewed as a two-way process with practical experiences and complementary campus-based education (Karim et al., 2007). Interns can remain within their communities and networks as they explore careers. Co-op students can offset some college costs by working full-time and because students have more time invested into their co-ops, “they can provide a significant contribution to an organization, which can include working on big projects- unlike interns, who only work 10 or 12 hours a week over the course of two or three days” (Boyington & Moody, 2019, p. 2).

Internal Engagement (Applied Learning)

Internal engagement occurs when industry supports university partnerships by engaging in on-campus activities that further enriches the academic learning for students and advances faculty knowledge of industry in their area of focus. Internal engagement includes, but is not limited to, participation in industry advisory boards that help inform curricular decisions, classroom guest speakers, and participation in mock job interviews. Furthermore, applied learning is a large component of internal engagement. The Victorian Applied Learning Association (2006) defines applied learning:

> Applied learning is an approach, which emphasizes the relevance of what is being learned to the ‘real world’; the world outside ‘the classroom’ and make that connection as immediate and transparent as possible. Partly as a result of this, applied learning involves students and their teachers in partnerships and connections with organizations and individuals outside school. (p. 1).

Applied learning projects are often found in engineering schools as it requires students to take the knowledge and technical skills they’ve learned in the classroom and apply it to a “real world” project. These projects help students deepen their knowledge and competencies in their areas of focus, but it also helps students to develop other skills needed to be successful in today’s workforce such as communication, teamwork and project management (Mokhtar & Duesing, 2008). Applied learning is viewed as an effective method to enrich learning. “It increases the students’ interest in the subject presented and bridges the barrier between the theory and practice” (Mokhtar & Duesing, 2008, p. 265).

In the engineering applied learning project, often referred to as capstone projects, a business provides a “real-world” experience for students to work on as their capstone project. The business also sponsors the capstone project and works with the student team through the academic year as they work to complete the project. The business project sponsor can serve as another point of contact or resource to utilize in order to effectively complete the work. This provides students with additional resources and expands their networking skills as well (Mokhtar & Duesing, 2008).

Research

The most common form of partnership and collaboration between higher education and industry is research. In fact, most of the scholarly research conducted on partnerships focus on research as the shared outcome of the collaboration. The amount of funding and interest in research and development proves the success and importance of research as the pivotal partnership in the global economic market and society.

After World War II, a large surge in federal funding for scholarly research in atomic energy, and space became available which quickly expanded graduate education in engineering schools, as doctoral students were urgently needed to work on the research projects (Edström, 2018). Engineering education in America was an applied practice and primarily taught by engineers rather than scholars. However, engineering education made a considerable shift, expanding to graduate education with a focus on research after the funding became available.

The engineering faculty prior to the war primarily held master's degrees and had engineering experience in industry:

> Doctorates were rare because experience in industry counted almost as much as formal schooling. However, after the war engineering schools "began to hire faculty who could win research grants, thus shaping a new breed of faculty members. (Edström, 2018, p. 40)

This was a formative time for engineering education in the United States as the emphasis was removed on practical engineering experience in industry for engineering faculty who could perform research and win grants. According to Edström (2018), "The engineering science enterprise became a strategy for status and a strategy for growth, and as a result, the goals shifted, ‘not to serve in industry, rather to attract federal research funds,” (p. 41). Today, research and development are large incentives for industry to partner with higher education as it increases innovation and advancement.

Industry Changes and Economic Impact

Changes within industries have demanded transformation in education because of the rapid shifts in industrial processes, innovations, and advancements. The transformations in society’s surrounding system “create changes in the complex interplay between humans and technology and transformations that result in new ways of perceiving, acting and being” (Philbeck & Davis, 2019, p.19). Historical evidence has shown institutions of higher education, although reluctant at times, respond to the changes by creating modifications within educational programs and curriculum based on the skills and knowledge required for the future workforce and the needs of the industrial sectors (OECD, 2016; US Department of Education, 2017). This is to stay competitive in the national and global market. There have been four notable industrial changes that have called for rapid response and change from educational institutions.

In the early development of education and training, the apprenticeship program model was widely used to train workers in manufacturing. This model was adopted from Europe and given that many of the settlers were from European decent, it was not surprising that this was used as their method of formal training for highly skilled work, such as engineering. However, after the United States signed new trade deals, promising large returns on investments in US production facilities, businesses rapidly began trying to apply advanced technologies to their manufacturing processes and move to large-scale production (Gordon & Schultz, 2020). The mixture of steam power and mechanical production created an increase in capacity and productivity. This led to scientific and technical pursuits (Philbeck & Davis, 2019) because the widely used apprenticeship model was unable to support the demand for highly trained and educated workers. It required new methods of training, teaching, and learning to emerge. The working class, as well as industry, insisted on new and advanced educational programming and training that included the knowledge and understanding of scientific theory in conjunction with the skills necessary for practical theoretical applications (Gordon & Schultz, 2020).

The second industrial change followed quickly with the modern belief that science and technology were the way to generate a better life (Philbeck & Davis, 2019). Standardization, technology, precision manufacturing, and new forms of public transportation brought the ideology to life. The use of science and engineering within production, and the creation of new innovations led to the public desire for goods, travel, and information (Philbeck & Davis, 2019).

After the Second World War, the discovery of the DNA double helix, the Space Race, and the development of nuclear power thrived alongside the era of information and data (Philbeck & Davis, 2019). During this time, engineering education transformed into the academic education that is known today with government funded research and used to reach practical goals for economic and societal development, and security (Edström, 2018). Computers also began to be identified as a potent tool for elaborate calculations, and rapid progress toward increasing computational power leading to a more interconnected world driving change across sectors once again (Philbeck & Davis, 2019).

Currently, there is a global industrial change occurring, referred to as the fourth industrial revolution, or Industry 4.0. It is characterized by the rise of technologies which will transform how work and life is conducted globally and within all disciplines, economies, and industries. The change is due to the rapid technological advancements, embedment of smart technologies, global reach and connection, and changes in interactions and overall relationships (Chia et al., 2019). More specifically, Industry 4.0 brings rapid progress in artificial intelligence, the Internet of Things, and the advancement of neurotechnology centered on human cognitive and physical capabilities (Philbeck & David, 2019).

As the world becomes more connected through advanced and embedded technologies, the global workforce is tasked to respond with the competencies and expertise necessary to contribute to these advancements and work within the new structures and processes. As a result, the United States economy looks to remain competitive and relevant with innovative practices, products, and strategies, calling upon higher education to respond to the needs by transforming their instruction, methodologies, and curriculum to produce a highly skilled, qualified, and workforce. The United States is currently facing labor talent shortages and the shortage is predicted to grow across many different economic sectors, including engineering, manufacturing, technology, and construction. As stated by Gresham (2013), “The American education-to-employment system is largely failing to prepare more people with the required skills to compete in this new labor market era” (p.1).

From a global perspective, engineering is no longer specific to a concentrated discipline like electrical, civil, or mechanical. Rather, engineers are expected to be globally aware, flexible, creative, and have problem solving skills, ethical standards, and communication skills, in addition to their specialized area of focus (Fomunyam, 2019), because of the rapid interconnectivity and embedment of smart technologies. Furthermore, the new era of advanced and emerging technology brings additional technical and ethical challenges to various sectors, and societies calling for more robust education throughout industrial organizations and higher education institutions (Phillbeck & Davis, 2019). As we prepare for the future, "…then education is at the heart of economic and social policy" (Brown & Keep, 2018, p. 31).

Unity and Discord within Partnerships

Partnerships and collaborations between industry and higher education have been used to improve the local, regional, national, and global economies (Eddy, 2010). Collaborations support innovations and advancements in industry and they help to ensure industrial relevance in academics (Wohlin et al., 2012). Industry is challenged to seek new methods for creating a competitive advantage with innovation and advancement while higher education institutions face decreasing budgets and are pressured to find new opportunities for funding. For both sectors, "collaboration is seen as an important method for achieving their respective objectives, as observed across countries worldwide" (Plewa et al., 2014, p. 36).

However, forming quality partnerships involves many different collaborators, factors, and objectives because of the variety of differences in the modes of operation, structural dynamics, the network of partners (Kruss, 2006). Yet, there is only limited literature on the fundamental elements that lead to successful partnerships between higher education and industry. As such, partnerships and collaborations have many layers to their intricate web of functionality, and scholars have only begun to scratch the surface on the factors and key building blocks that create successful collaborations. Nonetheless, the knowledge that researchers have revealed lays the foundation for this study and will be discussed in the following sections.

Shared Success Factors between Industry and Higher Education

Similar success factors for industry and higher education are very common, as much of the research indicated similar findings. The literature cites the importance of the past experiences in collaborations and partnerships with industry. The positive results of previous partnerships and the overall feelings of satisfactory relationships removes the barriers for higher education and industry to establish more partnerships (Kim et al., 2017). The previous partnerships also help to establish trust, which is cited throughout the literature as a large contributor to successful partnerships.

Furthermore, communication is linked to both industry and higher education as a factor leading to success. The communication between two contributors of a partnership impacts the trajectory of the partnership and the progress. With successful and transparent communication, trust is built, and as mentioned previously trust is vital to positive long-term partnerships between higher education and industry (Kim et al., 2007). Due to successful communication, partnerships and the collaborative work progresses by obtaining the specific stated goals while also creating a better experience for future and long-term partnerships to occur (Kim et al., 2007).

In order to create an effective partnership, the literature suggests acknowledging the past partnership experiences to build trust. Once this has been done, the two entities can complete a joint strategic plan during the early partnership establishment phase and establish clear communication. (Tener, 1996). The invitation to have both higher education and industry discuss the strategic plan and determine the best options to get from planning to execution and reach the goals of each contributor requires communication and trust to be at the forefront of the partnership from the beginning. By completing a strategic plan together, the first experience of the partnership has been established and hopefully with a positive outcome. This reinforces the key factors of success for the partnership from the beginning (Tener, 1996).

Success Factors from Industry.

There are several reasons why industry decides to collaborate with higher education. Opportunities for funding and grants, access to advanced research and development, accessibility to scientific knowledge and competency, world-class scholars, connections to students and potential future employees, marketing, the acquisition expanding networks and expediting the product development process to become more competitive and even fulfilling philanthropic duties, are just a few of the many reasons why industry may decide to develop a partnership (Dooley & Kirk, 2007). Industries often view the factors of a successful partnership differently than the way their partners in higher education perceive their success regardless of how they enter the collaboration with shared goals.

According to Rybnicek & Königsgruber (2018), the pre-planning process for industry prior to entering a partnership is an important piece in establishing the foundations of success. The pre-planning process consists of a series of questions to help inform the decision to either engage in the partnership or look for another opportunity. The first question is whether the industry needs to be involved in the partnership (Rybnicek & Königsgruber, 2018). As Pertuze et. al. (2010) states, “Managers see working with academia as beneficial only to the extent that it advances the company towards its goals" (p. 1). Opportunity for financial support through grants, and as well as access to college and university experts in the field, and access to future graduates for the future of the company's workforce are all factors that can lead to the decision to engage in the partnership. Access to highly skilled personnel and employment of graduates from universities has been cited as a major benefit of university industry linkages (Rybnicek & Königsgruber, 2018).

The determination and explicit understanding of what needs will be met helps to ensure that the objectives of the project are realized and matched properly with the industry's requirements is the second question to consider for industry during the pre-planning process (Rybnicek & Königsgruber, 2018). It is during this time that the company is also evaluating their requirements and what needs to be done before entering the partnership from their side. The third question in pre-planning for industry, as noted by Rybnicek & Königsgruber (2018) is a consideration of the obligations for the company and the future commitments that they may face with their higher education partners. This is important as it creates a timeline for the lifespan of the partnership.

Moreover, once the pre-planning process is complete and the goals and motivation of the partnership is established for the industry it is important to have the right project managers in charge of the partnership. Research indicates the placement of the right people in charge are critical to making a successful partnership. "In every organization, there are certain individuals who naturally engage in networking activities, maintaining relationships that cross organizational lines" (Pertuze et al., 2010, p. 5). These partnership champions help to manage the acquired knowledge, disseminate information and helps to inform the organization how it benefits from the collaboration.

This is a crucial role for industry as they have the responsibility to facilitate knowledge with higher education and their company while directing contributing to the success of the partnership (Pertuze et al., 2010).

A notable study conducted by a group of researchers from the professional association, the Institute of Electric and Electronic Engineers (IEEE) Software (Wohlin et al., 2012), explored how the software industry in Sweden and Australia viewed success with higher education partnerships. Their research found that industry focuses more on the collaboration results, the meetings and overall engagement with the institutions, and the amount of trust that was built (Wohlin et al., 2012). Additionally, their research revealed that software industries in Sweden and Australia do not regard the actual research environment as importance as their counterparts in higher education, and the higher education partner, “must be committed to contribute to the industry need,” (Wohlin et al., 2012, p. 72).

Success Factors from Higher Education.

There are numerous partnerships established between higher education and industry which results in partnership that vary greatly. However, research has uncovered some similar factors that lead to success as perceived by higher education, as well as specific institutional factors of success.

There are many benefits for a university to participate in a partnership which include access to funding, space, proprietary technology, status, and validation of research in a timely manner (Dooley & Kirk, 2007). Participation provides access to a large network of experts. A network makes the formation of relationships easier and has a positive influence as the start and set-up of the collaboration, but it has been found to have limited impact on the long term development of the partnership (Thune & Gulbrandsen, 2014). Regardless, the network creates an accessible pathway for higher education institutions to connect with potential partners and gain access to additional contributors based on the type of partnership and objectives been sought.

The professional engineering experience of the engineering faculty outside of academia or the engagement with professional engineers contributes to the interest in establishing additional industry partnerships as they educate future engineers (Schell & Kauffman. 2016). Faculty that has a great understanding of the industrial needs of the profession either by spending time working as a professional or engaging deeply with working professionals see the importance of partners as it would benefit the students to engage with working professionals. Additionally, the faculty also understand the industry perspective when creating an effective partnership. This help to lead to successful partners because of the ability of the faculty to see both perspectives of the partnership (Tener, 1996)

The direct impact on the students and the long-term success of the students' education is a leading factor to successful partnerships. The literature addresses this and stresses the importance of the partnerships impact on the students.

> Exposure to industry professionals enhances student learning by providing them with new forms of knowledge and hands-on experiences that complement the theoretical concepts delivered in the classroom and by enhancing their practical skills. (Smith et al., 2018, p. 1)

As higher education institutions identify factors of successful partners, the direct link between the impact on the students and their success is viewed as an important factor to measure the success of a partnership.

In 2005, the Rose-Hulman Institute of Technology's Department of Civil and Environmental Engineering successfully established an array of complex partnerships (Plewa et al., 2015). This was due to the learning and development that the students experienced during their work participating in a global, capstone design course. During the capstone design, they were exposed to international design codes, standards, and local construction practices to better prepare the students for global careers. In order to successfully complete this work, complex partnerships were leveraged by the university and industry to work across cultures and work through the policies of each country's government to determine and shape the nature of the study and realities of the experience (Plewa et al., 2015).

Shared Challenges between Industry and Higher Education

Education and industry have long been criticized by both scholars in higher education and engineering practitioners. Edström (2018) states:

> Within the institutions, the academic and professional values can be seen competing in the allocation of resources, power, and status, not least in the appointment and promotion procedures. The tension is also present in many practical decisions concerning the curriculum, in the classrooms, and in the assessment of students learning. Hence, it is a dilemma with practical consequences for all stakeholders, e.g., students, faculty, society, and industry. (p. 39)

Nevertheless, there are many similar challenges industry and higher education face when embarking on partnerships. As noted, the diverse classifications of institutions of higher education, the large sizes of the institutions and the various initiatives in different departments within institutions themselves create challenges for industry looking to begin a partnership.

> Today many campuses – especially large public universities – are characterized by a constellation of independent principalities and fiefdoms, each disconnected from the others and from any common institutional purpose or transcending value. It is not uncommon for student affairs' divisions, colleges and schools to be quite autonomous with different foci, priorities and expectations for staff, faculty and students. (Schroeder, 1999, p. 17)

Similarly, the different cultures of the industrial organization can impede perceived success by institutions of higher education. The two sectors operate on different timelines, have different goals they want to accomplish and often have different value systems. Discovering the appropriate balance to satisfy both sectors in a collaboration is a big challenge while creating partnerships (Dooley & Kirk, 2007). This barrier to success is seen throughout the literature as the differences in organizational and institutional cultures, as well as misidentified information and cultural barriers creates additional challenges for success (Kim et al., 2017).

A sizeable barrier that both higher education and industry face is the challenge of effectively evaluating partnerships. There is not a simple evaluation method when discussing partnerships between higher education and industry. This is due to the varying factors that create the partnership as well as the goals and outcomes specific to each partnership.

> Colleges and universities are deeply engaged in endeavors that can be very hard to evaluate. In particular, changes in the quality and effectiveness of educational programs are difficult to perceive except over a period of years and many may not be evident even then. (Bok, 2013, p.23)

Research-based partnerships are able to see results faster than other partnerships. “Much better information is available about the quality of the university’s research, since the results are published and usually evaluated by other experts in the field,” (Bok, 2013, p. 23). However, the evaluation not always effective in measuring the needs of the industry or higher education partner.

Challenges for Industry.

The challenges industry face is different from those higher education experience. The industrial organizations have very robust structures and organizational cultures that are rooted deeply into the organization. Industry who wants to pursue a partnership emphasizes the need for buy-in and support from company management and leadership more than academia does (Wohlin et al., 2012). Unfortunately, higher education does not always understand the importance of management and leadership support when launching collaborative projects.

Furthermore, it is critical for the industry management and leadership teams to recognize the contribution that higher education will provide by participating in the partnership. Researchers must be committed to contribute to industry needs. For example, an industry partners who chooses to partner with higher education because they are interested in technological development perceive “the main challenge is how to manage such that the engineering firm can benefit the most from collaborative R&D,” (Johnson, 2007, p. 12). Gaining support from the right individuals in the company while also proving the benefit to the company is an important factor that can be challenging for industry when partnering with higher education (Wohlin et al., 2012).

Another impeding factor is the ownership of intellectual property and the division of revenue amongst the collaborators in a partnership. Disagreements are common regarding the ownership as often industry claim the intellectual property from the university partner is over-priced. Industry also faces concern that the universities ignore the increased risk industry faces while commercializing products (Dooley & Kirk, 2007).

The literature indicates there are obstacles in building collaborations focused on applied projects and curriculum. The challenge industry faces is the lack of communication between professors and the overall “lack of industry friendly professors” (Kim et al., 2017, p. 55). Industry also struggles when higher education is not able to identify real problems faced by industry and the facilities are not properly set up for industry needs (Kim et al., 2017). The nuances in the development of applied partnerships can cause industry to become disinterested in establishing and progressing in a partnership.

A common and frequent concern presented by industry is the allocation of resources and time to create and sustain effective partnerships. Although the literature indicates there is a return on investment and the importance of a dedicated partnership champion, industry continues to remain unclear about the actual return on investment and the best use of their employee’s time. This is because many of the projections and models provide contrary evidence due to the lack of knowledge and input of partnership details (Gresham, 2013).

Challenges for Higher Education.

The challenges for higher education institutions to partner with industry range from the working relationships within the partnership to the collaborative outcomes to the impact on students. As with most intricate institutions, the complexity of the internal structures combined with the external partners create barriers to overcome.

Although institutions of higher education are large and complex organization, industries operate differently than that of higher education. As higher education engages with industrial organizations, they must adopt their strategies in response to their external partners. These changes can result in the level of interaction between university and industry either increasing or decreasing in importance. Since much of the academic research is long-term in nature, instability and high-turnover in industry can cause difficulties for the university in planning for the future (Dooley & Kirk, 2007). These difficulties stem from new leadership, a lack of commitment or even a different strategic plan and initiative for engagement with higher education.

The collaboration between industry and higher education in working together to update curriculum and programs to speak to the needs of the emerging and changing industry creates challenges for higher education. While curriculum design is understood at a very high level by industry, the ability for industry to assist effectively in this area remains challenging (Plewa et al., 2015). This is because the expertise of instructional design is often not part of the industrial professional skill set. Rather, the industry remains the expert in the need of industry and as a working professional and the faculty remain the expert in instructional design and teaching (Plewa et al., 2015).

Higher education also faces challenges in the design of applied projects and curriculum. Their challenges differ from those expressed by industry. The reluctance to contribute financially, and the absence of the importance of attending educational programing is a deterrent for partnership. More pressing, however, is the perception that industry questions the education programing formed by the university (Kim et al., 2017). The questioning of the education of the programming creates a large hinderance in the formation or progression of the partnership, as once the institution's programming is questioned, faculty become detached and dissociated with industry because of the offensiveness of the question (Kim et al., 2017).

Research partnerships brings another set of challenges for success. The impeding factors of intellectual property and the division of revenue amongst the collaborators in a research partnership is tricky. As university partners develop innovative ideas, some may fear that industry may steal their discoveries and generate revenue streams that rightly belong to the university (Dooley & Kirk, 2007). Additionally, as with research partnerships, there are numerous studies that discuss the concern for educating students when it comes to partnerships in research. Far too often, faculty are preoccupied with the research and the goals of the partnership that teaching begins to suffer and ultimately hurt the engineering student (Edström, 2018).

Furthermore, there have been concerns over the involvement of private industry in academia, as well as more direct commercialization initiatives taken by research universities. The main concern was that relations with industry would corrupt the fundamental knowledge creation and transmission functions of universities. More directly: there have been concerns that research universities might become “job shops” for industry. (Aktinson & Blanpied, 2008, p. 41)

However, as noted earlier, the fundamental mission of a research institution is to create broad research where results are published in open scientific literature. Some instances have occurred when research universities partnered with industry and were funded to conduct research, however, “universities and their industrial partners appear to have been prudent in recognizing g that although academia and industry have different goals, they can arrive at common ground in research cooperation” (Aktinson & Blanpied, 2008, p. 41). Nonetheless, this concern can create barriers and challenges if industrial partners are not able to recognize the fundamental mission of the institution.

Summary

Partnerships among higher education and industry continue to remain intricate and complex. Although there exists a large amount of research conducted on these partnerships, the research fails to identify the overall elements of success (Czajkowski, 2006). As Kim et al. (2017) state:

> The literature on industry-university cooperation has mainly focused on uncovering types of collaboration between universities and companies and offers relatively little explanation on success factors of ways to reduce barriers in collaborations. (p. 54)

Nonetheless, the history and evolution of the American higher education system allows for several different partnerships between industry as each institution and industry seeks to obtain their objectives. Additionally, the rapid and constant changes within industrial sectors and economies provides evidence of the need for more understanding of successful partnerships between the workforce and academia to replicate and remain relevant in the global economy.

Finally, the literature provides a foundation for the core factors of success for partnerships between higher education and industry. With the extensive literature, it can be concluded that there are a number of similarities and differences in how higher education and industry view the factors that lead to success and the factors that create barriers to success. For example, trust, communication, and past experiences were all expressed to be importance factors contributing to the partnership. Additionally, the importance of the right person and the knowledge of the partnership's objectives are key to creating a successful partnership.

Chapter III

Method

As innovation, research, training, collaboration, and advanced infrastructure grow throughout the world, partnerships between higher education and industry within the United States will continue to be imperative to remain viable throughout the Fourth Industrial Revolution and beyond (Fomunyam, 2019; Philbeck & Davis, 2019). Many of the innovations and advancements within society call upon engineering advanced knowledge, skills, and industrial awareness. Therefore, the purpose of this study was to determine if there are a core set of factors necessary for successful partnerships between higher education engineering faculty and engineering business and industry. Accordingly, three hypotheses were tested:

Hypothesis 1. It was hypothesized that engineering faculty would identify a core set of factors necessary for successful industry partnerships.

Hypothesis 2. It was hypothesized that industry professionals would identify a core set of factors necessary for successful academia partnerships.

Hypothesis 3. It was hypothesized that engineering faculty and industry professionals would identify a shared core set of factors necessary for successful partnerships.

Subjects

The subjects for this study were comprised of engineering faculty and business and industry professionals. Engineering faculty were recruited from 5 state universities across the Minnesota State system. Although there are a total of 7 state universities within the Minnesota State University and College System, only 5 offer degree programs in engineering disciplines. Since engineering is a very board discipline, subjects were only selected from programs that award a Bachelor of Science or a Bachelor of Applied Science with a focus area in either civil engineering, electrical engineering, mechanical engineering, manufacturing engineering, engineering technology, or integrated engineering. For the purpose of this study, faculty were defined as anyone with the title of (a) professor, (b) associate professor, (c) assistant professor, (d) fixed-term, (e) facilitator, or (f) adjunct. This classification allowed the research to give a broad perspective of partnerships from faculty with varying years of experience. There were 109 engineering faculty across the 5 state universities who were asked to participate in this study.

Business and industry professionals were managers and directors from engineering businesses throughout the state of Minnesota. Based on data from the American Council of Engineering Companies in Minnesota (ACEC), there are over 7,000 engineers employed throughout Minnesota (www.acecmn.org). For the purpose of this study, business and industry professionals were selected from medium to large companies. This meant the business employed more than 100 people at the time of the study. Selecting medium to large companies mirrored higher education's large, and complex system. Furthermore, the business and industry leaders were defined as anyone with the title of (a) engineering manager, (b) engineering director, (c) engineering supervisor, (d) senior engineer, or (e) lead engineer.

Measures

Subjects were requested to complete an online survey confidentially administered via Qualtrics (www.qualtrics.com). The survey asked subjects demographic and empirical items. Demographic items included: (a) organization (four-year university or business/industry), (b) number of years in the position, (c) number of years at the current organization, (d) area of focus or expertise (e.g. electrical engineering, mechanical engineering), (e) age, (f) race, and (g) gender.

Participants were then be requested to complete the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018) to identify successful factors for collaboration and professional partnerships. The *WFCI* assessment considers 22 successful collaboration factors that are grouped into 6 categories: (a) environment, (b) membership characteristics, (c) process and structure, (d) communication, (e) purpose, and (f) resources. On the assessment, there were 1-3 questions for each of the 6 categories. In entirety, the assessment was comprised of 44 questions directly associated with the 22 successful collaboration factors (see Appendix A).

A version of the *WCFI* was developed in 1915 to promote collaborations among community-based organizations (Jarchow, 1981). In 1992, it was updated and expanded upon by the Wilder Amherst Foundation with a literature review resulting in 19 factors influencing successful collaboration (Mattessich & Monsey, 1992). At the start of the twenty-first century, researchers sought to review new research to determine the validity of the earlier editions' success factors and to provide examples of the factors, based on experiences of organizations during the 1990s (Mattessich et. al., 2001). The third, and current, edition of the *WCFI* addresses the changes in who the partners are within collaborations due to technological advancements and the diminished locational constraints, providing more opportunities for collaborations with diverse populations and international organizations (Mattessich & Johnson, 2018). The third edition adds the new perspectives while also providing a "how-to" guide to help evaluate and implement the success factors in professional collaborations.

The *WCFI* has been validated and widely used as a measure of factors contributing to successful collaborations within groups working together and building partnerships (Bunger et.al., 2020; Crandal et.al., 2019; Czajkowski, 2006; Derose, 2004; Dillahunt-Aspillaga et. al., 2020; Estabrooks, 2021; Fox, 2020; Hargreaves et. al, 2020; Howard, 2020; Gillam et. al, 2016; Marek, et.al, 2014; Orzech, et. al., 2020; Perrault, 2008; Sarmiento-Marquez et. al., 2021; Townsend & Shelley, 2008; Wells et.al, 2021; Winters et. al., 2020). Mattessich, Murray-Close and Monsey's 2001 validated the factors from the first edition as participants identified the same factors originally presented by Mattessich and Monsey in 1992. The validity was established by an initial pilot test and a Cronbach's alpha test of the revised *WCFI*. Furthermore, a study conducted by Dillahunt-Aspillaga et. al. (2020) confirmed the reliability of the *WCFI* by utilizing Cronbach's alpha coefficient to measure the internal consistency of the questions by determining the extent in which respondents answered similar items consistently. "The majority of inventory domains had alphas approaching or exceeding .80, indicating high internal consistency and reliability…" (Dillahunt-Aspillaga et.al., 2020, p. 75).

Procedure for Data Collection

Prospective subjects were recruited from the Minnesota State system's website directory, online business directories and through engineering organization's website directories and outreach (i.e., ACEC, National Society of Professional Engineers, Institute of Electrical and Electronics Engineers). Subjects were recruited via e-mail inviting them to participate in the study (see Appendix B). The e-mail had a link to an online survey using Qualtrics (www.qualtrics.com).

The survey began with an informed consent statement (see Appendix C). After subjects indicated their consent to participate, they were directed to the demographic questions (see Appendix D) and requested to complete the *Wilder Collaborations Factors Inventory (WCFI*; Mattessich & Johnson, 2018). The engineering faculty subjects were asked to respond to the *WCFI* assessment using their lens as an engineering educator and they were asked to reflect on their experiences, knowledge, and engagement with business and industry partners. Similarly, subjects from business and industry were asked to respond to the *WCFI* assessment using their lens as a leader in business and industry. They were asked to reflect on their experiences, knowledge, and engagement with institutions of higher education.

Procedure for Data Analysis

Data was collected within Qualtrics (www.qualitrics.com) and all statistical analyses was conducted via JASP (www.jasp-stats.org). Demographic data was used to identify the characteristics of the respondents. Rank order analysis was used to test faculty perceptions (Hypothesis 1), industry perceptions (Hypothesis 2) and both faculty and industry perceptions (Hypothesis 3). An independent t-Test was also used to test Hypothesis 3 to determine if there was a significant difference between the perceived core factors for faculty and for industry. Finally, a factor analysis was used to further examine faculty and industry responses to identify agreement among collaboration factors that might suggest targets for intervention.

CHAPTER IV

Results

Demographic Characteristics

Subjects for this study were comprised of engineering faculty and business and industry leaders. The engineering faculty was recruited from 5 state universities across the Minnesota State system since only 5 of the 7 state universities within the Minnesota State University and College System offer degree programs in engineering disciplines. For the purpose of this study, faculty was defined as anyone with the title of (a) professor, (b) associate professor, (c) assistant professor, (d) fixed-term, (e) facilitator, or (f) adjunct. This classification allowed the research to give a broad perspective of partnerships from faculty with varying years of experience. There were 109 engineering faculty across the 5 state universities who were asked to participate in this study.

The business and industry leaders recruited for this study were managers and directors from engineering businesses throughout the state of Minnesota. Based on data from the American Council of Engineering Companies in Minnesota (ACEC), there are over 7,000 engineers employed throughout Minnesota (www.acecmn.org). For the purpose of this study, business and industry professionals were selected from medium to large companies that employ more than 100 people. The selection of medium to large companies mirrors the large and complex system of higher education and provides a robust pool of diverse subjects. The business and industry leaders were defined as anyone with the title of (a) engineering manager, (b) engineering director, (c) engineering supervisor, (d) senior engineer, or (e) lead engineer.

A total of 26 engineering faculty and industry professionals responded to the request to participate in this study. All reported their ethnicity as white, and the average age of respondents was 43 years old (SD = 11.82). Of the subjects, 9 subjects reported their gender as female and 17 reported their gender as male. The average subject occupied their current professional position for 9 years (SD = 8.05) and had been working at their current organization for 7 years (SD = 5.12).

There were 14 engineering faculty who responded to the survey, of which 8 selected their role in higher education as “other,” writing in the title of “facilitator” or “director.” The other roles selected were 6 as “professor,” 2 selected “associate professor,” 5 selected “assistant professor,” and “fixed-term professor” and “adjunct professor” received 1 selection each. The engineering faculty reported to have occupied their current position for a mean of 7 years (SD = 6.72 years) and to have been at the same institution for a mean total of 7 years (SD = 5.66 years).

There were 12 industry professionals that responded to the survey, of which “vice president,” “manager/supervisor,” and “other” were selected 3 times each, followed by the selection of “consultant,” and “director/principal” 2 times each. The industry professionals reported to have occupied their current position for a mean of 11 years (SD = 9.04 years) and to have been at the same organization for a mean total of 8 years (SD = 4.60 years).

Core Factors Identified by Engineering Faculty

Subjects were requested to complete the *Wilder Collaboration Factors Inventory (WCFI;* Mattessich & Johnson, 2018) to test the hypotheses of the present study. The *WCFI* requires subjects to rate their perceptions of successful collaboration factors by answering 44 questions that are grouped into 6 categories: (a) environment, (b) membership characteristics, (c) process and structure, (d) communication, (e) purpose, and (f) resources.

It was hypothesized that engineering faculty would identify a core set of factors necessary for successful industry partnerships. The engineering faculty rank order of the *WCFI* factors were essentially equivalent across the factors. The factor *Purpose* ranked the highest with engineering faculty (M = 4.07, SD = 0.62), closely followed by the factor of C*ommunication* (M = 4.01, SD = 0.51), and the factor of *Environment* (M = 4.00, SD = 0.55). The remaining three factors had average scores under 4, however, they remained closely ranked. The factor *Membership Characteristic*s (M = 3.92, SD = 0.75), the factor *Process and Structure* (M =3.70, SD = 0.59), and the factor ranked last was *Resources* (M = 3.52, SD = 0.61). The engineering faculty's rank order indicated slight variation across the 6 categories of collaboration factors (see Table 1). This implies engineering faculty from this sample valued three factors as potential "core" factors.

Table 1

Engineering Faculty Rank Order of Wilder Factors

Core Factor	*n*	*M*	*SD*
Purpose	14	4.07	0.62
Communication	14	4.01	0.51
Environment	14	4.00	0.55
Membership Characteristics	14	3.92	0.75
Process and Structure	14	3.70	0.59
Resources	14	3.52	0.61

Core Factors Identified by Industry Professionals

It was hypothesized that industry professionals would identify a core set of factors necessary for successful academia partnerships. The industry professionals rank order of the *WCFI* factors were essentially equivalent within each factor. Unlike the engineering faculty rank order, each of the industry factors had notable lower mean scores between 3.87 and 3.50. The factor *Purpose* ranked the highest for industry professionals (M = 3.87, SD = 0.40), closely followed by the factor of *Environment* (M = 3.86, SD = 0.53). The factor of *Membership Characteristics* (M = 3.75, SD = 0.43), the factor *Communication* (M = 3.68, SD = 0.72), the factor *Process and Structure* (M = 3.62, SD = 0.57), and finally the factor of *Resources (M* = 3.50, SD = 0.78). The industry professional's rank order indicated no statistical difference across the 6 categories of collaboration factors (see Table 2). This implies industry professionals may perceive all six factors as "neutral" factors.

Table 2

Industry Professionals Rank Order of Wilder Factors

Core Factor	*n*	*M*	*SD*
Purpose	12	3.87	0.40
Environment	12	3.86	0.53
Membership Characteristics	12	3.75	0.43
Communication	12	3.68	0.72
Process and Structure	12	3.62	0.57
Resources	12	3.50	0.78

Shared Core Factors Identified by Engineering Faculty & Industry Professionals

It was hypothesized that engineering faculty and industry professionals would identify a core set of factors necessary for successful partnerships. The data indicated no clear statistical difference within each of the core factors of successful partnerships identified by engineering faculty and industry professionals (see Table 3). Among the six categories of factors, engineering faculty and industry professionals both ranked *Purpose* first with Engineering (M = 4.07, SD = 0.62), and Industry (M = 3.87, SD = 0.40), the second factor for faculty was *Communication* with Engineering (M = 4.01, SD = 0.51), and Industry (M = 3.68, SD = 0.72), the *Environment* factor was Engineering (M = 4.00, SD = 0.55), and Industry (M = 3.86, SD = 0.53), *Membership Characteristics* factor was Engineering (M = 3.92, SD = 0.75), and Industry (M = 3.75, SD = 0.43), *Process and Structure* factor was Engineering (M = 3.70, SD = 0.59), and Industry (M = 3.62, SD = 0.571), and the final factor, *Resources* was Engineering (M = 3.52, SD = 0.61), and Industry (M = 3.50, and SD = 0.78).

Table 3

Core Factors Identified by Engineering Faculty and Industry Professionals

Core Factor	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Purpose	4.07	0.62	3.87	0.40
Environment	4.00	0.55	3.86	0.53
Membership Characteristics	3.92	0.75	3.75	0.43
Communication	4.01	0.51	3.68	0.72
Process & Structure	3.70	0.59	3.62	0.57

Table 3 (continued)

Core Factors Identified by Engineering Faculty and Industry Professionals

Core Factor	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Resources	3.52	0.61	3.50	0.78

Further analysis of the engineering faculty and industry professionals' data indicated the data were not statistically different (see Table 4).

Table 4

Independent Sample t-Test for Shared Core Factors between Engineering Faculty and Industry Professionals

Core Factor	t	df	p
Environment	0.65	24	0.52
Membership Characteristics	0.68	24	0.50
Process & Structure	0.36	24	0.73
Communication	1.38	24	0.18
Purpose	0.97	24	0.34
Resources	0.07	24	0.95

The engineering faculty responses and industry professional responses to each of the individual questions within the six core factor categories were further analyzed (see Table 5). Results indicated no statistical difference between faculty and industry on any of the items of the WCFI. This implies that engineering faculty and industry professionals "agreed" and were "neutral" to each of the factors as potential "core" factors for successful partnerships.

Table 5

Factor Analysis of Collaborations Among Engineering Faculty and Industry Professionals from the Wilder Collaboration Factors Inventory

WCFI Item	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Factor 1: Environment				
Item 1	4.07	0.73	3.83	0.84
Item 2	4.14	1.03	3.75	1.14
Item 3	4.27	0.61	3.92	0.90
Item 4	4.07	0.73	3.75	0.75
Item 5	3.57	1.09	4.17	0.39
Item 6	3.86	0.86	3.75	1.14
Total	4.00	0.55	3.86	0.55
Factor 2: Membership Characteristics				
Item 7	4.14	0.95	4.08	0.67
Item 8	4.43	0.65	4.08	0.52
Item 9	3.71	1.14	3.75	0.62
Item 10	3.21	1.05	2.83	0.94
Item 11	4.29	0.73	4.42	0.52
Item 12	3.71	0.91	3.33	0.88
Total	3.92	0.75	3.75	0.43

Table 5 (continued)

Factor Analysis of Collaborations Among Engineering Faculty and Industry Professionals from the Wilder Collaboration Factors Inventory

WCFI Item	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Factor 3: Process & Structure				
Item 13	3.71	0.73	3.42	0.67
Item 14	4.21	0.89	4.42	0.52
Item 15	3.79	0.80	3.42	0.90
Item 16	3.34	0.85	3.75	0.45
Item 17	3.43	0.85	3.33	0.89
Item 18	3.86	0.66	4.08	0.79
Item 19	3.71	0.83	3.67	1.07
Item 20	3.93	0.83	3.42	0.90
Item 21	3.71	0.73	3.00	0.85
Item 22	3.86	1.23	3.67	0.89
Item 23	3.23	0.73	3.75	0.62
Item 24	3.36	1.08	3.50	0.80
Item 25	3.86	0.66	3.75	0.62
Item 26	3.50	1.09	3.33	1.23
Item 27	3.27	1.00	3.68	1.07
Item 28	3.64	0.93	3.75	1.06
Total	3.70	0.43	3.62	0.57

Table 5 (continued)

Factor Analysis of Collaborations Among Engineering Faculty and Industry Professionals from the Wilder Collaboration Factors Inventory

WCFI Item	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Factor 4: Communications				
Item 29	3.93	1.00	3.92	1.00
Item 30	3.71	0.83	3.67	0.89
Item 31	3.93	0.62	4.08	0.90
Item 32	4.21	0.43	3.50	1.29
Item 33	4.29	0.61	3.25	1.29
Total	4.01	0.51	3.68	0.72
Factor 5: Purpose				
Item 34	4.29	0.83	4.00	0.85
Item 35	3.79	0.89	3.92	0.67
Item 36	3.86	1.10	3.58	0.79
Item 37	4.29	0.61	4.30	0.45
Item 38	3.79	0.98	3.92	0.52
Item 39	4.23	0.51	4.17	0.58
Item 40	4.07	1.21	3.25	1.10
Total	4.07	0.62	3.87	0.40
Factor 6: Resources				
Item 41	3.00	1.18	3.08	1.08

Table 5 (continued)

Factor Analysis of Collaborations Among Engineering Faculty and Industry Professionals from the Wilder Collaboration Factors Inventory

WCFI Item	Engineering Faculty		Industry Professionals	
	M	*SD*	*M*	*SD*
Factor 6: Resources				
Item 42	3.43	0.76	3.42	0.90
Item 43	4.14	0.66	3.83	1.03
Item 44	3.50	1.02	3.67	0.99
Total	3.52	0.61	3.50	0.78

Overall, the results from the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018) indicated that each of the factors were considered core for successful partnerships among higher education and industry. The two subject groups also shared strong agreement on the rank order of factors. This indicated that each group perceived the importance of the specific factors, such as *Purpose* and *Environment*, with a stronger emphasis on the importance for successful partnerships.

CHAPTER V

Discussion

Partnerships and collaborations among higher education and business and industry have a long and rich history within the United States. Many partnerships have emerged between universities and industry yielding positive outcomes with advancements in the economy, education and training, humanity and in the organizations with shifting culture, structures and perceptions for universities and industry alike. Historically, partnerships have been used to enhance economic development locally, regionally, and nationally, and provide students with the knowledge and skills required by the respective industry, specifically to enhance the employability of undergraduates and leverage resources (Nathan et al., 2013).

From the university perspective, partnerships are omnipresent. They are observable throughout the various groupings in academia and the objective of each partnership vary from department and program, special initiatives, projects, funding, and student outcomes. Common partnerships in higher education have been created to address the following: (a) effect educational reform, (b) provide regional economic development, (c) allow dual enrollment for K-12 students or to encourage transfer between community college and four-year universities, (d) improve student learning, (c) save on resources, (d) obtain a shared goal or vision, and/or (e) create international partnerships (Eddy, 2010).

From the business and industry perspective, partnerships are commonly utilized as strategic initiatives to help lower costs, increase service, and improve competitive advantage (Tuten & Urban, 2001). Industry can benefit from partnerships with universities through access to expertise they do not have in house, aid in the renewal and expansion of their technology, put them in contact with students as potential employees, expand pre-competitive research and leverage internal research capabilities (Prigge, 2005). The new era of advanced and emerging technology has brought forth additional technical and ethical challenges to a variety of sectors, and societies calling for more robust education throughout industrial organizations and higher education institutions (Phillbeck & Davis, 2019). As we prepare for the future, "…then education is at the heart of economic and social policy" (Brown & Keep, 2018, p. 31).

However, forming quality partnerships involves many different collaborators, factors, and objectives because of the variety of differences in the modes of operation, structural dynamics, the network of partners (Kruss, 2006). There is only limited literature on the fundamental elements that lead to successful partnerships between higher education and industry. As such, partnerships and collaborations have many layers to their intricate web of functionality, and scholars have only begun to scratch the surface on the factors and key building blocks that create successful collaborations. The question remains how universities and industry achieve successful partnerships when the goals, language, culture, and structures significantly differ from one organization to another. Research suggests that the greatest barrier to collaboration between industry and higher education lies in a lack of understanding by the different partners of university, corporate or scientific norms and environments (Lutchen, 2018). Without clear knowledge of the factors that lead to successful partnerships many institutions of higher education and industry forge collaborations that bring additional questions, inconsistencies, failed professional relationships, and missed opportunities and goals. For example, failed student projects, or the misuse and mismanagement of donated funds and supplies can harm current and future collaborations if the factors that lead to successful partners are not identified

Summary of Findings

The purpose of this study was to explore the core set of factors necessary for successful partnerships between higher education engineering faculty and engineering professionals in industry. The engineering faculty were selected from the Minnesota State universities and colleges system because of the robust geographical area, which is served throughout Minnesota, as well as the number of engineering programs offered. Engineering professionals in businesses throughout the state of Minnesota were selected to represent statewide perceptions. Data were collected using a confidential online survey using the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018). Subjects were engineering faculty recruited via e-mail from 5 state universities across the Minnesota State system, and business and industry professionals from medium to large engineering companies throughout the state of Minnesota.

The utilization of the *WFCI* assessment allowed for the following 6 categories to be considered for successful collaboration: (a) environment, (b) membership characteristics, (c) process and structure, (d) communication, (e) purpose, and (f) resources. The subjects were asked to consider statements and rate their perceptions of successful collaboration factors. The utilization of the *WFCI* assessment sought to identify the core set of factors necessary to establish and maintain successful partnerships between higher education and industry. Accordingly, three hypotheses were tested.

First, it was hypothesized that engineering faculty would identify a core set of factors necessary for successful industry partnerships. The current study demonstrated that each of the 6 categories of core factors from the *WCFI* were essentially equivalent across the factors regarding their importance in forming a successful partnership with industry. However, the engineering faculty did not rate any of the core factors as "strongly" important. Rather, the three factors of *Purpose*, *Communication* and *Environment* were recognized as important factors. Alternatively, indicated *Membership Characteristics*, *Process and Structure*, and *Resources* were viewed as "neutral" to the success of partnerships.

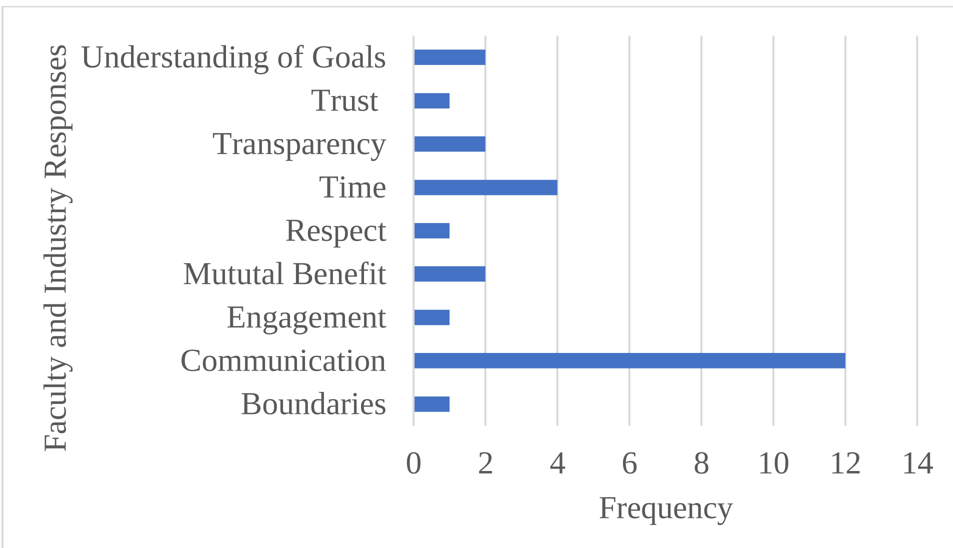
Second, it was hypothesized that industry professionals would identify a core set of factors necessary for successful academia partnerships. The data indicated that industry perceived all six of the core factors as "neutral" to the success of partnerships. None of the factors were considered to be "important" or "unimportant". However, it is worth noting that the mean factors were closely grouped together with small standard deviations. This implies that there was not major deviation in how industry perceived the core factors suggested for importance in the *WCFI* assessment.

Third, it was hypothesized that engineering faculty and industry professionals would identify a shared core set of factors necessary for successful partnerships. Interestingly, the order in which engineering faculty and engineering professionals ranked the core factors were similar. Although the engineering professionals only perceived the factors "neutral," they did rank-order the factors in a similar order as the engineering faculty. *Purpose,* and *Environment* were identified as the top core factors in their rank order. Therefore, it is suggested that engineering faculty and industry professionals perceive the same factors as important when collaborating with one another. The engineering faculty and industry professionals were in agreement with the rank order of factors important for successful collaborations.

In addition to the data collected regarding the perceived core factors on the *WCFI*, subjects of this study were asked to respond to an open-ended question: “What do you perceive as the most important factors for successful partnerships and/or collaborations between higher education and industry?”. All of the 26 subjects responded to this question (see Figure 1).

Figure 1

Faculty and Industry Responses to Open-Ended Question

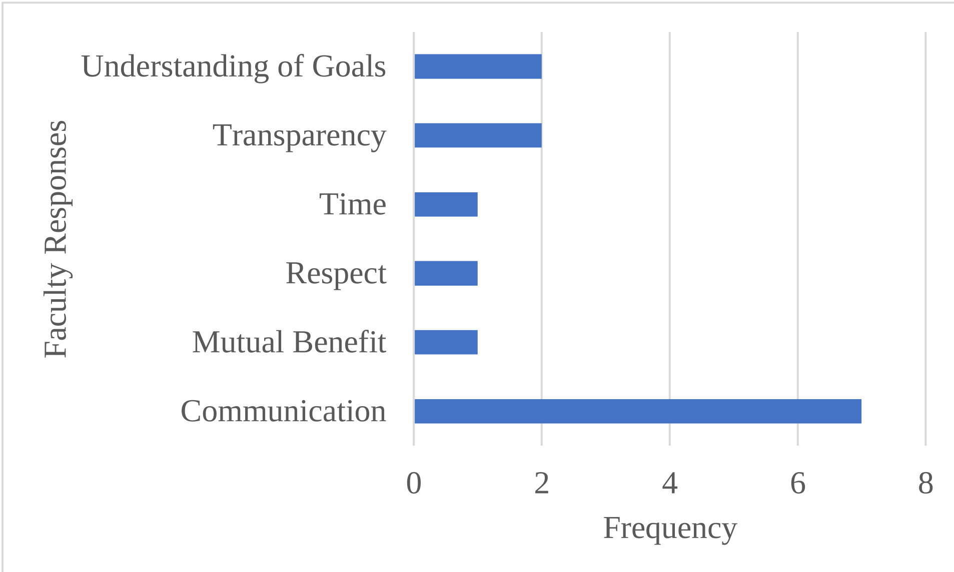


The most frequent responses were “Communication” (n = 12), “Time” (n = 4), “Mutual Benefit” (n = 2), and “Understanding of Goals” (n = 2).

In comparison, the engineering faculty (n = 14) responses also described “Respect” (n = 1), and “Transparency” (n = 2) as perceived factors of importance (see Figure 2).

Figure 2

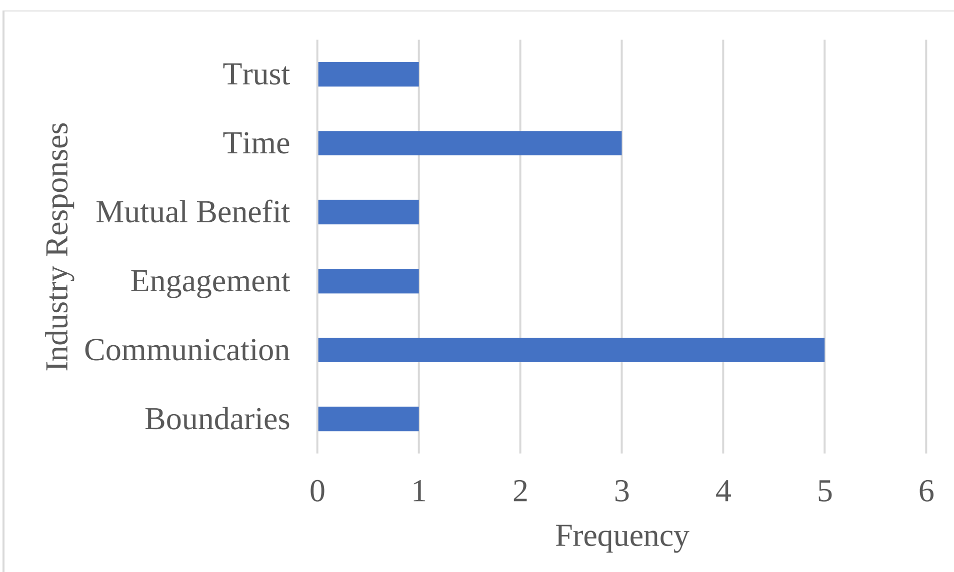
Engineering Faculty Responses to Open-Ended Question



Industry professionals (*n* = 12) also included in their responses "Engagement" (*n* = 1), "Boundaries" (*n* = 1), and "Trust" (*n* = 1) as perceived factors of importance (see Figure 3).

Figure 3

Industry Responses to Open-Ended Question



The open-ended responses provided additional suggestions for successful factors that were not tested in the *WCFI* and could be used to help further advance this study. Since the core factors in the *WCFI* only considered six categories, it would be advantageous to add questions that specifically examine “Time”, “Mutual Benefit”, and “Understanding of Goals” as potential core factors for success in future studies.

Overall, the data from the current study indicated that engineering faculty and engineering professionals perceive the core factors for successful collaborations similarly. *Purpose* and *Environment* emerged as significant and reappearing factors for the subjects in this study. Engineering faculty may perceive the core factors on the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018) with more significance for a successful partnership than engineering professionals, however, the rank order remains comparable in the two groups, indicating a shared agreement when establishing and participating in collaborations.

Implications

The results of the current study suggest that engineering faculty at Minnesota State Universities and engineering professionals within that state of Minnesota demonstrates strong congruence across what they perceive as core, or at least important factors for success. However, neither faculty nor industry “strongly agreed” or “strongly disagreed” on any of the six factors needed for successful collaboration. Rather, the core factors were only scored as “agree” or “neutral”. In other words, the factors from this study did not provide strong indication of core factors for collaboration.

Based on the responses that were received, it is conceivable that there are other factors of successful collaboration that were not listed or examined on the *Wilder*

Collaboration Factors Inventory (*WCFI*; Mattessich & Johnson, 2018). Given the responses of “agree” or “neutral” from both engineering faculty and engineering professionals, and the small deviations, it is conceivable that there are factors that are perceived as more important to success that were not listed on the *WCFI* assessment that would have provided a stronger response from subjects. The six categories of successful factors on the *WCFI* provides a very broad perspective of partnerships and collaborations. Although the six categories encompass several additional factors that could be utilized in the creation of successful collaborations, they are not overtly described in the *WCFI* assessment. Since this assessment was developed for broad collaboration assessment in a variety of sectors including government, and non-profits, there may be factors specific to collaborations within higher education and industry that are not overtly presented throughout the assessment based on the responses provided by the subjects. It is conceivable that additional factors such as *Time* would be scored as “strongly agree”.

Furthermore, subjects were asked to consider and evaluate previous partnerships and collaborations they participated in. The survey provided this direction for subjects. However, the lack of completed surveys may indicate that the context of the survey and the questions on the *WCFI* were difficult to understand.

It is conceivable the results of this study were affected by the small size of the study. Although the survey was initially emailed to over 100 engineering faculty within the Minnesota State University system, and over 100 engineering professionals in business and industry in the state of Minnesota, the response rate was low. After a week of slow responses, a reminder email was sent to the prospective subjects, and another reminder was sent the following week. Unfortunately, the response rate remained low. Of the 109 engineering faculty emailed, only 27 responded and of those only 14 engineering faculty fully completed the online survey. Similarly, of the 125 engineering professionals emailed only 15 responded and of those only 12 fully completed the online survey. A larger sample size could have impacted the results of this study.

Additionally, the subjects who participated in the study were of similar ethnicity and gender. Of the 26 engineering faculty and industry professionals that responded to the survey, all subjects reported their ethnicity as white, and 9 of the 26 subjects reported their gender as female. Although statistically there are more academic and industrial engineers that self-identify as white and male, diversity in engineering is growing. Therefore, the lack of diversity within the ethnicity of the sample size as well as gender could have impacted the results of this study and missed the emerging changes and trends within the engineering field from both an academic and professional perspective.

Strengths and Limitations

A strength of the present study is that there is limited research on the core factors for successful partnerships between higher education and industry. Discovering the appropriate balance to satisfy both sectors in a collaboration is a big challenge while creating partnerships (Dooley & Kirk, 2007). This barrier to success is seen throughout the literature as the differences in organizational and institutional cultures, as well as misidentified information and cultural barriers creates additional challenges for success (Kim et al., 2017). However, this present study provides a tool to begin to examine collaborations in other disciplines to discover pathways to success throughout higher education and industry. Results from the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018) can provide a foundation that can be utilized to continue advancing the research on successful factors to collaborations among higher education and industry.

An additional strength of this study is that it identifies the potential congruence in perceptions of higher education and industry expectations for successful partnerships among varying institutions and with a variety of objectives. Much of the research related to partnerships among higher education and industry focus on research and development and financial contribution and marketing. This study began to narrow the focus of what partnerships and collaborations can be given the core factors for success.

There were several limitations in this study. The first limitation was the limiting sample size. There were multiple attempts to remind and encourage faculty and industry professionals to participate, however, the response rate remained low. The survey using the *Wilder Collaboration Factors Inventory* (*WCFI*; Mattessich & Johnson, 2018) also may have limited the response rate. There were a number of subjects that started the survey but did not complete it. This could be due to the length of the survey and assessment tool, or subjects may not have understood what was being asked to consider regarding collaborations prior to taking the *WCFI*. Additionally, the COVID-19 pandemic may have impacted the subject responses, specifically around current collaborations and partnerships with higher education and industry. Many historic and emerging collaborations and partnerships among higher education and industry had to stop or change drastically when the pandemic occurred to limit the risk of exposure to the virus. Furthermore, many industries faced additional budgetary restrictions, and worker shortages. This may have caused engagement between higher education and industry to decline, and overall collaborations to decrease, making recollection of successful partnerships and collaborations between the two difficult.

The second limitation of this study was the lack of diversity among subjects. Subjects in this study were asked to self-identify. All of the participants identified as white, and 65% identified as male. Of those that identified as male, 100% were from industry. Although engineering is male-dominated, latest research indicates that roughly 15% of engineers are women (Kantrowitz, 2022). The responses to this study did not incorporate the engineers who self-identify as women which could have resulted in an inaccurate collection of the perceived core factors for success for industry.

A third limitation was that of the *WCFI* (Mattessich & Johnson, 2018) assessment tool. The tool may not have been entirely clear as to how individuals should assess and score the questions. It would be interesting to understand how subjects from higher education and subjects from industry scored the survey, given the different perspectives they have from their professions. Additionally, the *WCFI* may not have included all of the factors necessary for successful collaboration. Although the *WCFI* has been validated and widely used, there may still be factors that were not included in the assessment tool. Since engineering faculty and industry were unable to "strongly agree" or "strongly disagree" on factors presented in the study, it prompts the question as to what factors may be missing. Additionally, the open-ended question presented at the end of the survey provided additional suggestions for factors that may be more appropriate for the subjects in higher education and industry than those presented by the *WCFI*.

Recommendations for Further Research

Several recommendations can be offered for further research on the core factors for successful partnerships. First, it is recommended that the present study be replicated with a larger sample size of engineering faculty and engineering professionals. This study was limited to engineering faculty in Minnesota State System and engineering professionals in industry throughout Minnesota. Research with larger samples is needed to determine if these findings can be upheld in other states. This could be done throughout the Midwest region, or nationally, and at diverse institutions. A larger sample size would allow additional examination of the core factors for successful collaboration, and it would provide examination among varying institutions, as well as examination from potentially varying subject demographics.

Second, it is recommended that this study be replicated in other disciplines throughout higher education and industry. The current research for successful partnerships is limited and this present study provides a useful tool to examine the multitude of layers to collaborations within various disciplines and industrial sectors. Higher education partners with numerous other sectors ranging from healthcare to aviation, to business and criminal justice. Since the current research for successful partnerships among higher education and industry is limited, it would be beneficial to examine what other disciplines perceive as successful factors for collaboration. This may lead to additional collaborative opportunities as well as begin to discover additional pathways for successful partnerships throughout higher education and industry.

Third, it is recommended to conduct this research as a qualitative study. Although the current study provided insightful data regarding the core factors for success, a qualitative study would have provided more time and depth to understand the core factors of successful collaboration among engineering faculty and industry while better utilizing the *WCFI* (Mattessich & Johnson, 2018) assessment tool. A qualitative study would allow for additional questions and it would generate conversations about partnerships and collaborations which could provide additional core factors to be uncovered. This could also help to develop a better tool for further research on collaborations between higher education and industry.

Fourth, further study of partnerships between higher education institutions and partnerships between businesses is recommended to be conducted separately. There are many nuances throughout higher education that impact collaborations and partnerships. Examination of only higher education partnerships would provide additional information as to the correct formation of partnerships and perhaps help to determine the factors for success or failure since there remains limited research. Similarly, examination of partnerships within industry would provide additional information and perhaps provide factors for success or failure. With an in-depth examination of each separately, additional data, factors, and understanding of how each higher education institutions and how business view collaborations could be concluded. This additional information could be used to help develop a better tool for future research on the successful core factors for collaboration between higher education and industry.

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APPENDIX A

The Wilder Collaboration Factors Inventory

1. **Agencies in our community have a history of working together.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

2. **Trying to solve problems through collaboration have been common in this community. It has been done a lot before.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

3. **Leaders in this community who are not part of our collaborative group seem hopeful about what we can accomplish.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

4. **Others (in this community) who are not part of our collaboration would generally agree that the organizations involved in this collaborative project are the "right" organizations to make this work.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

5. **The political and social climate seems to be "right" for starting a collaborative project like this one.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

6. **The time is right for this collaborative project.**
    - Strongly Disagree

- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

7. **People involved in our collaboration trust one another.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

8. **I have a lot of respect for the other people involved in this collaboration.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

9. **The people involved in our collaboration represent a cross section of those who have a stake in what we are trying to accomplish.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

10. **All the organizations that we need to be members of this collaborative group have become members of the group.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

11. **My organization will benefit from being involved in this collaboration.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

12. **People involved in our collaboration are willing to compromise on important aspects of our project.**
    - Strongly Disagree
    - Disagree

- Neutral, No Opinion
- Agree
- Strongly Agree

13. **The organizations that belong to our collaborative group invest the right among of time in our collaborative efforts.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree
14. **Everyone who is a member of our collaborative group wants this project to succeed.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

15. **The level of commitment among the collaboration participants is high.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

16. **When the collaborative group makes major decisions, there is always enough time for members to take information back to their organizations to confer with colleagues about what the decision should be.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

17. **Each of the people who participate in decisions in this collaborative group can speak for the entire organization they represent, nor just a part.**
    - Strongly Disagree
    - Disagree
    - Neutral, No Opinion
    - Agree
    - Strongly Agree

18. **There is a lot of flexibility when decisions are made; people are open to discussing different options.**
    - Strongly Disagree

- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

19. People in this collaborative group are open to different approaches to how we an do out work. They are willing to consider different ways of working.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

20. People in this collaborative group have a clear sense of their roles and responsibilities.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

21. There is a clear process for making decisions among the partners in this collaboration.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

22. This collaboration is able to adapt to changing conditions, such as fewer funds than expected, changing political climate, or change in leadership.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

23. This group has the ability to survive even if it had to make major changes in its plans or add some new members in order to reach its goals.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

24. This collaborative group has been careful to take on the right among of work at the right pace.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

25. This group is currently able to keep up with the work necessary to coordinate all the people, organizations, and activities related to this collaborative project.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

26. A system exists to monitor and report the activities and/or services of our collaboration.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

27. We measure and report the outcomes of our collaboration.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

28. Information about our activities, services and outcomes is used by members of the collaborative group to improve our joint work.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

29. People in this collaboration communicate openly with one another.
- o Strongly Disagree
- o Disagree
- o Neutral, No Opinion
- o Agree
- o Strongly Agree

30. I am informed as often as I should be about what is going on in the collaboration.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

31. The people who lead this collaborative group communicate well with the members.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

32. Communication among the people in this collaborative group happens both at formal meetings and in informal ways.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

33. I personally have informal conversations about the project with others who are involved in this collaborative group.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

34. I have a clear understanding of what our collaboration is trying to accomplish.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

35. People in our collaborative group know and understand our goals.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree

- Strongly Agree

36. People in our collaborative group have established reasonable goals.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

37. The people in this collaborative group are dedicated to the idea that we can make this project work.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

38. My ideas about what we want to accomplish with this collaboration seem to be the same as the ideas of the others.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

39. What we are trying to accomplish with our collaborative project would be difficult for any single organization to accomplish by itself.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

40. No other organization in the community is trying to do exactly what we are trying to do.
- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

41. Our collaborative group has adequate funds to do what it wants to accomplish.
- Strongly Disagree
- Disagree
- Neutral, No Opinion

- Agree
- Strongly Agree

42. Our collaborative group as adequate people power to do what it wants to accomplish.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

43. The people un leadership position for this collaboration have good skills for working with other people and organizations.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

44. our collaborative group engages other stakeholders outside of our group as much as we should.

- Strongly Disagree
- Disagree
- Neutral, No Opinion
- Agree
- Strongly Agree

APPENDIX B

Invitation to Participate in Study

Hello,

I am writing to invite you to participate in a voluntary research study that explores the experience of partnerships and/or collaborations between higher education and industry. This research is being carried out by Doctoral Candidate, Molly Schaefer and her advisor, Jason Kaufman, Ph.D., Ed.D., at Minnesota State University, Mankato.

Participation includes an anonymous, online survey that will require roughly 15 minutes of your time to complete. The survey will ask you to respond to a series of questions including demographic questions, as well as questions regarding your experiences with partnerships and/or collaborations between higher education and industry.

To participate in this voluntary study, please click the following link to begin the process.
https://mnsu.co1.qualtrics.com/jfe/form/SV_8qaZ6xptqKYGlW6
It is extremely important to hear the industry perspective.

If you would like additional information about this study, please contact me at molly.schaefer@mnsu.edu, or Dr. Jason Kaufman at Jason.kaufman@mnsu.edu.

Thank you for your consideration, and once again, please do not hesitate to contact us if you are interested in learning more about this project.

Molly Schaefer
Doctoral Candidate
Minnesota State University Mankato

MSU IRBNet ID #1869877

APPENDIX C

Informed Consent and Survey

INFORMED CONSENT
MSU IRBNet#1869877

INTRODUCTION
You are invited to participate in a research study regarding your experiences participating in partnerships among industries and higher education. Your participation in this study will help us to better understand your experiences with collaborations and your plans for future partnerships between industry and higher education. This research is being carried out by Doctoral Candidate, Molly Schaefer and her advisor, Jason Kaufman, Ph.D., Ed.D., at Minnesota State University Mankato.

PROCEDURE
If you agree to participate as a subject in this research, you will be asked to complete an online survey that will ask you about your experiences with partnerships and collaborations between industries and higher education. The survey will ask you to respond to a series of questions including some demographic questions, as well as questions regarding your perception and experiences of partnerships with industry/higher education. You can expect that this will require about 15 minutes of your time to complete.

POTENTIAL RISKS OF PARTICIPATION
Responses will be anonymous and will pose no more risk than everyday life and work.

VOLUNTARY NATURE OF THE STUDY
Participation is voluntary. You have the option to not choose to participate in this research. You may stop taking the survey at any time by closing your web browser. Participation or nonparticipation will not impact your relationship with Minnesota State University, Mankato, and refusal to participate will involve no penalty or loss of benefits.

STATEMENT OF CONFIDENTIALITY
Your survey responses will not have any identifying information and will be stored for three years. They will only be available to Molly Schaefer and Dr. Jason Kaufman. This will pose no more risk than everyday life and work. If you would like more information about the specific privacy and anonymity risks posed by online surveys, please contact the Minnesota State University, Mankato IT Solutions Center (507-389-6654) and ask to speak to the Information Security Manager.

CONTACTS AND QUESTIONS
This research is being directed by Molly Schaefer, Doctoral Candidate (Minnesota State University, Mankato), under the advising of Dr. Jason Kaufman, Ph.D., Ed.D. (Minnesota State University Mankato). If you have any questions about this research study, please

contact Molly Schaefer at molly.schaefer@mnsu.edu or Jason Kaufman at 952-818-8877/jason.kaufman@mnsu.edu. If you have questions about participants' rights and for research-related injuries, please contact the Administrator of the Institutional Research Board, at (507) 389-1242.

STATEMENT OF CONSENT

“By clicking on the NEXT button, I am indicating my informed consent to participate in this study. Also, the submission of this survey attests that I am at least 18 years of age or older. All questions that may have arisen have been answered by this document or the investigators listed above.” Please print a copy of this page for your future reference.

APPENDIX D

Demographic Questions

1. **Please indicate our professional role:**
    a. I primarily work in higher education as faculty
    b. I primarily work in industry

If subject selects: "I primarily work in higher education as faculty"

2. **Which of the following titles most closely matches your current professional role in higher education?**
    a. Professor
    b. Associate Professor
    c. Assistant Professor
    d. Fixed-Term Professor
    e. Adjunct Instructor
    f. Other (Facilitator, Mentor, etc.)

If subject selects: "I primarily work in industry"

2. **Which of the following titles most closely matches your current professional role in business/industry?**
    a. President/CEO
    b. Vice President
    c. Director/Principal
    d. Manager/Supervisor
    e. Consultant
    f. Other

3. **How long have you been in your current professional position?**
4. **How long have you been at your current organization or university?**
5. **Please describe your area of focus or expertise, e.g., electrical engineering, mechanical engineering, etc.**
6. **What is your gender?**
    a. Female
    b. Male
    c. Non-binary
    d. Other
7. **Which of the following best describes you?**
    a. Asian or Pacific Islander
    b. Black or African American
    c. Hispanic or Latino
    d. Native American or Alaskan Native
    e. White
    f. Other
8. **What is your age?**