A CASE STUDY EXAMINATION OF AN ENGINEERING ARTICULATION PROCESS BETWEEN A COMMUNITY COLLEGE AND A UNIVERSITY

A Dissertation

by

CLAIRE MARIE PHILLIPS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2011

Major Subject: Educational Administration

A CASE STUDY EXAMINATION OF AN ENGINEERING ARTICULATION PROCESS BETWEEN A COMMUNITY COLLEGE AND A UNIVERSITY

A Dissertation

by

CLAIRE MARIE PHILLIPS

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

Approved by:

Co-Chairs of Committee,	Mary Alfred
	Vincent Lechuga
Committee Members,	Angela Bies
	Fred Bonner
Head of Department,	Fred Nafukho

May 2011

Major Subject: Educational Administration

ABSTRACT

A Case Study Examination of an Engineering Articulation Process between a Community College and a University.

(May 2011)

Claire Marie Phillips, B.S., M.B.A., Rockhurst University

Co-Chairs of Advisory Committee: Dr. Mary Alfred
Dr. Vincent Lechuga

Industry data suggests that the U.S. educational system is being challenged to produce more STEM (Science, Technology, Engineering and Math) graduates and, in particular, engineering baccalaureate degreed students. However, this is not a simple issue of increasing engineering program applicants because academic preparation begins early in the student's academic career, with significant math and science requirements. Even though half of today's undergraduate students are taking classes at community colleges, and 20% of baccalaureate degreed engineers started in the community college system, community college students in pre-engineering studies do not transfer to university engineering programs in numbers necessary to decrease the engineering deficit. This dissertation was based on the assumption that, if pathways between two- and four-year institutions were improved through systematic approaches like articulation, the supply of engineers in the U.S. might be positively affected.

This dissertation used a case study approach to analyze an articulation process used by a community college and a university to forge a partnership designed to enhance this engineering pipeline. Using systems theory as a conceptual backdrop, the study

looked at significant inputs, throughputs, outputs, and outcomes to the articulation negotiation process and analyzed roadblocks to that process. In the summary chapter, the paper addressed practical ways to bridge this gap and provide support mechanisms needed for STEM students to smoothly move from one higher education sector to the next.

ACKNOWLEDGEMENTS

I would like to acknowledge a number of people and organizations who supported and assisted me throughout the process of creating this dissertation. First, I would like to thank my dissertation co-chairs, Dr. Vincent Lechuga and Dr. Mary Alfred of Texas A&M University who guided me through this process giving me constructive criticism designed to improve this document and also showing me the way to an appreciation of scholarly research. I also acknowledge the efforts of committee members Dr. Fred Bonner and Dr. Angela Bies, whose classes I thoroughly enjoyed and whose opinion I value highly.

Secondly, I want to show my appreciation to two organizations: Lone Star College and Texas Tech University. Thanks to the sabbatical awarded by Lone Star, I was able to move more quickly through this process and interview a number of people within the organization who provided both cogent information and encouragement while writing this dissertation. I also visited Texas Tech University during this sabbatical, where I experienced universal welcome and a collegial spirit of idea sharing.

Finally, I would like to thank two people who have been a part of my life for many years. Thanks to my childhood friend Trish Costello, who in her retirement from industry volunteered to use her formidable editing skills to spend significant time reviewing this document. Lastly, I would like to thank my husband Jack Phillips, who not only supported my decision to return to school, but also shared his knowledge of the engineering profession that provided a “real world” focus to this paper. Thank you all for making this dissertation a true co-creation of knowledge.

NOMENCLATURE

A.A.	Associate of Arts (Community College degree)
A.A.S	Associate of Applied Science (Community College degree)
A.S.	Associate of Science (Community College degree)
CC, CCs	Community college, Community colleges
ENGR	Engineering common course rubric
ES	Community college engineering science programs
F 2 F	Face to face
FOS	Field of study
FTC	First time in college (student)
LSC, Lone Star	Lone Star College (System)
OECD	Organization for Economic Cooperation and Development
SACS	Southern Association of Colleges and Schools (regional higher education accrediting agency)
STEM	Science, Technology, Engineering, and Math
Tech, TTU	Texas Tech University, Lubbock Texas
THECB	Texas Higher Education Coordinating Board
Two plus Two (or 2 + 2)	Agreements signed between a community college and a partnering university

TABLE OF CONTENTS

CHAPTER Page

CHAPTER Page

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

INTRODUCTION

"Whether it's improving our health or harnessing clean energy, protecting our security or succeeding in the global economy, our future depends on reaffirming America's role as the world's engine of scientific discovery and technological innovation" (Obama, 2010).

President Obama, who has been working on science, technology, engineering, and math (STEM) educational initiatives since his tenure as a U.S. senator, referred in this quote to a concern that has been expressed by American leaders in fields ranging from business to education; that is, how can the U.S. continue as a leader in global economies if our technological infrastructure is in jeopardy due to a long-term deficiency in intellectual prowess? "Rising concern about America's ability to maintain its competitive position in the global economy has led to a renewed interest in STEM education" (Chen, 2009, p. 1).

U.S. Government's Emphasis on STEM Education

Educators and economists alike point to the need to increase our nation's capacity to educate students in STEM fields. Recognizing the importance of this issue, the federal government has spent "roughly $3 billion a year on STEM education, and $943 million is devoted to undergraduate education" (Cavenagh, 2008, p. 8). Our government has made STEM educational initiatives a high funding priority so that "building a larger and more diverse workforce education sector in STEM is a critical imperative for the 21st century" (U.S. Department of Defense, 2001, p. 21).

This dissertation follows the style of *The Review of Higher Education*.

With plans for future growth, the 2011 federal budget proposes an investment of $3.7 billion in STEM educational programs. The focus of the budget at the undergraduate level is the support of "effective approaches that will increase rates of program completion in STEM areas and increase the number of graduates for employment in STEM fields" (*Preparing our children for the future*, 2010, p. 2) and will emphasize the engineering discipline through its allocation of $19 million in National Science Foundation (NSF) and $55 million in Department of Energy funds designated for engineering, especially clean energy fields (*Preparing our children for the future*, 2010).

This dissertation seeks to investigate an area of education that has been, in the 21st century, of great concern to educators from the primary through higher education levels in STEM fields and, more specifically, in engineering disciplines as a subset of STEM education. Because of this need to augment engineering ranks through education, higher education is seeking ways to increase the flow of engineering students through the educational pipeline and explore tools to facilitate this movement. Articulation is one of the tools that educators are using to smooth the progression of students through the system.

Increased Need for Engineers in the U.S.

Engineering professionals continue to be in great demand in the U.S. with projected yearly increases in the number of engineering jobs averaging 11% (U.S. Department of Labor Statistics, 2008). In highly technical growth fields like bio-medical engineering, this growth reached a high of a +72% yearly increase in demand between 2007 and 2008. Based partially on this demand, engineers as a group earn a relatively high starting salary among bachelor degree holders, ranging from the mid $50s to

$83,000 for petroleum engineers who graduated in 2009 (U.S. Department of Labor Statistics, 2009). When compared to the fact that engineering graduates in India receive starting salaries of $4,300 to $8,000 per year (Hargreaves, 2005), one can understand why foreign engineering students attempt to stay in the U.S. after graduation. Even in the recent economic downturn, U.S. engineering graduates leaving college have consistently found employment opportunities. *CNN Money* reports that, although college graduates in most disciplines can expect to make less than comparable graduates in better economic times, for engineering graduates, "initial pay offers are 1.2% higher at $59,149" (Yousuf, 2010, p. 10). In summary, "there is no shortage of jobs in the fields of science, technology. In fact, while overall U.S. unemployment is rising, STEM industries are looking for qualified applicants" (STEM and workforce development legislation, 2009, p. 1). In the U.S., however, the number of professionals entering technical fields like engineering after college graduation has not grown enough to fully supply the needs in the workplace. With the oil boom in the early to mid 1980s, engineering schools produced record numbers of engineering baccalaureate graduates. However, the oil bust that followed in the late 1980s caused some companies to lay off those engineers—the backlash being that fewer qualified students entered engineering schools, choosing instead to go into fields like business and technology. Even when, in the 1990s and early 21st century, industry demand again dramatically grew the need for engineers to support emerging technical fields, student entry into engineering schools did not grow proportionately to that need and, in fact, has never returned to the halcyon levels of the early 1980s.

Figure 1 graphically shows the trend line in baccalaureate engineering enrollments from 1970 to 2005, with 2005 the last date figures are available, which demonstrates a peak of 400,000 engineering students that has not been reached again in the 21st century, despite the market demand. Table 1 corroborates this slowdown in engineering enrollments, comparing the steady rise in total student enrollment to stagnating engineering enrollments for this same time period.

Figure 1

Undergraduate Engineering Enrollments 1970−2005

From "Data for Enrollments," by the Engineering Workforce Commission. Copyright 2010 by the American Association of Engineering Societies.

Table 1

Engineering Bachelor's Degrees Awarded in the U.S. as a Percentage of Total Student Enrollment

Academic year enrollments	Engineering degrees awarded	Total student enrollments
1970	44,770	8 million
1975	39,824	11.2 million
1980	58,810	12 million
1985	77,572	12 million
1990	64,705	14 million
1995	63,371	14 million
2000	59,536	15 million
2005	66,133	17 million

From "Preparing our Children for the Future," by U.S. Department of Education, 2010.

Because of the imbalance between supply and demand of engineers in the U.S., students who graduate with an engineering degree can anticipate being immediately employed after graduation.

> Continuing a pattern that has been evident for decades, recent bachelor's and master's engineering graduates are more likely than graduates in other fields to be employed full time after graduation and, upon entering the

> workforce, they are rewarded with higher salaries (*Recent engineering and computer science graduates continue to earn the highest salaries*, 2005, p. 20).

Also, those engineers are more likely to make more over the course of their career than other baccalaureate graduates, according to the Department of Labor (Hargreaves, 2005).

Role of Community Colleges in Engineering Higher Education

Mentoring students through the entire STEM curriculum process—from junior high school through college—is complicated, since potential engineering students must start early in their educational process by taking prerequisite courses in math and science to prepare them for the challenging engineering curriculum. With decreasing numbers of high school graduates, competition among four-year colleges for qualified candidates has grown more pronounced, and enrollment managers at four-year colleges have turned their sights to the community college student pool. From the founding in 1901 of Joliet Junior College, which is considered to be the first community college, a key mission of this segment of higher education has been the transfer function. The original concept, which is maintained today, was that "a well-equipped two-year college, with appropriately credentialed faculty, was assumed to be capable of offering instruction at the freshman and sophomore levels equal in rigor and breadth to a university" (*Access to the baccalaureate,* 2003, p. 2). A number of investigators (Adelman, 1998; Henry, 2003; Karp, 2008; Mattis & Sislin, 2005) have endorsed the idea of looking towards the community college to augment the ranks of engineering students and provide their foundational engineering classes. Mattis and Sislin (2005) suggested that

> increasing the number of engineers will first require increasing the number of engineering students, and one way to do that is to tap into the pool of students pursuing engineering science studies at a community college, who could then transfer to four-year institutions, where they could pursue baccalaureate or advanced degrees (p. 7).

Community colleges have already been shown to be "essential to the education of engineers in the U.S. since 20% of the engineering degree holders began their academic careers starting in and earning at least 10 credits at community colleges" (Adelman, 1998, p. 5). Henry (2003) corroborates Adelman's opinion through her estimate that over half of America's college students now begin at a community college, a rich pool for potential engineering graduates. It is to this large and growing contingent of students that Mattis and Sislin (2005) directed their attention with their research studies. Many of the higher education students Mattis and Sislin studied did not begin and end their academic careers at the same college, complicating the ability to advise them on a sequential course of study. These students moved back and forth between two- and four-year institutions because of factors like grade point average and monetary considerations. In academic circles, this student phenomenon has become known as student swirl.

This concept of swirling students, first introduced by De Los Santos and Wright (1990), has relevance to the transfer issue being studied in this dissertation. "Some inter-institutional methods of accommodating swirl are already developing…..for example, the burgeoning of transfer articulation agreements bring together, however reluctantly, faculty from various institutions to discuss learning objectives and outcomes associated with the courses being `matched' across institutions" (Borden, 2004, p. 4). The title of

Borden's article, "Accommodating student swirl: When traditional students are no longer the tradition", reflected a national student demographic trend from the typical four-year baccalaureate student to 21st century students whose complicated lives obscure a clearly defined educational path. When transferring, these students' academic portfolios are often complicated, requiring high level advising to transition them to a university program without major loss of credit. In Texas, the Texas Higher Education Coordinating Board has made this transfer issue one of their highest priorities to resolve because "as students continue to switch and swirl through the educational process, the need for good quality state articulation agreements becomes more pronounced" (Jacobs, 2004, p. 107).

Texas Transfer Trends

In the state of Texas, "of about 1.2 million students enrolled in Texas public and private higher education institutions in 2007, 90% of those college students attend public institutions of higher education and 48% of those students were enrolled in public two-year institutions" (Jacobs & Dougherty, 2007, p. 53). Partially due to economic conditions, enrollment at these two-year institutions is growing more rapidly than enrollment at public universities and this skewing towards community college enrollment is expected to increase in Texas. In this state, "between 2000 and 2005, enrollment at public two-year institutions grew by 26.4%, compared to 17% in Texas universities" (*Career, technical, and workforce education in Texas*, 2006). Wellman (2002) cautions that, "if the 2/4 transfer function is weak, students who initially enroll in a community college will be less likely to earn a baccalaureate degree, and those who do earn their degree will take longer and need more credits to do so." (p. 4). Wellman's comment alludes to a basic issue that forms the basis of this dissertation's problem statement.

Problem Statement

Even though the U.S. business community continues to challenge higher education to produce more engineers and rewards graduates from that discipline with relatively high starting salaries, "many community college students in engineering-related disciplines do not transfer to four-year engineering programs" (Mattis & Sislin, 2005, p. 7). In researching this issue, Adelman (1998) cited facts from the *NCES Higher Education Institution and Beyond* survey that examined the engineering pathway through community college and into universities and highlighted the following statistics pertinent to engineering student transfers.

First, 20.1% of U.S. students who earned bachelor's degrees in engineering started their higher education work in community colleges. This 20% is a subset of the 44% of all STEM graduates who attended community college (Kincaid, et.al., 2005, p. 2). Kincaid, et al., also noted regional variation in this pattern, with STEM graduates in the Southwest and Pacific regions of the U.S. much more likely than their counterparts in the New England region to have started at the community college, possibly because of demographic differences between the regions. Next, the degree completion rates (65.8%) of students who transferred from community colleges to engineering schools were equivalent to those of students completing their entire degree at a four-year institution. Lee (1993) corroborates Adelman's (1998) statement, citing equivalent degree attainment rates of 69% for both groups. Additionally, Barry and Barry (1992), Handel (2007), Melguizo (2009), and Ursu and Sygielski (2007) provided evidence that community college students can successfully navigate university programs after transfer. Finally,

transfer students currently account for one-sixth of the baccalaureate degrees awarded in engineering (Adelman, 1998).

Adelman's findings provide relevance to this study about engineering transfers since his statistics suggested that, even though transfers in the engineering field remain low relative to other fields, engineering students are already self-selecting the community college-university combination to effect their academic goals. Cross-referencing community college growth rates with the decrease in university engineer graduates, and inserting Adelman's statistics as cited previously, one could argue that, if pathways between two- and four-year institutions were improved in engineering through systematic approaches like articulation, the supply of engineers in the U.S. might be positively affected.

Related to the issue of low enrollments in baccalaureate engineering programs is the problem of student withdrawals from pre-engineering programs. Drop-out rates in pre-requisite courses for STEM remain high. For example, the State University in New York, for the 2003-2006 school years, showed an attrition rate of 51% in organic chemistry and a 38% drop-out rate for students taking calculus (Adelman, 1998). These statistics reflect trends in STEM gatekeeper courses throughout the country and many college students take gatekeeper courses (entry level courses students often have difficulty passing) at a community college, either while enrolled full-time or as part-time students enrolled during summer breaks. Also, Adelman's statistics imply that the transfer function at the community college has yet to reach its full potential, especially in these highly technical fields where "there is a lack of understanding on the part of teachers, counselors, and students of the importance of community colleges in

engineering education" (Mattis & Sislin, 2005, p. 8) as well as "ineffective articulation agreements and lack of cooperation between community colleges, four-year institutions, and state higher education agencies" (p. 8), all of which inhibit transfer, retention, and graduation of engineering students. Researchers are searching for ways to ameliorate this problem and have found articulation to be an effective tool in promoting student transfer.

Articulation as a Means of Improving Engineering Program Transfers

Creating articulation agreements is one method that can be used to increase the flow of students through the higher education engineering pipeline. "Articulation agreements are the principle instruments to facilitate the transfer process" (Anderson, Sun, & Alfonso, 2006, p. 262). Articulation agreements have been used for the past fifty years (Jacobs, 2004) to facilitate student movement, but as community college student enrollment grows, the need for effective articulation has correspondingly grown stronger. However, this need does not necessarily result in increased numbers of articulations, nor does it mean that college personnel understand the articulation process. So two questions would be: what exactly is an articulation agreement and how does it facilitate that movement? "Specifically, articulation agreements serve to negotiate the requirements for students' movement from institution to institution and support the transfer intent" (Anderson, Sun, & Alfonso, p. 262) as well as "ensure that students who transfer among two- and four-year institutions do not experience problems such as loss of credits within their program of study" (Laanan, 2005, p. 5). Kintzer and Wattenbarger (1985), who conducted in-depth research on transfer and articulation issues, defined articulation as the entire range of processes and relationships involved in the systematic movement of students inter-institutionally. A well-designed articulation agreement "permits credits

earned at the two-year college to be counted towards the baccalaureate at the four-year institution (*Access to the baccalaureate,* 2003, p. 3). A secondary, but very important result of articulation is its assistance in bringing faculty and administration together to create and maintain good intra-college working relationships.

Types of Articulation Agreements

Articulation agreements take a number of forms. Some are state-mandated, as is the case in Florida. Other states have more loosely defined articulation processes and, since I work in Texas, I looked more closely at articulation work in that state. To date, Texas has not negotiated any state-wide articulations in the engineering field and, in this state articulations have most often been created between specific two- and four-year colleges that voluntarily enter into an articulation for a specific purpose, often for a particular curriculum area. One of the problems with a state-mandated articulation is the generality of the coursework embedded into the first two years of the articulation,

> which involves prerequisites that students must complete at the community college in order to be admitted at the junior level to professional programs such as engineering or other limited access programs, thus in a sense reducing the value of the guarantee that receipt of the associate degree appears to offer (Jacobs, 2004, p. 105).

Nevertheless, the trend within the past twenty years has been towards formal state-wide articulations mandated by law (Bender, 1990), a movement prompted by political pressure to solve problems of student movement through our increasingly complicated higher education system. This movement towards greater accountability has resulted in academic movements ranging from restrictions on sabbatical leaves to

scrutiny of degree length (Jacobs, 2004), but one of the most prevalent areas of accountability focus has been the ability to articulate coursework between colleges to minimize time spent on a degree.

Some two/four-year agreements specify the acceptance of a core set of courses that can be articulated into the four-year degree plan, leaving other credits to be accepted at the discretion of the department. Other colleges create articulation agreements that are designed to accept the entire body of the student's work, as long as that student follows a prescribed list of coursework while at the community college. This model is designed to provide an almost seamless postsecondary education wherein students complete a substantial number of credit hours at a less expensive rate. In effect, the model is one of a junior and senior college working together. It is this latter type of articulation agreement that was proposed in the articulation model under review in this case study.

Purpose Statement

The purpose of this study was to examine the process a community college and partnering university used to create an articulation agreement designed to provide a smooth pathway for students to transfer from a two-year to the four-year engineering program. Although there are many means by which these two college segments could further their partnership, articulation was the most formal and commonly used way to forge such a relationship. Therefore this study, using systems-theory as a conceptual backdrop, employed a case study methodology to systematically delineate the factors implicit in the creation of the initial engineering articulation as well as challenges inherent to that process.

Conceptual Framework

Systems theory provided an appropriate analytical framework to guide this study and was found to be useful in investigating the factors involved in the creation of a community college/university partnership, culminating in an articulation agreement. Specific to the topic of articulation, the systems perspective was able to analyze processes in terms of relationships and integration, recognizing that systems, instead of being rigid formations, are intrinsically dynamic in nature. This view of systems creation and renovation had relevance to the topic of engineering articulations because 2 + 2 (community college to university) articulation agreements are, by their very nature, a reconfiguration of the more traditional path to a baccalaureate degree and "local and statewide articulation agreements have become the focal points of transfer facilitation in recent years" (Jacobs, 2004, p. 12).

For the purpose of this study, the following concepts were especially helpful in isolating the specific factors that made up the articulation process. These concepts are briefly defined here with more specific definitional discussion in Chapter II. *Inputs* are elements that contribute to the genesis of a system or precipitate a change to that system. An example of an articulation input found to be a factor in the articulation studied was a change in organizational leadership. *Throughputs* are those factors that cause the process to be accomplished. In this case, throughputs were comprised of those actions stakeholders took to effect the articulation. *Outputs* in systems theory are the product(s) of the throughput chain of events. In terms of this articulation, the expected output was an increase in the number of engineering students transferring from the community college to the university level. *Outcomes* are the long-term consequences, both expected and

unexpected, that result from a programmatic decision or process change. In this case study, one possible process outcome was the development of a long-term partnership between the two educational entities.

Although "the American compulsory education system is rationally organized" (Cohen, 1996, p. 25) and students moving from one school to another usually have little problem with course transfer, in comparison, higher education is "disorderly…and the curriculum in American higher education is confusing. The content of what are ostensibly the same courses varies across institutions and often varies within different sections of the same course" (p. 25). This disorganization works against the goal of student graduation and calls for a construct to "make sense" (Birnbaum, 1988, p. 175) of this confusing network and impose order. It is this need to impose order that made systems theory an appropriate framework for this study.

Articulation as a Method of Systematically Linking Educational Components

Specific to the issue of articulation, the systems perspective looks at processes in terms of relationships and integration, recognizing that systems, instead of being rigid formations, are intrinsically dynamic in nature. This view of systems creation and renovation has relevance to the topic of engineering articulations because agreements where students take two years at the community college and two more at the university (termed 2 + 2) are, by their very nature, a reconfiguration of the more traditional path to a baccalaureate degree and "local and statewide articulation agreements have become the focal points of transfer facilitation in recent years (Jacobs, 2004, p. 12). However, the transfer path for students is littered with a number of roadblocks, some based on traditional and old school thinking. It is commonplace in the literature to characterize

higher education as concerned with maintenance of the status quo and plagued by inertia (Cohen, 1996; Kerr, 1982; Kotter, 1981). Birnbaum (1988) described this negative situation, saying that "when groups lose their ability to affect their institution through the implementation of positive and constructive programs" (p. 15), inertia becomes more pronounced. Much attention is being paid today to methods of changing archaic higher education systems to those where "the general public and their elected representatives" (Bender, 1990, p. 6) support postsecondary institutions as a system of interdependent and complementary elements that fit together as a whole, not as different, competing elements. Once this occurs "education is then viewed as a process, not as institutional forms or types" (Bender, 1990, p. 6). Within the positive and constructive process of creating an interdependent and complementary articulation, "calcified thinking needs to give way to a more flexible attitude" (Ciciarelli, 1993, p. B2).

However, it is also important to also acknowledge that "challenging the conventional wisdom is sometimes a painful process. It demands questioning the sacred assumptions and developing a collective ability to reconceptualize the relevant variables into a new ensemble" (Gharajedaghi, 1999, p. 87). The old adage `change is hard' is certainly relevant to the process of creating a new articulation, especially between colleges and departments that have not previously worked together. This proved to be valid in this case study. The reconceptualization could take many forms, but one way to reconfigure higher education transfer processes could be through an improvement in linkage between the educational components through articulation. Accordingly, this study served to investigate the process an engineering partnership between a community college and a university employed to create an articulation agreement.

Systems Theory Components Defined

Although a number of authors (Cain, 1999; Crawford, 2005; Frost, 2005) referred in general to systemic components of higher education, relatively few of these writers defined or isolated the terms. For the purpose of this study, it is meaningful to explicitly define the discrete components of the systems terms that were used to research the articulation process.

Inputs. At its most basic level, an input is something that is put into a system or a component of that system. In terms of higher education systems, and articulation processes in particular, inputs range from general concepts like sociopolitical, economic, and organizational leadership philosophy (Shibley, 2004) to very detailed "inputs such as students, money, and books" (Birnbaum, 1988, p. 31). It is also important to recognize the potential effect of college administration on the process, especially the support of a colleges' chief executive officer (Bogart & Murphey, 1985). More subtle inputs could include external influences such as state-wide articulation agreements as well as "the various resources needed to (start and) run a program, e.g., money, facilities and staff" (Mizikaci, 2006, p. 43). So, from this definition, it is evident that a variety of inputs would be responsible for pushing `products,' i.e., students, into the engineering pipeline, and dissertation research delved further into what inputs contributed to the successful implementation of an articulation agreement.

Throughputs. Mizikaci (2006), who termed educational throughput as the "transformation process" (p. 48), described the throughput process as the actions taken to effect the program, i.e., articulation, and the processes used by the educational institution(s). In terms of the initial agreement, throughput consisted of the processes

used (formal and informal) to create and sign the agreement. Once that agreement was signed, throughput would be comprised of the courses, the delivery of those courses, and in general how that knowledge is disseminated to the students. Throughput would also include how the institution relates to the student outside of the class environment and those entities that advise them throughout the process. So throughput would greatly influence the extent to which the students stay in that educational pipeline and matriculate from a specific program of study.

Outputs. Output is the concept in systems theory used to indicate the immediate end product of a chain of events and is usually measured in terms of volume. In higher education, outputs include the detailed units of service attained; that is, the number of clients served, number of students taught, number of program graduates "as well as academic achievement (success rates), and graduation pass rates on professional examinations like the Professional Engineer's exam" (Mizikaci, 2006, p 48). However, output also includes subtle ways "students are likely to be changed as they progress through the program so that after the system processes them, they are different from the way they were initially" (Birnbaum, 1988, p. 34) and professed to be workforce ready by the institute of higher education bestowing the degree. Output could also refer to changes in administrative style or functionality within the institution, "changes in administrative behavior, processes, or procedures" (Falcone, 2003, p. 4). In terms of the articulation process, the desired outcome was an articulation agreement approved by the required parties from both schools.

Outcomes . "Outcomes are the intermediate and long-term goals, objectives and intended or unintended consequences" (Falcone, 2003, p. 4) of a programmatic decision.

Based on this definition, there is a subtle but important difference between output and outcomes, one that employers are increasingly bringing up as an issue to higher education administrators; that is, college graduates are not automatically workforce ready when they achieve output status. However, in general, the attainment of an engineering degree results both in increased employability for the individual graduate and an increase in the number of engineers for the U.S. workforce. Another long-term outcome to an engineering articulation process might be the development of a long lasting community college-university partnership that transcends the initial agreement and results in further benefits to students in the form of scholarships and summer readiness programs. However, an unintended outcome to such an agreement might be the additional cost to maintain the progression of students resulting from the articulation. This includes both labor and non-labor costs. For example, advising might become a more important component embedded in the community college program once the articulation is finalized.

Feedback loops. The systems concept of a feedback loop also has application to articulation and transfer processes since the creation of an articulation connotes a change to an existing system, and that change may either be perceived as negative or positive. Accordingly, feedback may either reduce or enhance the impact of any change and feedback loops can either be a positive reinforcement or "may act as a negative to make minor adjustments in ongoing organizational processes" (Birnbaum, 1988, p. 183). Also, feedback loops may be internal and created within a system or may exist outside of a system and connect two subsystems together. Feedback loops are traditionally viewed as a circular path of cause and effect and can be visualized through causal loop diagrams.

This concept of feedback loops forms a key element in the recommendations made within Chapter V.

Systems Thinking Model Applied to This Study

The use of systems thinking can help to analyze the progression of an articulation agreement through the negotiation and implementation process and serve as a base for the creation of a formalized articulation procedure or improvement of an existing college process. It also allows for visualization of how the articulation comes together, demonstrating what Stogdill, Goldner, and Stinchcombe (1967) described as an "input-process-output system" (p. 667). In fact, an articulation can be said to have two levels. The course of action used for the initial construction of the articulation agreement might be considered as the first level. The second level would be the subsequent processing of students through the engineering curriculum established by that articulation, resulting in the creation of additional engineers entering the workplace. Stogdill et al.'s work allows for the visual representation of the variables that come into play during the creation of an articulation agreement by using what he called an "input, processing, and output variable table" (p. 668). Processors within this structure are analogous to throughput.

This process of articulation may also be visualized through the use of the logic model, which draws its basic structure from systems theory. “The logic model follows the aggregation track, organizing the components of a program into a coherent whole” (Falcone, 2003, p. 2). To Stogdill et al.’s table, the logic model would add the additional component of an outcome. As represented by Table 2, the information shows system components of an articulation, borrowing the column designations from Stogdill et al’s variable table for process analysis and adding a fourth column, differentiating outcomes from output. Note that this case study only looked at the snapshot in time that follows the articulation through Level 1 on the chart. However, the steps taken during Level 1, creation of the articulation, greatly influence the ongoing success of the articulation, so Level 2 components became part of the interview discussion and are alluded to in the *Implications for Future Research* section of Chapter V.

Table 2

Systems Theory Components of College Articulation

Level 1–Creation of the articulation (dissertation concentrated on this level)

Inputs	Throughputs	Outputs	Outcomes
College/dept. strategic goals	Process used to agree upon articulation parameters	Signed articulation agreement document	Partnership initiated between the two engineering departments
Socio-political and economic (Shibley, 2004)	Faculty interaction and support during the articulation process	Costs, both labor and non labor	Potential increase in departmental/institutional publicity and prestige
Leadership philosophy and institutional support (Shibley, 2004)	Administrative response and support		Potential of increased student applications to the program

Level 2–Implementation of the articulation

Inputs	Throughputs	Outputs	Outcomes
Student support (applicants entering the eng. program)	Knowledge delivery systems (Mizikaci,2006 & Birnbaum, 1988)	Units of service/ customers served (Mizikaci, 2006)	Improved student success rates (of transfers who persist)
Economic support from the colleges (personnel, advertising)	Support services (financial aid, advising)	Students taught	Increased employability of graduates
	Faculty support and continued interaction (at both community college/university)	Program graduates; Success rates/grades	Additional engineers entering the workforce

Research Questions

Research questions supply the foundation for a qualitative study and "are the basis for the appropriate research strategy employed in the study" (Calabrese, 2006, p. 9). In this research study on articulation, the following questions were designed to provide the foundation for inquiry into the process used to create that articulation, using systems theory as a guide.

Question 1: What is the process by which a community college and a four-year university create a partnership, resulting in an articulation agreement that would facilitate student transfers?

Question 2: What are the specific inputs, throughputs, outputs, and outcomes implicit in the creation of this type of agreement?

Question 3: In what ways do college stakeholders contribute to the creation of an engineering articulation between community colleges and four-year universities?

Summary

Education in the U.S. has not fully developed policy and procedures in STEM disciplines that are able to respond to industry needs for graduates in this area. One of the most critical processes needed is the smooth student transition between community colleges—where half of U.S. 21st century students begin college—to university programs where they can obtain a baccalaureate degree in disciplines like engineering. However, a review of transfer literature, as delineated in Chapter II, illustrates that transition mechanisms between the two educational sectors are either nonexistent or not fully developed. This chapter has therefore set the stage for a discussion of the key issues facing students transferring from community colleges to four-year institutions, especially

those moving into challenging STEM fields. Chapter II proceeds into an in-depth review of recent transfer and articulation literature relevant to this problem and gives further background on systems theory applications that informed the study. Because the literature demonstrates that articulation between the sectors presents a viable option to bridge this educational gap, the balance of the dissertation, using the example of an engineering articulation, further develops and researches this subject and uses a case study methodology to investigate this transfer mechanism, revealing transfer barriers and recommendations for facilitation of transfer processes.

CHAPTER II

LITERATURE REVIEW

This chapter begins with a general overview of literature relevant to the topic of student transfer then moves into support for the conceptual framework suggested by systems theory. The overall purpose of this chapter is to provide a comprehensive review of research published on the topic of engineering transfer and articulation between the community college and the university systems, positioning the utility of this study within that framework. The chapter also reviews authors who call for more qualitative research into this topic, giving immediacy to this topic and supporting the need for this study. Finally, the chapter covers the depth of the engineering shortage issue in the U.S., citing multiple studies and statistics to describe the challenge.

Historical Perspective

Studies about transfer and articulation issues began as early as 1924 when Leonard Koos (1924) spoke about the junior college (as it was then universally called) in what he termed a "feeder school" for universities. Beginning in the 1960s, a number of researchers began to investigate the dynamics of process and the policy implications inherent to the transfer process. Despite recommendations from authors like Medsker (1960) showing the need for policies designed to formalize articulation agreements, no formal action occurred until 1971 when Florida began a vanguard policy movement to standardize articulation agreements at a state level.

In the 1970s, the public began to look at community colleges as more than feeder schools to universities when these two-year schools began to expand their mission and offer both academic and `terminal' workforce-oriented degree programs. During that era,

researchers began to intensify their work in transfer and articulation topics. In 1975, Kintzer identified three types of statewide articulation and/or transfer agreements pertinent to community colleges: formal and legally-based policies, state system policies, and voluntary agreements between individual college systems. A number of studies in the 1980s statistically detailed a decline in transfer rates between two-year and four-year institutions and attempted to analyze the factors contributing to that decline. Key among those studies was a report created by Kintzer and Wattenbarger in 1985 for the American Association of Junior and Community Colleges that made general public policy recommendations. Since then, transfer rates have stabilized, but the questions raised in those studies have yet to be fully resolved.

Another key orientation of transfer research is the documentation of national and state trends in transfer policy development. For example, Dorothy Knoell, nationally known for her work on transfer and articulation, began to study the transfer phenomenon in 1965 with her work, *From Junior to Senior College, a National Study of the Transfer Student.* This study focused on institutional-level practices of forty-three colleges and collected data about students transferring between institutions.

In 1990, working with the American Association of Community Colleges (AACC) and under the auspices of the Ford Foundation, Knoell led a team that updated that report in *Transfer, Articulation, and Collaboration: Twenty Five Years Later*. This report took a more global approach, discussing policies, programs, regulations, and practices that influenced relationships between two- and four-year institutions, especially those "facilitating student flow and inter-institutional collaboration" (Knoell, 1990, p. 8). The report reviewed policies and statistics in eleven states (including Texas), looking for best

practices that might provide policy guidance for those working on transfer issues. Twenty-nine General Principles in the report provided a framework for processes and policies that should govern inter-institutional student flow, ranging from state-wide policy statements to standardized testing instruments.

Public and State Involvement in Articulation

In the 20th century, most articulation signings were precipitated by personal connections within specific institutions of higher education, and it was not until late in that century that states became involved in any significant way in articulation directives.

> Historically, two- and four-year college transfer and articulation agreements were primarily institutional initiatives rather than state mandates. Now, nearly every state has some policy on transfer of credit for students moving from two- to four-year institutions. Striking differences have emerged, however, in articulation policies and practices among the states. These differences include not only how policies and practices were initially established, but also their degree of selectivity, specificity, and uniformity (Committee on Education and the Workforce Report, 2006, p. 29).

Also, historically "transfer in occupational fields has traditionally been less common and arguably more difficult to accomplish than transfer in the liberal arts" (Ignash, 1993, p. 109). This has partially been due to the public perception that this type of curriculum at the two-year level should be looked at as "terminal," i.e., that students in these programs would not look towards further higher educational opportunities or ask four-year colleges to accept the transfer of these courses.

Although students have a tendency to move freely in and out of educational systems and "one of the advantages of the American system (is) its openness to recurrent opportunities to attend higher education" (Newman, Couturier, & Scurry, 2004, p. 73), early public policy decisions in effect tracked students into one of two footpaths of higher education–occupational education that prepared the student to enter the workforce at the earliest opportunity versus the more "elite academic education path" (p. 14) that took longer but prepared the student to manage those already in the workforce.

Critics of the community college concept have argued that this division created by higher education policy makers in the 19th century actually served to maintain a social hierarchy since the community college produced workforce-ready employees with "the needed skills and a willingness to accept the authoritarian work relations that capitalism demands" (Jacobs & Dougherty, 2006, p. 18). The response on the part of the states was to develop policies that bureaucratized and standardized public education at all levels. This standardization is, in part, the reason that students in vocational programs even today are placed on this somewhat narrow and inflexible track that basically precludes baccalaureate attainment. This topic has relevance to engineering transfer because some community college engineering students are enrolled in engineering technology classes, which are classified as workforce and therefore not as susceptible to university transfer.

In summary, the movement towards formalization of articulation agreements between higher education sectors is not a new phenomenon and "the growth in the number and type of articulation agreements between two- and four-year institutions during the past 100 years could be described as a work in progress" (O'Meara, Hall, & Carmichael, 2007, p. 9). Although literature indicates that higher education is beginning

to gain a greater understanding of this issue through recent research activity specific to transfer between community colleges and universities, no one at this point would describe the knowledge of articulation processes as a science, rather more of a work in progress. An additional topic of great interest to researchers is the adjustment period for transfer students once at the university level. This concept is known as transfer shock.

Transfer Shock

Much of the earlier transfer literature concentrated on transfer students' adjustment issues, a phenomenon called "transfer shock" (Bauer & Bauer, 1994; Hills, 1965; Laanan, 1996). There is also a lingering perception within four-year academics that community college students are not academically prepared for the rigor of tier one and two institutions' coursework. This sentiment sometimes puts subtle but real pressure on articulation processes, ultimately causing some negotiations to fall apart because of perceptional differences. For example, one researcher who has looked at engineering transfer students (Ashby, 2008) proposed that future studies on this issue might investigate if there is bias on the part of university faculty against students from community colleges. In their 2005 study, Mattis and Sislin also noted that misconceptions about the relative worth of transfer students may bias students, parents, and policy makers from supporting community college engineering transfer programs.

21st Century Focus on Transfer Issues

In more recent literature, one begins to see a movement away from the concept of transfer shock and underperforming students towards the attitude that, if community college students are motivated and properly prepared, they can be successful in rigorous university programs like engineering. For example, Flaga (2007) said that students who

take responsibility for researching educational pathways have shown that the student transition process from two- to four-year colleges can be successful, resulting in minimal loss of credit or reduction of GPA at the university level. However, she called for enhanced programmatic efforts to make academic pathways more transparent to the students. She also advocated the implementation of "appropriate interventions" (p. 9) such as collaborative counseling work between community college and university advisors and formal peer mentoring programs.

In another study that looked at Washington State engineering transfer students, quantitative data showed that the community college transfers graduated with engineering baccalaureates at the same rate as their direct entry counterparts. The study found a small difference in the GPA level between the two groups of students (one tenth of a point negative difference for community college students), which the author contributed to the transfer shock phenomenon (Ashby, 2008). This study, which corroborated earlier studies (Cohen & Brawer, 2003; Townsend & Wilson, 2006), also served to confirm the viability of engineering transfer education. Research that specifically focuses on community college transfer and articulation issues is one narrow but very important piece of this educational conundrum, and, within the past twenty years, a significant amount of academic inquiry has focused on this subject. The following section serves to demarcate the transfer research most relevant to this dissertation study.

Within her paper describing different types of transfer studies, Kozeracki (2001) provided a good breakout of the types of research being conducted on transfer issues and under which umbrellas the research was conducted. She began at the macro level with a review of national studies, then moved to regional and university-based studies, and

completed the review by discussing the work of individual researchers investigating transfer issues.

At the macro level, national studies were commissioned by the U.S. Government through such entities as the U.S. Department of Education (Adelman, 1998), the National Science Foundation (*Higher Education in Science and Engineering*, 2010), and the National Academy of Engineering (Culver, Wadach, Weeks, & Anderson, 2005). Also on a national level, an increasingly large number of foundations have recently studied STEM/transfer issues, including the Lumina Foundation (*Improving Access to the Baccalaureate*, 2004) and the Pell Institute (Smith & Miller, 2009). "The overwhelming majority of the studies reported in the ERIC database are quantitative, using existing data gathered" (Kozeracki, 2001, p. 63) and provided recommendations to stakeholders based on interpretation of that data.

Kozeracki (2001) then described a second layer of investigation on articulation and transfer that came from reports produced by a growing number of university-based research centers that specifically studied community college/transfer issues. These programs included the Community College Research Center at Columbia University (Bailey, 2008), the National Institute for the Study of Transfer Students, located at the University of North Texas (Jacobs, 2004), and the Educational Leadership and Policy Studies Institute at Iowa State (Laanan, 2005). These organizations not only provided data about the progress of transfer students, but explored the effectiveness of community colleges in preparing students for transfer.

As is common in a literature review for a dissertation study, a third source of information for this review came from individual researchers. "Such reports tend to be

driven by a specific research question" (Kozeracki, 2001) and traditionally looked at the transfer issue from a student perspective. Some of these researchers have studied transfer issues for a number of years (Adelman, 1998; Cejda, 2001; Laanan, 1996, 2005; Townsend, 2001; Townsend & Wilson, 2006; Wellman, 2002), and through a combination of quantitative and qualitative methods, correlated trends on this topic, often building upon each other's work. In addition to veteran researchers, a growing number of doctoral students have begun to use transfer and articulation as the subject matter for their research as the issue is topical (Ashby, 2008; Shibley, 2004). All three source genres are represented in this literature review.

Support in the Literature for This Study

As previously alluded to, the subject of two- to four-year student transfer has recently become somewhat of an active topic in educational research. As a result, a number of investigators have started to examine where the educational system has structural deficiencies that create student roadblocks and have called for further study into specific transfer processes such as articulation. While many of these researchers use quantitative research methods, a growing number of writers investigating this issue have realized the value of qualitative tools to look at the human factors inherent to the problem. The following section highlights some of the recent literature that supported a qualitative study investigating the human relationship elements of articulation, as well as the systems required for an articulation process to be successful.

Use of the Qualitative Paradigm

A majority of the research studies published on this topic took a quantitative approach in researching the issue and focused their analysis on statistical transfer

patterns. Within literature reviews on the topic of transfer, "the overwhelming majority of the studies reported in the ERIC database are quantitative, using existing data" (Kozeracki, 2001, p. 63). As Kozeracki pointed out, quantitative research is a popular method of looking at problems in this area because of the extensive amount of existing student data collected for other reasons, for example, state reporting. Jacobs (2004) also reviewed transfer literature between 1994 and 2000 and noted that, although the number of studies on transfer issues grew dramatically within that time period, "the majority of the articles that dealt with transfer issues were developed from the quantitative paradigm" (p. 21).

Fewer investigations utilized qualitative research and the case study approach, an approach that allowed the researcher, while citing quantitative reports to highlight that there was a problem, to also delve into the *whys* behind the problem. Support for this research approach came from the "Recommendations for Future Study" sections within documents studied during the literature review. For example, the Anderson team, at the end of their statistical analysis of the effectiveness of statewide articulations, proposed that this issue of "transferring (students) must be contextualized" (Anderson, Sun & Alfonso, 2006, p. 15).

Very few studies on this topic looked at the issue from a field study perspective. In one early study, Heard (1989) investigated the development of an articulation model between a community college and two universities using case study methodology. In the study, he commented that, where articulation was nonexistent, transfer problems caused student frustration and the outcome was high attrition. In his recommendations section, Heard noted the need for greater attention at state and national levels to articulation

processes. Two other studies were found that did address the transfer issue from a field study perspective: *Innovative linkages: Two urban community colleges and an elite liberal arts college*, co-authored by Morphew, Twombly and Wolf-Wendel (2001) and *Creating and sustaining community college-university transfer partnerships: A qualitative case study* by Kisker (2007). In her work, Kisker commented that "future research that more closely examines mutually reinforcing relationships between faculty and collaborative transfer partnerships would be a valuable addition to the literature" (p. 25). Among the Twombly team's many implications for research and practice were recommendations for a qualitative investigation of articulation in vocational programs and systematic applied program articulation work. In addition to the Twombly and Kisker research teams, Hagedorn (2004) used qualitative methods to investigate student perspectives on the transfer experience and called for more work of this type. However, all three field studies looked at the issue from the student perspective and not the perspective of administrative stakeholders within the process, which was the focus of this study since higher education employees craft articulation agreements, not students.

The use of existing and quantitative data also preempted the necessity of finding specific students after transfer or gaining the cooperation of college faculty or administrators to complete the study. In her review of transfer literature, Kozeracki (2001) commented that "qualitative studies are reported much less frequently in the literature, despite the assertion that they can help us uncover the right questions, the questions raised by our students and ourselves about what we are doing, and whether we are accomplishing our goals" (p. 64). Kozeracki's statement corroborated the choice of qualitative case study research for this dissertation as a means of determining if college

strategic goals are a significant factor in successfully navigating an articulation process. Also, because naturalistic inquiry is the research method by which researchers can gain a "holistic, systemic, integrated overview of the context under study" (Miles & Huberman, 1994, p. 6), a qualitative research study best addressed the research questions posed in this dissertation, supported systems application to the study, and added to the body of transfer research that, up to now, concentrated primarily on quantitative analysis.

Researching Community College-University Collaborative Partnerships

Key investigators in community college-university interactions have warranted a strengthening of what some called "considerable leakage in the educational pipeline" (Kuh, Kinzie, Buckley, Bridges, & Hayek, 2006, p. 1). First, Thomas Bailey (2008), who directs the Community College Research Center at Columbia University's Teachers College, pointed to the need for a strengthening of relationships between community colleges and four-year colleges in order to facilitate a more efficient flow of students through the educational system. He also called for better integration with the secondary education system. Second, Townsend (2001) recommended the development of more inter-institutional articulation agreements, especially in vocational programs; for example, engineering, in the community college, is often classified as vocational.

Other writers called for additional research specific to articulation processes. Jacobs (2004) stated that "there exists a need for continued research related to agreements between two- and four-year institutions…The bottom line is that further information is needed to inform a movement towards more collaboration among all institutions" (p. 108). A National Science Foundation study, designed to examine partnerships between community colleges and four-year engineering programs while enhancing community

college pathways to engineering careers, also provided meaningful support for this inquiry. Within the study, the authors described a workshop whose participants "generally agreed that strong partnerships between community colleges and four-year engineering programs improve student recruitment and retention at both institutions" (Mattis & Sislin, 2005, p. 6). The authors of the report identified the "recruitment and retention of students at various junctures of the community college pathway to engineering careers" (p. 2) to be one of the five overarching goals for technical higher education in the 21st century.

In their study, Mattis and Sislin (2005) called for "further research identifying ways to improve the clarity, transparency, and accessibility to documentation in two-year/four-year institutional partnerships" (p. 68) in technical disciplines like engineering. "Additional research would be helpful to identify the underlying characteristics of successful partnerships (since) different types of (engineering) transfer partnerships have been developed for different reasons and from different starting points" (p. 69). Mattis and Sislin concluded the report by calling for the improvement of enabling mechanisms related to articulation and transfer but noted that this type of enhancement can only be effected "when communication and collaboration improve between two-year and four-year educational institutions" (p. 66). They also made repeated mention of the importance of including faculty and other key personnel from both the community college and the university in the planning of transfer partnerships so as to solidify a long-term agreement.

While community colleges are frequently identified in the literature as potential sources for engineering students, "relatively little work has been done to better understand how we can increase the number of students using community college as a

gateway to a four-year engineering degree" (Nelson, 2007, p. 1). Jacobs (2004) provided support for a qualitative study of this type with this statement:

> Questions pertaining to how institutions respond and work with transfer students include those directed at administrative functioning as well as those having to do with institutional-student relations. At a minimum, research in this area must describe what kind of administrative and institutional behaviors and practices produce a culture that supports transfer students' success. Further, institutional barriers and enablers must be catalogued, described, and examined to understand…how the intentionality of actions results in environments, cultures, decisions, and policies that favor transfer student access and success (p. 24).

In conclusion, an initial review of the literature on the topic of articulation indicated that researchers had not adequately concentrated on addressing the human elements of what contributes to the creation of, or lack of, a coherent process resulting in a signed articulation. In addition, this research suggested that a qualitative study researching institutional behaviors related to the transfer process would inform and strengthen the existing body of research on transfer and articulation.

STEM and Engineering Research

Because the underlying premise of the articulation studied was that community college engineering transfers could bolster flagging graduation rates in this field, it was also necessary to conduct a review of research studies that looked at engineering professions. Recognizing that the U.S. is facing a possible future shortage of engineers, in the last decade of the 20th century, the National Academy of Engineering "initiated a

study to investigate how community colleges can help to increase the number of science and engineering graduates. The goal of this study was twofold. First, to make better use of community college pathways leading to baccalaureate engineering programs; second, to establish forward-looking partnerships between community colleges and four-year engineering programs, their faculty and students" (Culver, Wadach, Weeks, & Anderson, 2005, p. 1). The study's report, describing the results of this longitudinal study, noted the need for further research on the challenges and opportunities for improving articulation and transfer between community colleges and four-year educational institutions, as well as the recruitment of students at various stages of the community college pathway to engineering. Participants in the study stated that, while those who work closely with community college engineering students accept that they are equal to their four-year counterparts, the public does not recognize the strength of those programs and that, by partnering with the community college, universities could help raise public awareness of the value for such feeder programs (Culver, Wadach, Weeks & Anderson, 2005).

U. S. declining interest in engineering education has led to global technological disadvantage. "Concerns have been raised (within the federal government) about our nation's ability to maintain its global technological competitive advantage in the future" (Ashby, 2006, p. 1) because the proportion of students obtaining degrees in STEM-related disciplines continues to fall while employment opportunities in those fields has risen. Ashby, who is Director of Education, Workforce, and Income Security Issues, stated emphatically that the health of the U.S. economy is directly tied to STEM-related industries. Specific to the engineering field, "external forces in society, the economy, and the professional environment will all challenge the stability of the engineering workforce

and affect our [U.S.] ability to attract the most talented individuals to an engineering career" (*Educating the Engineer of 2020*, 2005, p. 4).

A 2005 report from a U.S. business consortium warned that the number of engineering degrees awarded in the U.S. was down 20% from the peak year of 1985 and further noted that "out of the 1.1 million high school seniors in the U. S. who took a college entrance exam in 2002, just under 6% indicated plans to pursue a degree in engineering—nearly a 33% decrease in interest from the previous decade" (*Tapping America's potential: The education innovation initiative*, 2005, p. 6). The Engineering Workforce Commission also reported that between 1990 and 2002, the number of bachelor's degrees awarded in engineering decreased by 5% (*Bachelor's degrees awarded in engineering*, 2002). For instance, the Texas A&M website reported that, between 2000 and 2002, they experienced a 4.9% drop in technical awards granted, reflecting general enrollment patterns in Texas.

This negative trend is exacerbated by changes in U.S. demographics. Traditionally, STEM fields like engineering have been populated by a relatively high proportion of Caucasian or Asian males. Ashby (2006) cited a National Science Foundation survey that noted, between 1975 and 1997, the number of male science and engineering baccalaureate graduates declined by 5% in the U.S. During this same time period, women made slight gains in general baccalaureate degree attainment—possibly a reflection of general college enrollment—and females now predominate but the millennium population has become more culturally diverse, and "demographic trends affect STEM fields because different races and ethnicities have had different enrollment patterns" (Ashby, 2006, p. 5). Some minorities are not well represented for a number of

reasons in the STEM student population. Although Asian students are well represented in STEM disciplines, African-Americans and Hispanics especially remain under-represented both in the STEM student and workplace ranks.

Importing engineers into the U.S. In 2003, science and engineering indicators showed a slight upturn in the number of graduates (*Science and engineering indicators*, 2006), but this additional supply has not kept up with demand, and many companies are now `importing' engineers from other countries to fill their work ranks, contingent on work visa availability. In fact, after a period of decline due to a decrease in student visas issued, foreign student enrollment in U.S. science and engineering programs has increased for the past three years, and three quarters of those students plan to stay in the U.S. after graduation, with the goal of finding an American company to sponsor them (Higher education in science and engineering, 2010). As of the time of this January 2010 report, approximately half of those foreign student graduates had accepted firm offers of employment. With the declining number of U.S. engineering students enrolled in American colleges, American students are in danger of becoming a minority population within engineering programs. In addition, with business globalization, the marketplace for engineering services is more worldwide with jobs moving more freely across national boundaries, so the U.S. risks losing the native engineering brainpower it develops through its educational systems to other countries' industries.

*America's STEM/engineering education not keeping pace with the world***.** Statistics demonstrate some alarming trends in this area. In math academics, a key engineering pre-requisite subject, U.S. students are not keeping pace with the rest of the world. In the 2006 Program for International Student Assessment, the U.S. ranked 24th

out of 30 countries belonging to the Organization for Economic Cooperation and Development (OECD) (*Preparing our children for the future,* 2010, p. 1). The National Center for Educational Statistics corroborates this negative trend by noting that "fewer than one-third of U.S. 8th graders performed at or above a level called proficient in mathematics" (*Rising above the gathering storm,* 2007, p. 15). Other relevant statistics are listed in the following paragraphs.

In science rankings, another key academic area required for engineering disciplines, OECD rankings place U.S. students 17th out of the 30 countries measured. This may be due in some part to the fact that 93% of U.S. elementary aged students are taught science by teachers lacking certification in the physical sciences (*Rising above the gathering storm*, 2007, p. 15). According to the National Center for Educational Statistics, "U.S. 12th graders performed below the international average for 21 countries on a test of general knowledge in mathematics and science" (*Rising above the gathering storm*, 2007, p. 15). This figure represents a steady decline in academic world leadership over the previous twenty years.

U.S. engineering graduation rates lag behind many industrialized countries; for example, 50% of all undergraduate degrees granted in China are in engineering fields. In France, the figure is 47%; South Korea reports a 38% rate; and Singapore leads with 67% of its undergraduates leaving school with an engineering degree. In contrast, the U.S. reports a relatively unimpressive 15% engineering graduation rate for all baccalaureates during the same time period (*Science and engineering indicators,* 2004).

Between 2004 and 2007, both China and India doubled their production of engineering degree holders while, during that same timeframe, U.S. engineering

graduation rates stagnated at the previously mentioned 15% graduation rate (*Rising above the gathering storm*, 2007, p. 16). One factor in this engineering degree increase in foreign countries is a pronounced increase in the number of higher education entities in both countries, including American universities that have created international satellite campuses. For example, Texas A&M now offers a comprehensive engineering program at their satellite campus in Qatar.

Other nations are spending more than the U.S. to provide incentives for students to study science and engineering. In comparison, U.S. federal funding of engineering students has remained constant since 1996 with less than 25% of the engineering students receiving governmental support for their education (*Science and engineering indicators,* 2010). Other nations go beyond monetary aid to support engineering higher education. For example, "to attract the best students from around the world, universities in Japan are offering science and engineering courses in English" (*Rising above the gathering storm,* 2007, p. 76). In 2000 (the last date figures were available), 38% of the Ph.D.s working in U. S. science and technology were foreign born, and presumably this figure continues to rise in the 21st century. Specific to engineering, the number of foreign students studying that discipline in the U.S. rose by 7% in 2007−2008 (*Higher education in science and engineering*, 2010). The U.S. government has put the following STEM-related degrees under a classification known as an area of national need, a classification that includes engineering, biological and life sciences, mathematics, and physical sciences. (*Closing the gaps by 2015: 2009 progress report,* 2010). This prioritizes grant money for students who show the aptitude and inclination to progress through the somewhat arduous path of STEM coursework.

U.S. companies are beginning to outsource their technology-related work to countries like China and India both because of the lack of qualified workers in America, and because companies can hire eight professionals in a foreign country such as India for the cost of one in the U.S. (U.S. Department of Labor Statistics, 2008). "The movement overseas [is] not only in manufacturing jobs but also jobs in administration, finance, engineering, and research" (*Rising above the gathering storm,* 2007, p. ix).

Table 3 and Figure 2 illustrate how the U.S. compares to other industrialized countries with respect to engineering graduates. Table 3 compares the U.S. to China in terms of engineering graduates to total baccalaureate degrees granted. Figure 2 then visually demonstrates America's relatively poor position in science and engineering graduates, compared to other economically developed nations in the world. Although the statistics that make up the first chart were taken from 1998 figures, the *Higher education in science and engineering report* (2010) confirms that, while the percentage of Chinese science and engineering graduates has risen to 53% in the 21st century, the U.S. percentage has remained relatively flat. This report shows a further breakdown of statistical patterns, showing engineering-only graduates in the year 2006 and demonstrating the continuation of a negative trend in U.S. engineering graduates compared to the U.S.'s largest economic competitor—China.

Table 3

Comparison of U.S. Engineering Graduates to China

Country	Science and engineering % of total grads	Engineering only % of total grads
China	53%	33%
U.S.	32%	5%

From *Higher Education in Science and Engineering*, 2010.

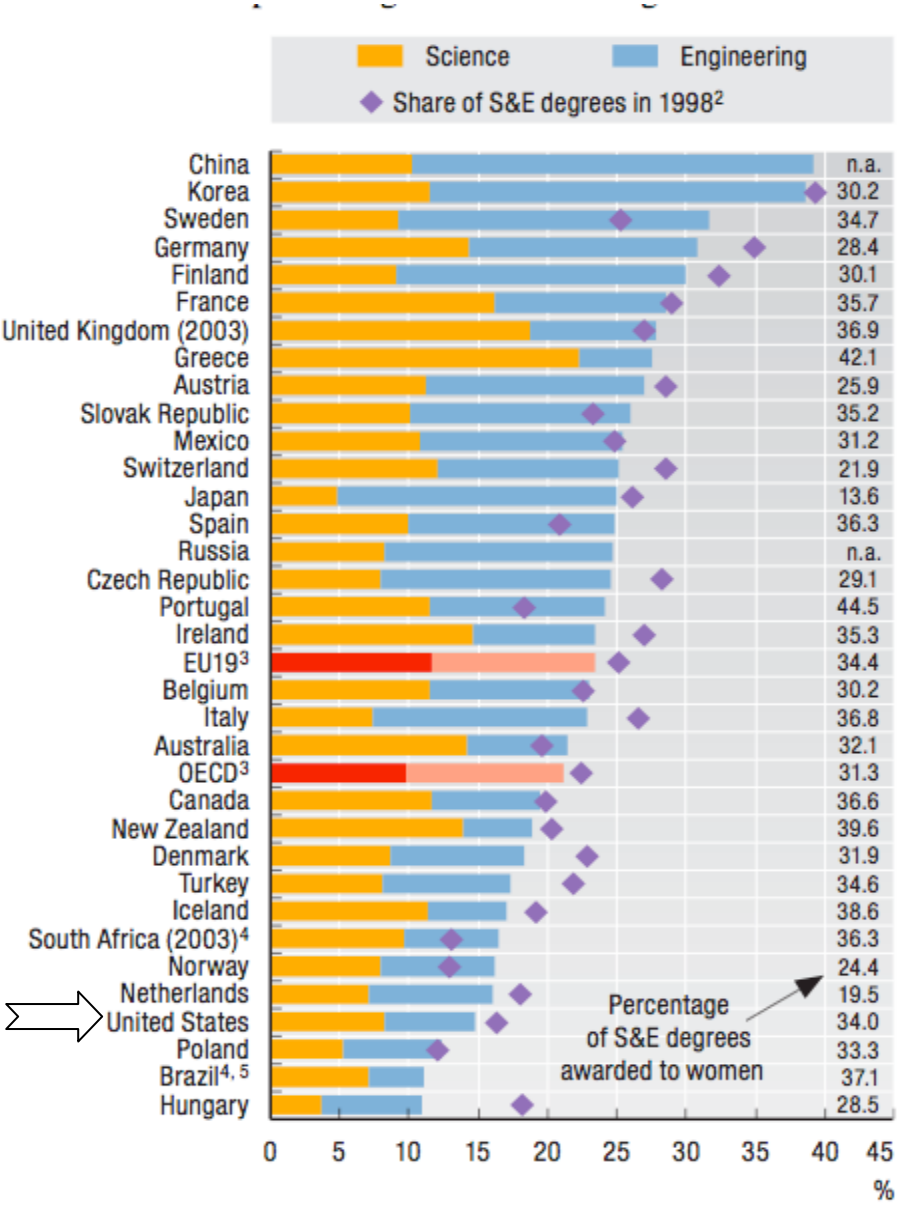


Figure 2

International Comparison of Engineering Degree Recipients

From"Science and Engineering Degrees as a Percent of New Degrees Internationally," (2007). *Science, Technology and Industry Scorecard.* Copyright 2007 by OECD.

While Table 3 and Figure 2 indicate engineering educational deficiencies in the U.S., some higher education leaders have objected to these international comparisons and believe such figures are misleading and not a true reflection of the number and quality of engineers that U.S. colleges continue to produce. Although many higher education administrators express concern that "the greater funding for overseas universities will put American universities at a disadvantage" (Immerwahr, Johnson, & Gasbarra, 2008, p. 20), this decline in intellectual production in the U.S. is not considered irreversible, and the OECD has noted that the U.S., over the long term, still maintains its leadership position in science and engineering, which has driven its dominant strategic positioning in the global economy.

This section of the literature review has delivered an overview of the status of U.S. STEM-related industry trends, juxtaposed against other developed countries. It served to highlight the potential threat of intellectual deficiencies in science and math areas and alluded to the need for the entire education system to work hand-in-hand with industry to alleviate that deficiency. Community colleges are an integral piece of the academic puzzle, and the next section shows how those pieces of the puzzle support STEM education.

Current Trends in Engineering Education

As of 2000, 44% of all bachelor's degree recipients had attended community college; for engineering graduates, that figure is 40%. However, only 22% of those engineering students had stayed to receive an associate's degree, presumably completing their core coursework then transferring to a four-year university (Tsapogas, 2004, p. 2). It will be pointed out later in the dissertation that this low percentage of graduates in

community college engineering programs has caused the potential for goal incongruence between community college and university administrators working on articulation agreements. This incongruence is heightened because a key accountability measure by which states evaluate community colleges is their graduation rates, while universities are not specifically evaluated on the perseverance of transfer students to degree attainment.

The U.S. government, realizing the importance of the STEM transfer issue, has become involved in this initiative at all levels of education. One example of this involvement is the Commission on the 21st Century Education in Science, Technology, Engineering, and Mathematics that recently completed a report calling for the creation of state and regional P-20 councils charged with aligning STEM benchmarks. This council would work to ensure that students are ready for college-level coursework in demanding curriculum areas like engineering (Dembicki, 2007). This report also called for a reduction in barriers that inhibit students from transferring between higher education institutions. A second example of governmental action is the National Science Foundation, which has designed an Engineering Education Coalitions program established to "stimulate bold, innovative, and comprehensive systemic reform of undergraduate engineering education and join universities and colleges of differing characters in collaboration, acting as change agents for the engineering education community at large" (Frair, Cordes, Cronan, Evans, & Froyd, 1997, p. 10). A third example is the League for Innovation, one of the premier research organizations geared to community college advancement in the U.S., which organized a College and Careers Transitions symposium. During this conference, keynote speaker Scott Hess from the

U.S. Department of Education urged community college professionals to work on STEM pipeline issues to improve student transitions and success.

Regional Focus on Transfer

State governments can have a great deal of influence on colleges' positions on transfer and "the success of the transfer function across the U.S. has had more to do with strong state leadership and the resulting commitment to transfer success than to any (other) issue…the transfer function is alive and well and works best in states where formal articulation-transfer agreements are mandated" (Barry & Barry, 1992, p. 37). Although states are not yet uniform in their position on transfer, today every state has some form of transfer and articulation policy in place (Knoell, 1990; Townsend 2001; Ignash, 1993), but the level of enforcement varies widely from state to state and, in some states, articulation is a voluntary process for schools to implement on a discipline-specific basis. States, however, are gradually moving to increase efforts to motivate colleges towards formalized articulations and are starting to monitor colleges' adherence to published agreements. A representative of the Southern Regional Education Board, Dr. Cheryl Blanco, says that "the growing effort by states to create tighter linkages between community colleges and four-year schools has evolved partly because state officials anticipate their work forces will require a great number of four-year earners" (Roach, 2009, p. 2). This is partially due to the Perkins Act of 1991 that pushed states to develop comprehensive technical preparatory higher education plans or risk losing federal funding.

In her report, Blanco noted that state officials, looking especially at the growth in the Hispanic population in their states, realized that they will not see enough population

entering directly into four-year schools to meet future workforce demand; consequently, they are turning their attention to community college workforce preparation programs, and in particular, regional education leaders are focusing on ways to make gains in engineering transfers through articulation. In states such as Texas, where there is a disproportionate demographic growth in the Hispanic population, this research topic is especially pertinent to higher education at both the community college and university levels.

Higher education administrators are becoming more innovative in finding ways to smooth student pathways without compromising academic rigor. For example, while at Kansas State, De Leon and Dandu (2006) presented "a cooperative enterprise with Kansas community colleges to construct an innovative articulation model for seamless transfer of community college credit hours" (p. 2) to Kansas universities. They offered a plan to create a mechanism by which students could attain an Engineering Technology Bachelor's degree from Kansas State after matriculating from area community colleges and especially noted the need to involve faculty in the decision making process, as well as the importance of developing a plan of action congruent with the strategic goals of the college(s). Although this study looked at the question from the perspective of the university partner, it had direct relevance to this dissertation because the lead author, De Leon, is now a dean at the community college that was observed in this case and had influence on the choice of case study. Accordingly, this study built upon De Leon's research and his efforts to bring an engineering articulation to Lone Star College, especially as it relates to strategic planning efforts.

Texas Transfer Trends

As a qualitative researcher, I had a choice in both the methodology and the geographical location within which I focused my study. Since a number of researchers had previously referenced Texas as a state within which much transfer and articulation work was being investigated, and since the majority of my higher education contacts resided within that state, I made a conscious choice to direct this research study so that it could build upon the work of other investigators whose work targeted Texas. The following section further details Texas transfer trends that influenced this study.

According to Kintzer (1975), Texas Education Code Chapter 61.051 created the Texas Higher Education Coordinating Board and directed the new board to develop a basic core of general academic courses (termed statewide common core) that, "when offered at a junior college during the first two collegiate years shall be freely transferable among all public institutions of higher education in Texas who are members of recognized accrediting agencies on the same basis as if the work had been taken at the receiving end" (p. 26). This code was geared to academic courses only and resulted in the Texas Common Core of Curriculum. This code was amended by the state in 1981 to require every higher education institution to appoint an articulation officer with the responsibility of both disseminating transfer information and coordinating transference of credit, as well as working on articulation agreements. This position served as an inter-institutional contact between community colleges and universities. Kintzer terms the Texas model a "modified transfer core approach" (p. 27), which offers flexibility between institutions rather than the one size fits all articulation policy other states had adopted. Although Kintzer cautioned that, because of this flexibility, the Higher Education

Coordinating Board in Texas must continually watch "for different interpretations of the lower division placement of community college courses by university departments" Kintzer, p. 27), which has, in fact, led to instances of `game playing' through different interpretations of state policy regulations. Wellman (2002) reported that Texas alone, among six states reviewed in her 1999 transfer policy report, had "established a small financial aid program designed to reach transfer students" (Wellman, 2002, p. vii), linking such funds to transfer commitment. Texas is also one of the states that have designed a common course numbering system; however, this system is not yet utilized by all Texas public universities.

Although Texas has fairly robust two/four-year student transfer rates (Barry & Barry, 1992), a review of transfer literature showed that Texas is not known as what Wellman (2002) refers to as a `high performing' state in terms of transfer policy, unlike Florida and North Carolina. This is partially due to the higher education governing structure in place in Texas. Whereas Florida's educational governance system is highly centralized with much power given to the Coordinating Board, in Texas the Higher Education Coordinating Board, while charged with "overall responsibility for postsecondary planning, data collection and policy analysis" (Wellman, 2002. p. 1) has a more limited role in curriculum functions, maintaining final approval on all new courses and programmatic changes. Texas' Higher Education Coordinating Board also requires that schools report student transfer data; however, there does not yet appear to be an accurate and comprehensive method in place in Texas to track after-transfer student baccalaureate degree completion rates.

Under statutory direction, as previously mentioned, the Texas Higher Education Coordinating Board has developed both field of study guides and a common course numbering system for lower division courses. Information published by the state notes that

> many institutions—including every public college and university as well as many private colleges—have adopted the common course numbering system for lower division courses (and) institutions that choose not to use the common course numbers are required to publish a cross walk between the common course numbering system and their own (Wellman, 2002, p. 2).

Interviewees for this research study commented on a number of situations where this mandate had not been followed by universities. This topic is revisited in Chapter IV, as the common course number system affects articulation processes.

Texas is a state where less than 10% of its students leave the state to attend college (Cohen, 1996) and is noted as having one of the most robust community college systems with a community college "within easy commuting distance of practically everyone in the state" (Cohen, p. 26). This is especially beneficial to underrepresented minorities who use the community college as their access point to higher education, but it also intensifies the need for more and better articulation between educational sectors. In spite of the ready access to community college, Hispanics are currently not enrolled in higher education in proportion to overall state demographic growth. The 2010 *Closing the gaps* report issued by the Texas Higher Education Coordinating Board showed that, in order to reach their targeted goals by 2015, Hispanic student enrollment in higher education needs to increase by 310,000 students (or +84%), a charge the report called a

"daunting task" (p. 21). Secondly, the report also said that Texas undergraduate degrees in technology-related fields have been flat for the past decade and must increase by 125% to reach 2015 goals. Thirdly, the report noted that the Texas Higher Education Coordinating Board, using a Lumina grant, was specifically seeking ways to improve articulation for community college students in STEM disciplines who would like to transfer to Texas universities (*Closing the gaps by 2015: 2009 progress report*, 2010, p. 3).

This same *Closing the gaps* report identified engineering as one of four areas in most need of bachelor's degree awards. The others were education, biology/life sciences, and computer information systems. Although state economic conditions may cause fluctuations in workforce needs, engineering consistently remains close to the top of this list due to Texas' economic reliance on the energy field. However, only a few researchers (Bush, 2002; Coleman, 1991; Creech, 1997; Timmerman, 1995) have specifically focused on the state of Texas and articulation processes within the state. The portion of the literature review described in the following paragraphs highlights the appropriateness of concentrating a case study investigation of engineering articulation in Texas schools.

Timmerman's report (1995) of a two-year survey of administrators from all Texas community colleges delineated their perceived importance of factors contributing to the success of community college transfers to four-year institutions. Factors they rated most important (4 or 5 on a 5 point scale) included: formalization of articulation agreements with senior institutions, faculty participation in articulation conferences, early identification of potential transfer students, faculty advising, and transfer scholarships, all

topics that were worked into the interview either within the protocol or during informal discussion.

Bush (2002) looked at Texas policies regarding articulation and transfer and noted the importance of faculty involvement, stating that "one factor that is vital when studying higher education issues is the perception of the faculty" (p. 139). He followed by recommending that future studies include examination of the faculty perspective on articulation, and he also described an example of a Texas university professor who, during a Texas House subcommittee hearing on proposed articulation legislation, "expressed concern that courses in the field of study curriculum of one institution may not be on the same level as the receiving [i.e., university level] institution's courses" (p. 102) and thus might cause the student to be unprepared to meet the rigor of the four-year program. Based on the input of Bush and other researchers, the protocol within the study specifically addressed the issue of faculty involvement in the articulation process.

Faculty Issues

Research has shown that community college instructors in a specific discipline have a great deal of influence on students' plans to transfer to a four-year program (Britt & Hirt, 1999; Cejda, 2001; Tatum, Hayward, & Monzon, 2006; Townsend, 2001). Britt and Hirt's study cited faculty interaction as one of two key themes that precipitated student transfer into a four-year program; however, it was not clear if faculties perceived themselves in this role of transfer facilitator or were qualified to perform this function. Tatum, Hayward, and Monzon studied this question and reported that, not only were faculty in general not involved in the transfer process or knowledgeable about it but,

within their sampling, faculty did not perceive that transfer facilitation was part of their role.

Even though faculty apparently are often not initially involved in the creation of transfer processes, the literature was filled with references for the need to include them to a greater extent in policy decisions related to student transfer (Fathe & Kasabian, 2008; Helm & Cohen, 2001; Kincaid, et al., 2005; Tatum, Hayward, & Monzon, 2006). These authors made the point that, although the articulation agreement was often the first step in smoothing student pathways to transfer, it did not become a living document unless and until the stakeholders who interacted with students on a daily basis (i.e., the advisors and faculty) accepted that the process worked to the benefit of the students. Especially when the impetus for the articulation came from top administration, faculties sometimes believed that the agreement between the two schools was made for political purposes and not for the good of the students. So because faculty were often the disseminators of transfer information, these writers believed it was to the benefit of administration to include at least one faculty member on the negotiating team early in the articulation negotiation process rather than when the agreement was ready to be signed. Since "it is essential that university faculty collaborate with their community college peers in the development of a seamless transfer curriculum" (Tobolowsky, 1998, p. 3), this group of writers felt it important that faculty on both ends of the process understand their role in that process.

Although studies on transfer and articulation highlighted in the previous paragraph point to the benefits of increased cooperation between the two- and four-year levels, research findings also revealed a number of barriers to effective transfer. As noted

by Tobolowsky in the previous paragraph, faculty may be instrumental in creating pathways between the two tiers of education. However, they may also be just as effective in putting up barriers to those pathways. "Political turf arguments result in a divisive and false dichotomy" (*Improving access to the baccalaureate*, 2004, p. 6) with university personnel sometimes devaluing community college faculty's credentials while community college faculty's defensive posturing interferes with effective communication. Also, because of the "strong tradition of local faculty autonomy over curriculum" (Moore & Shulock, 2009, p. 1), it has often been difficult to create state-level transfer plans that are faculty endorsed. Faculty at each university act autonomously to set program requirements and course prerequisites, which makes it harder for community college students to preplan their freshman/sophomore level curriculum since they often do not know to which university they are planning to transfer when they sign up for the courses, and programs vary widely among institutions.

Barriers to the Transfer Process

Allied to the faculty issue is the concern about course content. Engineering curriculum at the university level, responding to rapid marketplace changes, is frequently modified, and these adjustments make it hard for engineering and science (ES) programs at the community college to consistently adjust content and match course outcomes. This causes a mismatch of courses offered, found to be an issue in the articulation studied in this dissertation, making the course-by-course evaluation required for an articulation very difficult to effect, and the common course numbering system advocated by the state equally challenging to maintain. As a result, "students can find that, just when they think they have met the requirements for transfer to a particular program, those requirements

are changed so that additional courses are required….in short, transfer requirements are a moving target" (Moore & Shulock, 2009, p. 6).

Another barrier is the lack of articulation itself. When asked to rank obstacles to the acceptance of the first two years of credit into university programs, four-year colleges ranked the lack of existing articulations as the number one barrier and community college officials ranked this number two in terms of obstacles to effective transfer (*Improving access to the baccalaureate*, 2004). A panel of community college and university STEM administrators, while acknowledging that two-year colleges provide large numbers of upper division students, also agreed that "articulation at this transfer point is difficult and requires a serious and permanent collaborative effort between the source and acceptor colleges" (Kincaid, et al., 2005, p. 3). To follow up on this potential barrier to long-term success, the case study protocol included a number of questions that asked participants to think more deeply about the implications for long-term collaboration between the two sectors.

A third potential barrier was admissions requirements within programs at the accepting institution. For example, a specific discipline, even though it may have a negotiated articulation, may have GPA requirements that exceed general education requirements for the institution, or that program may require course-specific tests to ensure that transferring students have the competencies required for subsequent coursework (tests that native students are not required to take). While sometimes unintentional, these "practices and policies might have unintended consequences" (*Improving access to the baccalaureate*, 2004, p. v), creating sufficient barriers or additional obstacles to stop a qualified community college student from transferring.

Added to this is the fact that "community colleges do not have a robust network of support services, including an adequate number of counselors and advisors to help students navigate through the complex transfer process" (Moore & Shulock, 2009, p. 1), and it might appear to an outsider observer that the higher education system has created a "perfect storm" of impediments designed to prevent student transfer.

The 2009 report Prepared for the Lumina Foundation (*Best practices for state wide articulation and transfer systems)* attributed the existence of many of these transfer barriers to institutional culture and mission differences between the community college and the university. "A major source of cultural differentiation occurs between subsets of institutions, such as community college and research universities. Their administrators are apt to use different vocabularies….and emphasize the importance of different missions and purposes, and their faculties are likely to have different interests and training" (Birnbaum, 1988, p. 75). All of this contributes to a potential lack of communication between sectors.

Although college students often begin their academic careers in community colleges for monetary reasons, transfer into high demand programs such as engineering may be problematic for the community college transfer student as schools cut back acceptance of that category of student for budgetary reasons.

> Many schools are tightening their belts as transfer applications rise, making it harder to gain admittance….at many schools, particularly those where students tend to stay put after freshman year, acceptance rates for transfers are significantly lower than they are for incoming freshman (Britt, 2009, p. 1).

Britt used Boston College statistics to demonstrate this phenomenon, where the acceptance rate for transfer students was less than 15%, compared to 30% for incoming freshman applicants.

As the previous paragraph points out, there are a number of legitimate barriers to engineering student success within the higher education system, which implies that this system is not working effectively. For this reason, I looked at systems theory to inform the study with the thought that, if educational systems were improved, transfer rates might also be enhanced. Therefore, the next section gives the reader an update on literature related to systems theory.

Systems Theory Literature

Although "the American compulsory education system is rationally organized" (Cohen, 1996, p. 25) and students moving from one school to another usually have little problem with course transfer, in comparison, higher education is "disorderly…and the curriculum in American higher education is confusing. The content of what are ostensibly the same courses varies across institutions and often varies within different sections of the same course" (p. 25). This disorganization works against the goal of student graduation and calls for a construct to "make sense" (Birnbaum, 1988, p. 175) of this confusing network and impose order. It is this need to impose order that made systems theory an appropriate framework for this study.

Articulation as a method of systematically linking educational components. Specific to the issue of articulation, the systems perspective looks at processes in terms of relationships and integration, recognizing that systems, instead of being rigid formations, are intrinsically dynamic in nature. This view of systems creation and renovation has

relevance to the topic of engineering articulations because agreements where students take two years at the community college and two more at the university (termed 2 + 2) are, by their very nature, a reconfiguration of the more traditional path to a baccalaureate degree and "local and statewide articulation agreements have become the focal points of transfer facilitation in recent years" (Jacobs, 2004, p. 12). However, the transfer path for students is littered with a number of roadblocks, some based on traditional and old school thinking. It is commonplace in the literature to characterize higher education as concerned with maintenance of the status quo and plagued by inertia (Cohen, 1996; Kerr, 1982; Kotter, 1981). Birnbaum described this negative situation, saying that "when groups lose their ability to affect their institution through the implementation of positive and constructive programs" (Birnbaum 1988, p. 15), inertia becomes more pronounced. Much attention is being paid today on researching ways to change archaic higher education systems to ones where the general public and their elected representatives support postsecondary institutions as a system of interdependent and complementary elements that fit together as a whole, not as different, competing elements. Once this occurs, "education is then viewed as a process, not institutional forms or types" (Bender, 1990, p. 6). Within the positive and constructive process of creating an interdependent and complementary articulation "calcified thinking needs to give way to a more flexible attitude" (Ciciarelli, 1993, p. B2).

It is also important to acknowledge that "challenging the conventional wisdom is sometimes a painful process. It demands questioning the sacred assumptions and developing a collective ability to reconceptualize the relevant variables into a new ensemble" (Gharajedaghi, 1999, p. 87). The old adage `change is hard' is certainly

relevant to creating a new articulation, especially between colleges and departments that have not previously worked together. The reconceptualization could take many forms, but one way to reconfigure higher education transfer processes could be through an improvement in linkage between the educational components through articulation**.** As the case study planning unfolded, systems theory provided a valuable backbone around which the research study was organized. The following section expands upon the introduction to systems theory laid out in Chapter I.

Systems theory background. A historical overview of systems theory provided the lens through which one could visualize how this theoretical application to this higher education issue was appropriate. Pioneer studies in systems theory, such as those set forth by authors like Bertalanffy, "recognized the compelling need for a unified and disciplined inquiry in understanding and dealing with increasing complexities" (as cited in Banathy & Jenlink, 1996, p. 37). In his landmark study *General systems theory*, Bertalanffy noted the need for integration in scientific education and suggested that "models can be generalized across various systems" (as cited in Banathy & Jenlink, p. 37). Bertalanffy's work set the stage for other researchers who, in the latter part of the 20th century, began to use systems theory as an application for analysis of processes and systems within the field of education. For example, Checkland (1981) furthered Bertalanffy's use of system theory applied to education when he stated that "education as a human activity system is a complex set of activity systems" (as cited in Banathy & Jenlick, p. 44). The Bathany team also built on Bertalanffy's work; in their article on systems inquiry, they proceeded to use early system thinking advocates' concepts to suggest a new "systems view of education" (Banathy & Jenlick, p. 47), one that operates at interconnected levels, all

interdependent and integrated. Bathany and Jenlick felt that "systems inquiry is highly under conceptualized and underutilized" (Banathy and Jenlick, p. 47) in education studies and advocated the development of open systems thinking to resolve problems like the one described in this study. Systems thinking, as described by Bathany et al., would suggest that instead of viewing education as a series of isolated components [e.g., secondary education, community college education, undergraduate education], educational researchers would benefit from a more thorough analysis of the interactions among the various components of the educational system. Ackoff (2009) supported this viewpoint by describing educational systems as "purposive systems (that) are more open than closed and react to their environment in order to maintain their viability" (p. 45). He believed that the educational systems "cannot be divided into independent parts and that its properties derive out of the interactions of its parts and not the actions of its parts taken separately" (p. 31). At the same time, each of these parts must be clearly delineated from the other so each is clear about its relative role in the educational system and can effectively carry out the appropriate mission.

In the 1990s, two seminal reports on student transfer set the stage for further work in investigation of transfer systems. In 1990, Knoell reported the findings of her 1985 study on transfer and articulation, *Transfer, articulation, and collaboration: Twenty-five years later,* which was in itself an update of her earlier study commissioned by the American Association of Community Colleges (AACC). A highlight of that report was Knoell's acknowledgement that it was time to (re)position community colleges as comprehensive educational institutions and recognize them as equal partners in the higher education system. Also in 1990, Bender published a report for the AACC that addressed

transfer opportunities for underrepresented populations and called for moving from articulation to collaborative programs, which would make student flow a more seamless process.

Systems theory used as a lens to view higher education. Although some researchers (Forrester, 1996; Lee, 2002) in the education field had previously applied general systems theory to the research of secondary education, starting in the 21st century, a number of educational investigators (Crawford, 2005; Frost 2005; Shibley, 2004) began to examine higher education through the lens of systems theory. Crawford (2005) used systems theory to illustrate how higher education institutions, realizing the need for change and adaptation, began to open themselves more fully to the outside environment. In his text, Crawford (2005) explained how "new models of organic systems theory provide the first attempts to describe organizational adaptation of higher education institutions, whose turbulent environments demand changes in this class of organization" (p. 11). Shibley (2004) used systems theory to develop a conceptual framework for a case study analysis of the accreditation process of a specific university. In this study, Shibley concentrated on individual elements of the accreditation process using the systems approach of analyzing inputs, throughputs, and outputs.

Another researcher applying systems theory in his higher education research work was Frost. Frost (2005) noted that systems theory was being applied to academic organizations as a means of better understanding processes. He felt that, by utilizing a systems approach to analyze an organization, one can "identify commonalities through use of systems components…to better identify the inputs, components of, and type of

system" (p. 18). All of these authors informed the dissertation study process through the use of systems terminology and thinking as applied specifically to higher education.

Community colleges viewed as the Wal-Mart of higher education. Most of the authors mentioned in the previous section applied systems thinking either to higher education in general or used it to analyze four-year institutions. Cain (1999), however, applied a systems approach to specifically critique the community college, and since one half of the partnership studied was a large community college system, it was appropriate to include his work in the review of relevant literature. Cain's somewhat controversial book, *The community college in the 21st century: A systems approach*, presented an admittedly critical viewpoint that the community college had become the Wal-Mart of higher education partially by "maintaining good quality at low prices" (p. 2). Cain made the important observation that, when an institution of higher education is "viewed from a systems perspective" (p. 16), its students, faculty, and administration all have influence over an outcome so all could be considered inputs into the development of a process like articulation. Cain further stated:

> The systems thinker recognizes that situations…do not directly recur. Systems thinking recognizes that each situation is new and must therefore be handled in a new way. For the systems thinker, each situation grows out of a specific set of interactions (p. 112).

So, in the case of an articulation, one set of interactions resulting in a signed agreement may not have the same effect in another articulation negotiation. This point was important to keep in mind for the last chapter of this dissertation. Even the interviewees corroborated what Cain said. "Articulation agreements/processes can't be cookie-

cuttered" (p. 112). Cain concluded with the lyrical description of higher education as "a systemic whole, made up of relationships between the various parties; the parts are not actually separate and distinct but instead are intermingling; they are water from several glasses flowing together in a pool" (p. 122). With this quote, Cain painted a visual picture of systems theory in action.

Higher education, a series of loosely-coupled systems. Systems theory ascribes to the idea that smaller systems (subsystems) exist within a larger system and that these systems are loosely coupled (Fusarelli, 2002). The term loose coupling creates an image of educational organizations related through some common denominator—in this case, the desire to produce engineering graduates. In his 1976 article, Weick defined loose coupling as a situation in which elements are responsive to each other but retain evidence of separate identity. Therefore, the engineering discipline in higher education might be described as a system with subsystems consisting of community college engineering programs and university engineering programs that are loosely coupled and have the mutual goal of producing workforce-ready engineering graduates. Birnbaum believes that, while it is not necessarily a negative for higher education subsystems to be loosely coupled, "in general, loose coupling makes coordination of activities problematic" (Birnbaum, 1988, p. 40), therefore impeding inter-system planning and coordination.

Systems theory applied to transfer and articulation. It is advantageous for the boundaries of subsystems to be open to interactions with other system sectors. Birnbaum (1988) terms this "relatively permeable", which is the degree of openness between the two subsets of the system that would determine the extent to which the respective players are willing to enter into a partnership and encourage students to cross subsystem

boundaries, symbolized by the creation of the articulation agreement. “A more cohesive transition process [for students] might emerge if institutions could realize that a systematic and proactive retention and graduation plan is beneficial to both two- and four-year colleges, as well as to transfer students” (Jacobs, 2004, p. 12).

But what impetus do these subsystems have to look beyond their own environment and reach out to become loosely coupled to another higher education entity through articulation? In his work, *All one system*, Hodgkinson (1985) observed that educators tend to perceive education as “a set of discrete institutions working in isolation from each other” (p. 6), and because of this lack of connection among the various levels of education, “the school is defined as the unit, not the people who move through it” (p. 6), thus reducing the potential for students to move between levels, in this case, between community college and university levels. The question of stakeholder motivation to engage in articulation processes was introduced by interviewees a number of times during the conversations; accordingly, the topic of how to inspire potential participants to reach through semi-permeable systemic walls to create partnerships is further discussed in Chapter V.

It would be appropriate, however, to note that each tier or subsystem of education has an “external environment of which it is aware” (Tamas, 2000, p. 7), and in the 21st century, academic higher education systems are beginning to work assiduously, through environmental scanning processes, to incorporate external environmental factors into their strategic plans. Today’s college programs are listening to employers who demand greater numbers of graduates in technical fields, but in order to meet that demand, administrators are beginning to realize they must reach beyond their college boundaries

to acquire qualified students. So during this study, the importance of both internal and external factors as motivators to affect articulation through questions posed during the interviews was investigated.

Systems Theory Components Defined in the Literature

Although a number of authors (Cain, 1999; Crawford, 2005; Frost, 2005) referred in general to systemic components of higher education, relatively few of these writers defined and isolated the terms. For the purpose of this study, it was meaningful to explicitly define the discrete components of the systems terms that were used to research the articulation process.

Inputs. At its most basic level, an input is something that is put into a system or a component of that system. In terms of higher education systems, and articulation processes in particular, inputs range from general concepts like sociopolitical, economic, and organizational leadership philosophy (Shibley, 2004) to very detailed "inputs such as students, money, and books" (Birnbaum, 1988, p. 31). It is also important to recognize the potential effect of college administration on the process, especially the support of the colleges' chief executive officer (Bogart & Murphey, 1985). More subtle inputs could include external influences such as state-wide articulation agreements as well as "the various resources needed to (start and) run a program, e.g., money, facilities, and staff" (Mizikaci, 2006, p. 43). So, from this definition, it is evident that a variety of inputs would be responsible for pushing `products,' i.e., students, into the engineering pipeline and dissertation research delved further into what inputs contributed to the successful implementation of an articulation agreement.

Throughputs. Mizikaci (2006), who termed educational throughput as the "transformation process" (p. 48), described the throughput process as the actions taken to effect the program, i.e., articulation, and the processes used by the educational institution(s). In terms of the initial agreement, throughput consisted of the processes used (formal and informal) to create and sign the agreement. Once that agreement is signed, throughput would be comprised of the courses, the delivery of those courses, and in general how that knowledge is disseminated to the students. Throughput would also include how the institution relates to the student outside of the class environment and those entities that advise them throughout the process. So throughput would greatly influence the extent to which the students stay in that educational pipeline and matriculate from a specific program of study.

Outputs. Output is the concept in systems theory used to indicate the immediate end product of a chain of events and is usually measured in terms of volume. In higher education, outputs include the detailed units of service attained; that is, the number of clients served, number of students taught, number of program graduates, "as well as academic achievement [success rates] and graduation pass rates on professional examinations like the Professional Engineer's exam" (Mizikaci, 2006, p. 48). However, output also includes subtle ways "students are likely to be changed as they progress through the program so that after the system processes them, they are different from the way they were initially" (Birnbaum, 1988, p. 34) and professed to be workforce ready by the institute of higher education bestowing the degree. Output could also refer to changes in administrative style or functionality within the institution, "changes in administrative behavior, processes, or procedures" (Falcone, 2003, p. 4). In terms of the articulation

process, the desired outcome was an articulation agreement approved by the required parties from both schools.

Outcomes. "Outcomes are the intermediate and long-term goals, objectives and intended or unintended consequences" (Falcone, 2003, p. 4) of a programmatic decision. Based on this definition, there is a subtle but important difference between output and outcomes, one that employers are increasingly bringing up as an issue to higher education administrators; that is, college graduates are not automatically workforce ready when they achieve output status. However, in general, the attainment of an engineering degree results both in increased employability for the individual graduate and an increase in the number of engineers for the U.S. workforce. Another long-term outcome to an engineering articulation process might be the development of a long-lasting community college-university partnership that transcends the initial agreement and results in further benefits to students in the form of scholarships and summer readiness programs. However, an unintended outcome to such an agreement might be the additional cost to maintain the progression of students resulting from the articulation. This includes both labor and non-labor costs. For example, advising might become a more important component embedded in the community college program once the articulation is finalized.

Feedback loops. The systems concept of a feedback loop also has application to articulation and transfer processes since the creation of an articulation connotes a change to an existing system, and that change may either be perceived as negative or positive. Accordingly, feedback may either reduce or enhance the impact of any change and feedback loops can either be a positive reinforcement or "may act as a negative to make

minor adjustments in ongoing organizational processes" (Birnbaum, 1988, p. 183). Also, feedback loops may be internal and created within a system or may exist outside of a system and connect two subsystems together. Feedback loops are traditionally viewed as a circular path of cause and effect and can be visualized through causal loop diagrams. This concept of feedback loops form a key element in the recommendations made within Chapter V.

Significance of the Study

Engineers, both academics and career professionals, need to work together to produce more engineering college graduates. As previously indicated, studies have shown that the educational pipeline does not produce sufficient numbers of students who flow through the system and attain degrees. Community colleges, which currently educate half of U.S. college-aged students and are the fastest growing segment of higher education, need to be co-opted into this process to a greater degree. Preliminary research indicated that more effective community college/university engineering partnerships created through tools like articulation agreements could help alleviate this problem, and that systems thinking was applicable in researching the creation of such partnerships.

Many of the qualitative studies that have investigated the creation of student pathways between community colleges and universities have researched the issue from the students' perspective (Balzar, 2006; Nelson, 2007; Omdal, Brennan, Richards, & Gonzales, 2006; Morphew, Twombley, & Wolf-Wendel, 2001). However, few have examined the issue through an in-depth investigation of the perspective of the stakeholders involved in the creation of the articulation partnership. As a result, this onsite qualitative inquiry was an appropriate way to delve deeply into the issues implicit

in the creation of an engineering articulation agreement between a community college and a university, concentrating on stakeholder actions.

As concerned citizens demand increased accountability of the U.S. educational system, college leaders are being charged to take a closer look at the educational pipeline and develop more accurate measurements of community college completers, the number of transfer students produced, as well as the number of transfer students who successfully complete four-year degrees. This scrutiny, in fact, begins at the earliest level, with

> proponents of the K-16 movement emphasizing the need to address student success throughout the educational pipeline, from prekindergarten through the senior year of college….and all sectors of education being asked to pay closer attention to transition points throughout the pipeline (Jacobs, 2004, p. 133).

Possibly due to the immediacy of this problem, a number of researchers have investigated STEM higher education and ways to ameliorate the situation, with articulation one of the proposed solutions. This chapter offered a comprehensive review of literature related to transfer and articulation, as well as challenges inherent to those topics. A second focus of this chapter was a review of the theoretical perspective applied to the dissertation–systems theory. The third focal point of the chapter was coverage of literature that supports the framework around which this dissertation was written.

CHAPTER III

RESEARCH METHODOLOGY

This chapter outlines the research methods used to respond to the three research questions covered in Chapter I. It begins with an in-depth overview of how the study was designed, the type of research paradigm used, and a description of the research case. The next section of the chapter outlines the data collection and analysis strategies used to respond to the research questions. Also detailed in this section is the method used to ensure trustworthiness within the study, as well as discussion of the influence of my positionality as researcher.

Research Design

This dissertation has used as its foundation a qualitative research approach designed to provide an in-depth investigation into the creation of an engineering articulation agreement. Qualitative research, according to Creswell, is an appropriate strategy to use when attempting to understand the "meaning individuals or groups ascribe to a social or human problem" (Creswell, 2009, p. 4). So the use of qualitative methods provided a deeper understanding of ways group interaction affected articulation because of its ability to delve in-depth into the issue.

Within the qualitative paradigm, the researcher has the option of a number of approaches in the development of a research strategy. Among the many authors who have delineated the various approaches to qualitative research, Creswell (2009), Stake (1995), Wolcott (2001), and Yin (2009) have detailed descriptions exploring the variety of qualitative strategies, which include: ethnography, within which the researcher studies a cultural group in their natural environment over a prolonged period; phenomenology,

where the researcher studies a group through extensive engagement; and case study research, which uses an in-depth investigation of a single group, instance, or event to explore underlying principles or theories. Case studies usually rely on multiple sources of evidence and explore a phenomenon in a real-life setting. Because of the research questions posed and the need to explore articulation and transfer in a natural setting, case study research was the most appropriate choice for this study.

Using case study methodology. In conducting case study research, the investigator conducts an in-depth exploration of "a program, event, activity, or process" (Creswell, 2009, p. 13) and collects detailed information using a variety of data collection procedures. It is appropriately used when "how" or "why" questions are being asked and when the researcher is focusing on "contemporary phenomenon" (Yin, 2009, p. 2). Since the articulation process under investigation was a contemporary issue being studied and the queries embedded in the design related to "how" and "why" issues, the case study strategy was an appropriate qualitative tool to investigate this issue. Case study research also allows the researcher to explore a phenomenon using various sources of data. While both Stake (1995) and Yin published legitimate approaches that guide the researcher in case study methodology, in general this study followed Yin's method to investigate the topic. Yin's work on case study methodology discussed both single and multiple case study approaches but, for the purpose of this study, I chose a single case approach.

Single case approach. One of the first questions I needed to decide as a qualitative researcher was the number of cases I planned to investigate. Yin (2009) recommends that the researcher decide on whether a single case or multiple case approach be used to answer the research question prior to beginning data collection.

Although the case under consideration was not critical or unique to engineering articulation, it was certainly a "representative or typical case" (p. 48) which is Yin's third rationale for single case selection. "Single cases are a common design for doing case studies" (p. 52) especially in dissertation research. Although one might choose to investigate multiple articulation situations, in this case, the data obtained from additional sites would likely not have significantly affected research results and would have extended the data collection and analysis portions of the study. (Note that this study's definition of a single case includes two colleges because of the nature of articulation). However, Yin cautions that single case designs are vulnerable "if only because you have put all your eggs in one basket" (p. 61) and the need to choose an alternative case was a risk I was willing to take as I chose the case to be studied. However, because the articulation process I chose to study did conclude in a successfully signed articulation, it was not necessary for me to change case study circumstances in order to complete the dissertation.

Site selection and unit of analysis. Qualitative researchers must first search for appropriate cases that support the premise for their study then choose the most applicable case(s) that provide the richest opportunity for research data. For this dissertation, I had a number of case study research options since engineering has recently been identified as a field wherein additional articulation is needed. Although every "single case study involves a choice of this case rather than others" (Maxwell, 2005, p. 87), this case was somewhat naturally bound by place and opportunity since, for financial reasons, my goal was to remain in Texas to conduct the study. Narrowing the focus of the study to Texas public institutions of higher education also allowed me to use my already-established

contacts to gain entry to the schools and access to information. Texas, because of its diversity and breadth of educational programs, is also among the states most often studied by higher education researchers and is liberally exampled in the literature review.

According to Texas Higher Education Coordinating Board documentation, relatively few engineering articulations have been implemented to date in this state and, to execute a case study that adequately responded to the research questions put forth in this dissertation, an engineering case study currently being negotiated was preferable. Through networking and general discussion of my research topic, I learned that the community college at which I work was in the process of negotiating two engineering agreements, so I chose to study one particular negotiation because a) that articulation process looked like it was proceeding rapidly—although the articulation had not yet been signed, and b) university personnel involved had expressed initial interest in assisting me with the study.

Colleges Highlighted in the Case Study

Both schools are large institutions of public higher education in Texas, and both have a strong reputation for academic excellence. Following is a brief description of each college; further narrative on each college is found in Chapter IV.

Description of the community college. The third largest community college system in Texas, the Lone Star College System educates over 80,000 full- and part-time students in the greater Houston area each year. According to documents produced by the Lone Star Department of Institutional Research (*Fast facts, 2009-2010)*, between four and five thousand students transfer from Lone Star to universities each semester. This community college is also currently the largest associate's degree producer in the greater

Houston area and is ranked 18th in the nation in associate degree producers, according to the "Top 100 Associate Degree Producers," 2009 edition (2010). It enjoys a reputation for academic excellence as it was ranked 24th by *Community College Week's* "Top 100 Two-Year Institutions" (2009). It is close to becoming a minority-majority college, with 44% of its student population classified as non-white, as detailed in the 2009 edition of the "Top 100 Associate Degree Producers" publication (2010).

Although the pre-engineering program is currently not one of their strongest discipline fields, a dean at Lone Star with engineering background had begun to actively build the program and look for universities to which Lone Star students might articulate pre-engineering course credits. The articulation discussion began at the North Harris Lone Star campus that employs a dean with significant engineering background and has the most robust pre-engineering program. The initial contact to begin the articulation discussion was made by Texas Tech personnel through communication with Lone Star's articulation officer, who in turn reached out to the North Harris engineering department dean.

Description of the university. Texas Tech University, a major research university located in Lubbock Texas, is the fifth largest public university in Texas and is one of the four-year public institutions of higher education that Texas Coordinating Board data (Texas Higher Education Data, 2010) shown to be a major recipient of Lone Star transfer students (although it in not currently listed in the top five, possibly due to its distance from Houston). It has a strong academic reputation and was ranked #55 in the Forbes "100 Best Public U.S. Colleges" listing in 2009.

The TTU Edward Whitacre College of Engineering, founded in 1925, has approximately 3,400 undergraduate students and eight academic departments (*Texas Tech Facts*, 2010) and has a reputation for collaborating with other educational entities. Because of this, TTU was recognized during a 2009 Texas Articulation Summit for its work in creating educational pathways for engineering students. A spokesperson for the articulation summit posted on the summit website that certain colleges and universities have a history of supporting transfer and articulation, so one of the reasons Texas Tech was chosen for this study was that they were an exemplary example of this classification.

Purposeful Sampling Strategy and Participant Selection

Unlike quantitative samplings, qualitative researchers tend to work with small samples of people, and those samples tend to be more purposive. Experts in qualitative research methods (Merriam, 1998, 2002; Miles & Huberman, 1994) provided excellent advice on ways to narrow the focus of this study and target interviewees. First, Merriam (1998) noted that "purposeful sampling is based on the assumption that the investigator wants to discover, understand, and gain insight and therefore must select a sample from which the most can be learned" (p. 61). Specifically, the individuals targeted for interviews were those most familiar with the specific articulation under study and so a purposeful sampling technique was appropriate. "The use of purposively selected participants requires the researcher to have access to particular types of participants who are especially likely to help in gaining an understanding of a phenomenon" (Patton, 1990, p. 29).

Study participants were selected based on a combination of job description, familiarity with the articulation under study, and through personal recommendations. In

some cases, specific personnel to be interviewed were identified from a search of titles listed on the college's website or through a review of public documents posted by the colleges. For example, the March 2009 Texas Tech system board of regents minutes noted the appointment of a former interim provost to the new position of community college relations specialist so that person was contacted for an interview.

Secondly, Miles and Huberman (1994) cautioned the novice researcher that, as much as one might want to interview everyone concerned with the issue under study, "you cannot study everyone everywhere doing everything" (p. 27), and the choice of interviewee should reflect those who can best inform the researcher relative to the research questions. Based on this, some names and titles from the original target list were removed. For example, although it had originally been intended that engineering faculty at both colleges be interviewed, the associate deans noted that faculty had had no involvement in the original articulation negotiation process, and that they (as current engineering instructors) could represent the faculty voice on curriculum issues. Accordingly, faculty names were removed from the interview target list.

Third, Miles and Huberman commented that "within-case sampling is almost always nested…with regular movement up and down the ladder" (p. 29). Originally, I had planned to conduct 12-14 interviews (7 per campus) but, by the time the research phase was completed, I had completed 5 additional interviews. As noted by Miles and Huberman, personnel were nested by college (ex. North Harris College), by discipline (e.g., engineering), and by area of responsibility (e.g., advising), so I was able to effectively reach out to additional personnel, interviewing 19 participants in total.

Miles and Huberman's reference to a ladder was an appropriate analogy to keep in mind as I targeted interviewees for the purposive sampling. To recognize and contact the personal points of interaction involved in the articulation process, it was necessary to identify the stakeholders of that process (i.e., who had a vested interest in changing the curricular status quo at each college, signified by the signing of the articulation). "Counselors, articulation officers, inter-institutional representatives, instructional coordinators, admissions practitioners, and public relations officials all attempt to bring order to the process, continually reforming the enterprise" (Cohen, 1996, p. 25). The functions mentioned by Cohen, along with the engineering department personnel, formed the nucleus of the sampling. Cohen's sampling technique also helped me further narrow the list of individuals to be interviewed. Merriam refers to this as the "bounded system, the unit of analysis to be investigated" (Merriam, 1998, p. 65). In this case, the initial boundary was established by the two colleges, further defined by those with influence over the engineering departments, as well as by those personnel who worked on the creation of college articulations. Data was collected from three levels of personnel involved in the articulation process: low level personnel (e.g., advisors), mid level managers (e.g., associate deans), and top level administration (e.g., associate chancellors/provosts). Comments from all of these groups are represented in Chapter IV data.

Personnel were identified either through the use of contacts, from a search of personnel titles listed on the colleges' websites or, for those cases where purposively selected participants were not previously identified, through departmental gatekeepers. This took the form of a snowball sampling, especially at Texas Tech. In a snowball

sampling technique, the researcher identifies a few members of the phenomenon group who are then used to identify others (Lincoln & Guba, 1985). As a qualitative researcher, acknowledging that "samples in qualitative studies are usually not wholly pre-specified, but can evolve in an iterative process once field work begins" (Merriam, 1998, p. 66), the snowball sampling technique allowed me to interview four more personnel not listed on the original Texas Tech interview schedule. This technique resulted in an interview wherein I gained some of my most cogent information. Because Tech's previously signed articulation with an adjacent community college provided data relevant to the study, I also traveled to a community college approximately 30 miles from Lubbock, where I was able to talk to two engineering department personnel whose college had piloted a similar articulation with Texas Tech.

Entry to the Research Sites

Before initiating contact with school personnel, it was first necessary to complete Institutional Review Board (IRB) paperwork through the Texas A&M Human Subject Protection Program. Once IRB approval was granted, I was able to contact targeted interviewees by email to explain the project. With the email request, I attached the IRB consent form (see Appendix E), which gave potential participants the details of the study. At Texas Tech, the process of making appointments was facilitated by the Tech associate dean, who agreed to act as a "gatekeeper who can facilitate…the study" (Maxwell, 2005, p. 83) and who endorsed me as a researcher.

Because I was local to the Lone Star College campuses, the process of setting up interviews proved to be easier at that college. I was able to use the Outlook meeting function to request time on interviewee calendars. In all circumstances, I set up the

interview meeting for a one-hour block of time and worked with interviewees in their office setting, both so they would have access to any hard-copy documents relating to articulation, but also so they could be observed in their work environment.

Data Collection Strategies

Since "a hallmark of case study research is the use of multiple data sources, a strategy which enhances data credibility" (Baxter & Jack, 2008, p. 554), I researched this case using a variety of resources. Within the research strategies, Yin (2008) suggested in his writings, he listed six sources of evidence for data collection: "documentation, archival records, interviews, direct observations, participant-observation, and physical artifacts" (p. 101). Among these choices, the data collection strategies used for this study were archival records, document analysis, focus groups, observation, and interviews (both in-person and by phone).

Archival records. While closely related to document analysis, an archival record is an account of something that happened or exists; "to put it in another way, every human action leaves tracks" (Lincoln, 2008, p. 278). Prior to setting up interview appointments, I first perused both the LSC and TTU websites which, along with a general internet search, yielded such samples as TTU meeting minutes that alluded to a strategy session on community college transfer and articulation matters. I also asked interviewees to make copies of archival records in their possession that had relevance to articulation. Third, I looked online for articulation information from other colleges and associations. Last, while visiting the campuses, I picked up any published literature that alluded to transfer and articulation. I then transferred any relevant information from the records to data cards and included that data in my description and interpretation of the results. As a

general comment, while I found relevant materials on transfer and articulation from TTU resources, there was very little information on the topic from LSC sources.

Document analysis. Documents are an available and low-cost source of information for the researcher and, as such, should be included among the sources of data in a case study. Lincoln and Guba (1985) differentiated the term document from archival record by stating that a document is "any written or recorded material other than a record that was not prepared specifically in response to a request from the inquirer" (p. 277). For example, the signed articulation agreement was an official document, whereas meeting minutes consisting of data contributing to that signed document were considered archival records. Documents are helpful not only to verify the correct spelling and title of names but can be used "to corroborate information from other sources" (Yin, 2009, p. 103) thereby enhancing validity.

I then searched for existing articulation agreements that showed either past LSC or TTU work or that detailed engineering articulations created by other college partnerships. I informally began a document search before initiating contact with the colleges by using the Internet to identify potential interviewees by name and title. During this first phase of research, I also looked for press releases and news accounts of past articulation agreements created by the respective colleges. I did a complete search of both colleges' websites for existing articulation agreements that showed either past LSC or TTU work or that detailed engineering articulations created by other college partnerships before the interview process began. I also asked each interviewee to collect administrative documents (e.g., meetings notes, non-confidential emails) pertinent to the discussion or relating to the dissertation topic.

All of this helped inform the interview protocol because I was able to ask more probing questions about current processes. It also gave me a general historical perspective so I did not have to spend time during the interviews gathering that level of detail, thus respecting their valuable time. It also gave me a certain level of credibility with participants that I had "done my homework" and was generally very knowledgeable about articulation.

Interviews. Interviewing as a qualitative research technique is more of "a conversation with a purpose" (Lincoln and Guba, 1985, p. 268) than a regimented question and answer session and, if the interviewer is properly prepared and sets the stage effectively, can be a tool in the creation of new knowledge. "One of the most important sources of case study information is the interview which will be guided conversations rather than structured inquiries" (Yin, 2009, p. 106). As Yin implied in this statement, the interview process became the most valuable data collection tool I used to research this topic. Yin, who takes a reporter's approach to investigation, recommended the creation of questions that addressed the "who, what, where, how, and why" (p. 107) of the issue under investigation. Accordingly, in developing the questions as recommended by Yin, I kept the attributes of systems theory (inputs, throughputs, outputs, and outcomes) in mind as I developed the protocol. As recommended by Creswell (2009), I developed the protocol using an established method for asking and recording questions that included a heading (date, place, interviewee), icebreaker questions, a set of 12-15 core interview questions, probes/follow up questions and a recap/request for a follow up interview as needed.

Based on this operational procedure, the resulting conversations were rich and (as noted by more than one interviewee) basically led to a co-creation of knowledge related to articulation. The process by which I planned the interviews contributed to their effectiveness. First, I asked for a one-hour block of time with the option of continuing for an additional half hour, if required. For high-level administrators whose schedule is filled, I offered to bring lunch and talk over food. I was also flexible in scheduling; two of the high-level interviewees were forced to cancel and reschedule appointments because of last-minute problems. In two other cases, student issues pre-empted the interview, so I was not able to talk for the entire hour but adjusted my protocol accordingly to maximize the remaining time.

The initial interview protocol (see Appendix A) served as a general guide for the discussions but was amended before each interview for two reasons: (a) although most questions were asked of each interviewee for consistency and data comparison purposes, I altered each interview slightly to focus on their specific area of responsibility as related to articulation, and (b) after each interview, I filled out a contact summary sheet (see Appendix B), which not only forced me to articulate the most salient points made during the interview but also allowed me to reflect on what questions worked most effectively to solicit effective data. I then eliminated, rewrote, or added questions to make the protocol more effective for the next interview.

In terms of an interview process, each interviewee knew in advance that I would bring my laptop computer into the interview and use it to record the interview. This allowed me to access the person-specific protocol through Microsoft Word and then type key observations into the document as the interview progressed. Since I was relying on

the recording for transcription, I was able to more actively listen to the responses and engage in the conversation, letting participant responses lead the discussion to some extent. In other words, although I was careful not to allow the interviewee to direct the conversation so that I acquired necessary data in one hour, I also asked follow-up questions on sections of the protocol while omitting those questions I thought least relevant to that particular interview. At the end of each interview, I asked the interviewee for permission to forward to them a transcription of the interview along with any follow up questions that came up during transcription.

Within three days of conducting the interview, I listened to the recording and created a preliminary transcription of that interview, which in all but one case captured the preponderance of data. In one instance, however, I had technical recording difficulties with the level of recording due to background noise. I immediately returned the transcription to the interviewee through email along with a note of thanks, asking them to review the transcription, and adjust/augment it as needed. I received amended versions of the transcript from approximately 2/3 of the participants. Amendments were primarily minor points of clarification, but two participants removed wording they felt, upon reflection, to be either inaccurate or something they did not want put in writing (see *Ethical Issues* later in this chapter for further details).

Focus groups. In a few cases, it was not logistically practical to interview respondents individually, so a focus group technique was used. Focus groups, within which a limited number of participants (usually a maximum of 5-6) gather to discuss a particular issue, are especially helpful "for gaining access to unique concerns" (Hoyle, Harris, & Judd, 2002, p. 407). However the researcher who uses focus group

methodologies must be aware that results are not generalizable and also must be aware of the social dynamics of the conversation so as to not permit any one individual to lead the group. I had originally planned a lunch time focus group to interview faculty, but that option (due to their lack of involvement in this particular articulation) did not materialize. Due to time constraints, I did conduct one informal focus group at South Plains Community College with the engineering dean and faculty at that location, during which they confirmed that their partnership with TTU was the impetus for the engineering articulation model I was studying.

Observation. With the case study interviews taking place during a field visit and in the natural setting of the case, there were multiple opportunities for direct observation of the participants and the environment in which they worked. In their discussion of observation in case study research, Kilbourn (2006) and Merriam (1998) both suggested that researchers ask themselves questions as they conduct observations to gauge what is going on and to see if there are discernable patterns and sequences of activity among people interacting, both with the activity and with each other. These questions were highly relevant to the research questions proposed in this study because it was the relationship of the participants to each other and to the process being created that demarcated systemic factors like input, throughput, output, and outcomes.

Due to the nature of the research study I conducted, I neither concealed my role as an observer nor acted as a completely impartial observer (during which the researcher observes without participating). At the same time, my positionality as a researcher dictated that I attempt, where at all possible, to disconnect myself from the process under investigation, which proved to be one of the biggest challenges I faced, especially since I

worked at one of the colleges chosen for research. The reflective journal I kept helped me to periodically ask myself where my biases could alter the course of the study. It also allowed me to record key observational patterns, which were used in the analysis section of Chapter V. Observation also gave me the level of detail needed to describe the case study environments more fully than whatever information could be garnered through a website. The most interesting aspect of observation came during the on-site meetings between the two instructional entities as they negotiated the articulation. In each case, interviewees spoke of mutual respect for the personnel at the college with which they were negotiating, both as individuals but also with respect to the contribution each college made to engineering education.

Phone conversation. During the research phase of the project, it became evident to me as a researcher that, while in-person interviewing was the preferred format for data collection, some phone conversations were necessary, especially with TTU personnel, and one interview had to be conducted entirely by phone. To ensure that the data was accurate, I took detailed notes during the conversation (asking for clarification if I didn't comprehend the wording the first time), and immediately after each telephone conversation, I reviewed my notes taken during that conversation, creating a log of that discussion.

Establishing Trustworthiness

While validity and generalizability in qualitative research do not carry the same connotations as they do in quantitative research, it was very important to establish trustworthiness by formulating a research design that ensured rigor. It was equally important to "understand the perspectives of those involved and present a holistic

interpretation of what is happening" (Merriam, 2002, p. 25). Lincoln and Guba (1985) made a distinction between traditional research methods and the qualitative approach to research by differentiating naturalistic inquirers' assessment of trustworthiness from quantitative methods. To determine how consistent the findings are with reality, instead of internal validity, qualitative researchers assess truth value through credibility measures. These measures include correct and well-established operational procedures, peer scrutiny, reflection on the part of the researcher, thick description, and examination of previous research findings. To ensure trustworthiness of the findings, the methodology I chose to implement included the following:

Triangulation of the data. Denzin (1970) suggested four different methods of triangulating data: multiple investigators, multiple theories, multiple methods to confirm emerging findings, and multiple sources of data. For this study, the last two methods of triangulation were deemed the most appropriate. "Collecting information using a variety of sources and methods is one aspect of what is called triangulation" (Yin, 2009, p. 93). For example, information collected at Lone Star was cross referenced to data collected during the TTU visit to see if significant differences could be attributed to college process or culture. I also took care to correlate the data collected during interviews with documentation assembled from the college's websites to determine the most accurate narrative on articulation. By gathering data from a "diverse range of individuals" (Yin, p. 112) and sources, then cross referencing responses when sorting data, I gained a broader understanding of the topic and how different facets of higher education responded to transfer issues, all of which will be further discussed in Chapters IV and V.

Fielding and Fielding (1986) caution, however, that use of triangulation does not automatically enhance validity since the variety of methods used to accumulate data (for example, interviews and documents supplied by the interviewees) may be subject to self-reporting bias. Therefore, "observations are also conducted to triangulate emerging findings; the participant observer sees things firsthand and uses his or her own knowledge and expertise in interpreting what is observed rather than relying on once-removed accounts from interviews" (Merriam, 1998, p. 96). I therefore took care to use my reflection log to record any observations I made while on campus. This process supplemented interview data with those observations and provided a venue for me to interpret what I had observed during the interview.

Thick description. First used by Geertz (1973) as a qualitative research tool for ethnographers, thick description involves more than amassing great detail in description. Ponterotto (2006) describes thick description as that which "speaks to context and meaning, intentions, motivations, and social interactions [i.e., behavior] that characterize a particular situation" (p. 539). Each finding in a qualitative study must be supported with data, much of which is contextual in nature. Accordingly, during the interviews, I tried to become a more active listener and be a good observer of human behavior so that I could provide background information that responds to the research questions dealing with "why," "how," and "who." On each interview summary form, for example, I included such descriptors as body language and key contextual examples I noted during the interviews, describing them in terms that I tried to make "context-rich and meaningful [thick]" (Miles & Huberman, 1994, p. 297) so the reader could decide to what extent the findings of this case study could be transferrable to other contexts.

Self-reflection. A reflective journal of my work provided a continual opportunity to self-reflect so that I could better recognize biases I might have and created an "honest narrative that will resonate well with readers" (Creswell, 2009, p. 192). I also kept a professional log (master list of names, locations, and dates) for an audit trail and a personal journal to keep track of my methodological decisions. As Lincoln and Guba (1985) suggested, it was very important during the qualitative research process to reflect critically on oneself as the instrument of research.

Member checks. Otherwise known as "respondent validation" (Maxwell, 2005, p. 111), member checks allowed the forum to request that the participant comment on the interpretation of the data by asking them if your interpretation "rings true" (Merriam, 2004, p. 26). Miles and Huberman (1994) made the obvious but important statement that "one of the most logical sources of corroboration is the people you have talked to" (p. 275). Some researchers (e.g., Stake, 1978) go as far as to suggest that feedback to the persons involved in the research is an ethical issue since interviewees have a right to know what the researcher found during the course of the study.

With a member check process, the researcher commits to "taking data and tentative interpretations back to the people from whom they were derived" (Merriam, 2004, p. 204) and asks the interviewee to comment on the plausibility of the results. At the beginning of the study, I asked two key participants who had the most comprehensive overview of the process to act as member checks, and both agreed to review my final draft of the dissertation. In addition, a professional colleague who was not interviewed but is well-versed in transfer issues also volunteered to read the final draft for meaning

and continuity. Finally, a colleague reviewed the paper for APA style, sentence construction, punctuation, and continuity between sections of the paper.

Well-established operational procedures and audit trail. In general, the data collection procedure I used was to read through the transcript immediately, transcribing all information into a Microsoft Word document, producing both a hard copy and saving the document electronically then sending a copy to all interviewees for review. After making changes requested by participants and reading through each transcript a number of times, I used content analysis to sort data and began to put it into meaningful categories. This process is fully detailed in the Chapter III section called *Data Analysis Strategies*.

Lincoln and Guba (1985) called this carefully constructed set of materials an audit trail, which not only consists of raw data (e.g., field notes, documents, and transcriptions) but also shows how the data was collected, how categories were created, and how the researcher made decisions throughout the study. An example of a document supporting the audit trail for this study can be found in Appendix C. The audit trail depends on the researcher keeping a detailed journal and recording changes to protocol in memo form, which I accomplished through my dissertation log.

Use of contact summary sheets. Subsequent to each interview, Miles and Huberman (1994) suggested using a contact summary sheet to record first impressions and important thoughts. "A contact summary sheet is a single sheet with some focusing or summarizing questions about a particular contact" (p. 51) that encapsulates the interview discussion, one that may run dozens of pages. These authors suggested that the following data become part of the contact summary sheet (see Appendix B for an

example of the contact summary sheet): name of person, location and role, main themes/issues arising from the interview, (research) questions that were most cogent to the discussion, new hypotheses or hunches suggested by the contact, additional questions or changes in protocol evolving from the interview (e.g., where should the interviewer "place the most energy" [p. 52] in subsequent interviews). I also included a section for reflective thoughts on the contact summary template I created.

I found the contact summary sheet to be useful in a number of ways. First, it provided a guide for the next set of interviews and suggested changes in protocol. Secondly, it was helpful to recall key points from a particular interview after the write up was completed. Thirdly, it assisted with the coding and analysis of the data. Perhaps most important was its usefulness in assessing the truth in what was heard during the interview with the notation of key observational points.

Data Analysis Strategies

In the case study analysis process, "data from multiple sources are converged in the analysis process rather than handled individually. Each data source is one piece of the puzzle with each piece contributing to the researcher's understanding of the whole phenomenon. This convergence adds strength to the findings as the various strands of data are braided together to promote a greater understanding of the case" (Baxter & Jack, 2008, p. 554). The content analysis process permitted me as the researcher to reorder the discussions I had with participants into meaningful categories. "Because what will be learned at the site is always dependent on the interaction between investigator and context" (Lincoln, p. 208), I purposely planned for the protocol design to emerge and grow organically as the project progressed. As Baxter and Jack (2008) have noted, data

collection and analysis tend to occur simultaneously so, to a large extent, I engaged in continuous data analysis and allowed it to inform and enrich the research phase of the study.

While not necessarily the most time consuming phase of the study, the data analysis step was to me the most challenging stage of the dissertation process, calling upon me to continually challenge my conceptual categorizations which led, in turn, to reorganizations of Chapters IV and V. In general terms, "data analysis consists of examining, categorizing, tabulating, testing, or otherwise recombining evidence, to draw empirically based conclusions" (Yin, 2008, p. 126). So while the initial categorization of data flowed fairly smoothly, it was the desire to find connecting strategies that caused me to re-organize the already accumulated data but ultimately yielded the most critical and productive analytical information in the study.

The basic steps followed for content analysis were: (a) divide each document into the smallest piece of data that can stand alone (called unitization of data). This included both interview transcripts as well as observational notations; (b) create data cards for each unit of data (I used 4 x 6 cards). On a separate document, I had recorded every interview and had created a discrete coding for each interviewee so I could tell from whom a quote came. This coding was displayed on the data cards; (c) sort, and resort all cards into similar themes; (d) create temporary categories for each pile of cards. I separated and marked each pile of data cards with a category name, which I adjusted periodically; (e) cross-reference those categories to the research questions and other emerging themes; (f) resort cards throughout the process, reformulating categories. One to two times a week, I reviewed all data cards, subdividing the category piles and moving

some cards to other piles. One problem I anticipated, but did not experience to any significant extent, was the existence of large number of outlier data cards, perhaps because I used the data re-sorting process to adjust the interview protocol in order to give better meaning to those outliers.

Creswell offered an excellent method that visually demonstrates the steps to be followed in content analysis. I used his guide to conduct my analysis.

Step 1. Gather and sort the raw data. To complete this step, I read through all interviews completely and properly transcribed them. I typed all field notes and had the relevant data from the literature review identified. I also had all data supplied by outside resources (e.g., college institutional research departments, Coordinating Board) documented and available. I then created data cards for each discrete unit of information (I used 4 x 6 note cards and a PC-printer process I learned in my qualitative research class to produce word processed data cards). This code was displayed on the data cards so I could tell, at a later date, from whom the quote could be attributed. Lincoln and Guba (1985) called this process "unitizing the data" (p. 285).

Step 2. Read through the data. Since some of the data was collected significantly ahead of when the data analysis occurred, Creswell (2009) noted that it was worth building time into the process to review and re-read the data, which provided connections that had not previously come to mind during the first reading. It also allowed for a more objective impression of the credibility of the data by triangulating it to other sources. Once I had accumulated a few of the data cards, I sorted the data cards and placed them in general categories, knowing that the data needed to be sorted multiple times to fully identify the themes.

Step 3. Begin detailed analysis with a coding process. “Coding is the process of organizing the material into chunks or segments of text” (Creswell, p. 186), a process during which topics will appear, which begins the process of creating thematic categories. “Codes are tags or labels for assigning units of meaning” (Miles & Huberman, 1994, p. 56) and are attached to chunks of data, which may be comprised of a few words up to entire paragraphs, making it easier to retrieve and organize the clusters of meaning. Lincoln (2008) recommended the technique of “constant comparison” (p. 347) where the researcher makes matches through intuitive means and continually sorts through the chunks of data, which provides the beginning of the creation of new knowledge. It was at this point in the analysis process that I could begin to see themes emerge.

Step 4. Interrelate themes. At some point in the coding process, pattern codes naturally emerge into categories or themes. Pattern coding helps reduce large amounts of data into manageable units and begin to create a “cognitive map, an evolving, more integrated schema” (Miles & Huberman, 1994, p. 69). Since there are multiple formats for data display, usually formatted by either matrices or networks with a series of “nodes,” (p. 93) a number of ways to initiate a data sort had been suggested to help with data organization and reduction. A data display is “an organized, compressed assembly of information that permits conclusion drawing and action” (p. 11). Data display also refers to “a visual format that presents information systematically” (p. 91) and summarizes it in a concise way so the user can more easily make recommendations. Although I attempted the use of a conceptual matrix for this process, I later decided it was not useful for this particular study and eliminated it from the analysis.

Step 5. Interpret the data. After the data sorting process was completed, I concentrated on the analysis and interpretation of the data. This process had several iterations "as data analysis involves making sense out of text and image data" (Cresswell, 2009, p. 183), conducting multiple analyses as new information was uncovered, and taking time to reflect upon the material (researchers describe this as unpeeling the layers of an onion). At this point, I went back to many of the interview transcriptions and reread them for clarification. In one example, I contacted an interviewee by email and asked for further clarification about an issue discussed. I then referenced the data back to the original conceptual framework to create the explanatory framework detailed in Chapter IV.

Minimizing Bias

Significant to researcher's bias, my positionality is that of an administrator within a community college system, so I somewhat naturally started with a positional bias that led me to want to champion the community college student through the transfer process. However, I purposely chose to study an engineering articulation model because I knew nothing about this curriculum area (my curricular background is business), which lessened that tendency towards bias.

My personal challenge, as I began the interview process, was to not allow the lens through which I viewed transfer color the interview discussion, resulting in the posing of leading questions to the interviewees. Because I was accustomed to operating within a community college environment, that setting naturally resonated with me so that behaviors, terminology, and ideas were intuitively understood. In the university setting, this was less so, since behavior in this setting stems from a different mission and culture.

Since I was not as familiar with the norm in the four-year setting, I was aware that I may have missed nuances in what was said and done, so I was very careful to use the member check process to confirm my first impressions. Likewise, I had an outside reviewer check my first draft for assumptions that I might have made based, not on the data, but on my past experiences in community college systems.

Personal history related to this qualitative case study. In their seminal work *Naturalistic Inquiry,* Lincoln and Guba (1985) stated that good qualitative research should do three things: (a) act as a vehicle for emic inquiry and represent the lived experiences of the people from whom data is collected, (b) build upon the researcher's tacit knowledge base, and (c) demonstrate the interplay between the inquirer and the respondent.

In an effort to exhibit transparency as a naturalistic inquirer, my positionality as a department chair influenced my choice of topic for my research because I wanted to learn more about the phenomenon during the course of the study. Through the rich interplay and conversation with the respondents, I was able to not only create new knowledge, but build upon my tacit knowledge of the subject and develop new propositional knowledge of transfer processes so as to better serve the students with whom I interact daily.

My experience in education and business had relevance to both the choice of dissertation topic and the method I used to research this topic. I was a mid-level manager at the community college discussed in this dissertation. Within this role, I had been involved in multiple articulation discussions with four-year colleges, some of which have concluded in an articulation agreement but other negotiations that did not accomplish this goal. As a department chair within a workforce degree area, I had personally advised

hundreds of students who wanted further education than what the community college was designed to provide. My positionality has been that students need more transparent and coherent pathways through the entire higher education process and articulation is a major contributor to the creation of these pathways. I was upfront with all interviewees (especially those at the university) about my position but also let them know that I launched into this study to broaden my perspective and learn both sides of the picture.

Past experience both in higher education and in business also led me to believe that a qualitative approach to this research topic was appropriate for me as a researcher. While working in industry, I led qualitative research efforts for mid- and large-sized companies, for which I conducted a number of focus groups and individual consumer interview sessions, honing my qualitative research and active listening skills. I also believe that my current position within the community college lent credibility to my study and opened doors both literally and figuratively into the workings of the higher education systems under study.

Ethical Issues

Trustworthiness in qualitative research depends on the researcher conducting the study in an ethical manner. Since the "researcher needs to anticipate the ethical issues that may arise during their studies….and research does involve collecting data from people about people" (Creswell, 2009, p. 87), many who know each other and have professional stature to protect, I considered the ethical pitfalls in advance to attempt to minimize them. Ethical issues in this study included:

- The need to develop trust and mutual respect with the participants, making a concerted attempt to not put them at risk since reputations might have been on the

line if harmful information about the college or the respondent were to be published. To circumvent this, I took the following steps. First, the Institutional Research Board (IRB) paperwork sent to participants in advance let them know that pseudonyms would not be used to identify the schools, and they had the option not to participate. At the same time, I let them know that names and specific titles would not be used in the final report. Second, the interview protocol was designed so the first part of the conversation established trust and confidence on the part of the interviewee that confidentiality would be maintained. Third, during the interview, I respected participants' requests to not record certain observations and accordingly did not use those comments as part of the data. Fourth, during the member check process, interviewees had the opportunity to refute data that might have been considered misleading or misinterpreted. Fifth, in Chapters IV and V, I attempted to let data drive all comments and recommendations thereby limiting editorializing.

- The need for the participants to "retain ownership of their own voice" (Creswell, 2009, p. 90) is an essential part of qualitative research. I included data from multiple sources for each section of Chapter IV that allowed the reader to visualize the environment within which the case study was set. Secondly, the report was rich in dialogue in the form of actual quotations from the participants that allowed their voice to be heard. However I also cautioned each interviewee that the final report could contain data they did not expect or observations with which they did not necessarily agree.
- The need to respect the research site since I interviewed participants in areas where confidential information was located and sensitive issues were being discussed. For

example, in two cases, I temporarily removed myself from the interview room when unavoidable student issues cropped up (one involving a parent). I made sure that I shared all documents (especially those found on the Internet) with participants, both to confirm their veracity and also to ensure they did not inadvertently contain confidential information.

- The need to gain permission in advance from the individuals in authority—`gatekeepers' of the data—and use proper channels to access the materials. By starting the interview process with the associate deans and using a snowball sampling technique to garner further interviews, professional etiquette was respected.
- The requirement to adhere to human subject protection through the formal institutional review board approval process. I obtained permission at an institutional level to conduct research and interview targeted personnel. I created informed consent forms and asked each interviewee to read it prior to conducting an interview; of course, each potential interviewee retained the right to decline to be interviewed after reading the consent form along with the explanation of the goals of the research project and, in one case, that person exercised this right. By participating in the study, each contributor not only had my full and respectful attention while being interviewed but was also able to "gain insight …improve their personal practice, program or policy they are involved so as to strengthened it" (Miles & Huberman, 1994, p. 291).

Limitations to the Study

Although the researcher wishes to conduct a perfect study, legitimate constraints limit the scope of the research that can be administered, especially for dissertation research. Some of the major constraints I experienced were:

Time. As previously mentioned, as a researcher I conducted this case study within a finite period of time. Additionally, I worked with participants whose time was very limited in some cases. Therefore, my study was bounded by the documentation I was able to gather during that limited time period and the observations I made during a snapshot of time.

Access. Some of the documentation I requested was proprietary in nature and not readily accessible to an "outsider" to the institution. For example, at Texas Tech, some meetings notes were considered confidential. Also, due to availability reasons, I was not able to receive interview access to key personnel (e.g., the TTU provost) for maximum study effectiveness. However, access issues were minimal and the great majority of participants were very sharing of their thoughts and data regarding articulation. The biggest issue was the paucity of documentation available on articulation processes within the colleges.

Summary

Chapter III has detailed the research methodology chosen for this study on engineering articulation agreements—a case study approach that looked at a single case scenario between a Texas community college and a university. Although a number of resources were available for data collection, because of my commitment to study stakeholder involvement in articulation processes, I chose to concentrate my research methodology on interviews with personnel involved in the articulation studied. Combined with an analysis of documents and archival records, this provided a rich description of the process. Especially since one of the colleges studied was my employer, it was very important to create ways to ensure trustworthiness and minimize researcher bias. I did

this through the establishment of well-defined operational procedures and an audit trail, as well as the maintenance of a self-reflection journal and the establishment of member checks. The construction and execution of this study yielded results that had clear implications for action and further research that will be further discussed in Chapter V.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE FINDINGS

The purpose of this chapter is to present the findings of the Lone Star College-Texas Tech University engineering articulation case study in an organized and cohesive fashion and provide an analysis of those finding. To accomplish this, the chapter has been divided into three discrete sections: the introduction, an evaluation of the overall process used by the colleges, and an analysis of key issues and roadblocks to the process that were uncovered through the research.

Introduction to Chapter IV

This introductory section of the chapter is divided into three subsections: first, a review of the purpose of the study and the proposed in Chapter I; second, a profile of the case participants presented in both matrix and descriptive forms; and last, an overview of the articulation process outlined through a systems thinking model. The first step in presenting the results of the study was to review the original purpose of the study, along with the research questions to determine if the goal of the research was met. This research study was designed to examine the process a community college and partnering university used to effect an articulation agreement that would provide a pathway for students who wished to transfer from the two-year school into a baccalaureate engineering program. Based on this purpose, three research questions framed the study. Question 1: What is the process by which a community college and a four-year university create a partnership, resulting in an articulation agreement that would facilitate student transfers? Question 2: What are the specific inputs, throughputs, outputs, and outcomes implicit in the creation of this agreement? Question 3: In what ways do college

stakeholders contribute to the creation of an engineering articulation between community colleges and four-year universities?

The second topic in this introductory section is a description of the universities and a profile of the stakeholders who participated in the study. The two colleges chosen were both major public institutions of higher education located in Texas that had engineering programs embedded in their curriculum. Beyond that, the two colleges were dissimilar.

Profile of Case Study Participants−the Colleges

*Lone Star College (LSC).*This college system, which constitutes several college campuses, is located in one of the most rapidly growing areas of Houston and is focused on their ability to continue to provide a quality education to the students who come to them for educational purposes. Its facilities are, in general, modern with up-to-date science labs to support the education of pre-engineering students. When meeting with personnel, it was usually in their well-appointed offices containing state of the art technology. However, the North Harris College campus, with the most active pre-engineering program, was also the oldest campus in the system and showed some signs of infrastructure wear and tear. Because LSC encompasses over 1,400 square miles and has over 15 different facilities, a significant amount of time was spent traveling from one location to another for interviews.

Because Lone Star College is in high-growth mode and enjoys a good reputation for academic excellence, a number of four-year colleges that approached LSC to initiate articulation discussions were observed while conducting this study. Many of those schools had established some form of partnership with LSC, and some had satellite

centers housed on an LSC campus. However, the only four-year college to have approached LSC within the time period of the study for articulation discussion specific to engineering was Texas Tech University. Based on a review of recent publications, LSC appeared to be putting major promotional effort and financial expenditures into their new University Park location, purchased last year from Hewlett-Packard and home to a second university center in Texas. Tech University, however, was not one of the targeted universities to partner within that university center; interviewees attributed it to Tech's substantial distance from Houston.

Texas Tech University (TTU/Tech). To conduct the case study portion of the research, a nine-hour trip to Lubbock Texas, a west Texas town where Texas Tech is one of the major employers, was undertaken. The Tech campus is basically surrounded by the town of Lubbock, and the key administration buildings (including the engineering building) are approximately 100 years old, adding to the traditional college atmosphere on campus. While some renovation work on these older buildings was in progress, many of the offices in which the interviews took place were in need of updating. For example, it was difficult to find an outlet in which to plug the computer used to record the interview, an unplanned problem. The issue of outdated buildings had an effect on pre-engineering teaching facilities. One engineering department employee familiar with both community college and university labs commented that students would do well to take pre-engineering lab sections at a community college where lab equipment was more up-to-date than some of the labs at Tech.

Profile of Case Study Participants−the Employee Stakeholders

While the research methodology portion of this dissertation provided a general rationale for subject choices, the following section gives a detailed description of study participants. Potential interviewees were targeted based on their participation, either as a key stakeholder in the process or as someone noted to have influence on this articulation process. One goal was to have approximately equal interviewee participation from both colleges. Another goal was to obtain interviews from all levels of personnel who had an interest in the articulation under study. Low-level participants included advisors and faculty: the dean and director level were considered to be mid-level administrators, and high-level participation came from the associate provost/chancellor/vice presidential level.

While interviewees were told that their names would not be used in the report, they were also informed in advance that the names of the colleges would be included in the final paper. To offer some level of protection to each interviewee, participants were coded by letter (see Table 4) and the participant letter was annotated after every quote used in this chapter to offer the readers of this dissertation a general cross-reference to which type of participant the quote could be attributed. Table 4 shows all key research interventions by date and location.

Table 4

Data Source Summary

Data source	Interviewee letter	Date obtained	College	Level/area of responsibility/ meeting description
Interview	A	2/22/2010	TTU	Low level/advisor
Meeting	none	4/1/2010		Signing of articulation
Interview	B	4/8/2010	LSC	Mid level/engineering curriculum
Interview	C	4/12/2010	LSC	Mid level/articulation
Interview	D	4/18/2010	LSC	Mid level/campus instruction
Interview	E	4/19/2010	LSC	Low level/advising
Interview	F	4/22/2010	LSC	High level/system instruction
Interview	G	4/22/2010	LSC	Low level/general support
Interview	H	4/23/2010	LSC	High level/system curriculum
Meeting	none	4/26/2010		Articulation summit
Interview	I	5/5/2010	TTU	Mid level/community college relations
Interview	J	5/5 & 5/7/2010	TTU	Engineering curriculum
Interview	K	5/6/2010	TTU	High level/academic affairs
Interview	L	5/6/2010	TTU	Mid level/advising
Interview	M	5/6/2010	TTU	Former employee/articulation
Interview	N	5/6/2010	South Plains	Low level/faculty
Interview	O	5/6/2010	South Plains	Mid level/engineering curriculum
Interview	P	5/7/10	TTU	Mid level/university college
Interview	Q	5/7/10	TTU	High level/student affairs
Interview	R	5/7/10	TTU	Mid level/advising and probation
Interview	S	5/7/10	TTU	High level/planning and assessment

During interviews with Texas Tech personnel, it was proposed that a visit with South Plains Community College personnel would inform and enrich the study because they had data related to a previous engineering articulation. So while these interviews were not part of the original research plan, with an emergent design and through a snowball sampling technique, two South Plains College personnel were identified and also interviewed. With the exception of the South Plains personnel, all interviewees were

stakeholders to the engineering articulation process based upon their responsibilities at their respective colleges. The seventeen people interviewed at LSC and Texas Tech were evenly dispersed between the two colleges and represented various levels of authority at their respective colleges.

The last section of this introduction presents an overview of the articulation process that is presented later in this chapter. Because systems thinking has been used as a theoretical overlay to this dissertation, it was appropriate to again call upon elements of systems theory to visualize the articulation process—inputs, throughputs, outputs, and outcomes. An analysis of the research data provided a macro overview of the articulation process, starting from inputs that may have occurred years before the agreement was signed and ending with outcomes that may (or may not) emerge in the years following the signing of the agreement. Table 5 presents a visualization of the entire process of articulation uncovered by case study research. Each box of the table is explained in the section that follows the table, along with supporting data collected during the research stage of the dissertation.

Two separate themes are highlighted by stand-alone sections of the table, each representing significant findings and analysis. The circular overlay draws attention to the issues, problems, and potential roadblocks uncovered by research that might negatively affect the articulation flow at any point in the process. The square text box at the bottom of the table outlines the specific steps the colleges undertook to complete the agreement, culminating in a signed articulation agreement. This level of detail was deemed important by the stakeholders to the articulation process since one of the problems uncovered was

the lack of understanding in the process itself. It also addressed research question 1 regarding the process used to create the agreement.

Table 5

Articulation Partnership Process between a Community College and a University

Inputs	Throughputs Informal>>>Formal	Outputs	(potential) Outcomes
Colleges' strategic direction	Gentleman's agreement	Signed articulation filed and made public	Marketing efforts
University's need to add new students: -Target Houston market -Add diversity	Memorandum of understanding	Reverse transfer process initiated	Sustained relationship between the two schools
Stakeholder influences: -Board of regents -Chancellors/presidents -Vice chancellors/provosts -Assoc. deans/deans -Faculty	Articulation agreement		
Institutional culture			

General Issues & Roadblocks

-Difference in goals
-Perceptual differences
-Lack of established articulation procedures/ processes
-Lack of process ownership/understanding of process
- (perceived) Lack of support from Coordinating Board
-Lack of planning to effect long-term outcomes

Steps Used to Create the Articulation Agreement

1. Determine need, 2-4 year "fit" and long-term potential
2. ID essential stakeholders in each organization
3. Compare curriculum & negotiate curricular/organizational differences
4. Come to agreement on all points, curricular and otherwise
5. Complete agreement paperwork process

Articulation Process—the Inputs

As explained in Chapter I, inputs are articles that go into a system and influence that system in either a positive or negative manner. Although many potential inputs were identified through preliminary research, the inputs found to most influence the articulation studied included the colleges' strategic planning efforts and need to grow enrollment, the influence brought to bear by various stakeholders to the articulation process, and the effects of institutional culture. Each is explained in this section.

General strategy. With over 200 colleges in Texas and 50+ community colleges existing in the state, and therefore literally thousands of possible partnership permutations, institutions such as Texas Tech and Lone Star College have made strategic decisions regarding the development of a relationship between particular colleges. Sometimes the strategy is based on nothing more than geography (e.g., the community college was built close to a four-year university, so students and employees flow naturally from one campus to another, thus creating an informal partnership relationship). However, this type of logistical relationship sometimes occurs in a serendipitous manner, which was not the case between Texas Tech and LSC. Obviously, geographic proximity was not a motivator because the two colleges are located in opposite parts of a very large state.

Higher education is slowly becoming more purposeful in developing strategic priorities, relationship building being one of them. As one interviewee expressed, "I think higher education is moving towards a business model, so administrators need to be able to think strategically. When we look back at what higher education has been, we've changed a lot" (Participant G). A review of public documents showed that both LSC and

Texas Tech had to some extent prioritized student transfer as a strategic initiative. Accordingly, the initial document research was followed up with protocol questions designed to determine how strategy was an input to the articulation process.

Lone Star College's strategic direction. A key element in LSC's mission statement is its professed commitment to assisting students in their efforts to transfer to the university level of higher education, especially students who concentrate on academic courses in the arts and sciences, as is the case with pre-engineering students. In addition, Lone Star College has made university centers a strategic priority. The LSC articulation officer was especially aware of her charge to utilize articulation as a tool to enhance collaborative efforts of MITC partners and LSC. In the following quote, she provided support for LSC's mission to advance students to a higher level through articulation:

> We're very involved in the MITCs [university centers] and the universities that are there. I'm going to make sure there's a very active articulation process with them because we want our students to be able to benefit from that facility and move on to them. (Participant C)

It was mentioned during interviews that Lone Star College top-level administration had talked about the transfer function in general terms, but the issue of how to facilitate transfer had never been discussed with a strategic focus or in a detailed planning mode. The LSC chancellor, in speeches to college stakeholders, had noted that LSC students transfer to prominent universities across the country, but no one interviewed for the study had ever heard him verbalize any specifics related to transferring LSC students to Texas universities to which a majority of LSC students transfer. Also, in spite of the college's mission to enhance transfer opportunities, a review

of LSC's 2009-2011 Strategic Goals had no reference to transfer or articulation as a current strategic priority.

> When I hear the chancellor speak, he always mentions our transfer students and where they go from here, especially the Ivy Leagues, but that's not where most of our students go. We don't talk about how to get them into Texas universities. (Participant G)

No one interviewed at LSC claimed that administration had made transfer and articulation a strategic priority or that the topic had been specifically addressed in any of LSC's strategic positioning statements. A high-level LSC administrator asserted:

> It's stated in Lone Star's mission statement that we prepare students for the workforce or to pursue additional studies [at a university]. But we don't address any added emphasis on transfer. We probably should. You know, we're just redoing our mission statement, but I don't recall any emphasis we gave to this in our revised statement. (Participant F)

When queried about transfer strategy during the interview, some LSC administrators noted that, as managers within the college system, they should possibly include transfer and articulation within their yearly goal statements:

> I'm trying to think of a time when any top administration talked about articulation. It's not a strategic priority, as far as I can tell. I absolutely do think more emphasis needs to be put on it, at the top levels. I don't think articulation is part of an LSC administrator's stated goals. (Participant D)

A third administrator, when queried, gave specific suggestions on how to better prioritize the transfer initiative:

> I think we need to make it part of the strategic plan and use the information to do staff development. That would really tie the process together. You'd be using the information and someone would evaluate you using it. You might be penalized if nothing happens in your program after a while but [as administrators] we've never talked about this. (Participant B)

In summary, Lone Star College does not yet appear to have made articulation and transfer a key strategic priority, but most interviewed at LSC believed this topic should be assigned a higher priority in future discussions of strategic direction.

Texas Tech's strategic direction. Documents like the Texas Tech University Strategic Plan for 2010-2020 specifically referenced the importance of the community college transfer student and targeted transfers from two-year colleges with at least 30 credit hours. Mid- and top-level administrators at Tech had been in meetings within the past year where the president and his delegates had encouraged personnel to begin to work more closely with their community college counterparts. However, this charge had not been universally accepted by the rank and file at the university. One administrator, charged by the Tech president to encourage university/community college collaboration, described meeting with curriculum areas and encountering some resistance: "I go to our academic areas and say 'we have direction from our president and chancellor to grow in this direction' [greater coordination with community colleges], but they just want to grow in the master's level and above" (Participant I).

Research focusing on Texas Tech showed evidence, in both written and verbal form, of the university's strategic focus on transfer. For example, the transcripts of interviews with every Tech administrator referenced the university's strategic plan and

the increasingly important role of the transfer student. Written evidence of Tech's commitment to this strategic direction was found in publicly-posted documents. For example, during a Tech Board of Regents meeting held in March of 2009, a review of strategic priorities noted that, to increase enrollment, a Pathway Partnership with Community College program, which is a type of memorandum of understanding, would target 60 community colleges in 2010. By 2020, Tech has projected to sign an articulation agreement with every community college in Texas. In order to reach the targeted 40,000 student count by 2020, Tech contracted with Noel-Levitz, a higher education consulting firm specializing in enrollment management. It was also apparent, during the interviews, that administrators at all levels were aware of the strategic growth plan, the consultant's contribution to that plan, and how their specific area was responsible for that growth. The top-ranked administrator I met with during my visit to Tech offered this interpretation of Tech's strategic growth goals as related to community college student transfer:

> At Tech, we'd like to grow, but it would only take a small segment of the community college population to immediately boost us up to the 40,000 student goal. Our current growth objective is to reach 40,000 students by 2020, but if we continue on the trajectory we're on now, we'll be there a couple of years early. There are just so many students out there and so many opportunities for growth, like the one we're discussing. (Participant S)

According to Texas Tech University System Board of Regents meeting minutes (2009), in his quest for additional students, Tech President Bailey has asked administrators to specifically target transfer students, the majority of which come from

Texas community colleges. This priority was corroborated by the comments of one university administrator who worked directly with him:

> This is a president who came in, looked around, and said "it looks like they [Texas Tech] need some more transfer students around here." He didn't say that he didn't want freshman students coming in, but the idea was to get more and more students coming in at a higher level, which nobody had ever talked about before. (Participant I)

Each department was to develop a plan to support the transfer initiative. To ascertain where Tech's Department of Engineering was placing strategic emphasis, the strategic plan for the engineering department (published in *Texas Tech's Facts* 2010) was accessed. It included the following stated goals to be achieved by the year 2020:

- Enroll 500 undergraduate mechanical engineering students.
- First year retention of 80%.
- Increase undergraduate graduation rate to 55%.
- Enrollment of Hispanics − 15% of student total (currently at13%).
- Enrollment of blacks − 5% of student total (currently at 4.3%).

According to an official of the Department of Engineering, enrollments in that department in general have been growing by 8 to10% per year for the past eight years, which means they are projected to meet the 2020 enrollment figure, but the proportion is skewed to white male freshmen and sophomore level students. This does not meet the other goals stated in the departmental strategic plan. Currently, the graduation rate for the average incoming freshman, called native students, is less than 40%, which is consistent with national averages in that curriculum area, according to that engineering department

administrator. The engineering administrator in that curriculum area expressed his concern about the drop-out rate:

> Our concern, for that 60% who won't finish in engineering, is that they end up floundering in math and science and get themselves in academic difficulty, so they end up dropping out during their freshman or sophomore year before we ever get them into the engineering classes. (Participant J)

Both the engineering department administrator and the advisor assigned to the engineering department acknowledged that, while some of these students leave the university, others are able to be re-channeled into less demanding curriculum programs at Tech. The engineering administrator ended the discussion by saying that he believes community college students can help Tech fill the gap left by the students exiting the engineering program their freshman or sophomore year due to academic problems.

In addition to supplying an ongoing student flow for upper division classes, community college transfers also provide the university an alternate financial stream of income. As pointed out during an interview with one mid-level Tech administrator (Participant J), targeting community colleges for third- and fourth-year transfers makes sense from a financial viewpoint because the Texas funding formula usually pays at a higher rate for upper division enrollments. Consequently, targeting community college transfers, in effect, is a strategy designed to increase both student count and university income. This administrator explains his theory:

> Formula funding from the state pays better for upper division students. If the university is going to invest resources in the undergraduate population, it pays better to have a large upper division student count. Currently, it's exactly the

> opposite. We have huge numbers of freshmen go out for math classes, and we end up with a smaller population in upper division classes. With the community college population, we could reverse that or at least balance that a little. (Participant J)

This same administrator went on to explain that the labs used at Tech for freshman and sophomore level engineering coursework are overcrowded. Using community colleges to teach lower level science courses would save Tech from building new classrooms, or as an alternative, limiting the number of pre-engineering sections.

> We really struggled to find enough room in the freshman and sophomore math and science classes and labs for all our students. So if I could bring in community college students who have taken those classes, they come in bypassing all the crowded classes. (Participant J)

Texas Tech University's desire to add students. Although Lone Star College personnel felt that one of their biggest strategic challenges was to educate their burgeoning student population, Texas Tech administrators demonstrated that a motivating input to the articulation was their desire to target student populations that previously were underrepresented on their campus. According to documents obtained from TTU personnel during visits to the college, Texas Tech's strategic plan includes a plan to grow the student population by 25% over the next ten years and to pull a greater proportion of students from areas outside of their region. According to the Tech 2010-2020 Strategic Plan (2010), Texas Tech currently has 30,000 students and plans to be at 40,000 students by 2020. This targeting of additional students would include both the Houston and Dallas

metropolitan areas, areas that would serve to strengthen the diversity of their student population.

Increased emphasis on first generation and minority students. As previously cited in Chapter II, Ashby (2008) has critiqued higher education for its perpetuation of under-representation of minorities in STEM-related fields. African Americans and Hispanics, in particular, are not well represented in disciplines like engineering and architecture that have heavy math and science prerequisites. Recognizing this, a Tech advisor commented on the ways the university is currently helping minority students overcome previous academic deficiencies in STEM areas and motivating them to continue through a relatively difficult course of studies by giving them a long-term perspective on ways STEM studies can lead to a lucrative career.

> You know there's a big push to get more students of color involved in STEM initiatives. If the students of color have a weaker background in math and science and have trouble with reading, they won't be successful in these types of studies. So these are the kids [for whom] we need to develop creative ways of reaching them, to understand the significance of what we're doing and how they can parlay that into a very lucrative career. (Participant R)

In the previous section of this dissertation that detailed the Tech engineering department's strategic goals, it was evident from the target figures that Tech was attempting to be discriminate in how they grow their student count by specifically targeting certain demographic groups, particularly Hispanics and African-Americans. Not specifically articulated in the strategic plan, but mentioned in conversation, was their attempt to accept more women into the program, a demographic that often comes from a

nontraditional student base. The Tech personnel interviewed were well aware that, not only are a majority of these targeted groups 1st generation college goers, but also that this student contingent is well represented on community college campuses in large metropolitan areas like Lone Star College in Houston. This comment came from an LSC administrator who was aware of the university's effort to target community college students from LSC:

> North Harris (the LSC campus targeted for the articulation) is an especially well known source of minorities. If you look at the numbers and the desires of universities and industry, they want minorities in a big way. Honestly, I think that's one of the big reasons they [four-year colleges] work with community colleges. (Participant B)

Texas Tech personnel who were interviewed readily admitted that one of the reasons they first approached Lone Star College was because LSC's student population was both diverse and had proven to be relatively well prepared, especially in the curriculum areas required for engineering. Additionally, LSC already had a pre-engineering curriculum with most of the prerequisite courses available. Unlike the traditional university entry, many nontraditional community college students must be motivated to consider STEM programs like engineering because they have not been exposed to role models, such as parents, who would help them visualize themselves as being successful in this field. As one study participant stated: "To encourage students to take engineering early is good because community colleges have the tools to develop people who wouldn't think they could do engineering, like women and minorities" (Participant L).

Targeting the prolific Houston market. Texas Tech was not only targeting the minority student demographic, they also targeted specific Texas cities within which large concentrations of minorities are located and that do not naturally migrate towards Lubbock. Multiple administrators that were interviewed indicated that Houston was a demographic base important to their future growth, not only because it is the most populated city in the state but also because it contained the diverse student demographic Tech wanted to reflect. Engineering personnel noted that Houston was the center of the lucrative oil and gas industry to which many of their graduates gravitated, and they wanted to create stronger affiliations to colleges in the Houston area. In addition to Houston, personnel in STEM curriculum fields have placed energy in attracting Hispanic students from El Paso for STEM fields of architecture as well as engineering. One Tech administrator reflected:

> Why are we in El Paso? We're in El Paso because less than 2% of the nation's architects are Hispanic, so there's something wrong, and we have to fix that picture. So this is an example of a 2 + 2 relationship that we could extend to other STEM fields. (Participant S)

Stakeholder Influence on the Articulation Process

As mentioned in the literature review section of this paper, articulation should be a shared responsibility (Smith, 1982) within an institution, from the board of regents' level through the program faculty/advisor level. This section reviews observations regarding the role of the major stakeholders who played a part in the articulation process under study.

Role of the board of regents. In general, the board of regents did not play a direct role in the articulation process. They did not approve the articulations nor did they direct the efforts of those who were involved in the process. However, the Lone Star College Board has requested that the articulation officer prepare periodic reports showing the number of articulations signed within a specific time period, signifying increased interest in transfer and articulation. At Texas Tech, certain regents have, in the past, used their `political pull' to motivate Tech to sign a particular agreement. One Tech administrator working on articulation recounts this story:

> I found out that one board member wanted us to talk to a particular community college. I made sure that the chancellor and president knew I'd been approached before I talked to him because I needed to know if we wanted to do this. They both instantaneously said yes. (Participant I)

As a result, the board of regents can have both direct and indirect influence over articulation. In this case, board influence was indirect but significant because both boards had indicated that they wished to see increased volume in articulations between Texas community colleges and universities.

Role of the college chancellors and presidents. Within the articulation studied, no one at the top level of either organization was directly involved in the process; therefore, no interviews were done at that level. However, according to interviewees, at times the president initiates an articulation discussion. This action (like that of the board member) appears to be politically motivated; that is to say, that president, wishing to foster a particular relationship between his organization and another, mandates that an articulation process be worked out between those two entities. This observation was

included in the analysis because multiple interviewees mentioned that if articulation was initiated in such a top-down manner, the rank and file often viewed it with suspicion, and this sentiment tended to lessen the effectiveness of that particular articulation.

At the top administrative level, the value of the articulation agreement seemed to be in `getting it signed' to meet strategic goals or for the continuation/development of positive relationships between the two schools, which resulted in an increase in transfer students, especially in pre-identified critical fields like STEM. The top-level administrator interviewed at Tech corroborated this trend: "We want to do agreements, and build relationships, around critical gaps and 'Closing the Gaps' areas like the STEM fields. Also, in those fields where we do have undergraduate accreditation, we need to partner more closely with community colleges" (Participant S). Tech's strategic plan, co-written by an associate provost and the college president, specifically alludes to the signing of partnership agreements with community colleges. Also, one top administrator who has interaction with the president quoted him as saying: "What I really need is somebody to talk about this community college issue. I want to have someone deal with relations with them. I want to have a lot more enrollment from them" (Participant I).

Role of vice-chancellors and provosts. As the top academic officers of the respective organizations, these administrators are considered to have a more direct responsibility to ensure that articulation processes work effectively. Although the Tech provost was unavailable for an interview due to time constraints on his part, the Tech associate provost with jurisdiction over articulation was available and recent memos from her regarding articulation were reviewed. Although she was not an official signer of the articulation, she was kept aware of the articulation process as it unfolded through emails

and departmental meetings and expressed a viewpoint that, while this articulation seemed appropriate, not all potential articulations should result in an agreement because of the intense allocation of manpower. She stated:

> It's a really difficult process to organize and maintain because each community college is a little different in terms of what they have available. It's not a one size fits all process. What I would prefer is an institutional level agreement. (Participant S)

LSC personnel at the associate and vice chancellor level also alluded to the need to be more strategic in pursuing articulations that can be institutional and system wide, rather that discipline-specific, given the labor intensiveness of the process, stating:

> It takes a lot of work. It takes someone willing to take a leadership role. The problem from our side is that it often happens from the discipline level at one campus. We're trying to push away from local articulations; articulation agreements should speak for the entire system. (Participant H)

The LSC vice chancellor of instruction was directly involved in articulation processes to the extent that she had recently requested that all articulations be forwarded to her and her direct subordinate (the associate vice chancellor of curriculum) for review to ensure that details of the agreement were academically sound. She was therefore the highest level official to sign the engineering articulation agreement and had requested that all articulations come through her office at system headquarters for approval. As one study participant stated: "We're talking about centralizing transfer and articulation operations and that would work better. Recently, we've changed the process so all articulations come through the central academic office for approval so we can verify

curricular content" (Participant H). In summary, while articulations have often been initiated from the discipline level, there was indication that, as articulation became more of a college-wide strategic priority, the process would in the future require a greater degree of oversight from the vice-chancellor/provost's office and a more global focus.

Role of the dean and associate dean. Dean/associate deans are critical players in the articulation process and can set the tone of the discussion that can make or break the articulation negotiation. While observation at a local articulation summit indicated that some engineering deans were not receptive to community college articulation, the Tech associate dean was in fact the precipitator in the negotiation of the articulation agreement and, from every indication, valued the efforts of community colleges in educating engineers. His peers considered him to be a model of an administrator who realized the strategic value of articulation:

> A positive is that [this associate dean] turned that position upside down for the positive, not just because of articulation, but because he understands how to look at the big picture. He understands that you make a decision within a context and that articulation agreements bring the transfer students—huge! (Participant R)

On the community college side, the associate dean stepped up in similar manner to lead the articulation effort. Associates looked to him for curriculum leadership within the process:

> It started with [the associate dean] who spent his sabbatical working on improving a pre-engineering course. It is this type of person who understands engineering, what an articulation agreement is, and what it can do for our students that we need to get to the operational level, people like [the associate dean]. (Participant B)

From observations during articulation meetings, these two counterpart deans were the key players in the negotiation and the primary impetus behind the signing of the articulation.

Role of faculty in articulation processes. The role of faculty was one area where the two articulation representatives were in accord. Neither side thought it necessary to bring engineering faculty into the discussion during the articulation process, stating that the respective deans could `speak' to faculty issues. This was somewhat surprising to observe because personal experience from my previous work in articulation negotiations included my involvement as a faculty member. I had been brought into the discussion at the mid-point of the process but before the articulation was finalized, primarily as a content expert.

While engineering faculty did not play an active role in this particular articulation process, various authors (Britt & Hirt, 1999; Cejda, 2001; Fathe & Kasbian, 2008; Tatum, Hayward, & Monzon, 2006; Townsend, 2001), as noted in Chapter II, indicated involvement of faculty in the initial process can more readily lead to an articulation that is a living document. Notes one community college administrator:

> Faculty are positioned naturally to become involved in articulation because they are the experts and can best negotiate the curriculum. Ideally, it should start with them, so I always try to take faculty with me to meet with the university. The faculty talk to each other; they see our faculty and the quality of our faculty and begin to talk to each other. (Participant C)

Some of the reasons cited in the data for not involving faculty in the initial process included: lack of full-time faculty in the discipline (cited by LSC personnel); lack of time, since the faculty are so involved in teaching and research (cited by Tech); distance

between the two schools, making it difficult for faculty to participate; and general lack of faculty involvement in the articulation process.

On the Texas Tech side, the department administrator felt that bringing faculty into the articulation process at the negotiation level might slow down the articulation process because, since the engineering department is divided into sub-disciplines, each with its own curriculum curricular differences, faculty are unable to develop a `big picture' mentality, possibly causing the negotiation process to stall. The comment was: "At universities, it's very strongly department driven. We want to be careful but not overly critical. I want faculty involved but can't get them to look at a detailed enough level" (Participant J).

Influence of Institutional Culture

Another theme emerged from the data, one that had significant influence on the articulation process; that is, how could changes in institutional culture either inhibit or (in this case) encourage articulation. This topic emerged most visibly while interviewing personnel on the Texas Tech campus. A Tech employee discussed how recent top management changes (e.g., a new president and the key administrators he had put in place) had prompted a change in organizational culture. One of those changes initiated by the new president was to make the campus less traditionally bound. The Tech employee stated: "There have been quite a few changes around Texas Tech recently, some due to SACS, but also we have a new chancellor. So we're getting rid of old school ways of thinking" (Participant K).

According to interviewees, in past years the vast majority of Tech students started their freshman year and traversed the Tech educational system in four years. Interviewees

noted that this traditional student pathway is slowly changing in Lubbock and more nontraditional and first time in college (FTC) students are coming to the Tech campus. With this change, however, comes a higher level of under-preparedness that sometimes might result in higher dropout rates. These students are "clinging with their fingernails as they're transferring with yet another transition" (Participant R).

Within the Tech engineering department, a number of administrators have embraced this cultural shift and are actively recruiting community college students. Among them is the associate dean of the engineering area who, as previously mentioned, was one of the facilitators of the articulation under study. However, other Tech interviewees talked about continuing pockets of traditional faculty who are not adept in adjusting course delivery for FTC students. All interviewees acknowledged that Tech culture is changing, but slowly. "It's a cultural change. I think that's what discourages many of our students from continuing" (Participant L). This discussion of the influence of cultural shift concludes the inputs portion of the paper, as demonstrated by the Inputs column of Table 5. The next section reviews the Throughputs column of the table and discusses the findings that related to procedural throughput of the articulation.

Articulation Process–the Throughputs

Throughputs, as described in Chapter I, are any actions taken to effect a program– in this case, articulation of student credit. This would include both informal and formal processes that lead to increased student transfer. As also noted in Chapter I, this process does not necessarily end at the signing of the agreement, although it was at this stage that the case study investigation was concluded. The following section describes a general throughput process two colleges like Lone Star College and Texas Tech go through to

build a relationship. Data uncovered during the interview stage highlighted the fact that LSC and Tech had been on this throughput path for years prior to the signing of this agreement, so it is important to note that the development of a partnership between two- and four-year schools is an evolutionary process, and the signing of the agreement is just one stage in this process. Additionally, as designated by the arrows in the throughputs column of Table 5, it is normally a sequential process wherein the two colleges move from an informal relationship to more formalized agreements. The first step in this throughput process was identified from data obtained from interviews as the `gentleman's agreement.'

Creating a gentleman's agreement. One interviewee, who had years of experience in development of inter-college relationships, called this stage the development of a 'gentleman's agreement' (Participant K). In this context, the parties must first create an atmosphere of mutual respect and need. Birnbaum (1988) would describe these as two collegial institutions whose counterparts consider each other as equals, as was the case between Texas Tech and LSC. This person also described a history of two- and four-year college relationship building as an informal process ending in a "handshake agreement" (Participant K). University and community college counterparts would meet informally, develop a personal relationship, and verbally commit to an informal agreement based on that personal relationship and the needs of the respective colleges at that particular point in time. This long-standing personal relationship often led to a high level of trust between the two parties and their respective colleges, which in turn has led to the development of reciprocal agreements benefitting students. These agreements were not put in formal written terms, and the continuation of the agreement was contingent on both parties

remaining in contact with each other. A Tech administrator commented on what some termed a gentleman's agreement: "Tech has always had a gentleman's agreement with surrounding schools, saying that we will not bother with other [technical] classes; that's your deal. Now, with this administration, it's "let's take a look at this [unwritten] agreement again" (Participant I). An LSC administrator also contributed to this discussion: "We have a handshake agreement with X university [engineering department]. If your students take these two courses, it's equivalent to our [X university] courses. But like I say, it's a handshake, so it usually works, but not always" (Participant B).

Although prominently used in higher educational relationship-building, the problem with a gentleman's agreement is its informality. If the players change, which has happened recently at both Texas Tech and LSC, it immediately renders the agreement null and void. Also, this type of agreement, because of its informality and nonofficial nature, often relies on nonofficial and limited communication between the two parties; consequently, the agreement is often not fully disseminated to all interested parties, relying on the `gentlemen' who created the agreement to spread the word. Lastly, as noted in the previous quote, because it is not a legal document, it is subject to interpretation, and the `contract' can be declared null and void under any circumstance and at any time.

Creation of memoranda of understanding. A memorandum of understanding (MOU) is an informal document that serves as a bilateral agreement for future action. It usually contains very general wording but is one step more formal than the gentleman's agreement because it is in writing and symbolizes the strengthening of a relationship

between two higher education institutions. A memorandum of understanding was found posted online, namely an agreement between Texas Tech and Austin Community College. It described the transfer process between the two schools and detailed methods by which the two schools would share information and marketing. It also recommended, but did not mandate, that the two schools initiate work on a more formal articulation agreement and a reverse transfer process.

A Tech transfer program administrator remembered an MOU between Lone Star College and Texas Tech had been completed in 2003, but articulation administrators from neither school were able to produce an MOU between the two institutions. One credited this omission to the fact that, during that time period, agreements were signed then placed in a file at each college but were not electronically saved. One Texas Tech administrator commented on the MOU process: "I find it very interesting because we actually have a memorandum of understanding with Lone Star College. It looks like, to me, that the engineering department didn't use that—in fact, they might not even be aware of that memorandum" (Participant M).

In general, a majority of those interviewed (with the exception of the LSC articulation officer, whose responsibility it is to create MOUs and articulation agreements) did not place great value on the MOU process, as exhibited by this statement: "There may have been particular instances [where the signing of the MOU helped]. But from what I can tell, they [agreements that work] came from a relationship; somebody knew somebody at that college" (Participant D). Some felt that the memorandum of understanding was an `excuse' for the college presidents/chancellors to travel, meet with their counterparts, and get publicity for themselves and their colleges.

> From what I can tell [from the files], the president of Texas Tech at that time apparently barnstormed across the state of Texas with the head of our Science Center. They must have liked to travel together because there are easily 55 memoranda of understanding between us and community college A, B, C and D signed that year. I'm sure every one of them [MOU signings] had a nice photography session associated with them, but they never helped and had absolutely no influence on student flow. (Participant I)

Other interviewees described the MOU as a very general agreement put in formal language but not specific to a particular degree. Some interviewees described the MOU as "basically, a press release" (Participant K). The current keeper of the MOUs at Texas Tech pointed to a file cabinet where they were all filed but noted that none had been systematically reviewed, updated, or electronically scanned. At the time of the case study, she was in the process of developing a targeted list of community colleges with outdated MOUs, but since she was leaving Tech within a month, was not aware of a particular person or department who would have the responsibility to follow up on contacting those community colleges, moving them to a step 4 relationship, which is detailed next.

Signing an articulation agreement. In contrast to an MOU, an articulation agreement is normally a formalized and usually discipline-specific document detailing the conditions under which students may transfer from one institution to another without substantial loss of credit (for the purposes of this study, from a community college into a university engineering program). As stated in Chapter I, Anderson, Sun, and Alfonzo (2006) believed that articulation agreements are a principle instrument for colleges to use to facilitate transfer. Articulation agreements were often predicated on substantial

existing student flow from one institution to another. For example, Lone Star College is a primary feeder school to Tech. In 2009, it ranked 6th among Texas community colleges transferring students to the Lubbock campus, according to Lone Star Fast Facts (2010). Using this statistic, Tech administrators flagged Lone Star College as a key community college target with whom Texas Tech would like to initiate articulation agreement discussion.

Like the MOU, articulation agreements may, or may not, lead to the outcome of increased collaboration between the two institutions, depending on the level of faculty interaction subsequent to the signing of that agreement. In the case of this agreement, three months after this agreement had been signed faculty meetings and discussion had yet to take place. Two interviewees commented that they had not observed articulation agreements in general to have promoted a greater level of inter-institutional cooperation at their institution. One stated: "It (the articulation agreement) doesn't necessarily lead to increased coordination between the two schools. Sometimes the papers are signed, and they go in a drawer" (Participant D).

One high-level Tech administrator suggested that faculty would need to be 'incentivized' to become more collaborative with their counterparts regarding the curriculum involved in the articulation agreement.

> We need to incentivize our faculty, who have a tremendous pressure to publish and do research, to spend more time on this, and this is the issue with faculty. They don't have the time. We could create some model where we say that these individuals are rewarded for their teaching capacity at the undergraduate level,

> and that's where we'd want them to have the articulation interaction. (Participant S)

Process Used to Create and Sign the Tech-LSC Articulation Agreement

The next sections break out the multiple steps that study participants recommended following to finalize an articulation agreement in a specific discipline area, starting with the establishment of the need for such an articulation and ending with a signed articulation. Because of the importance of this section to the overall process, as well as the ability to fully respond to research question 1, this process is highlighted in Table 5 in the rectangular box at the bottom of the table with a detailed explanation shown in the following paragraphs.

Establishing the need and determining long-term potential. According to participants, the first question that administrators should have determined was the level of demonstrated need for a particular articulation.

> The first question I ask is, is there a need for an articulation in that area? If a university comes to me and the need is not there, we may pursue that articulation in a low key way, but programs with higher workforce needs have priority. When we see the need, we reach out to them; I think we need to do more of that initiation. (Participant C)

Tech, through discussions with their advisory group and interactions with industry leaders, had recognized the need for engineering program growth. Additionally, those sources had encouraged them to add diversity to their student population because the engineering industry in general has recognized the need to diversify. As mentioned in the

strategic planning section of the paper that follows, the Tech engineering department purposely turned to state community colleges for growth in their student population.

At the same time, LSC deans in charge of engineering-related disciplines had been working with the system articulation officer to forge university partnerships so qualified students could move more easily into bachelor's degree engineering programs. Although they have had a series of discussions with other tier I and II Texas universities, at the time this particular articulation discussion began, LSC had not been successful in signing a two/four-year engineering articulation agreement. Again, the LSC articulation officer was instrumental in targeting this particular possibility for articulation, based on students' need for engineering pathways, stating: "I look for agreements that benefit students who normally would be told 'no, your courses are not going to transfer; you're going to have to start all over' " (Participant C).

According to study participants, articulation discussion is often prompted by proximity. Tech in the past had created articulations primarily with community colleges in west Texas while Lone Star College had concentrated on greater Houston area colleges for which they acted as a feeder college (some of which were already partnering with them at the LSC University Center). A second match factor, in order to serve the community college student, was to determine where the students transfer and into which programs they would *like* to transfer. As mentioned in the section about strategic planning, Tech had already begun to reach beyond their geographic confines in their quest for additional students and reached out first to those community colleges with whom they had had previous collaborative arrangements. As one Tech participant indicated:

> I got on the internet and found community colleges in Houston. I knew Lone Star's reputation, so it was the first one I called. Lone Star, Alamo, and Austin community colleges were the first I contacted because we had previous agreements with those colleges. (Participant J)

To validate collaborative agreements, the transferring institution, in this case Lone Star College, should ideally have some idea how their student transfers have done after progressing to the university under discussion.

> You want to have some history on the performance of those students who have transferred from your community college to that institution because you don't want to try to develop an agreement with an institution that has decided your students don't do well there. You are not going to find them receptive to working out an agreement. (Participant R)

Those interviewed who had worked for years on articulation issues tended to look at the long-range potential of the agreement. For example, the LSC articulation officer said that "a lot of it has to do with the need, an articulation that will benefit a lot of students in the long run, or else a niche in the market" (Participant C).

This goal of benefitting large groups of students potentially presented a dilemma in this case because engineering curriculum at LSC had traditionally not been given a high priority, so student enrollment was marginal and coursework had previously been limited to workforce training at some campuses. According to an LSC administrator in the engineering area, currently "priority is not given through budget and manpower allocation, and if it's not included, it's not going to get the attention" (Participant B).

Some first and second year courses overlapped between the two curricular orientations, but others were discrete and faculty qualifications were different. This curricular quandary is a classic question for the community college whose mission is bifurcated into two separate tracks—academic and workforce. One administrator pondered which track was the most appropriate for this engineering articulation:

> Do we just offer a workforce program that readies them for jobs in the workplace, and what are those jobs going to be in the future? On the vocational workforce side, that's a harder nut to crack. Although we've worked with some universities, we haven't signed any articulations [of that type] yet because we want to make sure where the industry is going, whether it is engineering technology, or if it's moving towards mechatronics. On the academic side, it's easier because we know that students need a baccalaureate to become engineers. (Participant H)

With multiple campuses, LSC had the additional challenge of coordinating course and schedule offerings. Based on a perusal of the engineering offerings shown on the Lone Star College website, there did not appear to be between-campus curriculum planning coordination, even though LSC students tend to swirl among campuses. In the short term, these factors may limit the number of students LSC can provide Tech in spite of the articulation and anticipated student scholarships.

Identify stakeholders to the articulation. While articulation talk can be initiated from either the two- or four-year level, in this case, the university instigated initial contact with the community college. The articulation officer at LSC professed herself to be "thrilled" to hear from the Tech associate dean, given past attempts to coordinate engineering articulations with other four-year institutions. Although it seemed like a

simple step to determine the correct people with whom to initiate articulation discussion, it became one of the most challenging steps in the process. First, those interviewed who had previously worked on articulation agreements commented that each college had a different title, function, or level of responsibility charged to negotiate articulations. Secondly, some colleges did not have an officer under which articulation resides; colleges like Lone Star College loosely defined articulation as the responsibility of an academic administrator but did not publish that information externally. Finally, within both organizations, the department within which the articulation function resided appeared to be in transition so a phone call would yield inconsistent responses. A comment from the university representative regarding this lack of positional clarity:

> You might document this. One of the most difficult things in starting articulation discussion was to find the correct contact within the systems. With some of them, I called the articulation director, with others I worked with the vice president of curriculum. But if you dig deep enough, there is someone in all the systems with the responsibility for developing these transfer arrangements and making sure the courses they're teaching are in the transfer databases. (Participant J)

Secondly, a comment from the community college representative who underscored the importance of knowing the right person to contact on the university campus: "It took me a little while to realize that I shouldn't be talking to the generic advisor to get courses to transfer; I should be talking to the department of engineering" (Participant B).

Both sides realized that it was important to reach the decision maker(s) and the person most knowledgeable about curriculum matters early in the articulation process so as not to duplicate effort, but that this person would most likely also need to bring other

decision makers into the negotiation at some point. In this case, once the engineering associate dean counterparts negotiated what they thought to be a workable agreement, the final approval process was fairly simple. I witnessed the meeting where together they drafted a tentative agreement then physically took the agreement to the level of administration appointed as final approvers for signature—the vice chancellor at LSC and the dean of the engineering department at Tech.

Both the literature review and multiple interviewees noted that the articulation discussion can begin at any level, from faculty up to chancellor, but a representative from the articulation office, if such an office exists, should be brought in during the early discussion stage. In this case study, the LSC director of articulation was involved from the beginning, but on the Tech side, the associate dean who initiated the contact handled all articulation negotiation and paperwork. An advantage of having one person, such as the associate dean, coordinate the entire process is simplicity in terms of less people from whom one needs to get approval. The downside is the political risk of someone at a high level questioning the agreement after the fact.

A high-ranking Tech administrator commented on this:

> One of the reasons that engineering was successful is that [the associate dean] said, "I don't want to deal with all of this. I'm just going to go out on my own." I told him, "I'm not going to get in your way. I won't bother you. You were wise to go out and not get bogged down by us." He did it by staying out of this whole thing [political situation]. (Participant S)

From the multiple comments of Tech interviewees, the perception was that their articulation function was in flux. No one had the title of articulation officer, making it

more difficult for the LCS articulation director to know with whom she should work, and multiple areas considered articulation to fall at least partially under their purview, including curriculum, advising, and University College—the branch that coordinates university center relations.

Compare curriculum and negotiate the differences. Engineering is an example of a higher education discipline with numerous sub-curriculum breakouts. Tech's engineering department included mechanical, electrical, civil, petroleum, and others while LSC offered coursework in both academic and workforce engineering sub-disciplines. In the Tech course catalog, each of these curricular areas had a discrete set of coursework to follow. So when the two associate deans initiated discussion between the two colleges, they had to decide which would be the first curricular area to use as a model. The Tech representative commented that "we started with mechanical engineering because it's the largest department here [at Tech], and the one I was most familiar with" (Participant S). The negotiation team then pulled up the four-year content of the mechanical engineering program to use as an example. They completed that agreement and then moved on to the sub-discipline they felt mirrored the first agreement, which was civil engineering. At the time of the signing, they were still working on the electrical engineering agreement but, due to the large number of discrete courses in that sub-discipline, had not finalized a pact in that area.

Come to curricular agreement. It is often at the negotiation phase wherein some articulations break down if the programs have too many points of difference. The goal during this stage was to determine how closely the two curricula mirrored each other to ensure that the students at the two schools were obtaining comparable educations. Tools

observed as being helpful during this stage included: institutional catalogs, syllabi, core curriculum guides, equivalency guides, and samples of articulation agreements with other institutions, similar to the South Plains Community College agreement previously signed by Tech. In the case of this agreement, the key tool used was the corresponding online catalogs between the two schools. As one participant stated: "I got their catalog and our catalog and matched up all the courses I could as closely as possible. The articulation officer and I talked, and she helped me better understand what was available at Lone Star" (Participant J).

During this step, it was also useful to refer to the Texas common course numbering listing and cross reference the courses the two institutions had in common, as suggested by the LSC articulation officer. "I start by going check, check, check. These are the courses that are on the common course listing and will transfer without problem" (Participant C). Next, the articulation team cross referenced each semester of the four-year program and looked for commonalities in coursework and course sequencing. Then the details of each course were reviewed side by side to ensure that course descriptions and outcomes were in synch, which they should be if both institutions use the Texas common core.

Finally, the two teams double checked that all course pre-requisites were in line with university requirements as one Tech advisor noted: "Students [entering the engineering program] need to have a strong physics and math background, so we really need to work on students' academic background in those areas" (Participant R). Because this step can be very time consuming, some articulation negotiations tend to short cut this step and not reach down into the detailed curricular outcomes level. However, the

participants at both institutions felt that it was important during this process to have a discussion about course outcomes and prerequisite/preparatory courses, especially because STEM discipline curriculums like engineering are sequentially ordered with competencies forming building blocks for future coursework. An additional challenge found was that the competencies varied from school to school for the same course and a particular outcome could be found in an alternate course. This step warrants in-depth dialogue about specific assignments, class exercises, and lab work as noted in the course descriptions and syllabi. A quote from an LSC administrator talks about the importance of discussing course outcomes:

> We had a lot of discussion about the courses we had and what they expected us to teach in them. We looked first at course outcomes. Like in engineering graphics, we talked about what we actually did. For some colleges, they just want to know if we teach the students how to draw. But Texas Tech wanted to know if we used a particular software package [that the students would need to know how to use when they reached Tech]. (Participant B)

A corresponding quote from his Tech counterpart described the level of detail that was required for articulation, including a review of course descriptions:

> You don't always realize what is in each course, so when we got together the first time, we looked course by course. We also pulled course descriptions, but you have to look carefully at the course descriptions [and discuss them] to make sure that the content in this course will form the basics of what subsequently will be taught at the receiving end. (Participant J)

A high-level official at Tech commented that this step had become even more critical with the changes in accrediting body requirements, which in turn are a result of political pressure to become more accountable to the public. States are also now requiring that all course syllabi be publicly available for perusal.

> With SACS 3.5.1, you [the university] are held to assessing the attainments of the students on our learning outcomes. Now, we have to document the extent to which students meet those outcomes. That is a very big difference. We must also be able to show that courses transferred from another college meet that standard, must meet this criterion. (Participant K)

In the case studied, this process was not seamless. For example, although Lone Star College listed a certain course in their inventory in the catalog, the reality was that the course was seldom offered. This could not be determined by looking only at a catalog or website. Tech, on the other hand, offered some introductory engineering courses that did not use the common course number rubric, so a cross reference would not have picked them up.

Once the basic courses were decided upon, it was then necessary to create a course specific curricular comparison, otherwise known as a planning guide. "Transfer planning guides are the programmatic level agreements that outline degree requirements such as course-by-course patterns for articulated transfer work" (*Texas State University Articulation Agreements Statement*, 2005, p. 1). As occurs in many articulations, in this case study, the Tech-LSC guide was laid out in the form of a crosswalk. As is normal during an articulation discussion, the cross-walk was formatted as a grid and divided by semester and year of college. It showed the university course sequence on one side and

the corresponding community college sequence on the other side. Courses deemed to match, in terms of course description and outcomes, were inserted in the appropriate place. This process visually demonstrated where the discrepancies were (e.g., no community college course corresponding to the university course) and where semester by semester course sequence was out of synch.

During this step in the articulation process, both sides of the articulation negotiation felt that it was preferable to meet in person and get the interested parties together for collaboration and curriculum planning purposes. As one participant from Tech stated:

> The next big thing was just the visits to establish the relationship. I had contacted her before I went down there [to Houston] for another event. She had faculty and administrators from several of the campuses meet with me; that was extremely responsive on her part. (Participant J)

It was especially important in this early meeting to have curriculum content experts at the table who were able to get to the level of curricular detail required. During my discussions with Tech personnel, one commented on what he had learned about this during a previously signed articulation:

> We had a very nice visit with the community college when they came here. They discovered that one course in the core for technology that they have at the community college could still fulfill the core [at Tech] and would be readily transferrable to curriculum here, instead of having whatever content we had. The point was to get down to that level of detail with people who could talk intelligently about it. (Participant J)

In this particular case study, faculty was not directly involved in curricular discussions. When queried, both associate deans had the same comment; that is, since they currently taught engineering courses, they were familiar with the curriculum and could speak as content experts for the engineering faculty. Also, at the community college, there were no full-time faculty hired to teach engineering, and part-time instructors were not expected to participate in curriculum development matters as part of their role.

Come to final agreement on articulation details. This step is easy to state in a research paper but, in real life, often difficult to accomplish during articulation negotiations. It is at this stage, more than any other, that the articulation process breaks down, and it is at this point that negotiation skills most come into play.

In the specific articulation studied, one of the key issues to negotiate before coming to final agreement was that the course sequencing and cross walk first suggested by Tech, while adequately preparing the student to enter Tech's engineering program their junior year, did not give the community college student the requisite number of hours to graduate with an associate's degree. While this met the goals of Tech personnel, it was not acceptable to LSC personnel and discussion temporarily stopped (as evidenced in February 15, 2010 LSC-Tech articulation meeting minutes).

> One of the hang-ups was that we weren't going to get graduates, and that's where [the LSC articulation officer] came in because we [community colleges] get measured by our graduates, and it seemed [in the agreement first proposed by Tech] that they weren't going to graduate. A student who does the minimum as

> dictated by the articulation would still have 6 hours left [to finish at the community college in order to get their associate's degree]. (Participant B)

This dilemma was resolved through the introduction of the reverse transfer concept (see *Importance of Reverse Transfer to the Articulation*).

It was also important to come to agreement on non-curricular aspects of the articulation. Once the coursework aspects of the articulation were negotiated, the two colleges discussed lingering questions that needed to be finalized before the agreement could be signed. This included a detailed description of which students would be accepted into the program based on the number of contact hours attained and grade point average within those contact hours. It made mention of the role of advisors both at LSC and at Tech and discussed the transcription process that would take place between the two institutions.

Although this particular agreement did not do so, those interviewed with previous articulation expertise commented that a model transfer agreement should look towards the long-term to defuse potential future problems. One interviewee suggested that "it needs to talk about the life span of the agreement and under what conditions that agreement might not be honored within that time period" (Participant F).

This administrator, well versed in articulation, also commented that the model articulation agreement should spell out the parameters under which the agreement would be discontinued:

> If, for several reasons that program is going to be discontinued at the receiving institution, it needs to have a stipulation for a "teach out" agreement, so those

> students who transfer or who will be transferring will have an opportunity to move in and complete the program. (Participant F)

These suggestions came with the proviso that they were refinements not included in all agreements. The agreement under review did not include those details; however, it did stipulate GPA (2.5 or better) and grade requirements (C or better in core courses) for transfer students as well as general marketing and advising requirements. It also provided the important proviso required by LSC for reverse transfer of student grades back to the community college. These are stipulations that may be discussed as the colleges continue to work together to sustain this agreement.

Complete agreement paperwork process. Once the articulation was agreed upon by the primary negotiators, the paperwork had to be signed by key administrators. From observations, gathering the requisite signatures was a manual process at both institutions as described by an LSC articulation official:

> I do that process and make sure the signatures are there and get signed. Some agreements have gotten lost; I'll even go to the college to pick it up. I'll do almost anything because I've worked so hard on it. Then I'll make sure each institution has a signed copy. (Participant C)

In some articulations, the respective chancellors/college presidents come together for a signing ceremony, but this agreement did not cumulate in a signing ceremony by top executives.

According to interviewees well versed in articulation, the signing of one articulation agreement sometimes prompts articulation discussion with other Texas institutions. At the time the study began, the Tech engineering department was in the

process of negotiating with over 20 community colleges and, as of the writing of this paper, had signed two additional engineering articulations. However, since no two articulation agreements are alike, they planned to use the LSC agreement as a prototype as they began articulation negotiations with other community colleges. Following are quotes that demonstrate the parties involved in this articulation realized its value as a model for other articulations, and that success begets success as one signing often leads to others. A comment describing the value of articulation from the Lone Star College side was: "This model goes beyond this one articulation. It gives us a model that we can investigate with other colleges when we talk about articulation" (Participant H). Tech personnel corroborated the idea of piloting with LSC with the introduction of a reverse transfer component to the articulation:

> I agreed to do this [reverse transfer] with engineering because I wanted to get it off the ground. But then hopefully I can hand it off to someone. I have to pilot things like that sometimes to demonstrate how useful it is. Beyond the signing of this particular articulation, both parties could demonstrate an increase in the total number of articulations signed by the respective educational systems, a figure that top administration monitors as a signal that the organization is positively effecting student transfer. (Participant J)

The community college articulation official noted that the LSC Board of Regents periodically monitors articulation status:

> I have to do a report for the board on an annual basis, and all they want to know is how many agreements were signed, and they're happy to hear it. But it does not show how difficult it was to sign, how many scholarships, whether we started a

reverse transfer component to increase our graduation rate. It's just a number. (Participant C)

Both sides realized that signing an agreement would not immediately result in increased flow of students from one organization to the other. As one participant commented: "At Lone Star, it will take a long time before we get more than a dozen transfer students [for engineering transfer]. Currently, you just can't justify having a full-time faculty member here" (Participant B). From the university perspective, the key Tech articulation representative mentioned the need for prerequisite skills to enter the engineering program, a requirement that may limit the number of students who could take advantage of the articulation: "That one [the engineering articulation] won't immediately produce big numbers because too many of the students come to us without the requisite math skills like calculus, but some will, so you're looking at quality versus quantity" (Participant J). With the signing of the agreement, the throughput process was complete. Therefore, this paper now moves to the outputs process, as demonstrated by the Outputs column of Table 5.

Articulation Process–the Outputs

In comparison to the throughput stage, output is fairly straightforward; it is the product of the throughput process. In this case, the output was the signed articulation agreement. After the articulation was agreed upon by the negotiators, the LSC articulation officer moved the document through a short approval process. On the LSC side, it was signed by the associate and vice chancellor of curriculum. At Texas Tech, it was signed by the dean of the engineering department. The agreement was then electronically filed in the articulation and transfer offices at the respective institutions.

Importance of Reverse Transfer to the Articulation

Throughout Chapter IV, reverse transfer has been referenced as an important system component required to finalize this articulation. Also called a retroactive degree by some Tech personnel, reverse transfer had become a critical component in many articulation negotiations, as was the case in this study. As a result, this idea became an output to the articulation process.

Reverse transfer, not a new concept in higher education literature, is defined by Townsend and Twombly (1999) as "students who transferred from either a public or private four-year institution to a community college" (p. 177). De Los Santos and Wright (1990) also referred to the swirling student phenomenon in their work on transfer students. However in the context of this articulation, reverse transfer refers less to physical student movement from four- to two-year colleges as it refers to the transfer of students' credits back to community college after the student completes coursework at the four-year institution. Community colleges want a clause included stipulating that universities provide a reverse transfer system because this is a way to gain additional graduates. An LSC administrator who has negotiated a number of articulation agreements related: "Probably the biggest thing institutionally that I've discovered [in working with articulations] is this process of reverse transfers for degree completions. I'm sure you picked up how important that is to the community college" (Participant C). Some four-year institutions go a step further and use reverse transfer to actively advocate that students take degree coursework at the university:

> We worked with X college, and they wanted to do an articulation agreement, build in a reverse transfer, and then tell the students not to graduate from here

> [Lone Star College]. They only wanted the students to take 30 hours from here, then transfer. It wasn't that their courses were these upper-level engineering classes; they just wanted the students to take all the engineering courses from them. (Participant H)

The level to which Tech supported the concept of reverse transfer appeared to be inconsistent throughout the organization. On one hand, the associate dean appeared to understand how essential it was to LSC's commitment to the articulation and vowed to make reverse transfer work in the engineering area even though there was not currently a working system to transfer the credits back to LSC. At the time of the writing of this paper, he was working with the enrollment management department to initiate a system by which these students could be identified, the data captured and sent back to the graduation specialist at LSC. This Tech administrator said: "I think it's really important that we do our bit to help the community colleges with their graduation rate and to become more integrated into the system" (Participant J). A former Tech transfer advisor also understood its importance, both to the community college administration and to the transfer student. She sold reverse transfer to the student with two arguments: (a) It would make the former community college student Texas grant eligible, and (b) the student would have a degree or certification to fall back on if, for some reason, they did not complete the baccalaureate degree.

However, reverse transfer was not universally popular among Tech personnel. One advisor questioned the need to "go through the bother because, after all, the baccalaureate is the degree the student values" (Participant K). Other Tech administrators appeared to de-emphasize reverse transfer for economic and logistical reasons.

> In fact, they [the community college] would prefer not to have to even do that [a reverse transfer agreement]. They would prefer the student stay and complete the associate's degree at the community college. I don't think that's [requiring reverse transfer of credits] reasonable to expect myself. (Participant S)

While acknowledging the importance of reverse transfer to the community college, one high-level Tech official wondered how to motivate Tech personnel to do the extra paperwork required to effect reverse transfer and pondered the repercussions of inclusion of this clause in the agreement: "So why and how would we incentivize them to do that? We've agreed to do it, and we're trying to do it, but it is very labor intensive" (Participant S).

Need for a Reverse Transfer Component in the Agreement

A reverse transfer component appeared to be a deal breaker for the community college personnel involved in the negotiation. Accordingly, LSC personnel actively negotiated for this clause in the articulation agreement; however, university personnel either acquiesced to this demand only because they knew negotiation would stop without the addition of this proviso or professed concern that the addition of this process would add an onerous requirement for Texas Tech. Data was unobtainable that showed students understood the value of reverse transfer so the question remains whether this clause benefitted students, or whether it was put in place to facilitate increased associate's degree completion figures for the community college. This question is revisited in the final chapter of the dissertation, and the paper now moves to the final portion of the process, as shown by the Outcomes column of Table 5.

Articulation Process–the Outcomes

Outcomes, as described in systems theory literature, refer to intermediate and long term goals, as well as intended or unintended consequences. Relevant to this agreement, long term goals could include the development of a sustained relationship between the two collegiate organizations. However, a more immediate outcome mentioned by the stakeholders was the creation of a sustained marketing effort to make both internal and external stakeholders aware of the articulation agreement.

Commitment of additional marketing efforts. Within the signed agreement, the colleges committed to increased marketing efforts to ensure that details of this agreement reached students who might be interested in a career in engineering. However, at the time this paper was being written, a Google search yielded no announcement about the articulation. A perusal of the two college's websites showed that LSC had posted the cross walk of the articulation, but Tech did not have any information about the articulation on their website. One might assume one of three things from this: (a) Information about the articulation is forthcoming and marketing efforts take time, (b) the colleges have chosen not to provide marketing for this particular agreement, or (c) no integrated system linking articulation and marketing functions currently exists at either college. From observations of systems and process workings at both colleges, option C is the most likely culprit. Accordingly, this topic is revisited in Chapter V.

Sustained interaction between the colleges. Sustaining the communication initiated by the agreement appeared to enhance the partnership initiated by the agreement and promotes long-term student movement between the two institutions. One administrator commented:

> The real beauty of the agreement is the value it will offer for degree purposes. What needs to follow, after the articulation is signed, is to have frequent contact between the deans or between the advisors we have at Tech and Lone Star so that every time there is any type of student event, like a job fair or transfer fair, they call us and invite us to participate. (Participant J)

A Tech administrator reinforced that ongoing personal dialogue between the two parties was essential: "There's got to be an ongoing professional dialogue. I know you, you know me; there has to be mutual professional respect and an ongoing forum for communication" (Participant L).

Creating the potential for ongoing physical presence. The creation of a sustained physical presence by the university partner on the community college campus was noted as a requirement of a long-term effective articulation agreement. In this case study, the signed articulation agreement detailed the presence of a Texas Tech advisor on Lone Star College campuses. The need to have university personnel on the community college campus was also discussed during interviews in the context of Texas Tech's relationship to other community colleges with whom they had previously signed agreements (South Plains Community College was prominently mentioned) and, at the time of the interviews, Tech was working on a plan to facilitate that action. Also, university presence on the Lone Star College campus was mentioned in the context of the University Centers run by LSC, and all high-level administrators at both colleges were very aware of the existence of these centers.

This concludes the portion of Chapter IV dedicated to the explanation of the process used to create the articulation agreement and the inputs, throughputs, outputs, and

outcomes implicit to the process. However, it is equally important to highlight some of the roadblocks to articulation that surfaced during the analysis phase of the data sort, as highlighted in the circular inset in Table 5. Accordingly, the following section delineates the key issues, problems, and roadblocks that could possibly have halted this articulation process.

Issues and Roadblocks in the Articulation Process

Both sides of the articulation negotiation experienced roadblocks that had to be circumvented before the agreement could be signed. This theme was highlighted in Table 5 with the circular inset, and the following section explains those issues from the perspective of both the community college and the university. These issues ranged from curricular issues to philosophical differences between the two educational entities.

Goal differences between the two educational sectors. Key goals, on the part of community college personnel, were that the articulation would support what some called a "seamless" student transfer process: secondly, a way for community college students to use all their completed credits to further their education, and finally, a method by which the community college could count those students as completers. During the negotiation process, it became evident that the signing of the articulation contract would be contingent upon a number of secondary processes being finalized, including reverse transfer, and these processes had to be agreed upon before the agreement was signed. The Tech representative at the negotiation table had to regroup, return to campus and meet with Tech personnel, then come back with a reverse transfer plan that would respond to LSC goals. This reverse transfer component complicated both the articulation process and the transfer system agreed upon because the transfer back of student credits was

determined to be a manual process and dependent on student interaction with advisors at both campuses. As one interviewee said, "I wish people would stop using that word seamless because there is no such thing!" (Participant S)

University personnel, on the other hand, did not talk as much about facilitation of student movement and inter-sector credit transfer as did their community college counterparts. Their primary goal seemed more in the recruiting of qualified bodies that could be accepted into the engineering program. This goal supported the university's need to replace students who drop out of the engineering program during their freshman-sophomore year due to poor academic performance or a change in major. Further, it pointed to possible goal incongruence between the two sectors–the university's goal was geared towards high-quality entrants while the community college's goal was to be able to count program completers and increase graduation rates. In this quote, an interviewee acknowledged how goal differential influences how administrators approach the student transfer differently:

> I think the goals are very different between the two. The community college's goal, in making the articulation work, is more to make the students happy with a seamless transfer process by not losing credits. On the four-year side, it's the recruitment of the student that's the goal. (Participant J)

Some interviewees at the community college expressed uncertainty as to the community college's goal and how or if Lone Star College actively fostered the goal of transfer. One summarized: "I guess the confusion is what exactly *is* transfer and what is our goal. Our students *do* transfer, but it does not seem like we're actively pursuing that transfer arrangement" (Participant E). What was critical in this articulation agreement

was that the goals of both entities were met during the negotiation process—the potential for increased student count for Tech and the ability to count completers for LSC through reverse transfer.

Perceptual differences in students' need to attain an associate's degree. Closely related to goal differential was the relative value placed on the associate's degree by the two institutions. As might be expected, all community college personnel were quoted as saying that there was value in students' attainment of an associate's degree. One LSC administrator admitted that she did not want to waste time on articulation negotiation with universities that did not support student attainment of an associate's degree: "I only want to do that when the university is very supportive of them finishing their associate's degree…some universities are not aware of the success measures that we have–graduation rates and completion rates" (Participant H).

While some Tech personnel had been educated about the value of associate's degree attainment, other Tech interviewees downplayed the value of the associate's degree, stating that the important degree for students to attain is the bachelor's degree, as demonstrated by a quote from one Tech administrator: "It's not in the student's best interest in terms of the amount of time spent on degree attainment to be overly concerned about getting the associate's degree" (Participant S). Other university personnel thought that the state of Texas should change their evaluative criteria and not place as much emphasis on associate's degree program completers. This Tech administrator downplayed the requirement that community colleges show completers while, at the same time, placing a higher value on the baccalaureate degree: "I would like to see the state

regulation changed so that community colleges are rewarded for transfer of students rather than posting an associate's degree. That's not the valuable degree" (Participant K).

Bias in two-year students' perceived ability to succeed at the university level. In Chapter I, multiple studies are referenced that gauged the level of success community college transfer students achieved after transfer to a university. Although the opinion of experts differed on this topic and research has not come to a consensus on the issue, the viewpoint held by key personnel within a university is a key factor in prioritizing transfer partnerships.

In the past, Lone Star College had attempted to negotiate engineering articulations with a particular college whose personnel did not want courses in the major taken at the community college. One administrator described that conversation: "Another roadblock is whether or not students should complete courses in a major before they transfer because that university wanted to have the students take all their courses in the major at their location" (Participant C). This previous engineering articulation negotiation experience was relevant to the case study because LSC personnel came into the articulation discussion expecting Tech personnel to have a similar viewpoint of the community college's ability to teach engineering coursework. One LSC administrator shared her experience: "I was frankly surprised and pleased that [Tech associate dean] showed such an open attitude and acceptance of our coursework" (Participant C).

Some Tech personnel interviewed endorsed the level of preparation given transfer students by community college instructors. It seemed that those supporting the community college's efforts had had previous, direct interaction with community college faculty. For example, one Tech administrator had first-hand knowledge of community

college preparation because she had begun her academic career at a community college. This administrator affirmed the ability of the community college to properly prepare students:

> First of all, I have an absolute underlying bias that one can recruit excellent students from community colleges, and that community college lower-division curriculum is as good, or better, than university lower-division curriculum. Was I irreparably harmed because I went to a community college? I would say not. I had an extremely fine academic environment in the three community colleges I attended. (Participant S)

Her administrative counterpart at the community college echoed that sentiment by saying that "it's a question of quality. In transfer, our [LSC] students do as well, if not better, than students that start out at a four-year college" (Participant L). However, the perception that community college freshman and sophomore level coursework within the curriculum area was adequate preparation for the rigors of junior and senior level engineering was not universal among Tech personnel. One administrator who worked closely with the Tech articulation negotiator described interdepartmental dissension regarding the viewpoint that the community college could adequately prepare pre-engineering students: "[The Tech administrator in charge of articulation negotiation] got a heck of a lot of push back from people in his department about this pre-engineering program, especially because of turf protection" (Participant R). In the end, the negotiators on both sides of the articulation were able to overcome these problems and signed the agreement, thanks to their willingness to negotiate the issues.

Because one of the research questions concentrated on the process of finalizing an articulation agreement, some of the interview protocol focused on the participants' level of understanding about articulation processes. Almost universally, interviewees decried their lack of knowledge about how the articulation process should work. Following are some of the most unclear process points, as cited by multiple participants.

Signature level required on the articulation document. There was inconsistency and confusion on the level of approval required for a college to sign off on articulation approval. The actual negotiators of the agreement (the associate deans) were not required to sign the document although, it is at that level that the commitment is required in order to accomplish phase II of this agreement (the movement of students from one sector to the other). In addition, the articulation director was not among the signatories, even though she has great responsibility in effecting the articulation process. Further, observed was that the level of authority required to approve the agreement was inconsistent between the two educational entities. On the university side, there was confusion on the required signatures:

> I inquired within the university who should sign these agreements. Should I be having President Bailey sign it, or the dean sign it? The word I got back was that it was okay for the dean [of the college of engineering] to sign it. On the other hand, when I get it [an articulation] signed by the [community college] institution, it's usually the president who signs it, which makes me feel a little bad. (Participant J)

In a previous articulation process, a community college actually challenged the Tech official as to the need to have the document endorsed at the highest levels: "I think it was

Alamo that challenged me whether or not we had enough authority within the college of engineering, if we could follow through on the agreement, specifically in respect to reverse transfer" (Participant J). In the end, the dean of the College of Engineering was the highest ranking official to sign this articulation at Texas Tech.

On the community college side, there was also confusion on the matter of who was to sign the agreement. The associate dean involved in the articulation waited for notification that the chancellor would become involved in the approval process as he had witnessed in the past, perhaps as part of a signing ceremony. The articulation officer later commented on this: "Articulation agreements do not usually have a signing ceremony. We did have one with Sam Houston and the University of Maryland though" (Participant C). In the end, the highest level of endorsement of this articulation, on the part of the community college, was at the vice chancellor level. This official signed the document in her office but admitted in a subsequent interview that it was a perfunctory endorsement, and that she relied on the articulation officer and associate vice chancellor to check over the details of the articulations for accuracy. It was unknown if public relations officials were involved or if any photos were taken of the event for publicity purposes. As witnessed by the researcher, the signing between the two educational entities was extremely informal and was not closed even by an official handshake. In general, as observed through meetings, emails, and other institutional documentation, the level and scope of the articulation endorsement was inconsistent between the organizations and among different articulations signed within the same organization.

Lack of authority, ownership, or understanding of the articulation process. Although LSC did have an articulation officer (Tech did not at the time of the study), the

extent of that officer's authority over the process was advisory in nature, and neither institution offered any type of training on articulation. Also not found were any written or published articulation procedures at either institution to guide interested parties through the process.

> It is not formal, and we don't have a written procedure. We fly by the seat of our pants. We do have forms to submit, but that puts a lot of pressure on us, and it's hard to learn the process that way. (Participant M)

Very few administrators at either college could fully describe the articulation process step by step. Most admitted that they had learned about articulation "by doing it" (Participant D) and had not experienced any mentoring to prepare them to be a key player in the process. Some further surmised that this lack of complete process knowledge might have slowed down the articulation process to some extent. As one stated:

> I'm a process person. Looking back, what would have made it easier is if I would have known the process we're going through. Something visual would have been nice; we're going to do this first, then…..I think we spun our wheels a little when first meeting because we didn't really know where to start. (Participant B)

Because the two associate deans decided to take ownership of the articulation process, the transaction was completed. Although a lack of complete understanding of the procedure may have slowed down the articulation process, both parties persisted. As one participant said: "I just did what I thought made sense" (Participant J) and moved forward to the conclusion–a signed articulation.

Perceived lack of support from the coordinating board. One piece of data that was found in almost every interview was the virtually universal negative perception regarding

The Texas Higher Education Coordinating Board's ineffectiveness in incentivize schools to produce more transfers and articulations, in particular but not limited to engineering. One participant commented: "They've tried everything. They've tried field of study, concurrent curriculum, national transfer groups….but the incentives work only to a certain extent" (Participant C).

In engineering curriculum, Texas higher education has attempted a number of transfer initiatives with limited success. One of the first initiatives was the field of study, a concept created by Texas Education Code 61.001 in the late 20th century that recommended a prescribed set of lower division courses that a community college student might take that would lead to a particular baccalaureate degree. If used, this field of study (FOS) might have lessened the need for the articulation under consideration, but many community colleges in Texas, including Lone Star College, did not actively promote this field of study, calling it problematic. One Tech administrator noted that "people don't even know that we have fields of study." An LSC administrator commented on its ineffectiveness:

> The state of Texas created a field of study in engineering, but for several years, we chose not to even advertise that field of study because it was so difficult for students to get courses at the two-year college that would be acceptable for transfer to a university. University faculty didn't want it, and even though by law it says it has to transfer, there was some really strong pushback. Almost any courses they [students] took with us, they were going to have to repeat, which defeats the purpose of the FOS. (Participant H)

The state of Texas also recently implemented an Engineering Voluntary Transfer Compact (see Appendix D for the complete compact) that goes further than the field of study in specifying which courses a pre-engineering student should take at the community college to facilitate transfer into a university engineering program. Texas Tech was one of the universities instrumental in creating that compact and "funding for the initiative just started two months ago" (Participant J), so transfer results based on this initiative are yet to be seen. However, few Texas university engineering programs have stepped forward to enter the compact, and administrators interviewed had mixed feelings about the coordinating board's ability to incentivize them to participate in this compact. From a Tech administrator: "A&M, UT, and U of H are not currently signing on to the transfer compact, but I don't think they can do that indefinitely. I think the coordinating board will say we are validating what community colleges are doing" (Participant J). A community college administrator expressed his doubts about the overall effectiveness of the coordinating board in facilitating articulations:

> The coordinating board should get involved, but Texas is still very much major university driven. I hesitate to say that the coordinating board could help; my interactions with them have not been good, but they do have a tough job. The political power in the state is not with them. The coordinating board can suggest things, but they can be ignored. Short of a governmental constitutional change, things will not change. (Participant D)

Despite the issues described in this section of the paper, the articulation agreement was signed in the fall of 2009. The next chapter discusses how the potential outcomes of this articulation process can influence the flow of students from LSC to

Texas Tech's engineering program and point out some of the constraints to this long-term process, as underscored by both the research data and the literature review on transfer and articulation.

CHAPTER V

FINDINGS, CONCLUSIONS, AND IMPLICATIONS

The purpose of this final chapter of the dissertation is to interpret and evaluate case study research findings in light of the literature review, theoretical framework, and life experiences, then draw upon this synthesis process to formulate a series of implications and recommendations. To complete this process, first an overview of the theoretical perspective methodology and results is provided. Next, the interpretation section of the paper is presented, and then proposed implications for further research that support and enhance the information is presented in the literature review. The implications section is divided into general implications, implications for policy (both college and state level). and implications for research. The chapter then ends with a summary statement of the findings and conclusions that provide a denouement for the paper.

Theoretical Overview of Systems Theory as Applied to the Study

One element of systems theory that provided relevance to the question of articulation processes was the terminology that isolated system/process components: inputs, throughputs, outputs, and outcomes. These terms were embedded into the research questions and the use of this terminology became increasingly relevant as the study progressed because data produced by the interviews underscored the lack of internal structures embedded in the articulation process. Few participants were able to identify or describe the specific components to the process, nor could they articulate specifically where the process was likely to break down, resulting in broken negotiations and the lack of a signed articulation. The systems structure as outlined by the inputs through outcomes

flow brought clarity to the process and provided the basis for articulation process analysis.

Gaps in Systems Theory Literature Applied to Higher Education

Chapter I outlined how researchers previously applied systems theory to education processes. Birnbaum (1988) discussed the concept of inertia and the relatively new idea that all educational entities are interdependent and complementary elements of a larger system. Bender (1990) followed up this concept with the idea that education as a whole is a process and the individual entities should not be viewed as discrete institutional forms or types. Along with Ciciarelli (1993), Cohen, (1996), and Gharajedaghi, (1999), all of these authors critiqued this traditional siloed view of education as calcified and archaic.

Another group of writers (Cain, 1999; Crawford, 2005; Frost, 2005) applied general systems components specifically to higher education. Chapter II described how systems thinkers used systems theory to analyze processes within the field of education. Checkland (1981) and Bathany & Jenlick (1996) pointed out the fact that systems inquiry has to date been underutilized in education studies. Beginning in the 21st century, a few isolated researchers (Crawford, 2005; Frost, 2005; Shibley, 2004) began to use systems theory in action research studies conducted within the higher education arena. However, none of these researchers applied the specific components of systems theory in any organized method to explain a higher education process. The utilization of the systems concepts of inputs, throughputs, outputs, and outcomes fills a gap in the literature and is this study's most significant contribution to systems theory application within education,

broadening the conversation on the use of systems thinking in explaining how higher education systems work and can be analyzed.

By utilizing elements of systems theory—inputs, throughputs, outputs, and outcomes—in the analysis section of Chapter IV, the articulation process was effectively broken down into individual components, as demonstrated in Table 2 of Chapter I (Level 1). Each element of the systems flow was divided into subcategories and analyzed, and this method of analysis also drew attention to the roadblocks in the articulation flow. Delineation of articulation processes had not only been a missing element in transfer literature but was noted by study participants to be valuable as an internal training tool in the respective organizations. In addition to the systems theory concepts of inputs, throughputs, outputs, and outcomes, another model within systems thinking provided process clarity; this model is the feedback loop.

Feedback loops embedded into the articulation process. By entering into an articulation negotiation, the higher education institutions studied signaled that their respective colleges were willing to develop a long-term relationship between the two institutions (i.e., a partnership) with the expressed goal of creating an increased flow of students between those institutions. Presumably, college personnel brought into the articulation discussion were of the mindset that an increase in inter-college communication presented a benefit to both institutions and therefore committed to foster open communication and the breakdown of existing barriers to effective interaction.

In order to fully represent their respective institutions however, articulation negotiators had to also commit to the creation of communication loops within their own institution, for within this articulation negotiation, they represented both their curriculum

areas and their institution as a whole. For example, in this particular articulation, the two negotiators, when speaking on curricular issues, represented the engineering faculty, thus taking on the responsibility of communicating back to their faculty how this articulation affected that curriculum area. The administrators who signed the articulation agreement, by acting as institutional representatives, were implicitly taking on the responsibility of disseminating information about the agreement back to their respective institutions so the terms of the agreement could be acted upon.

In systems terminology, this communication flow is known as a feedback loop. As stated in Chapter I of this dissertation, feedback loops can be viewed as circular paths of cause and effect (Birnbaum, 1988). For example, in this case study, if faculty had been found to be vehemently opposed to this articulation, college articulation representatives would presumably have listened to that feedback and have caused the articulation negotiation to stop before the agreement was signed. The importance of this particular feedback loop (i.e., faculty feedback) is further alluded to in the *Implications for Practice* section of this chapter, since authors cited in the literature review (Britt & Hart, 1999; Fathe & Kasbian, 2008; Helm & Cohen, 2001) emphasized the importance of faculty inclusion in the articulation process.

Review of Research Questions

Systems theory provided a framework around which the research questions were constructed. Since the problem statement alluded to the fact that relatively few qualified community college students (a potentially rich student base) currently transfer into baccalaureate engineering programs, and a review of the literature revealed that articulation was a promising means by which to resolve this problem, it became

important to facilitate a discussion within the interview protocol that would uncover a means by which an articulation agreement could be effectively produced.

The three research questions proposed in this study were:

- What is the process by which a community college and a four-year university create a partnership, resulting in an articulation agreement that would facilitate student transfers?
- What are the specific inputs, throughputs, outputs, and outcomes implicit in the creation of this agreement?
- In what ways do college stakeholders contribute to the creation of an engineering articulation between community colleges and four-year universities?

By asking study participants to think about the articulation process in systems terms, it forced them to think more deeply about those inputs that were contributors to the creation of the initial partnership between Lone Star College and Texas Tech University. The protocol further required them to provide detail on the throughput process they were following as they progressed through the articulation process. Some of the questions alluded to short-term results of the process (the outputs) as well as the long-term ramifications of the signed articulation document (the outcomes). Because the questions encouraged participants to think more deeply about process, many of the interviewees noted they had deepened their knowledge of articulation matters and more fully realized the importance of the issue by undergoing the interview experience.

To respond to the third research question (how did personnel who held various positions of responsibility within the colleges involve themselves in the engineering articulation process), a relatively wide range of administrators and faculty from both

institutions were targeted. Early in the study, it was revealed that faculty in this particular articulation scenario had relatively minor input into the process. This topic is addressed again in the *Implications for Practice* section of this chapter. However, meaningful data was gathered from administrators at all levels of both organizations.

Review and Interpretation of Major Findings

As stated in the previous section, although the employees interviewed for this study had primary responsibility for successfully concluding the articulation process under study, few could fully explain the steps of the articulation process nor were they typically able to pinpoint those elements that made the process successful. In this case, success was defined in two steps: step one being the process that resulted in a signed articulation, and step two success was defined as a substantial increase in qualified student movement from one institution to the other. Many interviewees admitted that they had learned about articulation "by doing it" and operated during the process "by the seat of my pants," which may have had the result of elongating the timetable of the articulation negotiation.

So to respond to research question 1, which asked about the specific process by which an engineering articulation was created, Chapter IV provided a detailed description of the steps outlining the articulation process as extrapolated from the interview data and document analysis. Although this information is not necessarily generalizable to every articulation negotiation, it provides a roadmap for the novice administrator who finds him or herself involved in articulation discussion. This step-by-step roadmap to an articulation agreement appears to be one of this dissertation's key contributions to literature on articulation processes because, despite a comprehensive review of the Internet and

documents written about articulation, only one source specifying step-by-step articulation processes was uncovered, which was a Texas State University document produced in 2005 that stepped their administrators through an articulation. Another significant finding was that feedback to internal stakeholders at strategic points in the articulation process was beneficial to the long-term stability of the articulation.

Development of Feedback Loops within the Articulation Process

Since feedback loops designed into a process can either reduce or enhance the impact of a potential change, it was beneficial for both colleges to build these loops into their articulation process. The following figure demonstrates where research shows those feedback loops would be most effective if built into the articulation process. The paragraphs following Figure 3 explain the utilization of these loops.

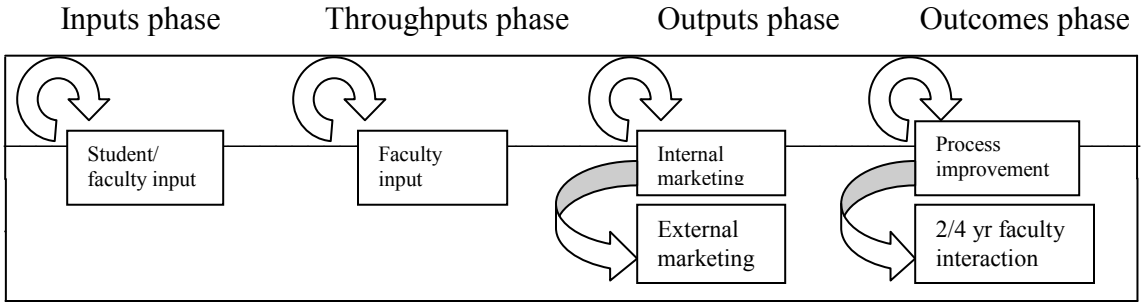


Figure 3

Articulation Feedback Loops

Usefulness of articulation feedback loops. As described by study participants, college articulations often begin informally. For example, two administrators start talking at a conference, or college presidents decide that it is politically in the best interest of both organizations to tie themselves more closely together through a formalized

articulation agreement. However, few interviewed believed that articulation as a process is strategically directed, and some participants felt that a more proactive approach to articulation planning, initiated from the highest level and carried out at mid-management levels, could result in more effective and long-lasting articulations. The idea of a feedback loop, a concept emanating from systems thinking, can be applied to articulation processes to provide more strategic focus in their development.

Input loop. The first feedback loop is initiated during the input phase, which happens before articulation discussion is begun. Rather than acting on their intuition and anecdotal evidence that an alliance between two colleges would be effective, study participants suggested that pre-articulation student feedback was essential to articulation officers. Key feedback includes questions such as: where do the students *want* to transfer, into which colleges or programs are they currently having problems transferring, and what would motivate them to transfer into a program they are not currently considering. Watson (2003) suggested that this student feedback loop was only valuable to the extent to which the student view was translated into action, thus closing that loop.

Although more formalized research vehicles like surveys and focus groups could query students, interviewees suggested that a readily available and rich source of information was faculty, who serve as the primary contact points with students within a particular program. For example in this case, before the engineering articulation negotiation started, faculty in LSC mathematics and pre-engineering classes might have asked their students a short series of questions such as what would motivate them to apply to a particular engineering program. These responses would not only give articulation officers general strategic direction but would have highlighted to the LSC

negotiators in this particular articulation those points essential to emphasize during the discussions. Key questions that could have been asked include: did students know or care about reverse transfer options, were scholarships an incentive to transfer to a particular college, and was Tech's ability to find engineering jobs for their graduates a motivating factor for potential transfers.

Throughput loop. The second feedback loop should occur during the throughputs stage; that is, when the negotiators are in the middle of the articulation process. As mentioned in Chapter II, a number of researchers (Britt & Hirt, 1999; Cejda, 2001; Mattis & Sislin, 2005; Tatum, Hayward, & Monzon, 2006) advocated the inclusion of faculty within the articulation process. Tobolowsky (1998) called for faculty participation, ensuring "equal representation for both institutions" (p. 21).

The counterpart argument was that faculty inclusion slowed down or complicated the articulation process, and as interviewees pointed out appropriate faculty may not be available or may choose not to participate at appropriate points of the negotiation. Tatum, Hayward, and Monzon (2006) also found that, not only were faculty unknowledgeable about articulation processes, but that they did not perceive articulation to be part of their role.

Nevertheless, involving faculty in curricular discussion within the articulation process has been proven to pay off in long-term benefits to organizations that have chosen to educate their faculty in articulation processes and involve them in the discussions. Fathe and Kasbian (2008) concluded that the articulation agreement did not become a living document until and unless faculty took ownership of it, for they are the stakeholders who interact with students on a consistent basis, and who have the greatest

credibility with those students. If community college faculty do not support an articulation and recommend a particular college to their students, it is unlikely that a significant number of students will look to that college for transfer. Likewise, if university faculty are not educated on the need to support articulations and the students who move into their program through transfer processes, they cannot and will not provide the necessary support mechanisms to ensure those students' success. It is a basic management premise that involving personnel in a decision-making process gives them a greater sense of ownership of that process, and this principle may hold true in this particular articulation.

Output loop. Once the articulation is signed, the outputs phase of the process commences and marketing should also be initiated—data from this study suggested that this step is often either inconsistently applied or skipped altogether. Marketing strategy traditionally advocates two marketing thrusts, internal marketing to constituents internal to the organization and external marketing to customers (i.e., students). Although academics in the past have not looked favorably on the application of marketing concepts to higher education, highly sophisticated consumers have deemed that attitude archaic and a luxury in today's complicated marketplace. Per the output loop in Figure 3, look at the internal marketing loop is viewed first, then external marketing implications.

Internal stakeholders must become aware of the articulation in order to properly market it to the external stakeholders—the students. This marketing process begins at the signing of the articulation and, in fact, an expansion in marketing efforts was a proviso of this articulation. It was required that two discrete entities at both organizations be informed about the agreement and its potential benefits to the students. First, the advising

departments needed to be educated on the details of the articulation because once the agreement was posted on the college's websites, students would presumably begin to ask the advisors to explain the intricacies of the articulation, and advisors would need to give additional information about the engineering program into which the students might enter. Advisors are also charged with organizing gatherings of specialized student groups and may have the potential to market this program to one of Tech's primary targets—1st generation college and minority students. A report on statewide articulations by Gross and Goldhaber (2009) suggested that the most positive correlation between the effectiveness of a particular articulation and actions a college may take was to make their advising personnel more knowledgeable about articulation matters. Gross and Goldhaber further postulated that community college faculty, especially full-time faculty, must be intimately acquainted in the details of the articulation agreement because they interacted the most with the students.

As a result, the second internal marketing thrust must be to faculty as the primary student liaisons; in this case, a primary target was LSC faculty who interacted with students with the potential to enter the Tech engineering program. This faculty target not only included pre-engineering faculty who might be reached through engineering curriculum teams and department chairs but also includes faculty who taught prerequisite courses in math and science curriculum areas. However, while individuals who participated in the articulation process expressed interest in talking to these two targeted groups, it was not witnessed that any particular group took ownership of the internal marketing process, nor was it built within their job description. This presented the possibility that, despite all the hard work on the part of the articulation negotiators,

insufficient internal marketing efforts may stifle the momentum begun with the signing of the articulation.

External marketing efforts are also critical to the long-term success of the transfer process initiated by the articulation. Not only must students wishing to transfer into a particular program be able to easily access information about the transfer process but 2/4 year colleges would do well to create comprehensive marketing campaigns to explain transfer programs to potential students. This is especially important for community college minority students who have not previously have considered engineering as a career or a college such as Texas Tech as an alternative.

Unfortunately, at the time of the writing of this dissertation, little effort had been put forth to market the engineering articulation. Students must assiduously search the LSC website to find information about engineering transfer, and the Texas Tech site does not mention the articulation in any way. To my knowledge, no brochures about the transfer program have been created for use within the classroom or to be distributed during transfer fairs, so marketing efforts is limited to word of mouth advertising.

Feedback loop in the outcomes stage. This last series of feedback loops would begin well after the signing of the agreement and should be designed to monitor the effectiveness of the agreement. Birnbaum (1988) called these loops sensing mechanisms, which are embedded into a system to provide data on the effectiveness of that system. Birnbaum also advised that, in order to be effective, this monitoring mechanism must "have access to open channels of communication" (p. 219) in order to receive accurate information. In this case, the communication channel would need to reach between

Tech's and LSC's advising departments, then loop back internally and provide feedback to departmental administrators.

Study participants suggested that the first feedback loop be process improvement oriented, not only monitoring the number of students who take advantage of the articulation agreement to move into Tech's engineering program but designed to monitor how well those students did once in the program, pinpointing where their specific areas of curricular deficiency might exist. This information would in turn by fed back to the specific LSC curriculum area so content experts could make adjustments to their course outcomes. At the same time, all participants acknowledged that this systemic refinement was not feasible within existing inter-college communication processes and would take a concerted effort, along with administrative support, to be effectively executed in the long run. At the very least, some interviewees believed that there should be a mechanism to consistently track how many LSC transfer students actually graduate from the accepting university program. A few participants commented that that they believed the state coordinating board was working on that monitoring process but because "there is a dearth of longitudinal information from community colleges about how their students perform at the four-year college" (Culver, Wadach, Weeks, & Anderson, 2005, p. 2), this would be a long-term effort on the part of the state.

A second long-term feedback mechanism suggested by study participants was the development of a vertical feedback loop by which two- and four-year faculty can share information about students and curriculum on a consistent basis. This interaction between educational entities could take the form of curricular sharing projects, student team activities, or co-teaching of courses. Perhaps the biggest benefit of this particular

feedback loop as identified by study participants is the ability to advance the student's preparation while at the community college so they are more fully prepared when they enter the university engineering program. It also helps stakeholders in both higher education sectors to view the transferred baccalaureate graduate as a "product" produced cooperatively by both sectors. However, this interaction presumes faculty openness on both sides of the equation and, as noted during this study, may require a cultural shift on the part of some engineering department personnel.

Implications for Practice

This section is divided into three sub-categories: general implications, policy implications, and implications for research. The proposition embedded in the implications section of the paper is that suggestions made as a result of the data may change the way readers think about a particular practice and give me as the writer "the opportunity of potential real-world impact of [my] results" (Calabrese, 2006, p. 89). As a community college administrator, I constantly look for ways to bring good management practices to college processes with the goal of better responding to student need. This practical focus is reflected throughout the *Implications for Practice* section of the dissertation. The primary goal, in choosing articulation as a topic, was to analyze current practices and find useful ways to suggest improvements to transfer policies and processes that result in increased success for students in terms of transfer and graduation rates.

General Implications

In general, the *Implications for Practice* section of the dissertation delineates applications of new insights derived from study that can be used to solve significant problems. In this case, data results indicate that many transfer problems could be

addressed through more thorough upfront planning. Therefore, this section will emphasize strategic planning, both on the part of the community college and the university.

The literature review showed evidence that researchers advocate strategic planning specific to articulation and transfer. For example Mattis and Sislin (2005) called for ways to institutionalize partnerships, and De Leon and Dandu (2006) wrote about the need for more strategic planning in articulation. Both pointed out that, at colleges where transfer and articulation were strategic priorities, student movement was enhanced and between-school agreements tended to be better thought out and more long lasting.

During the research analysis stage of this dissertation however, it was evident that the college administrators studied, although they perceived value in articulation, had not prioritized transfer or articulation as a top strategic priority. It was equally evident that top administration must be invested in the transfer process for articulation to produce long-term results. “To increase the number of transfers, presidents need to set clear expectations, invest in research, examine policy and practice, build relationships and programs, and provide visibility. By doing so, they can raise expectations for transfer” (Helm & Cohen, 2001, p. 99).

From documents uncovered during the research phase, it appeared that the Tech president had made some effort to emphasize transfer as a priority, but it did not appear that this emphasis had resulted in changes in either personnel or processes required to increase transfer. At the community college level, transfer processes remained at the status quo level with no recent strategic effort made to augment processes that would encourage further transfer and articulation. “Policies and practices that institutions adopt

to make transfer retain its place as a central community college function" (Helm & Cohen, 2001, p. 101) are needed at the community college studied in this dissertation.

At the four-year level, recommended best practices would include the targeting of specific feeder schools that already provide significant transfer traffic to Tech. Strategic emphasis should be placed on those community colleges that can augment the ranks of STEM-related curricula areas and minority enrollments. In order for Tech to reach their strategic goal of growing their undergraduate student body, they should conduct an analysis of which community colleges in which metropolitan areas would be their most effective feeder schools then make a concerted effort to reach out to them by following the articulation process outlined in this paper.

At the two-year level, more strategic planning and research is needed to determine those curricular areas and student cohort groups where an increase in articulations would most benefit the student population. Because transfer is now a bifurcated function at both institutions, they would benefit from a strategic plan that has the goal of creating a coordinated and comprehensive transfer center. Within that center, responsibility for the coordination of transfer and articulation functions must be fixed, though this does not appear to be happening now at either institution. Strategies within that strategic plan should also confirm the need for enhanced communication about the transfer function and increased training in articulation processes.

Policy Implications

Based on the outcome of this study, policy changes regarding articulation and transfer both at the college level and at the state level are appropriate. Since this study revolved around schools in the state of Texas, suggested state policy changes in this case

would be directed towards state agencies like the Texas Higher Education Coordinating Board but would also have generic public policy implications. In order to be effective, policy change must come at all levels involved: the community college, the university, and the state level.

Community college policy change. Results of this study suggest that top administration at the community college level create general policies that support increased emphasis regarding the transfer function. In a multi-campus environment such as Lone Star, policy statements would include the requirement that transfer and articulation processes be administered in a consistent manner between campuses so that universities approaching the system know what to expect in terms of process and communication. The policy statement would also include a value statement alluding to the importance of working within the state's public higher education systems to actively solicit articulation agreements with those universities into which their students seek to transfer. Policy might also allude to additional structures to be put in place to support the transfer function (e.g., transfer centers, required training for administrators, etc.).

University policy. Bringing about a change in university policy regarding incoming transfer students is a more complicated issue because policy change ideally should reflect cultural change, which is notoriously slow in higher education. As cited by authors earlier in the study (Ashby, 2006; Mattis & Sislin, 2005), there is still a prevalent attitude at the four-year level, especially in technical fields such as STEM, that community college transfer students and their credits are less legitimate and therefore less welcome at the university level. Some educators still believe that "transfer students aren't as smart as their peers. You have to convince faculty that these are talented students"

(Hoover, 2010, p. 1). Because of this prevailing attitude, it will take policy change at the university level to obligate particular colleges within a university to accept workforce credits, like community college engineering courses, as core curriculum and not just electives. University officials open to this change, such as the associate dean within the Texas Tech, can encourage this shift in mindset, but it will take policy to enforce this change.

State-level policy implications. The results of this dissertation also have public policy implications in three significant areas: first, policies regarding STEM curriculum, second, state policy environment concerning the public good; and third, policy change in the way state colleges are evaluated regarding effectiveness.

As cited in Chapters I and IV, higher education is currently being charged with producing additional graduates in STEM-related areas. This is especially true in a state such as Texas where the economy is oriented around technology. Although some emphasis has already been made at the state level to emphasize STEM education, changes in state policy could further stress the importance of research revolving around STEM areas.

In addition, businesses within the technology arena are looking for minority graduates and those minorities are disproportionately represented in community college classes. However, this dissertation has highlighted the fact that there is still a level of disconnect between community colleges and universities in terms of acceptance of workforce-related coursework completed at the two-year level. This is evidenced both by observations made during April 26, 2010 higher education articulation summit meeting and by the fact that so few major Texas universities have agreed to honor the Voluntary

Engineering Compact (see Appendix D) that was designed to facilitate transfer of workforce courses between the two educational sectors. This disconnect highlights the need for a broadening of the state policy environment geared to facilitate transfer movement. State policy changes could, in turn, support minority enrollment in STEM curriculum programs at the university level, which leads to a discussion of policy implications related to the public good.

Minority and low-income graduates, as cited in Chapter I, are still grossly underrepresented in STEM curriculum fields, and a majority of those students start their academic careers at community colleges. To date, accountability for moving these students from one higher education sector to the other through transfer mechanisms has rested solely on the shoulders of the community college. However, those "accountability structures fall short; accountability structures focus on two-year transfer performance and ignore the responsibilities of the four-year institutions" (*Statewide differences in 2/4 transfer*, 2004). This policy report, published by the National Center for Public Policy and Higher Education, further observed that existing state policies and rewards systems may actually work against this transfer priority in that many state systems are currently set up to reward universities if their students graduate in four years. However, statistics show that the reality is minority transfer students often take longer to graduate. As a result, four-year institutions may shy away from accepting those students and, due to budget allocation decisions, may not put in place the necessary support mechanisms to facilitate their success. In a state like Texas, which is soon to demographically become a minority-majority state, the public good would be served in the long run if state policy

would reward those university programs in STEM fields that support and nurture minority students.

The third area in which a change in state policy could positively affect 2/4 year transfer is an adjustment in the formula used by states to evaluate college effectiveness and allocate resources. Currently, one of the key measures a state uses to evaluate a college is their graduation rate. While no one would argue that this is a valid criterion, the issue is the weight given to this parameter. This method to assess effectiveness is especially punitive to community colleges who, with multiple missions, educate many students who have no intention of graduating from that two-year school. Because the community college is partially funded based on graduates, they will naturally attempt to encourage students to remain in their system until graduation and will negotiate clauses like reverse transfer into articulation agreements so as to inflate their graduation rates. Likewise, the four-year institution tends to evaluate incoming transfers based on their projected ability to graduate within a two-year window of time.

States like Texas would do well to implement policies that would drive initiatives resulting in more robust student tracking systems that would have the ability to effectively follow students through their entire academic career. This data system would have multiple benefits. First, it would give community colleges the ability to track students who exit their system and succeed, or not, at the university level, thus offering the state an alternative to the two-year graduation rate. Secondly, it would offer an alternative means for tracking minority and first-generation college students through their academic careers, along with the ability to reward them monetarily for steady progress, rather than the arbitrary goal of graduation within four years (which is not practical if a

student must work part or full time while attending college in order to maintain living expenses). Thirdly, if robust enough, this state system could track within-course success rates and feed information back to the community college, which would serve as a way to evaluate how well they have prepared their students within a particular curriculum area, such as math, for example. This system would address the need for an inter-sector curricular-oriented communications system, as suggested by stakeholders interviewed for this dissertation.

Implications for Future Research

Due to the nature of a single case study, this dissertation has looked at an articulation process within a particular snapshot in time, a period during which the articulation agreement was signed. However, it would be useful to revisit this articulation partnership at regular intervals to ascertain the long-term effectiveness of the agreement. In particular, key questions to be asked include: did it increase transfer rates for pre-engineering students (especially within minority populations), were those students who transferred retained by the university program through graduation, and were their GPAs comparable to native engineering students.

Table 2, System Theory Components of College Articulation*,* first introduced in Chapter I, spelled out specific long-term desired outcomes that researchers should look for in any articulation situation. These include: number of students taught in accepting program, program graduates (both native and transfer), and success rates as determined by quantitative means such as grades. Secondly, Table 2 suggested that better tracking of support services utilized, for example financial support and transfer oriented advising could tell colleges where to best put their limited resources to support student success.

Thirdly, the table called for colleges to follow graduates into the marketplace and track these graduates to see if statistics support enhanced marketability and if processes like articulation actually result in an increase in engineers in the marketplace. Future investigations may use the Level 2 section of Table 2 as a guideline in structuring research studies on articulation and transfer, using systems thinking as a theoretical overlay. It would be advantageous, for example, to conduct a follow up study to the case study scenario embedded in this dissertation to ascertain the long-term effectiveness (i.e., outcome) of this engineering articulation. This genre of study would also build upon the work of Shibley (2004) and Mizikaci (2006), as cited in Table 2.

A single articulation scenario like the one described in this dissertation, however well documented or analyzed, does not provide the breadth of data required to adequately evaluate the effectiveness of articulation as a tool in advancing student transfer. Only a comprehensive review of all articulations within a prescribed parameter would provide the macro view required to evaluate articulation processes. For example, the Texas Higher Education Coordinating Board could organize a research project that looked at transfer student data for every articulation produced within the state of Texas within a certain time period. Currently, the coordinating board does not have a system by which to collect such data, but study participants suggested the adoption of a computerized planning and assessment system, similar to systems used in Florida and Ohio, to collect this level of detailed data on articulation and transfer.

Study participants also pointed out other ways the Coordinating Board could facilitate articulation among Texas colleges. The Voluntary Transfer Compact (Appendix D) that was formulated under the auspices of the coordinating board was designed to

improve transfer among engineering programs. This engineering transfer compact was recommended by stakeholders as a means by which two/four-year transfer within this discipline could be enhanced. However, since "in Texas, such transfer curriculum guides are recommendations and not mandates for adoption by all institutions in the system" (Jacobs, 2004 p. 97), there are a number of impediments in the implementation of this innovative program. First, this voluntary transfer guide is currently not actively marketed to Texas colleges; Lone Star College personnel heard about it only because a Texas Tech administrator mentioned it during negotiations. Second, few incentives exist for major engineering schools in the state to join this consortium. Third, some participants felt that "the autonomy of the instructor may be compromised because, in their ability to interpret content and make coursework interchangeable, the content of these courses must be regulated (thus) restricting the faculty" (Jacobs, p. 198).

The Texas Higher Education Coordinating Board would do well to mediate these potential problems to make this voluntary agreement more palatable for prospective participants. Unless college leaders produce viable transfer arrangements in curricular areas like engineering, lawmakers who seek to help students fulfill their educational aspirations with the least possible time and money may well intervene. "The message is clear: if those who manage public institutions cannot solve the articulation problem, those who help finance them will" (Cicarelli, 1993, p. 82).

A last recommendation for further study would be in the area of reverse transfer. As mentioned earlier in the dissertation, this idea has gained popularity at colleges that actively transfer students. However, in the review of current transfer literature, no studies were found that investigated the effectiveness of this process. Future studies could look at

reverse transfer first from the student perspective (e.g., is there value in going through this paperwork in order to attain a certificate or degree). Research could also investigate reverse transfer by looking at the number of transfer agreements that include a reverse transfer clause and cross-referencing the actual number of students who were affected by those agreements. These studies could help determine if reverse transfer is directed by student demand or if it is a phenomenon precipitated by community colleges' need to demonstrate enhanced graduation rates to state regulatory bodies.

Summary

A key goal of this study was to build upon the existing body of literature on transfer and articulation detailed in Chapter II and add value to what had been previously researched on the topic. Much of this previous research has been quantitative in nature (Ashby, 2008; Cohen & Brawer, 2003; Townsend & Wilson, 2006) and either concentrated on macro trends in transfer or looked at transfer issues from a student perspective. A few studies, for example Mattis and Sislin (2005), investigated transfer issues from the viewpoint of faculty and discussed the importance of involving them in the process. However the review of the literature for this study did not uncover research that looked at articulation from the perspective of administration, which is a key stakeholder group in any articulation process. Indeed, this study highlighted the fact that higher education administrators are often the impetus behind the initiation of an articulation and as such are key contributors either to its success or its failure. So this is one of the first research studies on articulation that concentrates on stakeholder actions and interactions within the process, responding to requests such as from Mattis and Sislin's (2005) who called for additional research to help identify the underlying

characteristics of a successful partnership, specifically in engineering. This dissertation has not only responded to that call but has identified specific actions administration can take to foster articulation success.

Another key point of this dissertation was the acknowledgement that colleges are often not introspective about internal processes like articulation and therefore do not create adequate monitoring systems designed for process improvement. As Anderson, Sun, and Alfonso (2006) suggested, it is important to contextualize the issues within articulation, hence the decision to investigate articulation within the parameters of a case study that looked deeply at a particular articulation circumstance. Nelson (2007) echoed the opinion of the Anderson team by calling for research on how institutions respond, including administrative functioning and how administrative behaviors produce a culture that supports transfer. Nelson further called for a higher degree of intentionality of action to identify institutional barriers and examine enablers.

Responding to Anderson and Nelson's call to action, this research specifically targeted administrative stakeholders who were directly involved with an articulation under construction and had influence over organizational actions. The protocol was designed to query those administrators in a way that would, in turn, cause them to question themselves on their contribution to the articulation process. Within their responses, they acknowledged their lack of introspection regarding their actions and how those actions influenced the overall articulation process, either positively or negatively. So, in one sense, this study had value in that it led to a co-creation of knowledge within the interview sessions and allowed the participants the opportunity to rethink their articulation processes.

A more far-reaching value in the contextualization of stakeholder interaction was the extrapolation of the process details, the step-by-step course of action two colleges could follow that may lead them to the signing of an articulation agreement. Table 5 introduced in Chapter IV also visually pointed out that articulation is not the narrowly defined process college administrators sometimes think it to be. The relationship building required for the articulation between the two collegial entities often begins years before the agreement is signed and is solidified through intentional post-signing actions. Although perhaps prescriptive in nature, the step-by-step guide embedded in Chapter IV of this dissertation is information that has been missing from the general body of literature on articulation processes and may be a useful tool for any college administrator involved in articulation.

Merriam (2002) discussed how new knowledge resulting from a study should "make a contribution to the world…..and is often undertaken for the expressed purpose of improving practice (p. 15). A compelling facet of this study was the identification of those factors that, if not mediated, could become obstacles to the articulation process. Obstacles highlighted in Chapter IV included goal differential and attitudinal differences. However, the biggest factor interviewees noted as being an obstacle was the lack of established, well-defined articulation procedures and the lack of understanding on the part of internal stakeholders regarding the proper processes. Readers of this study may learn that identifying these potential barriers early in the articulation process can assist administrators at other colleges to make better decisions related to articulation.

Conclusion

With the growing trend of students beginning higher education in community colleges before launching into a university program of study, it is incumbent upon both sectors of education to find more effective ways to smooth student pathways. Commentators suggested that "collaborative efforts between institutions are important, including such initiatives as enhanced communication between sending and receiving schools, the presence of transfer specialists on both campuses, and articulation agreements" (Jacobs, 2004, p. 8), the particular topic of this study.

With differences in mission and culture between the two institutional types, significant challenges remain in their mutual quest to become more collaborative. "No matter how beautiful the paper model, success of the responsibility to serve transfer students is strongly dependent on the support and understanding of faculty and staff of both sending and receiving institutions. The problem is largely people-oriented" (Kintzer & Wattenbarger, 1985, p. 43). It is essential that both sectors put more robust structures in place to facilitate this ongoing communication and find practical ways to foster transfer movement.

Frankie Laanan (2005), who heads the Iowa State Office for Community College Research and Policy, advocated for the need to build bridges between the two educational sectors. Borrowing from systems thinking terminology, he alluded to these two segments as islands and called for educational leadership to more proactively build bridges between these two islands of education. Figure 4 visualizes this bridging process.

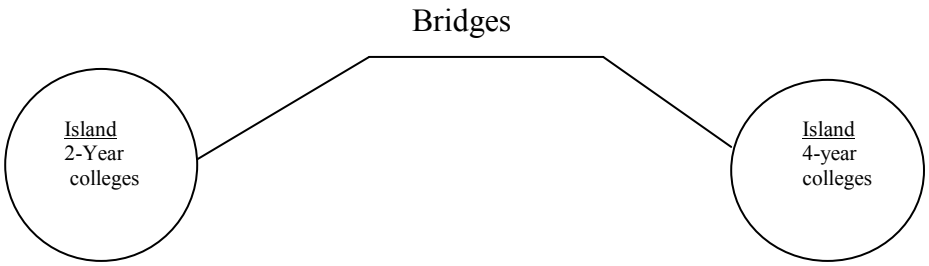


Figure 4

Visualization of Two/Four-Year Educational Islands

Bridging mechanisms include not only articulation, but innovations like faculty exchanges, collaborative assessment, and co-development of curricular programs. Program pilots for each collaborative concept exist in the United States but, as alluded to earlier in this chapter, these efforts require top administrative support and benefit from upfront strategic planning to sustain momentum after the pilot initiative ends.

In the end, sustainability is paramount if processes like articulation are to make a meaningful and measurable difference in students' paths to a baccalaureate. No matter how well-intentioned internal stakeholders are (examples of these well meaning stakeholders were described throughout Chapter IV), transfer bridging programs need to be supported by concrete, specific, and long-term action plans that all levels of college administration support both strategically and operationally. This support is not recommended for the sake of internal stakeholders operating within college boundaries; it is tendered for the sake of student movement and success.

REFERENCES

Access to the baccalaureate: Research synopsis. (2003).Report funded by the Lumina Foundation for Education. (ERIC Document Reproduction Service No.ED476677). Retrieved February 22, 2010 from http://www.pathwaytocollegeorgg/pdf/EXECSU.pdf

Ackoff, R. (2009). *Exploring systems thinking.* Retrieved September 9, 2009 from http://www.youtube.com/watch?v=IJxWoZJAD8k.

Adelman, C. (1998). *Women and men of the engineering path: A model for analysis of undergraduate careers.* Madison, WI: National Institute for Science Education.

Ali, H., Heidel, J., O'Connor, M., & Richter-Egger, D. (2005). *Innovative models for effective collaboration between universities and community colleges.* Paper presented at the annual meeting of the Higher Learning Commission of the North Central Association. Retrieved February 19, 2010, from http://www.unomaha.edu/step/docs.innovativemodels.pdf

Anderson, G., Sun, J., & Alfonso, M. (2006). Effectiveness of state-wide articulation agreements on the probability of transfer: A preliminary policy analysis. *The Review of Higher Education, 29*(3), 261-291.

Articulation agreements (2005). Texas State University Policy and Procedure Statement 2.15. Retrieved February 14, 2010, from http://gato-docs.its.txstate.edu/provost-vpaa/office-pps-files/pps2/PPS2-15.doc.

Ashby, C. (2006). *Higher education: Science, technology, engineering, and mathematics trends and the role of federal programs*. Washington, D C: Testimony before the Committee on Education and the Workforce, House of Representatives.

Ashby, F. (2008).*Community college undergraduate engineering transfer students at a research university.* Unpublished doctoral dissertation from the University of Washington.

Bachelor's degrees awarded in engineering. (2002). Washington, D.C.: Engineering Workforce Commission.Retrieved June 12, 2010 from http://www.nsf.gov/statistics

Bachelor's degrees awarded in engineering (2003). Washington, DC: National Science Foundation. Retrieved August 19, 2010 from http://www.nsf.gov/statistics/wmpd/pdf/

Bachelor's degrees awarded, by major field group. (2010).Washington, DC: National Center for Educational Statistics. Retrieved February 14, 2010 from http://www.nsf.gov/statistics/nsf08321/pdf/tab5.pdf

Bailey, T. (2008). Beyond traditional college: The role of community colleges, career, and technical postsecondary education in preparing a globally competitive workforce. *The New Role of Higher Education Attainment in Global Competitiveness, 23*(1), 25-30.

Balzar, J. (2006). *Community college and university degree partnership programs: A qualitative study of the student experience.* Retrieved October 13, 2009, from http://hdl.handle.net/1957/3147

Banathy, B., & Jenlink, P. (1996). Systems inquiry and its application in education. *Handbook of Research for Educational Communications and Technology*, New York: Macmillan, ed. D.H. Jonassen, 74-92.

Barnard, C. (1938). *Functions of an executive*. Cambridge, MA: Harvard University Press.

Barry, R., & Barry, P. (1992). Establishing equality in the articulation process. *New Directions for Community Colleges,* 78, Summer 1992, 35-44.

Bauer, J., & Bauer, T. (1994). The community college as an academic bridge: *College & University. 69*, Summer 1994, 5-30.

Baxter, P., & Jack, S. (2008). Qualitative case study methodology: Study design and implementation for novice researchers. *The Qualitative Report, 13*(4), December, 2008, 544-559.

Bender, L. (1990). *Spotlight on the transfer function: A national study of state policies and practices.* Washington, DC: American Association of Community and Junior Colleges.

Bertalanffy, L. (1968). *General systems theory.* New York: Braziller.

Best practices in state wide articulation and transfer systems. (2009). Prepared for the Lumina Foundation for Education by Hezel Associates. Syracuse, NY.

Birnbaum, R. (1988). *How colleges work.* San Francisco: Jossey-Bass.

Bogart, Q., & Murphey, S. (1985). Articulation in a changing higher education environment. *Community College Review,* 13(2), 17-22.

Borden, V. (2004). Accommodating student swirl: When traditional students are no longer the tradition. *Change,* March/April, 2004.

Britt, L., & Hirt, J. (1999). Student experiences and institutional practices affecting spring semester transfer students. *NASPA Journal,* 36(3), 198-209.

Britt, M. (2009).Making the grade. *MarketWatch.* Retrieved February 19, 2010 from http://www.marketwatch.com/story/transferring-a-four-year-college.

Bush, W. (2002). *Articulation and transfer: The Texas perspective*. Unpublished dissertation from Texas Tech University.

Cain, M. (1999). *The community college in the twenty-first century: A systems approach.* Landham, MD: The University Press of America, Inc.

Calabrese, R. (2006). *The elements of an effective dissertation and thesis.* Landham, MD: Rowman & Littlefield Education.

Career, technical, and workforce education in Texas. (2006). Austin, TX: Texas Comptroller of Public Accounts.

Caso, R. (2005). *Texas A&M/San Antonio college success profile comparison study.* Washington, DC: National Science Foundation.

Cavenagh, S. (2008). Project try to prepare students to succeed at STEM in college. *Education Week, 28*(4).

Cejda, B. (2001). Early transfer: A case study of traditional-aged community college students. *Community College Journal of Research and Practice, 25*(8), 621-638.

Checkland, P. (1981). *Systems thinking, systems practice.* Hoboken, NJ: Wiley.

Chen, X. (2009). Students who study science, technology, engineering, and mathematics (STEM) in postsecondary education. *Statistics in Brief, NCES, 161*.

Cicarelli, J. (1993). Making it easier to transfer from 2-year to 4-year colleges. *The Chronicle of Higher Education, 39*(32), B1.

Cipres, E., & Parish, C. (1993). *Transfer and articulation: Gaining institutional support and developing regional relationships.* Paper presented at the international conference for community college chairs, deans, and other instructional leaders, February, 1993.

Closing the gaps by 2015:2009 progress report. (2010). Austin, TX: Issued by the Texas State Coordinating Board. Retrieved February 22, 2010 from http://www.thecb.state.tx.us/reports/pdf

Cohen, A. (1996). Orderly thinking about a chaotic system. *New Directions for Community Colleges, 96,* 25-34.

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

Coleman, C. (1991). *Facilitating transfer: An issue of the 90's*. Paper presented at the North Texas Community College Consortium, Denton, TX. ED 342445.

Committee on education and workforce (2006). Retrieved December 15, 2010 from http://www.access.gpo.gov/congress/house/house06cp109.html

Crawford, T. (2005). *The effectiveness of California community colleges in local economic development.* Unpublished doctoral dissertation, University of Southern California.

Creech, J. (1997) *Improving college transfer policies is focus of 15 SREB States.* Atlanta, GA: Southern Regional Education Board. ED 415742.

Cresswell, J. (2009). *Research design: Qualitative, quantitative, and mixed design.* Los Angeles: Sage Publications.

Culver, R., Wadach, J., Weeks, P., & Anderson, M. (2005). *Work in progress: NAE study: Enhancing community college pathways in engineering*. Report from the 35th ASEE/IEEE Frontiers in Education Conference, Oct, 2005.

Data for enrollments (2006). Engineering Workforce Commission. Retrieved June 15, 2010 from http://www.ewc-online.org/data/degrees_data.asp

De Leon, J., & Dandu, R. (2006). *Easing the transition from the community college to an engineering technology bachelor's degree program*. 2006 IGME Intertech Conference. Union, NJ.

Dembicki, M. (2007). Panel recommend national STEM standards plan. *Community College Times*, September 17, 2009.

De Los Santos, A., & Wright, I. (1990). Maricopa's swirling students: Earning one-third of Arizona state's bachelor's degrees. *Community, Technical, and Junior College Journal*, 60 (6), 32-34.

Educating the engineer of 2020 (2005). Committee on Engineering Education, Washington, DC: National Academies Press.

Ewell, P., & Steen, L. (2008). *The four A's: Accountability, accreditation, assessment, and articulation.* National Center for Higher Education Management Systems. Retrieved March 2, 2010 from http://www.maa.org/features.fouras.html

Falcone, S. (2003). Modeling differences: the application of the logic model to public policy analysis. *The Innovation Journal*, March 31, 2008.

Fast Facts (2009-2010). Lone Star College Office of Research and Institutional Effectiveness. Retrieved August 11, 2010 from http://www.lonestar.edu/departments/insititutionaleffectiveness/

Fathe, L., & Kasbian, J. (2008).*The state of affairs: Impact and implications of STEM teacher education at two-year colleges.* A Report from the Meeting of the Minds Symposium, National Science Foundation, November 19, 2008.

Fielding, N., & Fielding, J. (1986). *Linking data.* Beverly Hills, CA: Sage Publishing.

Flaga, C. (2007). The process of transition for community college transfer students. *Community College Journal of Research and Practice*, *30*(1), 3-19.

Forrester, J. (1996). *System dynamics and k-12 teachers.* Lecture from the University of Virginia School of Education.

Frair, K., Cordes, D., Cronan, M., Evans, D., & Froyd, J. (1997). *The NSF foundation coalition: Looking towards the future* (1997). Proceedings of the Frontiers in Education Conference. Retrieved January 21, 2010 from http://fie-conference.org/fie97/papers/1078.pdf

Full-time undergrad enrollments in engineering (2010). Engineering workforce commission data for enrollments. Retrieved February 15, 2010 from http://www.ewc-online.org/data/enrollments_data.asp

Frost, R. (2005). *Responding to local needs in a global economy: Community colleges and their mission*. Unpublished dissertation from the University of Illinois.

Fusarelli, L. (2002). Tightly coupled policy in loosely coupled systems: Institutional capacity and organizational change. *Journal of Educational Administration, 40* (6), 561-576.

Geertz, C. (1973). *The interpretation of cultures.* New York: Basic Books.

Gharajedaghi, J. (1999). *Systems thinking: Managing chaos and complexity.* Amsterdam: Elsevier.

Gross, B., & Goldhaber, D. (2009). *Community college transfer and articulation policies: Looking beneath the surface.* Center for Reinventing Public Education, University of Washington, Seattle, WA.

Guidance on engagement of institutions in human subject research (2008). Washington, DC: Office for Human Research Protections. Retrieved February 21, 2010 from http://www.hhs.gov/ohrp/humansubjectguidance/engage.08.html

Hagedorn, L. (2004). *Transfer center stories: A mission, a plan, or missed opportunities.* Transfer and Retention of Urban Community College Students, ERIC document 493675.

Handel, S. (2007). Second chance, not second class: A blueprint for community college transfer. *Change, 39*(5), 38-45.

Handel, S. (2007). Transfer students apply to college too: How come we don't help them? *Chronicle of Higher Education*, *54*(9), 69-79.

Hargreaves, S. (2005). *College majors that boost your paycheck.* From CNN-Money.com. Retrieved February 11, 2010 from http://money.cnn.con/2005/08/11/pf/college/starting_salaries/index.htm

Heard, F. (1989). *The development of an articulation model between Shelby State community college and two comprehensive state universities.* Unpublished doctoral dissertation from Nova University.

Helm, P., & Cohen, A. (2001). Leadership perspectives on preparing transfer students. *New Directions for Community Colleges*. Summer, 2001, 114.

Henry, B. (2003). Successful vertical transitions: What separates community college transfers who earn the baccalaureate from those who don't? *Journal of Applied Research in the Community College*, *13*(2), 141-150.

Higher education in science and engineering (2010). Washington, DC: National Science Foundation, Retrieved May 12, 2010 from http://www.nsf.gov/statistics/seind10/pdf/c02.pdf

Hills, J. (1965). Transfer shock: The academic performance of the junior college transfer. *Journal of Experimental Education*. *33*(3). ERIC Document Reproduction Service No. ED 010 740.

Hodgkinson, H. (1985). *All one system: Demographics of education, kindergarten through graduate school.* The Institute for Educational Leadership, Inc.

Hoover, E. (2010). How to build a transfer-receptive culture. *The Chronicle of Higher Education.* October 27, 2010.

Hoyle, R., Harris, M., & Judd, C. (2002). *Research methods in social relations*. New York: Harcourt, Inc.

Ignash, J. (1993). *Community college non-liberal arts: Implication for transferability.* Los Angeles: Center for the Study of Community Colleges.

Immerwahr, J., Johnson, J., & Gasbarra, P. (2008). *The iron triangle: College presidents about costs, access, and quality.* San Jose, CA: National Center for Public Policy and Higher Education,

Improving access to the baccalaureate (2004). Report produced by the American Associate of Community Colleges and the American Association of State Colleges and Universities. Washington, DC: Community College Press.

Jacobs, B. (2004). *The college transfer student: The forgotten student.* Washington, DC: American Association of Collegiate Registrars and Admissions Officers.

Jacobs, J., & Dougherty, K. (2006). The uncertain future of the community college workforce development mission. *New Directions for Community Colleges, 136*, 53-62.

Jaschik, S. (2009). Articulation isn't enough. *Inside Higher Ed*. January 26, 2009.

Karp, M. (2008). *Towards a community college research agenda*: *Summary of the national community college symposium*. Washington, DC, June 19, 2008. Retrieved February 25, 2010, from http://www.ed.gov.about/offices/list/ovae/pi/cclo/cc-sympsmsmmry10-29-08-final.pdf

Kerr, C. (1982). Postscripts 1982. *Change*, October, 1982.

Kilbourn, B. (2006). The qualitative doctoral dissertation proposal. *Teachers College Record*, *8*(4), 529-576.

Kincaid, W. (2005). *Bringing community college faculty to the table to improve science education for all.* Proceedings from the February 2005 Math Science Partnerships Workshop at the National Academy of Sciences.

Kintzer, F. (1975). The articulation scene. *Community College Frontiers*, *3*(3), 18-23, Spring, 1975.

Kintzer, F., & Wattenbarger, J. (1985). *The articulation/transfer phenomenon: Patterns and directions.* Washington, DC: American Association of Community and Junior Colleges.

Kisker, C. (2007). Creating and sustaining community college-university transfer partnerships: A quality case study. *Community College Review. 34*(4), 282-301.

Knoell, D. (1965). *From junior to senior college: A national study of the transfer student.* Washington, DC: American Council on Education.

Knoell, D. (1990). *Transfer, articulation, and collaboration: Twenty-five years later.* Washington, DC: American Association of Community Colleges.

Koos, L. (1924). Survey of junior high schools. *The Elementary School Journal*, *25*(2), 153-168.

Kotter, P. (1981). Strategic planning for education. *The Journal of Higher Education, 52*(5), 470-489.

Kozeracki, C. (2001). Studying transfer students: Designs and methodological challenges. *New Directions for Community Colleges. 114*, 61-75.

Kuh, G., Kinzie, J., Barkley, J., Bridges, B., & Hayek, J. (2006). *What matters to student success: A review of the literature*. Commissioned Report for the National Symposium on Postsecondary Success. July, 2006.

Laanan, F. (1996). Making the transition: Understanding the adjustment process of community college transfer students. *Community College Review, 25*(3), 73-87.

Laanan, F. (2005). *Understanding today's transfer students: Translating research into practice.* Keynote Address at the 2005 Annual Articulation Conference, September 23, 2005.

Lee, H. (2002). *Systems theory and the earth systems approach in science* e*ducation.* Office of Educational Research and Improvement, Washington, DC: Eric Digest report EDO-SE-02-08.

Lee, V. (1993). Persistence to the baccalaureate degree for students who transfer from community college. *American Journal of Education*, *102*(1), 80-114.

Leitherer, B., & Tupper, D. (2009). Patching the pipeline: A community college approach. *Information Systems Education Journal, 7*(29) 33-34.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry.* Beverly Hills, CA: Sage Publications.

Lincoln, Y. (2008). *Logical structure: Theoretical framework*. Worksheet B distributed during Qualitative Research class, Texas A&M University, Fall 2008.

Martin, D. (1986). *A case study of private/public partnership philanthropy.* Unpublished dissertation from the University of South Florida.

Mattis, M., &. Sislin, J. (2005). *Enhancing the community college pathway to engineering careers.* Washington, DC: National Academies Press.

Maxwell, J. (2005). *Qualitative research design: An interactive approach*. Thousand Oaks, CA: Sage Publications.

Medsker, L. (1960). *The junior college: Progress and prospect.* New York: McGraw-Hill.

Melguizo, T. (2009). Baccalaureate success of transfers and rising four-year college juniors. *Teacher's College Record, 111*(1), 55-89.

Merriam, S. (1998). *Qualitative research and case study applications in education*. San Francisco: Jossey-Bass.

Merriam, S. (2002). *Qualitative research in practice: Examples for discussion and analysis.* San Francisco: Jossey-Bass.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis*. Thousand Oaks, CA: Sage Publications.

Mizikaci, F. (2006). A systems approach to program evaluation model for quality in higher education. *Quality Assurance in Education*. *14*(1), 37-53.

Moore, C., & Shulock, N. (2009). *Crafting a student-centered transfer process in California: Lessons from other states.* California State University, Sacramento, CA: Institute for Higher Education Leadership and Policy.

Morphew, C., Twombly, S., & Wolf-Wendel, L. (2001). A critical review of innovative linkages: Two urban community colleges and an elite liberal arts college. *Community College Review, 29*(3), 1-21.

Nelson, J. (2007). Work in progress: Understanding paths from the community college to a four-year engineering program, *ASEE/IEEE Frontiers in Education.* Milwaukee, WI.

Newman, F., Couturier, L., & Scurry, J. (2004). *The future of higher education: Risk and rhetoric,* San Francisco: Jossey-Bass.

Obama, B. (2010). Quote posted on the White House Office of Science and Technology Policy website. Retrieved February 12, 2010 from http://www.whitehouse.gov/administration/eop/htp

Omdal, S., Brennan, D., Richards, M., & Gonzalez, J. (2006). *STEMming the tide: A Colorado response to the national crisis in STEM education,* University of Northern Colorado, Center for the Education and Study of the Gifted and Talented.

One hundred best U.S. colleges (2009). *Forbes*, 8(6). Retrieved June 21, 2010 from www.forbes.com/2009/08/06/best-pulbic-colleges/

O'Meara, R., Hall, T., & Carmichael, M. (2007). A discussion of past, present, and future articulation models at postsecondary institutions. *The Journal of Technology Studies, 33*(1), 9-16.

Patton, M. (1990). *Qualitative evaluation and research methods* (2nd ed.). Newbury Park, CA: Sage Publications.

Policy matters: Developing transfer and articulation policies that make a difference. (2005). *American Association of State Colleges and Universities*, 2 (7), July 2005.

Ponterotto, J. (2006). Brief note on the origins, evolution, and meaning of the qualitative research concept "thick description." *The Qualitative Report, 11*, 538-549.

Preparing our children for the future: Science, technology, engineering, and mathematics (STEM) education in the 2011 budget. (2010). Executive Office of the President, Department of Education. Retrieved February 12, 2010 from http://www.whitehouse.gov/administration/eop/ostp/rdbudget2011

Recent engineering and computer science graduates continue to earn the highest salaries. (2005). Arlington, VA: National Science Foundation.

Reese, S. (2002). Articulation agreements: Easing the way. *Techniques, 77*(3), 37-38.

Rendon, L., & Garza, H. (1996). *Closing the gap between 2 and 4 year institutions*, *education for a new majority: Transforming America's educational system for diversity.* San Francisco: Jossey-Bass.

Rising above the gathering storm: Energizing and employing America for a brighter future. (2007). Washington, DC: National Academies Press.

Roach, R. (2009). The community college transfer problem. *Diverse Issues in Higher Education.* May 14, 2009. Retrieved December 15, 2010 from http://diverseeducation.com/article/12559/

Robertson, P., & Frier, T. (1996). The role of the state in transfer and articulation. *New Directions for Community Colleges*, *96*, 15-24.

Science and engineering degrees as a percent of new degrees internationally (2007). *Science, Technology, and Industry Scoreboard,* Paris, France: Organization for Economic Co-operation and Development (OECD).

Science and engineering indicators. (2004, 2006, & 2010). Washington DC: National Science Foundation.

Shenton, A. (2004). Strategies for ensuring trustworthiness in qualitative research projects. *Education for Information, 22,* 63-75.

Shibley, L. (2004). *The compared costs and benefits of inter-agency cooperation and separate accreditation processes: A case study.* Unpublished doctoral dissertation, Pennsylvania State University.

Smith, C., & Miller, A. (2009). *Bridging the gaps to success: An in-depth study of six exemplary community colleges in Texas.* Washington, DC: The Pell Institute for the Study of Opportunities in Higher Education.

Smith, J. (1982). Articulation and the chief instructional officer. *New Directions for Community Colleges*, *39,* 41-49.

Sorkin, S., ReVelle, P., Beiderman, A., & Tingling, T. (2007). *Interventions to promote degree completion in science, technology, engineering, and mathematics*. Conference presentation at the International Conference on Engineering Education-ICEE.

Stake, R. (1978). Case study method in social inquiry. *Educational Researcher, 7*, 1-34.

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

Statewide differences in 2/4 transfer. The National Center for Public Policy and Higher Education. May 2004. Retrieved December 29, 2010 from http://www.highereducation/org/reports/pa_transfers/differences.shtml

STEM and workforce development legislation (2009). *Converge.* Retrieved February 18, 2010 from http://www.convergemag.com/workforce/STEM-and-Workforce-Development-Legislation

Stogdill, R., Goldner, F., & Stinchcombe, A. (1967). Basic concepts for a theory of organization. *Management Science. 13*(10), B666-676.

Tamas, A. (2000). *System theory in community development.* Retrieved October 24, 2009, from Tamas Consulting: http://www.tamas.com/index.php?q=node/29

Tapping American's potential:The education innovation initiative. (2005). Washington, DC: Business Roundtable.

Tatum, C., Hayward, P., & Monzon, R. (2006). Faculty background, involvement, and knowledge of student transfer at an urban community college. *Community College Journal of Research and Practice*, *30*(3), 195-212.

Texas higher education data. (2010). Texas Higher Education Coordinating Board. Retrieved June 23, 2010 from www.txhighereddata.org/

Texas Tech University 2010-2020 strategic plan: Making it possible. (2010). Retrieved February 10, 2010, from http://www.ttu.edu/strategicplan/strategicplanrevision.pdf

Texas Tech University system board of regents meeting minutes. Meeting held March 5-6, 2009. Retrieved April 3, 2010 from http:///www.texastech.edu

Timmerman, L. (1995). *Transfer success work group report*. Austin, TX: The Texas Higher Education Coordinating Board.

Tobolowsky, B. (1998). *Improving transfer and articulation policies.* Los Angeles, CA: Clearinghouse for Community Colleges.

Top 100 associate degree producers. (2010). *Community College Week.* June 14, 2010. Retrieved April 18, 2010 from http://www.cc.week.com/news/?z=5&a=54

Top 100 two-year institutions. (2009). *Community College Week* .July 2, 2009. Retrieved April 18, 2010, from http://www.usastudyservice.com/en/content/top-100-colleges

Townsend, B., & Twombly, S. (1999). *Community colleges: Policy in the future context.* Westport, CT: Ablex Publishing.

Townsend, B. (2001). Blurring the lines: Transforming terminal education to transfer education. *New Directions for Community Colleges*, *115,* 63-71.

Townsend, B., & Wilson, K. (2006). The transfer mission: Tried and true, but troubled? *New Directions for Community Colleges, 136,* 33-41.

Tsapongas, J. (2004). *Role of community colleges in the education of recent science and engineering graduates.* National Science Foundation, April, 2004.

Unlike many graduates, engineers see rising salaries. (2010). Retrieved April 14, 2010, from http://www.NSPE.org

Ursu, D., & Sygielski, J. (2007). Why community college students make successful transfer students. *Journal of College Admissions*, *194,* 12-19.

U.S. Department of Defense. (2001). *Roadmap for national security: Imperative for change.* Washington DC: U.S. Government Printing Office.

U.S. Department of Labor Statistics (2009). *International comparisons of hourly compensation costs for production workers in manufacturing*. Retrieved February 11, 2010 from http://www.ftp.bls.gov

Watson, S. (2003). Closing the loop: Ensuring effective action for student feedback. *Tertiary Education and Management, 9*(2), 145-157.

Weick, K. (1976). Educational organizations as loosely coupled systems. *Administrative Science Quarterly, 21*, 1-19.

Wellman, J. (2002). *State policy and community college-baccalaureate transfer.* San Jose, CA: The National Center for Public Policy and Higher Education. Retrieved April 8, 2010 from http://www.highereducation.org/reports/transfer14.shtml

Wolcott, H. (2001). *Writing up qualitative research.* Thousand Oaks, CA: Sage Publications.

Yin, R. (2009). *Case study research: Design and methods*, 4th edition, Los Angeles, CA: Sage Publications.

Yousuf, H. (2010). Job hunting and career resources. *CNN Money*, March 5, 2010.

APPENDIX A

STANDARDIZED AGENDA FOR DATA COLLECTION AND

INTERVIEW PROTOCOL

Coding:_____

Interviewee _____

Date: _____

Location of Interview: _____

Title: _____

General Questions

We'll start with a few general questions
Describe your position/job responsibilities/academic background, especially as related to engineering and the creation of articulation agreements.

Describe the trend line at (college) regarding pre-engineering/engineering program *completers* (or *conversely dropouts*)

What do you think are contributors to this trend?

Looking at K16 as a continual pipeline of students who may become engineers, describe some practical ways to enhance the flow of (engineering) students through the educational system.

What role do you see the government (U.S. or state/coordinating board/state articulations) playing in the development of transfer and articulation between sectors in higher education?

What about state organizations (e.g., the transfer consortium or engineering organizations)?

Speaking in general terms, describe the contributors to/qualities of an effective and long-lasting articulation agreement?

A series of questions about the articulation agreement process

Describe (step by step) the process used to craft an articulation agreement at your college.

Is that process consistent among disciplines/between departments and & colleges at this school?

What (additional) resources might be required to ensure the effectiveness of this articulation?

Describe any processes or procedures at the college that might be changed to ensure that this agreement is effective in moving students through the pipeline.

With this articulation, there was negotiation between the two entities that took some time to resolve. In your experience with articulation, what are some common points that need negotiation, and how might negotiation processes be expedited to minimize points of difference?

Follow up: Describe any key differences between the community college and the university systems that would cause an articulation negotiation to stall or not be approved by one of the two parties.

(How) Does top administration at your school encourage and support the creation of articulation agreements? (strategic goal of the college/department)?

Is articulation expressed as part of your department's long-term goals?

What is the specific role of each of these administrators: chancellor/provost/vice provost/vice chancellor, articulation officer, college vice president/VP of instruction, dean?

What has been your particular role in the articulation under discussion (and, if different, what role have you played in past articulation negotiations).

(How) Are administrators in this college system evaluated on their success in creating and sustaining articulation agreements?

What, if anything, has either encouraged or inhibited *you* from being a more active participant in the articulation process? Has institutional support been a factor?

How did you gain your knowledge of transfer and articulation processes?

Is there training/mentoring available on this issue?

Describe some of the major challenges/hang ups in the process of creating (this type of) articulation agreement?

Follow up: Based on this, how could this process be improved? Should any function/person not currently involved in the process be included in the future?

What are some outcomes/benefits in signing this specific articulation and increasing the number of articulations in general?

Follow up:
How could this partnership lead to greater collaboration between the two schools?

(What changes) could it cause in your college's approach to student learning (outcomes, teacher prep, increased collaboration)?

<u>A series of questions about how students are educated on the transfer articulation process at your college:</u>

Who are the key contact points at your school to inform students about this process and what types of information can students obtain from each "touch point"?

To what extent are faculty here a knowledgeable source of information about transfer and articulations processes (and if they are not, is anything being done to change that)?

COMMUNITY COLLEGE ONLY

In looking at your students, what does the term "transfer intentionality" mean to you?

Follow up: How could community colleges be more intentional in assisting students move more effectively through the engineering pipeline to attain the goal of their choice?

UNIVERSITY ONLY

In your experience with past articulations (with other colleges), how has the creation of an initial articulation resulted in an openness with that school to create further partnerships (e.g., articulations in different disciplines, grant funding, student scholarship programs)?

How could university personnel be more intentional in assisting community college students to move more effectively through the engineering pipeline to baccalaureate degree attainment?

Some writers describe road blocks that inhibit student transfer, even with the existence of an articulation agreement (examples include low acceptance rate for transfers compared to freshman applicants, high GPA requirements, additional testing required for transfer students etc). Can you describe some of the roadblocks you have observed?)

Wrap up questions

What questions/topics did I *not* address that would have made this a more effective discussion?

Who else should I interview for this research?

May I contact you again (probably through email) if I have further questions?

Would you be willing to look through your files/emails for non confidential documentation related to articulation and forward that information to me?

Would you like to review a transcription of this interview?

Would you be willing to serve as a member check, reviewing and commenting on my preliminary findings? (I will do this through email).

APPENDIX B

EXAMPLE CONTACT SUMMARY SHEET

Contact/document Name: *Confidential*

Contact Type: In person X (hard copy) Initial interview Date: 4/1/2010

Phone_____ Follow up interview_____ Date: N/A

E mail_____ Site: LSC Coded:4/8/2010

Contact Role:

1. What were the main issues/themes from this contact? (brief summary of contents)

Discussed the entire articulation process to date and gave a history of the curriculum at LSC. Key issue: Even though he was the key engineering person at LSC involved in the articulation, he admitted that he didn't fully understand the articulation process. He also wondered how fully LSC was committed to the articulation.

2. What struck you as important, new, or interesting about this interview?

That Tech had specifically targeted LSC N Harris for two reasons: Firstly, community college transfer students do better than native engineering students in terms of retention at the university, and secondly Tech is trying to increase minority enrollment, and the community college has already helped them do this. N. Harris was specifically targeted because of strong minority enrollment.

3. What changes to protocol or hypothesis were suggested?

Eliminate 1/3 of the questions.

Add to the literature review a section on minority students and their importance in the transfer issue.

Note to self: don't type so loud on the PC.

Subject is willing to serve as a member check.

4. Reflections after reviewing this data.

The idea of minority enrollment was new to me and could be a significant factor in the study. I need to do more research on this to enrich the protocol.

APPENDIX C

EXAMPLE OF RESEARCH LOG

(names deleted to protect confidentiality)

Coding Lexicon

1st digit L=Lone Star, T=Texas Tech, O=Other college

2nddigit I=interview, T=telephone call, O=observation, E=email

3rddigit order received into database

4thdigit role, D=dean, A=administrator, F=faculty, O=other

Date	Person(s)/role*	Data gathering method	Topics	Code
2/22/2010	LSCS art officer	Telephone conversation	Status of articulation agreement	L I 2 A
2/22/2010	Texas Tech advisor	Telephone conversation	Status of articulation agreement	
4/1/2010		Meeting observation	Negotiate articulation points	
4/8/2010	LSC dean	In person interview	Reviewed protocol	L I 1 D
4/12/10	LSC dean	In person interview	Reviewed protocol	L I 2 A
4/18/2010	LSCS VP	In person interview	Reviewed protocol	L I 3 A
4/19/2010	LSCS transfer advisor	Telephone interview	Questions about transfer	L T 4 O
4/22/2010	Former LSC vice president	Short interview	Discussed articulation issues	
4/22/10	Senior vice chancellor	In person interview	Reviewed protocol	L I 5 A
4/23/2010	LCSC associate vice president			L I 6 A

4/26/2010	University of Houston Articulation Summit	Meeting observation	CC/4 year articulation issues	
5/5/2010	Texas Tech associate dean	In person interview	Reviewed protocol	T I 7 D
2/22/2010	LSCS art officer	telephone conv.	status agreement	L I 2 A
2/22/2010	T Tech advisor	telephone conv.	status agreement	L 12 B
4/1/2010		meeting observ.	negotiate articulation points	
4/8/2010	LSC dean	in person interview	reviewed protocol	L I 1 D
4/12/10	LSC dean	in person interview	reviewed protocol	L I 2 A
4/18/2010	LSCS VP	in person interview	reviewed protocol	L I 3 A
4/19/2010	LSCS transfer advisor	telephone interview	transfer questions	L T 4 O
4/22/2010	former LSC VP	short interview	discussed artic.	L I 4 A
4/22/10	sen vice chan	in person interview	reviewed protocol	L I 5 A
4/23/2010	LCS assoc VP	in person interview	reviewed protocol	L I 6 A
4/26/2010	U of H articulation summit/meeting observation art.issues			
5/5/2010	TECH assoc dean	in person interview	reviewed protocol	T I 7 D

APPENDIX D

TEXAS HIGHER EDUCATION COORDINATING BOARD

VOLUNTARY MECHANICAL ENGINEERING TRANSFER COMPACT

Obtained from THECB site: *http://www.thecb.state.tx.us/index.cfm?objectid=C02EE263-D0D4-CB89-63334BECB85CB617*

The Voluntary Mechanical Engineering Transfer Compact is a voluntary agreement among institutions of higher education within the state of Texas. Its purpose is to foster enhanced transfer processes for students pursuing a bachelor's degree in mechanical engineering and to increase the number and preparedness of students matriculating from a two-year mechanical engineering pre-engineering program (PMENG) at community colleges into a baccalaureate mechanical engineering program (BSMENG) at four-year universities. The intention of this transfer compact is not to change the curriculum of a four-year institution. The intention of this agreement is to provide guidance to students with respect to what courses offer the best mechanism for obtaining a BSMENG degree.

Participating Institutions

Table D.1

Participating Institutions

Community Colleges	Universities
Alamo Community Colleges	Lamar University
St. Phillips College	Midwestern State University
Austin Community College	Texas A&M University-Corpus Christi
Dallas Community College District	Texas A&M University-Kingsville
Houston Community College	Texas Tech University
Lee College	The University of Texas at Arlington
San Jacinto Community College District	The University of Texas at El Paso
Tarrant County College District	The University of Texas at San Antonio
Texas State Technical College-Harlingen	The University of Texas at Tyler
Tyler Junior College	The University of Texas of the Permian Basin
	The University of Texas-Pan American
	University of North Texas
	West Texas A&M University

Voluntary Mechanical Engineering Transfer Compact Curriculum

Freshman Year							
First Semester (Fall)				Second Semester (Spring)			
Course			SCHs	Course			**SCHs**
XXXX	####	Texas Core Curriculum Requirement	3	ENGR	1204	Engineering Graphics	2
XXXX	####	Texas Core Curriculum Requirement	3	XXXX	####	Texas Core Curriculum Requirement	3
MATH	2413	Calculus I	4	MATH	2314	Calculus II	4
CHEM	1311	General Chemistry I	3	PHYS	2325	University Physics I	3
CHEM	1111	General Chemistry I Laboratory	1	PHYS	2125	University Physics I Laboratory	1
ENGR	1201	Introduction to Engineering	2	XXXX	####	Texas Core Curriculum Requirement	3
Semester Credit Hours			16	Semester Credit Hours			**16**
Sophomore Year							
First Semester (Fall)				Second Semester (Spring)			
Course			SCHs	Course			**SCHs**
XXXX	####	Software Based Engineering Computations	3	ENGR	####	Fundamentals of Circuit Analysis	3
XXXX	####	Texas Core Curriculum Requirement	3	ENGR	####	Fundamentals of Circuit Analysis Laboratory	1
ENGR	2301	Engineering Mechanics—Statics	3	MATH	2320	Differential Equations	3
MATH	2415	Calculus III	4	ENGR	2302	Engineering Mechanics—Dynamics	3
PHYS	2326	University Physics II	3	XXXX	####	Texas Core Curriculum Requirement	3
PHYS	2126	University Physics II Laboratory	1	XXXX	####	Texas Core Curriculum Requirement	3
Semester Credit Hours			17	Semester Credit Hours			**16**

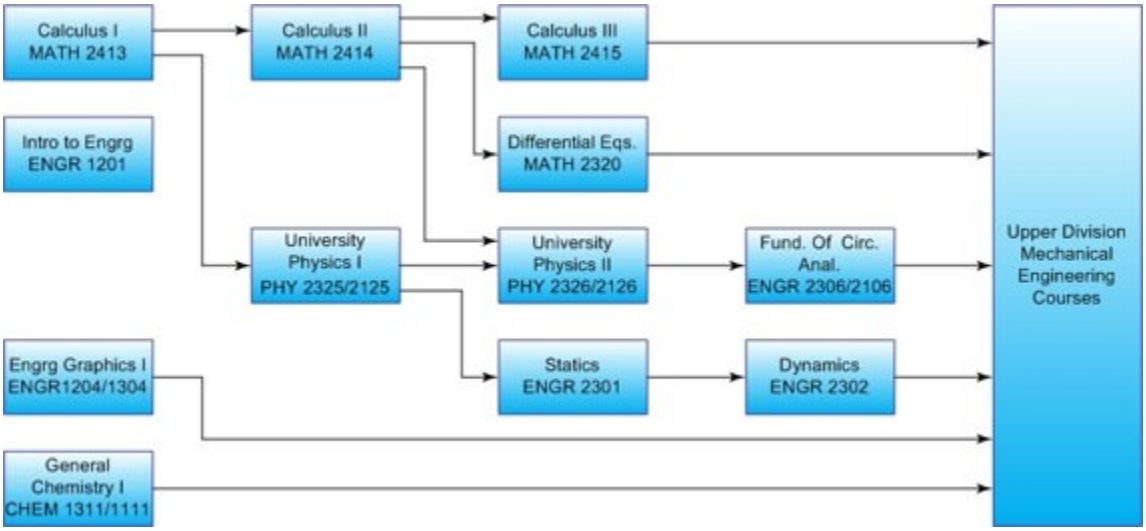
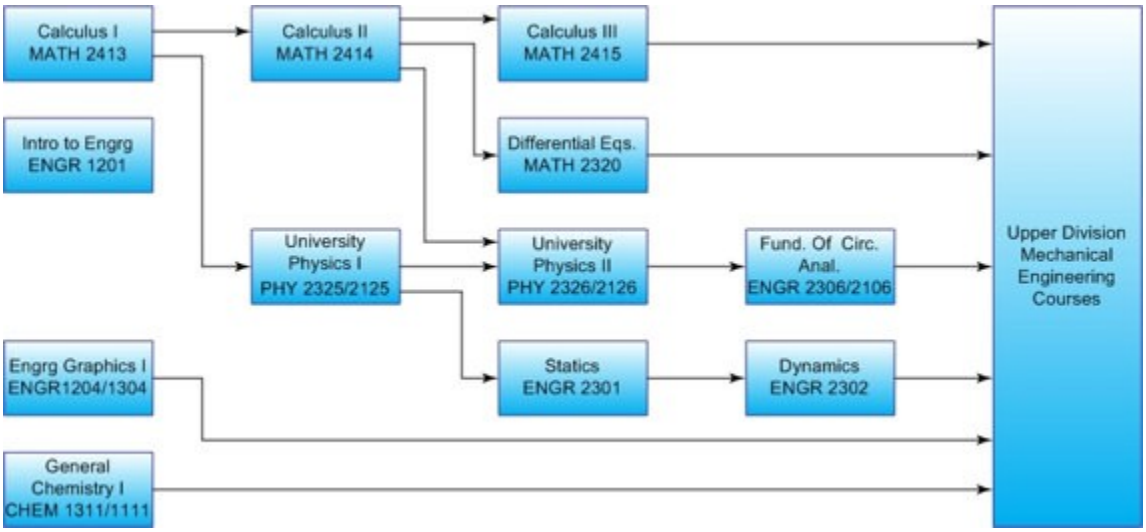


Figure D.1. Prerequisite flow chart **Flow Chart**



APPENDIX E

INSTITUTIONAL REVIEW BOARD INFORMATION SHEET FOR CASE STUDY PARTICIPANTS

Case study examination of the process used to create a community college/university engineering articulation agreement

Introduction
The purpose of this form is to provide you (as a prospective research study participant) information that may solidify your decision to participate in this research study.

You have been asked to participate in a research case study that analyzes the processes used in the creation of the Lone Star-Texas Tech engineering articulation currently under development. The purpose of this study is to determine the factors that produce a "successful" articulation—one that presumably results in an increase in engineering graduates. You were selected to be a possible participant because you in your position play a role in this articulation process. This study is being conducted under the auspices of Texas A&M University as part of a doctoral dissertation project.

What will I be asked to do?
If you agree to participate in this study, you will be asked to participate in a one-hour semi-structured interview session with the primary researcher, held at your convenience and in your office setting. During this interview, you may be asked to share non-confidential materials you might have in your possession relevant to this articulation. If follow-up discussion is required for clarification purposes, it will be done by telephone or email.
Your participation may be audio recorded to assist in the creation of a transcript, and these recordings will be securely stored. The risks associated with this study are minimal, and are not greater than risks ordinarily encountered in daily life (participants will have the chance to review transcripts and analysis of their interviews).

What are the possible benefits of this study?
While your participation is voluntary and your comments will be held in confidence, since the general results of this study will be disclosed to program administrators, the sharing of your time and experience may ultimately result in improvements to your college's articulation processes, resulting in an increase in signed articulations and program graduates.

Whom do I contact with questions about the research?
If you have questions regarding this study, you may contact

Researcher: Claire Phillips	**(281) 290 3967**	**claire.phillips@lonestar.edu**
Dissertation Co-Chair Vincent Lechuga	**(979) 845 7257**	**vlechuga@tamu.edu**
Dissertation Co-Chair Mary Alfred	**(979) 845 2788**	**malfred@tamu.edu**

Who do I contact about my rights as a research participant?
This research study has been reviewed by the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979) 458-4067 or irb@tamu.edu.

VITA

Claire Marie Phillips received her Bachelor of Science degree in modern languages in 1975 and her master's degree in business administration in 1986, both from Rockhurst University in Kansas City, Mo. After a career in business, she began teaching at Lone Star College (formerly known as North Harris Montgomery Community College District) in 1990 and is currently Dean of the Math, Computer Science, and Humanities division at Lone Star College-Cy Fair. She entered the Educational Administration doctoral program at Texas A&M University in September of 2006 and completed her doctoral studies in December of 2010. Ms. Phillips may be reached at Lone Star College-Cy Fair, 9191 Barker Cypress Road, Cypress, TX. 77433. Her email is claire.phillips@lonestar.edu.