

ABSTRACT

Exploring Industry Perceptions of the Development and Sustainability of Academia-
Industry Advanced Technological Education Partnerships

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The increasing demands on community colleges to broaden access and provide for the community's economic welfare, while maintaining its traditional educational role, have served as a powerful impetus for institutional change. Concurrently, institutions have been forced to explore non-traditional avenues to counteract resource scarcity. Community colleges have turned to partnerships as an avenue to ameliorate the challenges faced in the current economic and educational climate. While the onus has been placed on educational institutions to structure these partnerships to ensure success, the empirical literature regarding such collaborations is primarily from the academic perspective. The industry perspective is lacking. Such research is critical for researchers and practitioners in understanding which factors facilitate or impede alliance development with industry companies.

Using Austin's Cross-sector Collaboration Continuum Model as the theoretical framework (Austin, 2000b), this case study explores the major factors contributing to the successful development and sustainability of an industry-academia-government

workforce education partnership from the industry perspective. The case study, the Northeast Biomanufacturing Center and Collaborative, is funded by the National Science Foundation and focuses on biomanufacturing education and training. For this study, more than 145 documents were examined and 12 industry representatives from the partnership were interviewed.

The findings support the utility of the model in determining the progression of an advanced technological education partnership between industry, education, and government agencies. An analysis of documentation and interview transcripts revealed that the partnership has progressed from the philanthropic to the transactional stage in its seven-plus years of existence. Results also indicate that the eight drivers and enablers defined in Austin's model align with those cited by industry representatives.

Furthermore, the study identified 11 factors considered essential for sustaining an effective partnership—strategic and business planning, financial sustainability, a proven track record, currency and relevancy, continuous improvement, adaptability and flexibility, innovation, maintaining close ties with industry, consistent engagement with partners, continuity among staff members, and a physical presence in the right locale.

The revised model and the accompanying evolutionary progression tool will be helpful for any industry-academia partnership in the evaluation of their progression.

Exploring Industry Perceptions of the Development and Sustainability of Academia-
Industry Advanced Technological Education Partnerships

by

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CHAPTER ONE

Introduction

Background

The increasing demands on community colleges to broaden access and provide for the community's economic welfare, while maintaining its traditional educational role, have served as a powerful impetus for institutional change. Concurrently, institutions have been forced to explore non-traditional avenues to counteract resource scarcity. As Eckel, Affolter-Caine, and Green (2003) observe, "The current environment of limited resources and growing demands makes it increasingly difficult for institutions or organizations to 'go it alone'" (p. 3). Indeed, Austin (2000a) characterizes this century as "an age of accelerated interdependence" (p. 69).

Partnerships among education, business, government, and economic development agencies reflect the increasing levels of financial and operational interdependence across society. Congress has recognized the need for collaborative efforts among educational institutions and private industry to achieve educational goals that would not otherwise be achievable. Indeed, the federal Departments of Labor, Education, and Energy, as well as the National Science Foundation, have mandated that partnerships be involved in the development and implementation of grant projects. Not only do these government agencies expect that strategic alliances will be the vehicles for successfully attaining project goals, but they also believe that increased collaboration will be a natural result of alliance progression.

While the onus has been placed on educational institutions to structure these partnerships to ensure success, the empirical literature regarding such collaborations is primarily from the academic perspective. The industry perspective concerning successful development and sustainability of these types of collaborations is lacking. Such research is critical for researchers and practitioners in understanding which factors facilitate or impede alliance development. DeLuca (2008) suggests that the list of factors identified in her Delphi study of research-based academia-industry partnerships could serve as the basis for a qualitative study, one that would hopefully provide clarity as to why a factor is chosen or excluded. Furthermore, she posits that refinement and verifications of these factors should be performed across a diverse sample of collaborative types. Austin (2000a) suggests that further studies are needed to examine collaboration dynamics, alliance drivers, and alliance enablers. He speculates that focused examinations of the nature and operation of the alliance marketplace may quicken its growth.

Equally important, the National Science Foundation (NSF) Advanced Technological Education (ATE) program has cited several targeted research questions in which they are interested. This includes a question on how “stakeholders in technician education (e.g., community colleges in collaboration with business and industry, government, economic development groups, four-year institutions, secondary schools, and professional societies) can develop meaningful and mutually-beneficial partnerships” (National Science Foundation, 2011). Likewise, center directors have noted that empirical research regarding “the most effective approaches to developing effective partnerships and collaborations” is lacking (Ritchie L. A., 2008). In fact, in 2008, project

and center directors identified ten areas of research interests, including three research areas that address effective partnerships and collaborations:

- “What are [the] characteristics of effective partnerships and collaborations?”
- How are effective partnerships and collaborations developed?
- How are effective partnerships and collaborations sustained over time?” (Ritchie, 2008, p. 11)

To date, these research questions have not been addressed for NSF ATE-funded academic-industry collaboratives. Furthermore, empirical research has neglected the industry perspective on such issues. This unbalanced representation has the potential to thwart the successful development and sustainability of these types of collaboratives. Although framed somewhat differently, the research questions for this study address the three priorities listed above as defined by NSF ATE project directors and do so from an industry perspective.

Statement of the Problem

While partnerships that address workforce needs are prevalent among educational institutions, business, and government agencies, the industry perspective concerning successful development and sustainability of these types of collaborations is lacking. Such research is critical for researchers and higher education practitioners in understanding how to build and sustain effective partnerships of a regional or national magnitude.

Purpose of the Study

The purpose of this study is to discover the major factors contributing to the successful development and sustainability of an industry-academia-government

workforce education partnership from the industry perspective. The partnership selected for this study is an NSF ATE-funded biomanufacturing center. Another aim of this research is to identify impediments to the successful formation and sustainability of partnerships with industry. Furthermore, this study will illuminate both the evolutionary process of such partnerships and how to best represent this evolution through a collaboration continuum model. Finally, based on results of this study, instruments and tools will be developed to help other partnerships determine and justify where on the collaboration continuum their partnership is positioned.

Significance of the Study

As noted earlier, the literature on best practices for developing and sustaining workforce education partnerships between industry, academia, and government is lacking. The process of entering into an interorganizational relationship with business and government is fraught with uncertainties for postsecondary institutions. Higher education administrators are challenged with assessing when to enter into such an alliance and with whom. Furthermore, once the alliance is established, the relationship must be managed so that partners perceive a positive net value for their participation.

By applying a theoretical model based on the work of Austin (2000a, 2000b) to a case study of a biomanufacturing industry-academia-government alliance, this study provides research data to guide practitioners and scholars during their decision-making processes related to strategic alliance formation and implementation. This study also illuminates differences in culture perceived by industry that may impede collaboration with educational institutions. Moreover, there are implications for government

professionals who increasingly demand sustained collaboration between industry and education as a condition for grant funding.

Research Questions

With an NSF ATE-funded biomanufacturing center partnership as a context for analysis, the research study will address the following questions:

- What are the major drivers and enablers that lead to the development of an effective industry-academia-government partnership focused primarily on advanced technological workforce education?
- How well does the evolutionary progression of the partnership evolution align with Austin's Cross-sector Collaboration Continuum Model?
- What are the major factors that lead to sustainability of an effective industry-academia-government partnership?

In constructing the primary research questions, three secondary themes emerged:

- Are there impediments for industry working within the educational environment?
- In which stage of the collaboration continuum does the partnership currently operate?
- How does industry define sustainability, and is this condition always desirable?

Conceptual Framework

Austin's Cross-sector Collaboration Continuum Model will provide the basis of the theoretical framework for this study (Austin, 2000b). The model includes four components: a framework to categorize a partnership's progression, a value construct, alliance drivers, and alliance enablers. The model was selected because it was the only

one found in the literature that provides both a separate framework to determine evolutionary stages of the partnership and alliance drivers and enablers that are defined based on these evolutionary stages.

The collaboration continuum contains the philanthropic, transactional, and integrative stages. The three stages are differentiated by what Austin terms the nature of the relationship (Austin, 2000b). Austin provides several categories to define the nature of the relationship including engagement level; importance of the collaboration to the mission; resource magnitude categorized as financial, in-kind, and intangible; activity scope; interaction level; managerial complexity; and strategic value.

The second component of Austin's model is the collaboration value construct, involving four dimensions: value definition prior to alliance establishment and value creation, balance, and renewal that occurs during collaborative efforts (Austin, 2000a). In the value definition dimension, alliance members identify the expected benefits of the collaboration and assign a worth to each. Value creation centers on examining each partner's resources and capabilities to determine how they might add value. Value creation differs depending on the evolutionary stage.

Alliance drivers are those "forces that provide the primary power for strategic cross-sector collaboration" (Austin, 2000a, p. 71). These forces include (a) "alignment of strategy, mission, and values; (b) personal connection and relationships; (c) value generation and shared visioning; and (d) continual learning" (Austin, 2000a, p. 71). Alliance enablers facilitate the "effective management of the partnering relationship and process" (Austin, 2000a, p. 85). These factors include (a) focused attention and concentrated engagement by key players of the collaboration; (b) effective, efficient, and

frequent communication utilizing multiple channels; (c) an organizational system that identifies partner relationship managers for each organization involved in the collaborative; and (d) a mutual understanding of expectations and accountability for results. The alliance drivers and enablers are also characterized by the three stages of the model.

Delimitations

Delimitations of this study include the following:

- The proposed research examines one industry-education-government partnership focused on advanced technological workforce education at the two-year degree level. The Northeast Biomanufacturing Center and Collaborative (NBC²) was selected as the partnership for this case study.
- Interviewees were chosen from industry membership of the National Advisory Board, National Visiting Committee, Textbook Committee, and Strategic Planning Committee of the partnership. To qualify, the individual must have been either employed or previously employed in the industry. Furthermore, the individual must not have been currently employed by a community college system.

Limitations

Limitations related to this study include the following:

- The research study shares with other studies of its kind the limitations inherent in the case study approach. Primarily, generalizations that emerge may have limited extrapolation to other partnerships. However, it is anticipated that the experiences and perspectives of industry participants will advance the body of knowledge of

academia-industry partnerships. In explaining the value of case research to advancing the knowledge base, Stake (2005) enlightens, “The utility of case research to practitioners and policy makers is in its extension of experience” (p. 460). Indeed, emerging themes could be viewed as benchmarks by those practitioners aspiring to create mutually beneficial academia-industry partnerships.

- The qualitative research design adds another dimension to the limitations posed. Due to the sheer volume of data generated by this design, the determination of results to include in this study may provide an opportunity to introduce researcher bias. In addition, the results of the study are limited by the input provided. The quality of responses may vary depending on the ability of the interviewee to recall previous experiences, the value placed on the study by interviewees, and the inherent bias of interviewees (i.e., because interviewees are currently involved in an academia-industry partnership, these persons tend to be advocates for this type of partnership).
- The researcher’s selection of both the partnership to examine and participants to interview provides another limitation of this study. The study emphasis is on a national collaboration supported by federal funding and primarily focused on curricular and professional development for advanced technological workforce training programs. The focus is neither on research ventures between academia and industry nor on partnerships at the local level. Furthermore, the study seeks the input of industry partners. The viewpoints of government and institutional partners are not represented.

Assumptions

Assumptions made in this study include the following:

- Academia-industry partnerships play an increasingly important role in higher education and are beneficial to both academia and industry. Furthermore, the need exists to understand and manage partnership dynamics. There are both identifiable and definable factors that contribute to the development and sustainability of an academia-industry partnership, therefore academia-industry partnerships merit closer examination.
- The conceptual framework provides a suitable lens for examining the evolutionary dimensions of an academia-industry partnership.
- Both the qualitative technique employed and instrument constructed will provide valid and reliable data, accurately identifying factors contributing to the development and sustainability of academia-industry partnerships.
- The selected interviewees are highly competent and knowledgeable regarding academia-industry partnerships. Moreover, it is assumed that interviewees will respond honestly and completely.
- Interpretations will accurately reflect what respondents intend to convey.

Definitions

- *Adaptive coding* “combines the use of prior theory to lend order and pattern to research data while simultaneously adapting to the order and pattern contained in emerging data” (Layder, 1998, p. viii). With adaptive coding, the researcher analyzes relevant content with the constructs generated from a previous study in mind and then refines the constructs as needed.

- *Advanced Technological Education Program* is an undergraduate education funding program of the National Science Foundation established in response to the Science and Advanced Technology Act of 1992, whose mission centers on technician level education at two-year community colleges in advanced technology fields.
- *Alliance drivers* are variables that determine the nature and functioning of collaborations. Austin (2000a) identifies four forces that serve as the power source for cross-sector collaboratives: “alignment of strategy, mission, and values; personal connection and relationships; value generation and shared visioning; and continual learning” (Austin, 2000a, p. 71).
- *Alliance enablers* are variables that underscore the effective administration of the collaborative. Austin (2000a) identifies four enablers for cross-sector collaboratives: “focused attention, communication, organizational system, and mutual expectations and accountability” (Austin, 2000a, p. 71).
- *Biomanufacturing* is the process by which “a biological organism, or parts of a biological organism, in an unnatural manner...produce a product...” (Morgan, Colon, Emerson, Myers, & Ruffner, 2003, p. 6).
- *Case study* is “an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (Yin, 2009, p. 18).
- *Collaboration* “occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures to act or decide on issues related to that domain” (Wood and Gray, 1991, p. 146).

- *Constructivism* seeks “to understand and interpret through meaning of phenomenon (obtained from the joint construction/reconstruction of meaning of lived experience)” (Lincoln et al., 2011, p. 106).
- *Development* is “a specified state of growth or advancement” (Oxford University Press, 2011).
- *Effective* is defined as being “successful in producing a desired or intended result” (Oxford University Press, 2011).
- *Epistemology* focuses on the nature and limitations of knowledge as well as how it is acquired.
- *Evolution* is “the gradual development of something, especially from a simple to a more complex form” (Oxford University Press, 2011).
- *Industry representatives* are individuals that either currently participate or have previously participated in the NBC²'s National Advisory Board or National Visiting Committee. These individuals must have either previously or currently worked in the life sciences/biotechnology/biomanufacturing field and could not be currently employed by a two-year or four-year college or university.
- *Ineffective* is defined as “not producing any significant or desired effect” (Oxford University Press, 2011).
- *National Science Foundation* is a federal agency established by the United States Congress in 1950 to facilitate scientific progress and build a world-class science, mathematics, engineering, and technology workforce.
- *Northeast Biomanufacturing Center and Collaborative* is an education-industry alliance that supplies skilled technicians and professionals for biomanufacturing

companies in the Northeast and other areas of biomanufacturing activity across the nation.

- *Ontology* addresses “the form and nature of reality” and what “can be known about it” (Guba & Lincoln, 1994, p. 108).
- *STEM* is an acronym for disciplines in the science, technology, engineering, and mathematics fields.
- *Sustainability* is defined by the National Science Foundation (2011) as having “developed a product or service that the host institution, its partners, and its target audiences want continued.”

Summary

Community colleges have turned to partnerships as an avenue to ameliorate the challenges faced in the current economic and educational climate. The onus is often placed on institutional administrators to structure these partnerships to ensure success. Although scant, the literature does provide analyses from the academic perspective; the industry perspective, however, is generally lacking. Such research is critical for researchers and practitioners in understanding which factors influence and impede alliance development.

Using Austin’s Cross-sector Collaboration Continuum Model as the theoretical framework (Austin, 2000b), this case study explores the major factors contributing to the successful development and sustainability of an industry-academia-government workforce education partnership from the industry perspective. Furthermore, this study provides data to guide practitioners during their decision-making processes related to strategic alliance formation and implementation.

CHAPTER TWO

Review of the Literature

Introduction

The literature review identifies the theoretical perspectives and conceptual frameworks to explain which factors foster the development and sustainability of an academia-industry partnership. The chapter also provides a context for this study by describing the community college role in technical education and workforce development, motivations for forming alliances in general, and several models for collaborative evolution. The key attributes of high-performing workplace teams are highlighted, and the chapter concludes with the literature specific to effective academia-industry-government advanced technological workforce education partnerships.

The Community College Role in Technical Education and Workforce Development

By the end of the twentieth century, career and technical education had become one of the primary curricular functions of the community college (Cohen & Brawer, 2003). Indeed, results from the National Center for Education Statistics' surveys indicate that 98.3% (1,128 of 1,148) of public two-year institutions awarded career education credentials in 2006. The number of students seeking an Associate's degree in a career education program at public two-year institutions was more than 3,860,000 (U.S. Department of Education, Institute of Education Sciences). This part of the community college mission is not expected to wane. In fact, according to a 2007 survey of the National State Directors of Community Colleges, 64.6% anticipate that the vocational,

occupational, and technical function of the community college would be strengthened in the immediate future (Katsinas, Tollefson, & Reamey, 2008).

Community colleges have long held that a collaborative relationship with business and industry is essential to achieving their mission. Indeed, engagement with business and industry is not a novel idea; however, “the notion of ‘university partnership’ in the true sense of reciprocal and mutual relationships remains relatively new” (Zimpher, 2009, p. 176). With the significant decreases in funding for community colleges, partnerships have even been heralded as the “doors to the future,” alluding to the potential contributions and revenues from local businesses (Nielsen, 1994, p. 3). “The challenges of the current climate provide powerful motivation for institutions to build upon and expand their alliances and collaborations, working with others—rather than competing against them—to accomplish institutional goals” (Eckel, Affolter-Caine, & Green, 2003, p. 7). In particular, partnerships with the business community are critical to the success of career education programs. Several case studies appearing in recent literature support this basic premise (Carroll, Harris-Bondima, Norris, & Williams, 2010; Friend, 2010; Hodgins & Muha, 2008).

Furthermore, more often than not, recent federally-funded grant opportunities targeting workforce development at the community college level emphasize the importance of building collaboratives with business and industry as a condition of funding. For example, the 2006 Perkins Act states the following:

The purpose of this Act is to develop more fully the academic and career and technical skills of secondary education students and postsecondary education students who elect to enroll in career and technical education programs, by...supporting partnerships among secondary schools, postsecondary institutions, baccalaureate degree granting institutions, area career and technical

education schools, local workforce investment boards, business and industry, and intermediaries. (U.S. Congress (109th), 2006)

The federal Departments of Labor, Education, and Energy, as well as the National Science Foundation, have also recognized the need for collaborative efforts with business and industry to achieve goals that would not otherwise be attainable. These government agencies not only expect that strategic alliances will be the vehicles for successfully attaining grant goals but also that increased collaboration will be a natural result of alliance progression. Partnership sustainability after termination of grant funding is another anticipated long-term outcome of the federal agencies that provide workforce education and training funding.

The Definition of Collaboration

Although collaboration has been the focus of intense study across multiple disciplines, scholarly agreement on a definition for collaboration has proven difficult. Scholars have studied collaborations between similar organization types (e.g., nonprofit to nonprofit or business to business) and cross-sector relationships, most notably nonprofit to government (Powell & Clemens, 1998), nonprofit to business (Austin, 2000a), and multiparty collaborations (Gray, 1989). The terminology used to denote a collaborative effort is vast and includes partnerships, collaborations, alliances, coalitions, associations, networks, conglomerates, councils, task forces, teams, groups, interorganizational relationships, consortiums, cross-sector partnerships, consolidations, and joint ventures (Austin, 2000a; Gajda, 2004; Parmigiani & Rivera-Santos, 2011). Many scholars have defined collaboration as two or more individuals working toward a desired outcome. A quick review of the Merriam-Webster Dictionary reveals several meanings for collaboration and its synonyms, including to “work jointly with others...

having a common interest...further the common interests of the members...undertake an enterprise beyond the resources of any one member” (Merriam-Webster, Incorporated, 2011).

According to Frey, Lohmeier, Lee, Tollefson, and Johanning (2004), collaboration is “the cooperative way that two or more entities work together toward a shared goal” (p. 1). MacMillan (2001) describes a team in much the same manner, pointing to individuals “committed to a common purpose who choose to cooperate in order to achieve exceptional results” (p. 30). The definition has also focused on the processes employed (Wood & Gray 1991) and the beneficiaries (Austin, 2000a; Bailey & Koney, 2000; Gajda, 2004).

Motivations to Form Collaborations

According to the scholars studying interorganizational networks during the past few decades, both the reasons for and sustainability of these networks have remained elusive. Although several theoretical frameworks exist to both describe the motivations for forming collaboratives and highlight their ongoing dynamics, scholars concur that a single framework does not adequately explain either. The most commonly cited motivational theories in the literature include resource dependence theory, social exchange theory, institutional theory, efficiency theory, and corporate social performance theory. Although industry motivations to engage in a partnership are not the central focus of this research study, they provide a powerful context in which partnership factors facilitating success and sustainability can be examined. The first three of these theories are elaborated on below because of their applicability to academia-industry partnerships.

Table 1 summarizes specific motivations for forming collaborations found in the literature and includes the citation.

Resource Dependence Theory

In their early work on this theory, Pfeffer and Salancik (1978) explain that in order “to understand the behavior of an organization you must understand the context of that behavior—that is, the ecology of the organization” (p. 1). The ability to secure and sustain resources from the external environment lies at the crux of resource dependence theory. The theory classifies corporations as open systems whose behavior is contingent upon “critical resources that an organization must have in order to survive” (Johnson, 1995, p. 1) and gain competitive advantage. Scott (2003) further explains that these corporations are driven to compete with others for scarce resources in the environment.

Resources may be defined as money, human resources, inventory, equipment, materials, knowledge, technology, customers, and product legitimacy (Lavendar, 2007; Sharfman, Gray, & Yan, 1991). The literature is replete with studies highlighting these resources as motivators for forming collaborations. For example, several authors concur that in today’s society information technology is a strong motivating factor in establishing partnerships (Bollenbacher, 1998; Griffiths, 1998; Logan & Stokes, 2004; McAfee, 2006). According to Alter and Hage (1993), as opposed to single organizations, interorganizational networks are able to adapt more rapidly to technological advances and market conditions, thus experiencing superior financial gains. Consequently, these networks are more likely to survive.

More recently scholars have noted the advantages offered by collaborative technology tools in the creation of knowledge. In the current economy, Logan and

Table 1

Motivations for Forming Collaboratives

Author(s)	Motivations
McAfee, 2006; Logan and Stokes, 2004	Impact of Internet and World Wide Web technologies and applications
Bragg, 2001; Orr, 2001	Shift in policy and practice to increase in industry-education partnership activity
Austin, 2000b	Complexity of social problems, diminishing governmental budgets, devolution of responsibility from federal to local level, cost savings, economies of scope and scale, revenue enhancement, human resource management
Couture, Delong, and Wideman, 1999	Compelling cause, political context, ability to influence decision-making
Kanter, 1999	Information technology, revenue stream, consumer knowledge, community relations, enhance company's image, venue for experimentation, higher quality workforce
Bollenbacher, 1998	Growth of a knowledge economy, need for multidisciplinary expertise, information technology
Griffiths, 1998	Information technology, new models of relationships with industry
Lee, 1996	Access to new research, development of new products and patents, solving technical problems, funding, laboratory equipment, knowledge
Alter and Hage, 1993	Willingness to collaborate, need for expertise, need for financial resources and risk sharing, need for adaptive efficiency
Sharfman, Gray, and Yan, 1991	Competitive pressures such as shortage of workers, high rates of turnover, need for information exchange; institutional forces such as potential funding for training and enhancing the industry's image
Gray, 1989	Shrinking federal revenues, rapid economic and technological change, declining productivity, increasing competition, globalization
Oliver, 1990	Legal or regulatory requirements, power and influence over other organizations for resources, mutual benefits (reciprocity), financial efficiency, limit environmental uncertainty (achieve stability), appear aligned with environmental norms (legitimacy)
Powers, Powers, Betz, and Aslanian, 1988	Access to manpower, obtain knowledge of science and technology, improve instruction, gain access to facilities, obtain prestige or enhance company's image, community relations, new sources of revenue, improved training for students, cost effective research

Stokes (2004) point to knowledge as the source of wealth. They also trace the history of the Internet and discuss its role as a collaborative tool in the co-generation of knowledge. They emphasize the imperative nature of collaboration in the business world by quoting the software entrepreneur J.D. Edwards: “Collaborate or die—the writing is on the wall. Collaboration is the key to profitability in the New Economy.”

McAfee (2006) extends these observations to the newer Enterprise 2.0 technologies that are contributing to collaboration. Open source applications such as blogs and wikis allow for knowledge creation and sharing both within a company as well as with the larger community of practice. Additional motivations cited in Table 1 that are linked with resource dependence theory include shortage of workers and access to higher quality workforce; potential funding and revenue streams; and the need for expertise (Alter & Hage, 1993; Bollenbacher, 1998; Kanter, 1999; Powers et al., 1988; Sharfman et al., 1991).

If a continual influx of resources is received by the organization then the external environment is negligible in the equation. However, “problems arise not merely because organizations are dependent on their environment, but because this environment is not dependable” (Pfeffer & Salancik, 1978, p. 3). Indeed, if any of these resources are lacking, then the organization must be interdependent on other organizations that possess these resources (Pugh & Hickson, 1996) and adapt to changes within the environment to create resource stability. For example, an academic institution may generate additional revenues by increasing tuition, reducing expenditures, eliminating services, or securing grant funding (DeLuca, 2008).

An organization may also create joint ventures or associations to alleviate dependence on an unstable supply of resources (Pfeffer & Salancik, 1978). It has been argued that organizations form industry-education partnerships because these partnerships allow access to another organization's valuable assets and create an opportunity for the organization to stabilize its resources (Das & Teng, 2002; Wisniewski, 2001).

The theory also holds that organizations are most responsive to groups that retain the most valuable resources (Pfeffer, 1982). For community colleges, these groups could be students, the state legislature, or local businesses.

Social Exchange Theory

Blau (1994) defined social exchange theory as "the mutual gratifications persons provide one another that sustain special relations" (p. 152). According to Blau (1964), the theory suggests why individuals collaborate when participation in such an effort is not formally recognized by the company in which the individual works. Individuals, rather than groups (Das & Teng, 2002), pursue ways that reward their behavior and avoid behaviors associated with punishment. Indeed, Watson and Hewett (2006) opine, "An individual with valuable knowledge that could be reused by someone else in the organization would be motivated to contribute that knowledge to the system because he or she had a general expectation of some future return" (p. 148). It should be noted that the rewards can be either intrinsic or extrinsic (Homans, 1961). Social exchange theory also emphasizes equitable contributions or exchanges by individuals within the partnership.

The return does not need to be financial in nature. Emerson (1976) describes these exchanges as the “economic analysis of non-economic social situations” (p. 336). Although economic exchange often serves as the basis of academia-industry partnerships, the social exchanges of these networks extend beyond the economic realm (Chen & Choi, 2005; Zafirovski, 2003). An example of a non-financial exchange is values such as respect and trust. These non-economic exchanges have a profound impact on the development and sustainability of an interorganizational relationship.

Institutional Theory

The landscape of higher education is changing dramatically. Institutions are pressured and constrained by government agencies, competitors, interest groups, and public sentiment (DiMaggio & Powell, 1983; Meyer & Rowan, 1977). Institutional theory suggests that organizations conform to the “pressures and constraints of the institutional environment” (Oliver, 1991, p. 147) to achieve stability and legitimacy (Scott & Meyer, 1983). These institutional pressures serve as the motivation to form interorganizational collaborations and either foster or hinder their formations (Sharfman et al., 1991).

According to Campbell (1997), three mechanisms exist that spawn institutional change: coercive, mimetic, and normative. Pressures that result in academic-industry partnerships are predominantly exerted on institutions through either coercion such as government mandates or through competitive pressures to mimic other successful organizations operating under similar conditions (Dooris, 1988-89). These mimetic changes are generally driven by uncertainty (DiMaggio & Powell, 1983) and familiarity

with the imitation process rather than a reliance on evidence of efficiencies and effectiveness.

Institutionalization is not only coupled with stabilization of the environment but also legitimation (Deephouse & Suchman, 2008). Scott (1995) wrote the pivotal definition of legitimacy by stating, “Legitimacy is not a commodity to be possessed or exchanged but a condition reflecting cultural alignment, normative support, or consonance with relative rules or laws” (p. 45). In the same year Suchman (1995) further illuminated, “Legitimacy is a generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions” (p. 574).

There is broad consensus among scholars that legitimacy protects an organization from pressures of the institutional environment, thereby contributing to the survival of an organization (Fombrun, 1986; Singh, Tucker, & House, 1986). Galaskiewicz (1985) discovered that organizations attempt to gain legitimacy by making charitable donations and securing external endorsements. For example, institutions may gain legitimacy through the caliber of their board members.

Evolution of Collaborative Efforts

Collaboration is a continuous rather than static process (Fields, 1992; Flynn & Harbin, 1987; Knapp, 1995; Selsky, 1991; Tseng, 2004). It has long been reported that groups change predictably over their life span. Indeed, Gajda (2004) theorizes that collaboratives move along the continuum from lower to higher stages of collaboration. However, it has been posited that a pattern of “punctuated equilibrium” is the norm for group progression (Gersick, 1988). In punctuated equilibrium, organizations alternate

between long periods of inertia and “revolutionary periods of quantum change” (Gersick, 1988, p. 16). Regardless, the work undertaken by the collaborative depends to a large extent upon where the collaborative is in the evolutionary process continuum (Flynn & Harbin, 1987; Tseng & Wang, 2007). Furthermore, Flynn and Harbin (1987) argue that the work of a partnership should be evaluated according to the evolutionary stage in which the organization is operating.

According to the literature, several continuum models of collaboration exist that describe the evolutionary stages of a partnership (Arsenault, 1998; Austin, 2000a; Bailey & Koney, 2000; Gajda, 2004; Hogue, 1993; Peterson, 1991; Todeva & Knoke, 2005b; Tuckman & Jensen, 1977). These models contain stages that span from no collaboration to full collaboration to complete unification. Although these models differ in the number and definitions of their stages, many commonalities exist. Those most germane to this research study will be examined next. Figure 1 summarizes the stages of each model.

Peterson Model

Peterson (1991) proposed a model characterized by three distinctive levels of interaction: cooperation, coordination, and collaboration. These states are differentiated by the degree of member autonomy for each stage. In cooperation the focus is on independent groups supporting the outcomes of their employers through the sharing of information. The coordination stage is defined by these groups supporting mutually beneficial outcomes through the alignment of alliance activities or services. The third stage, collaboration, involves the groups working toward a shared goal through the loss of some degree of autonomy.

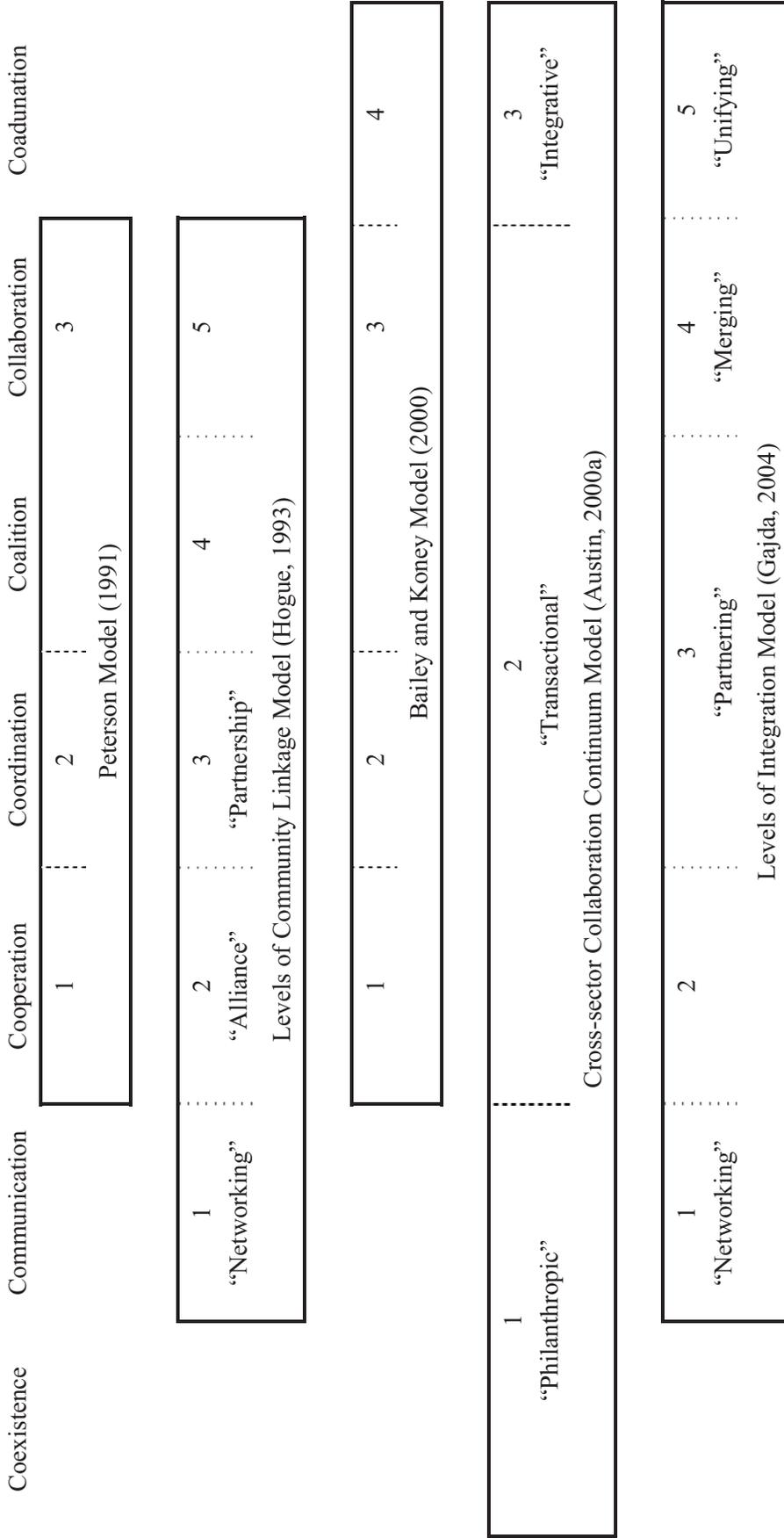


Figure 1. Continuum models of collaboration. Adapted from “Measuring Change in Collaboration Among School Safety Partners,” by B. B. Frey, J. H. Lohmeier, S. W. Lee, N. Tollefson, and M. L. Johannang, 2004, p. 11. Copyright 2004 by B.B. Frey.

Levels of Community Linkage Model by Hogue

Hogue (1993) proposed a five-level model of community linkage in which the stages are differentiated by purpose, structure, and process. The networking stage is characterized by dialogue based on a common understanding, and the partnership primarily serves as a mechanism for informational exchange. The structure at this stage is defined as non-hierarchical with loose and flexible linkages among partners. The network engages in minimal decision making, and communication is informal; thus, conflict is not an issue.

The cooperation or alliance stage focuses on limiting the duplication of services through coordination of shared organizational goals (Hogue, 1993). Linkages at this stage are semi-formal and advisory, with the roles somewhat defined. A formal communication mechanism exists, and a central group serves as the communication hub. The alliance acquires insubstantial new financial resources, if any. The decision making level is viewed to be complex, with some conflict arising.

In the coordination or partnership stage, groups share resources to address common goals (Hogue, 1993). This sharing often results in the creation of a new product or service. Linkages are more formalized, and roles of members are more defined. Leadership is said to be autonomous, with the focus on the common goal. Decisions are made by a central body and in subgroups, with frequent and clear communication being the norm. The partnership leverages and raises additional financial resources to address common goals of the members.

The fourth stage in Hogue's model of collaboration is categorized as a coalition (Hogue, 1993). During this stage members not only share ideas but are willing to

contribute existing resources. The commitment extends beyond the short-term; Hogue considers a three-year commitment to be the minimum for this stage. Leadership is shared; decision making is formal and involves all members of the group; and linkages are often formalized with written agreements. The determination of roles includes the accompanying time frame for each role. Communication becomes prioritized, and the group develops not only new resources but also a joint budget for operations.

Collaboration, the final stage in Hogue's model, is signaled by the achievement of a shared vision as well as impact benchmarks (Hogue, 1993). An interdependent system results, one that addresses issues and opportunities for the partnership. Work assignments are established in writing, and shared decision-making utilizes a consensus process driven by a high level of trust among group members. Both decisions and ideas are equally shared. The group maintains a highly developed communication system, and an evaluation component is added.

Bailey and Koney Model

Bailey and Koney (2000) expand the work of Peterson and Hogue, adding a final stage identified as coadunation. Their first stage, cooperation, involves sharing information and providing mutual support among group members. Common activities and compatible goals define the second stage, coordination. The collaboration stage encompasses "integrated strategies and [a] collective purpose" (Gajda, 2004, p. 69). The final stage, coadunation, results in a unified structure and combined cultures. This stage "implies the complete relinquishment of autonomy of at least one partnering entity in an effort to strengthen a surviving organization" (Gajda, 2004, p. 69). The model exhibits

formal integration moving from its lowest level during cooperation to its highest level during the coadunation stage.

Small Group Development Model by Tuckman

Through an examination of research studies focused on therapy groups, human relations training...and natural and laboratory-task groups, Tuckman (1965) described a four-stage sequence for small group development (Table 2). This model is characterized by two dimensions: interpersonal relationships and task activity. The interpersonal relationship “is interpreted as the interpersonal configuration and interpersonal behaviors of the group at a point in time, that is, the way the members act and relate to one another as persons” and task activity is interpreted as “the content of interaction as related to the task at hand” (Tuckman, 1965, p.385). The dimension of most significance is dependent on the group type.

Stages of this model include forming, storming, norming, and performing states. Adjourment was added as the fifth stage of the model in 1977 (Tuckman & Jensen, 1977). The forming stage has also been labeled as testing and dependence. In this stage group members identify behaviors that are acceptable to the group. This phase essentially defines boundaries of behavior, whether the behavior is interpersonal or task oriented. Dependency relationships are established at the same time. These relationships may occur with “leaders, other group members, or preexisting standards” (Tuckman, 1965, p. 396). In addition, the group defines relevant parameters of the task at hand and determines the methodology to be used in accomplishing said tasks.

The storming stage is characterized by conflict among members as they resist group formation and threats against their individuality. This resistance carries over into

Table 2

Tuckman's Stages of Group Development

Stage	Group structure (The pattern of inter-personal relationships; the way members act and relate to one another.)	Task activity (The content of interaction as related to the task at hand.)
Forming (Orientation, testing, and dependence)	Testing and dependence	Orientation to the task
Storming (Resistance to group influence and task requirements)	Intragroup conflict	Emotional response to task demands
Norming (Openness to other group members)	In-group feeling and cohesiveness develop; new standards evolve and new roles are adopted	Open exchange of relevant interpretations; intimate, personal opinions are expressed
Performing (Constructive action)	Roles become flexible and functional; structural issues have been resolved; structure can support task performance	Interpersonal structure becomes the tool of task activities; group energy is channeled into the task; solutions can emerge
Adjourning (Disengagement)	Anxiety about separation and termination; sadness; feelings toward leader and group members	Self-evaluation

Note. Reprinted from "Developmental Sequence in Small Groups," by B. W. Tuckman and S.P. Schuman (Ed.), 2001, *Group Facilitation: A Research & Applications Journal*, 3, p. 66. Copyright 1965 by the American Psychological Association.

the task realm. In the norming stage group cohesiveness is developed. In addition, the adoption of new standards and roles takes place, and new group norms are created.

Furthermore, group members openly express their opinions (Tuckman, 1965).

In the performing stage the interpersonal structure is leveraged to support task performance. Roles are characterized by their flexibility and functionality. Group energy is concentrated on the task. Adjourning, or disengagement, is characterized by member anxiety and sadness associated with group termination. It is also defined by a period of self-evaluation of the tasks performed (Tuckman, 1965).

Cross-sector Collaboration Continuum Model by Austin

The Cross-sector Collaboration Continuum Model includes four components: a framework to categorize a partnership’s progression, a value construct, alliance drivers, and alliance enablers (Austin, 2000b). The collaboration continuum contains the philanthropic, transactional, and integrative stages. In this model the stages are differentiated by engagement level; importance of the collaboration to the mission; resource magnitude categorized as financial, in-kind, and intangible; activity scope; interaction level; managerial complexity; and strategic value (Table 3). The alliance drivers and enablers are also characterized by the three stages as listed above.

Table 3

Austin’s Cross-sector Collaboration Continuum Model

Nature of relationship	Stage 1 (Philanthropic)	Stage II (Transactional)			Stage III (Integrative)
Level of engagement	Low	⇒	⇒	⇒	High
Importance to mission	Peripheral	⇒	⇒	⇒	Central
Magnitude of resources	Small	⇒	⇒	⇒	Big
Scope of activities	Narrow	⇒	⇒	⇒	Broad
Interaction level	Infrequent	⇒	⇒	⇒	Intensive
Managerial complexity	Simple	⇒	⇒	⇒	Complex
Strategic value	Minor	⇒	⇒	⇒	Major

Note. Reprinted from “Strategic Collaboration Between Nonprofits and Business,” by J. E. Austin, 2000, *Nonprofit and Voluntary Sector Quarterly*, 29, p. 72. Copyright 2000 by the Association for Research on Nonprofit Organizations and Voluntary Action.

Collaboration continuum framework. The first model component to be examined is the collaboration continuum framework. According to Austin (2000a), the alliance marketplace is “underdeveloped and inefficient” such that the majority fall at the lower end of the evolutionary spectrum (p. 88). Indeed, organizations lack experience in

developing cross-sector collaboratives that grow beyond the commonplace charitable donor-recipient relationship. This relationship type is characteristic of the philanthropic stage. During the transactional stage the relationship evolves to include an exchange of resources, with the resources based on the specific tasks of the partnership. The final stage, integrative, is defined as the merging of “partners’ missions, people, and activities...into more collective action and organizational integration” (Austin, 2000a, p.71). Austin cautions that progression along the continuum does not equate with effectiveness (i.e., the partnership may determine that a lower level of engagement is a better fit for their goals).

Value construct. The second component of Austin’s model is the collaboration value construct, involving four dimensions: value definition prior to alliance establishment, as well as value creation, balance, and renewal that occurs during collaborative efforts. In the value definition dimension, alliance members identify the expected benefits of the collaboration and assign a worth to each. Many of these benefits are synonymous with those motivations outlined in a previous section of this study (Austin, 2000a).

Value creation centers on examining each partner’s resources and capabilities to determine how they might add value. During the philanthropic stage the partnership experiences generic resource transfers such as money and positive public relations. As the partnership progresses partner members make a joint effort to create value. Joint value creation is viewed as the highest source of value because it is specifically unique to the nature of the alliance. In addition, according to Austin, more sustainable alliances are characterized by a “balanced exchange of value” (Austin, 2000a, p. 79). This is

supported by Cropper's assertion that balance is necessary to achieve sustainability of a partnership (Cropper, 1996).

Value creation is not a singular event. Member needs, priorities, and external environments change over time, therefore the value initially created may diminish. Thus, the value of the partnership must be continually recreated. Typically this renewal is accomplished through the innovation process (Austin, 2000a).

Alliance drivers. The third component of the model is alliance drivers. Alliance drivers are those "forces that provide the primary power for strategic cross-sector collaboration" (Austin, 2000a, p. 71). These forces include (a) "alignment of mission, strategy, and values; (b) personal connection and relationships; (c) value generation and shared visioning; and (d) continual learning" (Austin, 2000a, p. 71) (Table 4). Central alignment of the strategy, mission, and values of the alliance and its member organizations appears to solidify the relationship—the closer the alignment the richer the partnership and the greater the collaboration's cohesiveness (Austin, 2000a).

Another factor important to the cohesiveness of the group is emotional connections between alliance members as well as the connection of those members to the partnership's mission. Personal relationships form the basis for the development of interorganizational trust, a critical element in forming collaboratives (Burke, 1999; Dickson & Weaver, 1997; Kanter, 1994; Larson, 1992; Waddock, 1988). Although trusting relationships do not necessarily assure partnership success, the converse is true. Moreover, when confronted with leadership changes resulting in a loss of time-tested relationships, the level of alliance strength and resilience becomes readily apparent.

Table 4

Austin's Cross-sector Collaboration Continuum Model Drivers and Enablers

Drivers and enablers	Philanthropic	Transactional	Integrative
Alignment of strategy, mission, and values	Minimal fit required, beyond a shared interest in a particular issue area	Overlap in mission and values	High mission mesh
Personal connection and relationships	Gratefulness and charity orientation	Partnering mindset	Shared values
	Minimal personal connection to cause or people	Relationship as tactical tool	Relationship as strategic tool
Value generation and shared visioning	Generic resource transfer	Strong personal connection at leadership level	Expanded opportunities for direct employee involvement in relationship
	Unequal exchange of resources	Expanded personal relationships throughout the organization	Deep personal relationships and trust across organization
	Minimal collaboration in defining activities	Increased understanding and trust	<i>We</i> mentality replaces <i>us versus them</i>
Continual learning	Corporations respond to specific requests from nonprofits	Core competency transfer	Joint value creation and value renewal
	Minimal or informal learning	More equal exchange of resources	Culture of each organization influenced by the other
Focused attention	Little top leadership attention	Shared visioning at top of organization	Projects identified/developed at all levels within the organization, with leadership support
Communication	Generally annually around grant process	Projects of limited scope and risk	Broader scope of activities of strategic significance
Organizational systems	Corporate contact usually in community affairs of foundation; nonprofit contact usually in development	More active learning about process and substance	Systematic learning and innovations
Mutual expectations and accountability	Use for stated purpose but minimal other performance expectations	Top management engaged at start-up and periodically	Discovery ethic
		More frequent communication between partners and externally	Significant and ongoing attention from top management
		More people involved with responsibilities for specific collaboration activities	Explicit internal and external communication strategies and processes
		Explicit performance expectations for targeted collaboration activities	Partner relationship managers
			Organizational integration in execution, including shared resources
			High performance expectations and accountability for results
			Incentives for collaboration

Note. Reprinted from "Strategic Collaboration Between Nonprofits and Business," by J. E. Austin, 2000, *Nonprofit and Voluntary Sector Quarterly*, 29, p. 72. Copyright 2000 by the Association for Research on Nonprofit Organizations and Voluntary Action.

Indeed, according to Austin (2000a), sustainability of a collaboration is highly dependent on extending relationships throughout the strata of organizations that support the alliance.

The last driver cited by Austin is engagement in continual learning as an alliance. The learning may focus, for example, on how to generate more value or find new avenues to improve partner commitment (Austin, 2000a). Peter Senge (1990) explains in *The Fifth Discipline* the importance of continual learning: “Team learning is vital because teams, not individuals, are the fundamental learning unit in modern organizations. This is where ‘the rubber meets the road’; unless teams can learn, the organization cannot learn” (p. 10).

Alliance enablers. Supporting the alliance drivers are factors that facilitate the “effective management of the partnering relationship and process.” These factors have been labeled alliance enablers and include (a) focused attention and concentrated engagement by key players of the collaboration; (b) effective, efficient, and frequent communication utilizing multiple channels; (c) an organizational system that identifies partner relationship managers for each organization involved in the collaborative; and (d) a mutual understanding of expectations and accountability for results. It should be noted that the communication realm of the partnership must foster openness and allow for constructive criticism, thereby facilitating the building of trust (Austin, 2000a).

Levels of Integration Model by Gajda

In 2004 Gajda described a five-level model and constructed an accompanying rubric to assess strategic alliance formation. The five model levels include “networking, cooperating, partnering, merging, and unifying” (Frey, Lohmeier, Lee, Tollefson, & Johannig, 2004, p. 2). The multiple levels of integration are differentiated by purpose,

organizational strategies and tasks, leadership and decision-making, and interpersonal and communication characteristics (Table 5).

Key Attributes of High-Performing Teams and Effective Collaborations

A large percentage of research studies on partnerships and strategic alliances report a one-third to two-thirds failure rate (Hagen, 2002). What factors determine if an alliance thrives or disintegrates? How is success or effectiveness defined?

Workplace Teams

While the literature is scant regarding the effective development and sustainability of collaboratives between academia and industry, it is replete with information on the implementation of effective work teams. Hackman (1987) defined team success as completing the assigned task while maintaining good social relations and promoting the personal and professional development of team members. In human service delivery systems, effectiveness has been characterized as an increase in interagency linkages, diversity of activities undertaken, sense of empowerment, and information exchanges (Peterson, 1991; Smrekar & Mawhinney, 1999; Tseng, Liu, & Wang, 2011). In *The Wisdom of Teams*, Katzenbach and Smith (2003) posit that high-performance teams are rare and offer this glimpse into their operation:

[A high performance team] outperforms all other like teams and outperforms expectations given its composition. This is largely because a high degree of personal commitment to one another differentiates people on high performing teams from people on other teams (p. 4-5)...such commitments go well beyond civility and teamwork. Each genuinely helps the others to achieve both personal and professional goals. Furthermore, such commitments extend beyond company activities and even beyond the life of the team itself (p. 65)...Leadership is shared in high performance teams...Members of real teams usually feel empowered to make their common purposes happen...When combined, the

Table 5

Gajda's Levels of Integration

Levels of integration	Purpose	Strategies and tasks	Leadership and decision-making	Interpersonal and communication
Networking	Create a web of communication Identify and create a base of support Explore interests	Loose or no structure Flexible, roles not defined Few, if any, defined tasks	Non-hierarchical Flexible Minimal or no group decision-making	Very little interpersonal conflict Communication among all members infrequent or absent
Cooperating	Work together to ensure tasks are done Leverage or raise money Identify mutual needs, but maintain separate identities	Member links are advisory Minimal structure Some strategies and tasks identified	Non-hierarchical, decisions tend to be low stakes Facilitative leaders, usually voluntary Several people form "go-to" hub	Some degree of personal commitment and investment Minimal interpersonal conflict Communication among members clear but may be informal
Partnering	Share resources to address common issues Organizations remain autonomous but support something new To reach mutual goals together	Strategies and tasks are developed and maintained Central body of people with specific tasks	Autonomous leadership Alliance members share equally in the decision-making Decision-making mechanisms are in place	Some interpersonal conflict Communication system and formal information channels developed Evidence of problem-solving and productivity
Merging	Merge resources to create or support something new Extract money from existing systems/ members Commitment for a long period of time to achieve short- and long-term outcomes	Formal structure to support strategies and tasks is apparent Specific and complex strategies and tasks identified Committees and subcommittees formed	Strong, visible leadership Sharing and delegation of roles and responsibilities Leadership capitalizes upon diversity and organizational strengths	High degree of commitment and investment Possibility of interpersonal conflict high Communication is clear, frequent, and prioritized High degree of problem-solving and productivity

(Continued)

Table 5 (Continued)

Gajda's Levels of Integration

Levels of integration	Purpose	Strategies and tasks	Leadership and decision-making	Interpersonal and communication
Unifying	Unification or acquisition to form a single structure Relinquishment of autonomy to support surviving organization	Highly formal, legally complex Permanent reorganization of strategies and tasks	Central, typically hierarchical leadership Leadership capitalizes upon diversity and organizational strengths	Possibility of interpersonal conflict very high Communication is clear, frequent, prioritized, formal, and informal

Note. Reprinted from “Utilizing Collaboration Theory to Evaluate Strategic Alliances,” by R. Gajda, 2004, *American Journal of Evaluation*, 25, p. 71. Copyright 2003 by the American Evaluation Association.

intense commitments to one another and their mutual cause plus their shared leadership and interchangeable skills make high performing teams entirely self-sufficient. They move ahead by their own rules. Rejection does not get in their way. Nor does organizational hostility or indifference, limited resources, insufficient compensation, or ...even ‘freezing weather’ stop these powerful teams. (Katzenbach & Smith, 2003, p. 80-81)

Table 6 summarizes the factors contributing to the success of workplace teams by author.

Cohen and Bailey (1997) caution that the factors important for team success are dependent on team type. In other words, the factors promoting success in a production team may be significantly different from those for professional and managerial teams.

Interorganizational Alliances Involving Higher Education

From the institutional perspective Lavendar (2007) posits that community college personnel perceive a clear directive within their missions to develop interorganizational relationships. Moreover, she reveals that the institutional leaders that cultivate these partnerships are successful because they possess an entrepreneurial attitude. This attitude

Table 6

Factors Contributing to Team Success

Factors	Hackman (1987)	Larson and LaFasto (1989)	Katzenbach and Smith (1993)	Levi and Slem (1995)	MacMillan (2001)	Levi (2007)	Parker (2008)
Clear goals	X	X	X	X	X		X
Appropriate leadership	X	X		X	X		X
Organizational support	X	X		X		X	
Suitable tasks	X		X	X		X	
Accountability and rewards		X	X	X			
Right group composition					X	X	X
Good internal group processes			X	X	X	X	
Necessary resources	X						
Commitment to common purpose		X	X		X		
Informal climate							X
Active participation							X
Listening skills							X
Civilized disagreement							X
External relations							X
Excellent communication					X		

supports their resolve to develop workforce interventions that meet the specific needs of industry partners. While the author indicates that the partnership she studied formed because of state funding, she also notes that personal connections significantly impacted the development and continuation of the partnership.

From the industry perspective DeLuca (2008) examined the factors that contribute to the development and sustainability of successful university-industry research collaboratives. Results of a three-round Delphi method indicated twenty-five essential

factors for developing and twenty-six factors for sustaining an academia-industry partnership. DeLuca examined these factors for partnership development through a theoretical framework grouping of social, resource, and institutional factors. The author deemed such factors as mutual respect, trust, openness, interpersonal relationships, and strengthening of faculty scholarship as social factors. The resource grouping contained an agreement for profit sharing and the inclusion of intellectual property rights. The institutional grouping consisted of the development of periodic assessments, contractual agreements, and the recognition of institutional environmental pressures. While the study does have a research partnership slant, many of these factors have been identified in earlier sections of this chapter. Thus, for the purposes of this study, the factors that are relevant to a partnership focused on educational programs have been categorized according to Austin's alliance drivers and enablers and presented in Table 7.

NSF ATE-funded Academia-Industry Workforce Education Alliances

Established by Congress in 1950, the National Science Foundation (NSF) serves to facilitate scientific progress and build a world-class science, mathematics, engineering, and technology workforce. In FY 2010 the independent federal agency's budget soared to \$6.9 billion (National Science Foundation, 2010). The agency funds about 20% of the federally funded basic research at higher education institutions. Of the seven directorates that comprise the National Science Foundation, only one focuses on education. This directorate is further subdivided to serve graduate education, undergraduate education, human resource development, and research on learning (National Science Foundation, 2010).

Table 7

Select Factors Contributing to Development and Sustainability of Academia-Industry Collaboration Categorized by Austin's Alliance Drivers and Enablers

Drivers and enablers	Development factors	Sustainability factors
Alignment of strategy, mission, and values	Consistency with university's mission; Willingness of academic side to understand real world conditions of private industry	Maintaining relevancy to solve industry's problems; Continued clarity on joint relationship, insuring that needs of parties are being met
Personal connection and relationships	Mutual respect, trust, openness, and confidence in the relationship; Relationship between key people in business and education	Maintaining trust, openness, and confidence; Relationship not solely dependent upon single person from each partner; Constant attention to relationship
Value generation and shared visioning	Reciprocity	Reciprocity; A vision; Positive leverage—the partnership achieves more than the university could accomplish in isolation; Funding stability
Continual learning	None	None
Focused attention	Team leaders identified for each partner	Sustained long-term commitment from leadership of industry; Active participation of senior leadership from participating organizations
Communication	Identification of single "go-to person" within each partner's structure to channel all communication; Agreement as to how teams involved in partnership would be kept informed	Frequent and open communication; Regular reporting of results, issues, and successes; Team leaders responsible for assuring communication plan is followed; Agreed upon timetable, with actions, monitoring, reporting, and occasional face-to-face interactions
Organizational systems	Creation of action plan; Assignment of key objectives and associated tasks to designated individuals within partnership	Action is taken to ensure team members meet timelines; Team leaders ensure action is taken when troubleshooting is necessary (both project and relationship related); Partnership behaves like two equals rather than one being subordinate to other
Mutual expectations and accountability	Establishing clearly understood and agreed upon objectives; Execution of win: win Memorandum of Agreement which meets needs of partners; Agreement as to how profits resulting from collaboration would be shared	Focused team with clear priorities; Clear understanding of roles, responsibilities, scope of work, and statement of mutual expectations; Candid discussion and understanding of outcomes; Developing methods of evaluating progress of projects and determining their true value at completion; Periodic assessments, including modifications and adjustments
Other factors	Strengthening of faculty scholarship as a result of engagement; Enhancement of education experience for involved students	Retention of the champions/lead contacts from both higher education and industry

The Advanced Technological Education (ATE) funding opportunity falls under the auspices of the undergraduate education subdirector. Established in response to the Science and Advanced Technology Act of 1992, the program focuses on technician level education at two-year community colleges in advanced technology fields. Funded grant projects are expected to provide solutions to workforce issues in the high-technology fields at the state, regional, or national levels, and these solutions should result from the dialogue of a partnership between institutions and employers (National Science Foundation, 2011).

The ATE budget has grown significantly since its establishment. In FY 1994 the agency budget was \$13.5 million (Advanced Technological Education Centers, 2011). For FY 2012 the ATE program projects a funding level of \$64 million for advanced technological education in disciplines such as biotechnology, information technology, cybersecurity, manufacturing technology, nanotechnology, and telecommunications. Typically grant proposals concentrate on at least one of the following goals: curriculum development, professional development, program improvement, career pathways development and implementation, articulation establishment, and dissemination. In addition, three tracks of grant applications are accepted: projects, centers, and targeted research (National Science Foundation, 2011). Projects usually span three years in duration, during which time the grantee receives a maximum of \$900,000. These projects typically address one or more goals as listed above but do not cover them all. Moreover, the geographic scope of projects is generally limited. Conversely, centers cover a greater geographic and activity scope than projects. Whether regional or national in coverage, centers are typically funded for four years at a rate of three to five million dollars, with

opportunities for subsequent renewal of grant funding (National Science Foundation, 2011).

Since establishment of the ATE program nearly 1,000 projects and centers have been funded, more than 40 of which are centers. As of October 2010, 219 projects and centers were active awards. The NSF and its grantees recognize the importance of partnerships with the business community in ensuring the successful development of workforce education programs. Grantees reported 6,941 collaborations with business and industry, educational institutions, and public agencies in 2009 (203 of 219 active awards reporting). Business and industry represented 2,649 of the 6,941 (38%) collaborations reported. These partners contributed \$20 million of monetary and in-kind support to grantees (Wingate, Westine, & Gullickson, 2010). According to a site visit study of five ATE-funded programs and four non-ATE locations, ATE-funded programs contribute value to the business community in “terms of the number of technicians educated/trained and available, the quality of these technicians, improved business results, and reduced costs for business” (Germuth, Gullickson, Lawrenz, & Hanssen, 2006). Findings also suggest that partnerships initiated by industry rather than academia are perceived as adding more value.

According to the program solicitation, proposals must address the issue of sustainability. Sustainability is defined by the NSF as having “developed a product or service that the host institution, its partners, and its target audiences want continued” (National Science Foundation, 2011). Although some scholars posit that NSF has not provided a clear definition for sustainability (Bailey, Matsuzuka, Jacobs, Morest, & Hughes, 2004; Lawrenz & Keiser, 2001), there is agreement that sustainability remains elusive for the majority of centers. Bailey, Matsuzuka, Jacobs, Morest, and Hughes (2004) go so far as to argue that “the optimal level and nature of...sustainability depends

on the underlying problems that the ATE activities are trying to solve” (p. 3). This is juxtaposed with responses from grant principal investigators. Indeed, more than 90% of respondents with active grants prior to 2009 (216 respondents out of a population of 273 sites) agreed that “changes made in our technological education program will keep going after our current grant ends” (Welch & Ritchie, 2010, p. 1). In addition, only 17.5% believed that their collaborations with industry and academe would end after grant funding expired.

Despite the beliefs of principal investigators, Welch and Gullickson (2006) report that many grant activities were not sustained post-funding. The study also uncovered that collaborations were not continued. In fact, the total number of business and industry collaborators involved with ATE grant projects dropped from 103 in the final year of funding (for 87% of the 118 respondents) to 63 after funding completion (for 56% of the 113 respondents), a decline of approximately 39% (Welch & Gullickson, 2006).

Summary

Although collaboration has been the focus of intense study across multiple disciplines, scholarly agreement on a definition for collaboration has proven difficult. The terminology used to denote a collaborative effort is vast and includes partnerships, collaborations, alliances, consortiums, coalitions, associations, networks, conglomerates, councils, task forces, teams, groups, interorganizational relationships, cross-sector partnerships, consolidations, and joint ventures (Austin, 2000a; Gajda, 2004; Parmigiani & Rivera-Santos, 2011). The motivations for forming collaboratives are as diverse as the terminology used to describe these networks. Motivations cited in the literature include information technology, knowledge, complexity of social problems, diminishing

governmental budgets, economies of scope and scale, revenue enhancement, ability to influence decision-making, higher quality workforce, and community relations among others.

Collaboration is a continuous process. The work undertaken by the collaborative depends to a large extent upon where the collaborative is in the evolutionary process continuum (Flynn & Harbin, 1987; Tseng & Wang, 2007) and it should be evaluated accordingly. Several theoretical models exist that describe the various stages of partnership progression; most consist of three to five phases. Regardless of the stages traversed during their journey, partnerships experience a high failure rate. Team type often influences the specific factors important for team success (Cohen & Bailey, 1997).

From the institutional perspective, community college personnel perceive a clear directive within their missions to develop interorganizational relationships (Lavendar, 2007). The literature on effective workplace teams points to the following factors: clear goals, appropriate leadership, suitable tasks, accountability and rewards, good internal processes, and commitment to a common purpose. Furthermore, multiple studies underscore the importance of personal relationships and trust in developing and sustaining collaborations. While this list of factors is not exhaustive, it does provide a suitable basis for the examination of the academia-industry-government workforce partnership that is the focus of this study.

CHAPTER THREE

Research Design

Introduction

To examine the factors influencing the development and sustainability of an industry-academia-government advanced technological education partnership, a qualitative research approach has been employed. Qualitative research offers a broad array of prospective philosophical positions that underlie the research design and approaches for its design (Patton, 2002). Thus, it is helpful to elucidate the researcher's basic belief system or paradigm in choices of ontology, epistemology, methodology, and analysis (Table 8).

Table 8

Qualitative Approaches Employed for this Study

Research design category	Research position or approach
Ontological	Constructivism (Relativist)
Epistemological	Constructivism (Transactional/Subjectivist)
Methodological	Single case study (Data sources included documentation and focused interviews of industry members of the case study organization.)
Analytical	Adaptive coding (Unit of analysis was the organization, an NSF ATE-funded regional center for biomanufacturing education.)

Ontological Position

According to Guba and Lincoln (1994), the ontological question addresses “the form and nature of reality” and what “can be known about it” (p. 108). In earlier writings the two authors present four paradigms that they most closely associate with qualitative inquiry: positivism, postpositivism, critical theory, and constructivism. A fifth paradigm, participatory, was subsequently added to the list (Lincoln, Lynham, & Guba, 2011).

The researcher of this study subscribes to a constructivist ontological position. Constructivism aims “to understand and interpret through meaning of phenomenon (obtained from the joint construction/reconstruction of meaning of lived experience); such understanding is sought to inform praxis” (Lincoln et al., 2011, p. 106). Constructivism diverges from the other paradigms in that its ontological assumption centers on relativism as opposed to realism. With relativism as a foundational assumption, the belief is that multiple realities, rather than one reality, exist which are derived from human intellects. Groups then define which reality is useful and has meaning to the community.

Epistemological Position

The researcher’s approach to the ontological question is inextricably linked to the epistemological question. The epistemological question addresses “the nature of the relationship between the knower or would-be-knower and what can be known” (Guba & Lincoln, 1994, p. 108). Thus, because the researcher subscribes to a relativist construct for reality, the approach to the epistemological question is by default transactional/subjectivist. With this approach knowledge is viewed as being created

through interaction between the researcher and his subjects (Guba & Lincoln, 1994).

This is juxtaposed with the positivism and postpositivism approaches that subscribe to dualist/objectivist assumptions.

Methodological Approach

Definition of a Case Study

The single case study provides a research method for exploring the development and sustainability of industry-academia-government advanced technological education partnerships. Focusing on the design logic underpinning case studies, Yin (2009) provides a two-part definition for a case study. The first portion emphasizes its scope and the second includes other technical characteristics:

A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident. The case study inquiry copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result benefits from the prior development of theoretical propositions to guide data collection and analysis. (Yin, 2009, p. 18)

It should be noted that case studies can serve as the research strategy for both quantitative and qualitative studies. Case studies typically combine several methods for collecting data, including interviews, documentation, archival records, physical artifacts, participant observations, and direct observations (Yin, 2009). Data triangulation is of utmost importance. The goal of case study research is varied; the generation of theory (Gersick, 1988; Eisenhardt, 1989) and the testing of theory (Pinfield, 1986; Flyvbjerg, 2006) can be among its goals. Indeed, Eckstein (1975) argues that case studies are better suited for testing theories rather than generating them.

The case is often defined as “a bounded system,” giving preeminence to the case as an object (Smith, 1978). The current research study was bounded by the review of literature and the definition of the research question. Uncovered during the literature review phase, Austin’s Cross-sector Collaboration Continuum Model has provided a prominent boundary for data collection. The boundaries established serve to ameliorate information overload (Eisenhardt, 1989), a common occurrence with the case study method.

Rationale for the Case Study as a Research Method

The choice of the case study for a research method is largely dependent on the substantive questions on which the study is based. The more the research questions seek to explain a phenomenon through asking “how” and “why” questions the more relevant the case study methodology becomes (Yin, 2009). Yin (2009) terms the “how” and “why” case study as an explanatory case study, while Stake (2005) defines the type as instrumental. Regardless, providing insight into the phenomenon selected is of utmost importance; the case is cast in a supporting role. The research questions that guide this study are explanatory in nature; thus, according to Yin and Stake, employing the case study method is appropriate.

Yin’s definition for a case study also illuminates its importance as a research strategy when the phenomenon to be studied is a contemporary one and the researcher cannot manipulate behavioral events (Yin, 2009). This study also conforms to these conditions. Indeed, the partnership relationship can be observed in its real-world context.

The case study method may also be appropriate if previous research on the subject matter is lacking (Eisenhardt, 1989). As argued previously, research from the industry perspective on advanced technological workforce education partnerships is scarce.

Additional support for choosing the case study approach can be found in its prominence as the research method of choice when studying collaborations. In fact the conceptual framework employed by this study was generated from case study research by Austin (2000b). Citing Wood and Gray (1991), Austin explains that the case study has “proven particularly useful for generating theoretical and practical insights” (p. 70). Flyvbjerg (2006) further asserts that “the case study produces the type of context-dependent knowledge that research on learning shows to be necessary to allow people to develop from rule-based beginners to virtuoso experts,” and this type of context-dependent (practical) knowledge is the only knowledge available when examining human affairs (p. 221). Thus, attaining expert status must be derived from practical knowledge and experience gained while studying cases.

Objections to the Case Study Method

A primary objection to the use of the case study method focuses on the difficulty in generalizing from a single case. Although some authors such as Stake (2005) emphasize “designing the study to optimize understanding of the case rather than to generalize beyond it,” others address the issue head-on (p. 443). In his article “Five Misunderstandings About Case-Study Research,” Flyvbjerg (2006) states that “Galileo’s rejection of Aristotle’s law of gravity” was not evidenced by multiple observations from a broad base; it was not based on evidence collected from a large random sample (p. 225). Rather a single experiment or case study would have been employed. Flyvbjerg

uses this assertion to support his notion that whether or not generalizations can be made from a single case is dependent on the specific case and how it is selected.

Yin also challenges this objection, though from a slightly different perspective. He postulates that case studies “are generalizable to theoretical propositions and not to populations or universes” (Yin, 2009, p. 15). He argues that the researcher’s “goal is to expand and generalize theories (analytic generalization) and not to enumerate frequencies (statistical generalization)” (Yin, 2009, p. 15).

Finally, Flyvbjerg cautions against overvaluing generalization and undervaluing practical example:

One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas ‘the force of example’ is underestimated. (Flyvbjerg, 2006, p. 228)

Another objection to the case study is the perceived lack of rigor associated with this method. Yin (2009) posits that the quality of case study design can be improved by addressing reliability and validity concerns. Toward this end he provides examples of several tactics that may be employed to provide quality control and assurance for each of four tests. The quality tests and case study tactics suggested by Yin that are applied to this case study are provided in Table 9. Further discussion of each tactic is provided in the applicable research phase section.

Case Study Selection

The unit of analysis for this research study is an NSF ATE-funded regional center partnership that focuses on biomanufacturing education. The Northeast Biomanufacturing Center and Collaborative (NBC²) was chosen as the NSF ATE-funded

Table 9

Case Study Tactics Employed to Assure Quality

Quality test	Tactic applied	Research phase
Construct validity	Data triangulation	Data collection
	Chain of evidence	Data collection
Internal validity	Pattern matching	Data analysis
	Rival explanations addressed	Data analysis
External validity	Theory utilized	Research design
Reliability	Case study database	Data collection
	Case study protocol	Data collection

Note. Reprinted from *Case Study Research: Design and Methods* (p. 41), by Robert K. Yin, 2009, Thousand Oaks, CA: Sage Publications, Inc. Copyright 2009 by Sage Publications, Inc.

regional center for this case study in part because it is a typical case and a revelatory case. The partnership is typical in the respect that as an NSF ATE-funded center it addresses program development and improvement, curriculum development, professional development, and dissemination. The selected case is also revelatory due to the researcher’s relationship with the NBC² as their external evaluator during the past three years.

Funded in 2005, the NBC² is an education-industry alliance that supplies skilled technicians and professionals for biomanufacturing companies in the Northeast and other areas of biomanufacturing activity across the nation. The partnership accomplishes this through an educational pathway for biomanufacturing technicians from high school to the community college to the university.

The partnership currently contains four hubs in the northeastern region and three alliances in the west, mid-west, and southern regions of the country. Hub partners include Community College of Baltimore County-Catonsville, Montgomery County Community College, Finger Lakes Community College, and Minuteman Regional High

School. Alliance partners include Ivy Tech Community College, MiraCosta College, and Alamance Community College. Biomanufacturing partners include: Abbott, Acambis, Alexion Pharmaceuticals, Amgen, AstraZeneca, Baxter International, BioConcept Laboratories, Biogen Idec, BioProcessing, Biopure, Bristol-Myers Squibb Company, Celltech Group, Centocor Ortho Biotech, CookPharmica, CuraGen Corporation, Dow, Eli Lilly and Company, EMD Serano, Ethide Laboratories, Genencor, Genentech, Genzyme Corporation, GlaxoSmithKline, GlycoFi, Human Genome Sciences, Johnson & Johnson Services, Life Technologies Corporation, Lonza Biologics, MedImmune, Merck, Millennium Pharmaceuticals, Millipore, Northeast Biofuels, Novartis, Pfizer, Regeneron, Repligen Corporation, Roche, Rohm and Haas Company, Shire, Tengion, and Wyeth.

To achieve its overall goal of a world-class sustainable biomanufacturing workforce, the NBC² partnership performs the following:

- “Builds and fosters local partnerships between industry, educational institutions, and government to create sustainable learning communities around biomanufacturing clusters” (Northeast Biomanufacturing Center and Collaborative, 2011).
- Enhances, expands, and implements a biomanufacturing curriculum based on globally-harmonized “industry skill standards in response to industry needs” (Northeast Biomanufacturing Center and Collaborative, 2011).
- “Provides professional development opportunities for all members of the NBC², including faculty, teachers, and students” (Northeast Biomanufacturing Center and Collaborative, 2011).

- “Disseminates information on biomanufacturing education and training, workforce statistics, and career opportunities” (Northeast Biomanufacturing Center and Collaborative, 2011).
- “Plans for sustainability of the NBC², including both fiscal needs and... [maintenance of] the local, regional, and national biomanufacturing education and training, and workforce infrastructure” (Northeast Biomanufacturing Center and Collaborative, 2011).

Research Questions

With an NSF ATE-funded biomanufacturing center partnership as a context for analysis, the research study will address the following questions:

- What are the major drivers and enablers that lead to the development of an effective industry-academia-government partnership focused primarily on advanced technological workforce education?
- How well does the evolutionary progression of the partnership evolution align with Austin’s Cross-sector Collaboration Continuum Model?
- What are the major factors that lead to sustainability of an effective industry-academia-government partnership?

In constructing the primary research questions, three secondary themes emerged:

- Are there impediments for industry working within the educational environment?
- In which stage of the collaboration continuum does the partnership currently operate?
- How does industry define sustainability, and is this condition always desirable?

Data Collection

Information collected for this case study combines rich archival data from documentation with focused interviews of industry members from the case study organization. A primary strength of the case study method is in collecting data from numerous sources. Moreover, data triangulation is crucial in assuring construct validity in the case study (Yin, 2009). Indeed, Stake (2005) suggests that data triangulation is an iterative process that should be carried out during the life of the study.

Another tactic associated with the data collection phase that increases construct validity is the chain of evidence (Yin, 2009). Yin notes that the chain of evidence allows “the reader of the case study to follow the derivation of any evidence from initial research questions to ultimate case study conclusions” (p. 122). Furthermore, original evidence should not be disregarded through inattentiveness or bias and fail to receive proper consideration. To maintain a chain of evidence, the initial research questions are linked to the case study protocol and the case study protocol to data collection methods. The actual data collected must be linked to specific evidence contained within the case study database, and evidence provided in the case study database should be properly cited in the dissertation (Yin, 2009).

To address reliability issues typically associated with the data collection phase of the case study method, Yin (2009) suggests developing a case study protocol and a case study database (discussed in the following section). The protocol contains a number of important pieces of information to guide the study, including an introduction to the case study, data collection procedures, and case study questions. The dissertation proposal served as the case study protocol in this instance.

Documentation. A key feature of this study was collecting documentation that details the evolution of the NBC² partnership. Indeed, the value of documentation in generating and testing theory cannot be overstated (Corbin & Strauss, 2008; Glaser & Strauss, 1971). The co-principal investigators of the organization and the researcher provided more than 145 documents consisting of more than 2,000 pages for this study.

When a document was received the researcher entered it into NVivo 9.2 software and catalogued it to create a case study database (see Appendix). The database contains all the raw data on which the study's conclusions are based. According to Yin (2009), a database that provides a separate mechanism for inspecting the raw data rather than simply providing a dissertation narrative is critical to increasing the reliability of the study. Along with any case study notes and researcher narratives, the documents contained within the database were classified as blog, book, conference proceeding, grant, interview, journal article, magazine article, meeting audio, meeting transcript, minutes, newsletter, newspaper article, personal communication, presentation, press release, report, survey data, or web page. In addition, the researcher provided important information (e.g., author/publisher, title, number of pages, publication/access date, and source) for each document catalogued.

Interviews. Interviews are essential sources of data for case study research (Yin, 2009). Stewart (1982) notes that interviews enable understanding as to "how individuals construct meaning and significance of their situation from the complex personal framework of beliefs and values, which they have developed over their lives in order to help explain and predict events in their world" (p. 45). The interview is "the opportunity for the researcher to probe deeply, to uncover new clues, open up new dimensions of a

problem and to secure vivid, accurate, inclusive accounts... that are based on personal experience” (Burgess, 1982, p. 165).

In order to accomplish this task, the questioning stream in a case study interview is typically fluid rather than structured (Rubin & Rubin, 1995) and, therefore, is referred to as a semi-structured interview. For this study the researcher used semi-structured interviews to elicit information from industry representatives of the case study organization.

Pilot study - The researcher conducted a pilot study of the interview questions immediately following approval of the dissertation proposal by the researcher’s dissertation committee and the Institutional Research Board at Baylor University. The researcher generated the interview questions during the literature review process. First the researcher discussed potential lines of questioning with the NBC²’s executive director.

Next the researcher identified industry representatives from a similar NSF ATE-funded center with which to conduct the pilot interviews. Three industry representatives completed the interview process, one via the telephone and two face-to-face. All were audio-recorded and transcribed verbatim (see Appendix). The researcher then stripped all references to persons, places, businesses, etc. from the transcripts. Based on the pilot interviews, the researcher revised the interview questions and requested that a graduate of the same degree program as the researcher review the document. The final list of questions to guide the researcher during the interviews is appended (see Appendix).

Ranking of industry representatives - The population for this qualitative study was the 28 industry members of the National Advisory Board and National Visiting

Committee of the NBC² as identified by the executive director. These industry representatives either currently participate or have previously participated in the NBC² partnership. To qualify as an industry representative, the individual must have either previously or currently worked in the life sciences/biotechnology/biomanufacturing field and could not be currently employed by a two-year or four-year college or university. The population of industry members was ranked according to participation in a variety of activities that spanned multiple years. The principal investigator and co-principal investigators provided confirmation of industry representative participation in each of the activities listed below:

- 2011 National Visiting Committee meeting
- 2010 National Visiting Committee meeting
- 2009 National Visiting Committee meeting
- 2008 National Visiting Committee meeting
- 2007 National Visiting Committee meeting
- 2006 National Visiting Committee meeting
- 2010 Advisory Board meeting
- 2009 Advisory Board meeting
- 2008 Advisory Board meeting
- 2006 Advisory Board meeting
- Textbook development
- Skill standards harmonization
- 2008 strategic planning session
- 2011 strategic planning session

- BIOMAN Conference support
- Protein is Cash workshop support

For each activity, ten points were given if the individual participated in the activity, and five points were given if the individual could not participate but secured company representation. The range of scores for the population of industry members was from 0 to 80 ($\mu = 29.6$, $Mdn = 27.5$, $\sigma = 20.3$, $N = 28$).

Industry representatives with less than 15 points—participation in at least two activities—were excluded from the ranked list. Twenty-two industry members qualified for the study. Those that met the standards given above were contacted in rank order until a sample of twelve agreed to participate in the study. Sample scores ranged from 15 to 80 ($\bar{X} = 40.4$, $Mdn = 40$, $SD = 22.6$, $n = 12$).

Sample size - Regarding this study, or any qualitative study for that matter, researchers generally follow the concept of saturation to determine sample size (Glaser and Strauss, 1967). However, other factors can determine the time frame for achievement of saturation. Table 10 provides the viewpoints of various authors regarding factors that influence the sample size in a qualitative study.

In addition, multiple authors have taken the stance that saturation is often declared by a researcher with little evidence offered (Morse, 1995; Bowen, 2008). Guest, Bunce, and Johnson (2006) note, “although the idea of saturation is helpful at the conceptual level, it provides little practical guidance for estimating sample sizes for robust research prior to data collection” (p. 59). The point of saturation has also been referred to as “potentially limitless” (Green & Thorogood, 2009, p. 120) and thus can be difficult when

Table 10

Factors Influencing Qualitative Sample Size

Author	Factor(s)
Charmaz (2006)	Aims of study
Ritchie, Lewis, and Elam (2003)	Population heterogeneity; selection criteria number; multiple samples within one study; data collection methods used; budget and resources available
Morse (2000)	Scope of study; nature of topic; quality of data; study design
Jette, Grover, and Keck (2003)	Researcher expertise

constraints such as time, energy, and the availability of participants exist (Strauss & Corbin, 1998).

While the debate ensues on the issue of saturation, few researchers have defined in the literature what constitutes an adequate sample size. During the literature search for their 2006 study, Guest et al. discovered “only seven sources that provided guidelines for actual sample sizes” (p. 61), and none of these proposed sample sizes were for case studies. However, guidelines were available for the field of qualitative research and Bertaux (1981) suggests that 15 is the lower limit for an acceptable sample size in the field. Unfortunately there are no empirical arguments given for the sample sizes suggested by any of the seven sources.

In practice, evidence suggests that researchers do not follow guidelines concerning sample sizes. For example, a 2004 review of 50 research articles on grounded theory discovered a sample size range of 5 to 350 (Thomson, 2004 as cited in Mason, 2010). In addition, a 2009 review of Ph.D. theses conferred in Great Britain and Ireland employing qualitative interview data collection methods identified 179 case studies that

fit the criteria for inclusion in the review. The sample size for the 179 case studies ranges from 1 to 95 ($\bar{X} = 36$, Mdn = 33, SD = 21.1) (Mason, 2010). Of interest to the author was the evidence that Ph.D. students appear to use sample sizes that are multiples of 10.

For this study the researcher limited the sample size to 12 for several reasons. First, the population of more experienced subjects was small; these types of partnerships generally have a few key industry representatives that champion the organization. Second, the nature of the biomanufacturing industry and the positions that the industry representatives hold limits the amount of time they have available to participate in a study such as this. Finally, based on extensive experience with these types of organizations, the researcher felt that a sample size of more than 50% of the population was challenging but achievable within the time frame.

Initial contact with potential subjects - The initial contact to recruit subjects was via electronic mail from the researcher and included a brief description of the study, the motivations and aims, and participation requirements and instructions. The executive director of the NBC² penned a letter of support that was attached to the electronic mail (see Appendix). Access to these individuals was through the principal and co-principal investigators of the organization.

Subject demographics - The twelve subjects for this study represented seven states and the full spectrum of NBC² alliance regions. The companies that are represented focus primarily on pharmaceutical and/or biopharmaceutical manufacturing. Site employment ranges from 2 to 7,500 and corporate-wide employment ranges from 20 to 92,000. All but two corporations represented have a global presence. Regarding the subjects interviewed, the vast majority hold titles such as vice-president, director, or

manager and have been involved in the partnership since 2005-2006. Slightly more than three-fourths of interviewed subjects are male and one-fourth is female; this percentage roughly mirrors the population of potential subjects.

Interview scheduling and supporting material - The researcher sent an electronic mail confirmation notice to subjects when they agreed to participate in the study. If the subject had not already suggested a date and time for the interview, then the notice included several date and time options for the interview. The notice also requested that the subject read and return a signed, university-approved informed consent form.

The informed consent document contained important information for the subject about participation in the study. For example, subjects were informed that they could elect at any time during the study to withdraw their participation, with no penalty. Subjects were also notified that their participation was completely voluntary.

Because this was a research study and data could not be collected anonymously, the informed consent listed several safeguards employed by the researcher to maintain confidentiality and the subject's right to privacy. For example, all direct identifiers of the subject, his or her employer, educational institutions, and locales were stripped from transcriptions. These were replaced with the generic term for each. Interviews are distinguishable only by a code assigned to each. Data regarding employer and subject information were collected but not made part of the transcript; data were maintained as a separate record. Audio files were erased after the transcription process was completed. For additional security, data are maintained on a password-protected laptop. Also, the signed informed consent forms and any paper-based documentation that may contain subject information are kept in a locked file cabinet at the researcher's home. The

subject's right to privacy was safeguarded by making the interview questions available prior to the interview. Furthermore, the researcher queried subjects regarding their favored method of contact to ensure privacy.

After the interview was scheduled and a signed informed consent form received, subjects received two documents via electronic mail. The first document contained general information regarding the interview, definitions for several terms, and the interview questions. The second document contained Austin's Cross-sector Collaboration Continuum Model.

Interview sessions - Interviews were conducted via telephone because of geographic dispersion and audio-recorded to enable accurate transcription. A set of interview questions guided rather than prescribed the interview process. As noted in Table 11, data were collected during the period from November 2011 through January 2012. Data collection via interviews resulted in nearly 15 hours of material. Duration of the interviews ranged from 56 to 141 minutes.

All audio-recorded interviews were transcribed verbatim by a transcription company. The transcriptions were generated in Microsoft Word. Following the transcription process, the researcher stripped the transcription of confidential information as described above.

Data Analysis

Data analysis involves the processes of coding and interpretation. Coding is the first step toward the more rigorous step of interpretation (Saldana, 2009). The process of coding involves the following:

Table 11

Interview Schedule and Duration

Participant	Date(s)	Interview duration	Abnormalities
A	11-2-11	1 hr 18 min 58 s	None
B	11-4-11	1 hr 46 min 48 s	Two telephone disconnections
C	11-8-11	1 hr 3 min 49 s	One telephone disconnection due to subject's dead battery
D	11-18-11	1 hr 6 min 26 s	None
E	11-18-11	1 hr 1 min 38 s	One telephone disconnection
F	11-23-11	1 hr 3 min 36 s	None
G	11-30-11 12-1-11	56 min 18 s	Initial interview interrupted by company audit
H	11-30-11	2 hr 21 min 5 s	One telephone disconnection due to subject's dead battery
I	11-30-11	50 min 27 s	None
J	12-20-11	1 hr 7 min 32 s	None
K	12-28-11	56 min 4 s	None
L	1-30-12	84 min 12 s	None

...interacting with data using techniques such as asking questions about the data, making comparisons between data, and so on, and in doing so, deriving concepts to stand for those data, then developing those concepts in terms of their properties and dimensions. (Corbin & Strauss, 2008, p. 66)

Furthermore, coding involves linking data. “It leads you from the data to the idea and from the idea to all the data pertaining to that idea” (Richards and Morse, 2007, p. 137).

At the heart of data analysis is interpretation (Blumer, 1969). Denzin (1998) elucidates that interpretation “sets forth the multiple meanings of an event, object, experience, or text” and that “meaning is not in a text, nor does interpretation precede experience, or its representation. Meaning, interpretation, and representation are deeply intertwined in one another” (p. 504).

Data analysis is typically iterative with data collection such that “the researcher begins the analysis after completing the first interview...” (Corbin & Strauss, 2008, p. 57). Based on Layder’s adaptive theory (1998), the coding process employed for this study is similar to pattern matching (Trochim, 1989; Yin, 1994) and elaborative coding (Auerbach & Silverstein, 2003). Adaptive theory builds on grounded theory and “combines the use of prior theory to lend order and pattern to research data while simultaneously adapting to the order and pattern contained in emerging data” (Layder, 1998, p. viii). Thus, this type of coding serves to develop further theory. The researcher analyzes relevant content with the constructs generated from a previous study in mind and then refines the constructs as needed. Accordingly, adaptive theory uses both inductive and deductive procedures (Layder, 1998).

In this case study, the NBC² organization was the unit of analysis. All documentation and interview transcripts were entered into NVivo 9.2 computer software. As previously discussed, the conceptual framework chosen from the literature to be used in this study was Austin’s Cross-sector Collaboration Continuum Model. The constructs generated from this model yielded 18 initial data nodes that correlated to the following:

- three stages of partnership evolution
- seven relationship characteristics of partnership evolution (engagement level; importance of mission; resource magnitude; activity scope; interaction level; managerial complexity; and strategic value)

- four key drivers (alignment of strategy, mission, and values; personal connection and relationships; value generation and shared visioning; and continual learning)
- four enablers (focused attention; communication; organizational systems; and mutual expectations and accountability)

The researcher coded documentation and transcripts with the 18 initial data nodes in mind. If the data were not congruent with the categories from Austin’s model, then the researcher generated additional codes.

Summary

This chapter highlights the research design for the study. The researcher discusses the ontological and epistemological stance that underpins the methodological and analytical choices for a design. Table 12 summarizes the key features of the research design.

Table 12

Key Features of Research Design

Research category	Research position
Philosophical stance	Constructivism (Relativist; Transactional/ subjectivist)
Research method	Single case study of the Northeast Biomanufacturing Center and Collaborative
Study phenomenon	How advanced technological workforce partnerships between academia, industry, and government are developed and sustained
Data sources	Documentation and semi-structured interviews
Unit of analysis	Organization
Coding	Adaptive coding

This qualitative research study employed a single case study approach to explore the development and sustainability of industry-academia-government advanced

technological education partnerships. The unit of analysis for this research study is an NSF ATE-funded regional center partnership that focuses on biomanufacturing education, the Northeast Biomanufacturing Center and Collaborative.

Information collected for this case study combines rich archival data from documentation with focused interviews of industry members from the case study organization. The researcher examined more than 145 documents, consisting of more than 2,000 pages, and interviewed 12 industry representatives from the NBC² for this study. The companies represented focus primarily on pharmaceutical and/or biopharmaceutical manufacturing. Site employment ranges from 2 to 7,500 and corporate-wide employment ranges from 20 to 92,000. All but two corporations represented have a global presence.

The interview transcripts and documentation were coded according to Layder's adaptive theory (Layder, 1998). Adaptive theory builds on grounded theory and "combines the use of prior theory to lend order and pattern to research data while simultaneously adapting to the order and pattern contained in emerging data" (Layder, 1998, p. viii). Thus, this type of coding serves to develop further theory. The researcher analyzed relevant content with the constructs generated from a previous study in mind and then refined the constructs as needed. The researcher coded documentation and transcripts to 18 initial data nodes based on Austin's Cross-sector Collaboration Continuum Model. If the data were not congruent with the categories from Austin's model, then the researcher generated additional codes.

CHAPTER FOUR

Results and Analysis

Introduction

This chapter focuses on what was learned as a result of examining an industry-education-government workforce education partnership and applying Austin's theoretical model to the Northeast Biomanufacturing Center and Collaborative case. A chronological presentation of the case, organized according to funding events, highlights partnership evolution since 1994. The three research questions are addressed in the sections following the presentation. First, the evolutionary progression of the partnership and its applicability to Austin's model is described. Second, the alliance drivers and enablers identified by industry partners are mapped to Austin's model. Finally, the factors that lead to sustainability, as identified by industry representatives, are defined and discussed. The chapter also includes information on partner benefits as well as areas of partnership effectiveness and areas for improvement.

Chronological Presentation of the Case: The Northeast Biomanufacturing Center and Collaborative (NBC²)

Pre-NSF Regional Center Funding (Prior to September 2005)

Biomanufacturing industry activity. Prior to 2005 the Northeast flourished with biomanufacturing industries. The largest biomanufacturing facility in the world was located at Amgen in Rhode Island. It was also a hotbed of activity for *Big Pharma* companies who were rapidly growing in New Jersey, Pennsylvania, and New York.

Moreover, contract biomanufacturing companies such as Cambrex in Maryland and Lonza Biologics in New Hampshire were in a growth phase (Document #1).

The biopharmaceutical development process is lengthy and expensive. In 2004 the cost was roughly \$800 million to proceed from initial research to commercial drug approval. The process required approximately 16 years to complete. In 2004 more than 120 biotech drugs were in commercial production. Another 370 biotech drugs that targeted more than 200 diseases were in some phase of human clinical trials (Document #1). When the biotech drug arrives at the manufacturing phase, hundreds of technicians and professionals are needed to produce the biopharmaceutical in jobs such as process development; validation; upstream and downstream processing; quality control microbiology and biochemistry; quality assurance; metrology; environmental, health, and safety; and facilities. Unfortunately, the companies experienced difficulty in finding qualified technician candidates for jobs in the biomanufacturing facilities (Document #1). The need is predicted to reach a new intensity as biotech drugs move from 11% of the market in 2000 to 28% of the market in 2008 to 50% of the market in 2014 (Document #128).

Biomanufacturing two-year degree programs. Although a few community colleges in the Northeast were offering biomanufacturing degree programs, it was not in sufficient numbers to meet the need. Considering the first commercially produced human protein, insulin, was manufactured by Eli Lilly and Company in 1982, few education and training programs existed for the industry sector. The majority of institutions that developed biotechnology programs focused on research. The notable exceptions, containing manufacturing components, included the following:

- Alamance Community College, Graham, NC (program established in 1989)
- Contra Costa College, San Pablo, CA (1989)
- Minuteman Technical High School, Lexington, MA (1990)
- Middlesex Community College, Lowell, MA (1990)
- New Hampshire Community Technical College, Portsmouth, NH (1994) – During the first 10 years of the program, 195 students graduated with an industry placement rate of approximately 33%.
- Solano Community College, Fairfield, CA (1997)
- Moorpark College, Moorpark, CA (1998)
- San Diego City College, San Diego, CA (1999) (Document #1)

Compounding the issue was the lack of instructional materials to support the programs. With funding from the NSF ATE program in 1994, the New Hampshire Community Technical College had developed discovery research protocols and biomanufacturing Standard Operating Procedures (SOPs) to teach two biotechnology courses (Document #128). The Alfred P. Sloan Foundation awarded the New Hampshire Community Technical College two additional grants in 1996 and 1997 to convert these hands-on laboratory modules to an Internet accessible format (Document #146). Moorpark College, in collaboration with Amgen, also developed an Industrial Biotechnology book (Document #1). Outside of these two examples, few instructional materials existed.

New Hampshire Community Technical College grant funding for biomanufacturing. In addition to the funding secured from both the NSF ATE program in 1994 and the Sloan Foundation, the New Hampshire Community Technical College

secured grant funding from several sources to promote biomanufacturing education and training. In 1998 the college became the Northeast Regional Center of Bio-link, an NSF ATE-funded national biotechnology center (Document #s 1 and 128). Bio-Link is located at the City College of San Francisco and remains operational today. The focus of the Northeast region was biomanufacturing. As part of their responsibilities with Bio-Link, the college held five regional week-long summer workshops, three of which concentrated on biopharmaceutical production. As director for the Northeast region, Dr. Sonia Wallman also forged a relationship with BIO, the largest biotechnology organization in the world (Document #1).

In 2003 the college received additional NSF ATE funding through a developmental grant to plan for a regional center in biomanufacturing. The project goals included the creation and validation of competencies for ten targeted biomanufacturing jobs; the establishment of a resource depot that distributed equipment and supplies donated to institutions with a need; and the development of a project website (Document #1). Regarding the competency standards, information was obtained from 28 technicians and supervisors representing 12 companies in 5 states throughout the Northeast region in May 2004. A modified DACUM approach was used to solicit information from experts. The data collected was organized into 10 separate surveys and distributed to more than 170 subject matter experts. Fifty-seven experts from fifteen companies in six states of the Northeast and Mid-Atlantic regions completed surveys. In addition, six institutions validated the information. These institutions included Middlesex Community College in Bedford, MA; Community College of Rhode Island in Warwick, RI; CityLab, Boston University Medical School in Boston, MA; Minuteman Technical High School in

Lexington, MA; Montgomery County Community College in Blue Bell, PA; and New Hampshire Community Technical College in Portsmouth, NH. The Biopharmaceutical Manufacturing Industry Skill Standards that resulted were published in January 2005 (Document #146).

In 2004, the college, along with four other community colleges, received funding from the United States Department of Labor to establish the National Center for the Biotechnology Workforce. The college's designated expertise was biomanufacturing. With grant funding, a full-time biomanufacturing faculty member was employed, a biomanufacturing laboratory equipped, and an apprenticeship program established (Document #s 109 and 116). The college worked with the Department of Labor's Office of Apprenticeship and Training at the state level in New Hampshire, regional level in Massachusetts, and national level in Washington, DC, to develop the Biomanufacturing Standards of Apprenticeship. The program was certified and presented to the NBC² in September 2005 (Document #2). The college was the first institution in the nation to offer the apprenticeship program. The program helps students in the Biotechnology program find apprenticeships with sponsoring companies while they pursue their degree (Document #125).

In 2005, the college was also awarded a United States Department of Labor Community Based Grant, bioCONNECTnh, that supported incumbent worker training and the development and enhancement of high school Biotechnology programs in the state (Document #s 4 and 116).

NSF ATE Regional Center Funding (September 2005 – August 2009)

With funding for a regional center from the NSF ATE program in September 2005, the New Hampshire Community Technical College established the Northeast Biomanufacturing Center and Collaborative. Dr. Sonia Wallman served as the principal investigator. The center was organized into a hub structure; each hub represented a geographical area in the Northeast region. Hubs were located at the following educational institutions:

- Community College of Baltimore County-Catonsville, MD (program established in 2000)
- Community College of Rhode Island, RI (2004)
- Finger Lakes Community College, NY (2001)
- Montgomery County Community College, PA (2002)
- Minuteman Regional Technical High School, MA (1995) (Document #s 1 and 122)

One faculty member from each hub institution served as a co-principal investigator for the grant. The center was housed in the 8,000 square foot New Hampshire Biotechnology Education and Training Center at New Hampshire Community Technical College in Portsmouth, New Hampshire (Document #1).

Instructional modules. During the course of the grant period, NBC² hub partners developed 59 instructional modules that support education and training for the 10 biomanufacturing jobs. Work on these modules began in 2006 and spanned the grant period (Document #61). Various instructional modules were published as a collection,

resulting in a Biomanufacturing Laboratory Manual, and the CHO – tPA Core Production System Laboratory Manual for example.

BIOMAN Conference. This annual conference targets biomanufacturing educators from colleges, universities, and technical high schools. The conference provides faculty members and teachers an opportunity to discuss ideas and best practices that improve and augment biomanufacturing degree programs and courses. Since its first offering in 2006, the conference has been hosted by the following institutions in the years designated:

- Great Bay Community College, Portsmouth, NH (2006 and 2007)
- Montgomery County Community College, Blue Bell, PA (2008)
- Rochester Institute of Technology, Rochester, NY (2009) (Document #127)
- Ivy Tech Community College, Bloomington, IN (2010) (Document #77)
- MiraCosta College, Oceanside, CA (2011) (Document #88)

More than 250 participants have attended the conference. States and territories represented include Arizona, California, Florida, Hawaii, Illinois, Indiana, Iowa, Kentucky, Maryland, Massachusetts, Michigan, Missouri, North Carolina, New Jersey, New York, Ohio, Oklahoma, Oregon, Pennsylvania, Puerto Rico, Rhode Island, Utah, West Virginia, and Wisconsin (Document #s 77, 88, and 127).

Biomanufacturing skill standards harmonization. In September 2007 NBC² partners convened to develop a Harmonized Biopharmaceutical Manufacturing Skill Standard for ten biomanufacturing jobs that are the focus of the NBC²'s work. The rationale for the meeting was (a) the existence of many biopharmaceutical manufacturing

industry skill standards from around the nation and the globe, (b) the fact that NBC² is partnered with many global biomanufacturers, and (c) the need to develop a curriculum to support education and training for biopharmaceutical manufacturing that is global in both nature and use (Document #127).

Fourteen participants from industry represented the following companies: Abbott, BioConvergence, BiogenIdec, CookPharmica, Eli Lilly and Company, Genentech, Human Genome Sciences, Invitrogen, Lonza Biologics, Merck, and Wyeth. Fourteen faculty members from eight institutions in California, Indiana, Maryland, Massachusetts, New Hampshire, New York, North Carolina, Puerto Rico, Rhode Island, and Ireland participated as well. The skill standards provide the basis on which the organization's curriculum and instructional materials have been built (Document #127).

Strategic planning meeting (2008). In May 2008 NBC² members convened in Oceanside, California for a strategic planning meeting. Fifteen industry partners from nine states and thirteen education partners from ten states participated. The partners created a shared vision, mission, goals, and performance outcomes. The shared vision is “to be the nationally-recognized center of excellence that develops a world-class sustainable biomanufacturing workforce to improve the quality of life” of biopharmaceutical consumers (Document #58). The organizational mission is “to coordinate local and regional efforts into a national biomanufacturing education and training system to promote, create, and sustain a qualified workforce” (Document #58).

CHO - tPA Core Production System Laboratory Manual. In 2006 the NBC² published its first lab manual, a Core Production System utilizing Chinese Hamster Ovary (CHO) cells producing recombinant human tissue Plasminogen Activator (tPA).

The Core Production System included Upstream Processing SOPs with Batch Record, Downstream Processing SOPs with Batch Record, and Quality Control Biochemistry SOPs. The instructional materials were piloted at the annual biomanufacturing conference (Document #127).

Pichia pastoris - HSA Core Production System Laboratory Manual. In 2009 the organization also published a laboratory manual that focused on the recombinant Human Serum Albumin (HSA) secreting *Pichia pastoris* Core Production System. The manual includes Upstream Processing SOPs, Downstream Processing SOPs, Quality Control Biochemistry SOPs, and Quality Assurance Batch Records.

Several individuals from Great Bay Community College (formerly New Hampshire Community Technical College) contributed to the development of the SOPs for both the CHO - tPA and *Pichia pastoris* - HSA Core Production System Laboratory Manuals, including Dr. Sonia Wallman, Karen Bresciano, Deb Audino, Robert O'Brien, and Kari Britt (Document #127).

Biomanufacturing Laboratory Manual. In 2009 a hands-on laboratory manual was published that provided SOPs for the core biomanufacturing jobs of cell culture, purification, quality control, and quality assurance. The manual also addressed metrology, validation, and environmental health and safety within the biomanufacturing industry. Core production systems for the following three proteins are included: recombinant jellyfish green fluorescent protein, recombinant human tPA, and recombinant HSA protein (Document #127).

Introduction to Biomanufacturing Textbook. In September 2008 the organization began development of a biomanufacturing textbook (Document #127). Industry authors and reviewers were recruited for the 12 chapters of the book:

1. Introduction - Sonia Wallman, NBC² and John Hasyn, Montgomery County Community College, PA
2. Operational Excellence - Martha Matthews, Rick Lawless, Lisa Smith, Gary Ward, and Robert Crew, BiogenIdec, NC
3. Facilities - Bryan Shingle, Centocor, PA and John Hasyn, Montgomery County Community College, PA
4. Metrology - Gene Kernan, Human Genome Sciences, MD
5. Validation - Pat Sheehy, Human Genome Sciences, MD; Tom Burkett, Community College of Baltimore County, MD; and Mike Fino, MiraCosta Community College, CA
6. Environmental Health and Safety - Joe Piampiano, Kodak, NY
7. Quality Assurance - Cynthia Sarnoski and Frank Hallinan, Pfizer, PA; Ron Hudcosky, Merck & Co., PA; and Kevin Lampe, Montgomery County Community College, PA
8. Microbiological Control - Frank Hallinan, Pfizer, PA; Linda Rehfuss, Bucks County Community College, PA; and John Hasyn and Kevin Lampe, Montgomery County Community College, PA
9. Quality Control Biochemistry - Mary Harne and Zhenhong Li, Human Genome Sciences, MD
10. Upstream Processing - Olga Mollin and Jane Flanagan, Lonza Biologics, NH

11. Downstream Processing - Paul O'Neil, Pall Euroflow, NH

12. Process Development - Eszter Birck-Wilson, STC Biologics, MA (Document #147)

After multiple face-to-face meetings and telephone conferences, the textbook was ready for a final technical edit in the fall of 2011. The textbook is slated for publication in the spring of 2012 (Document #127).

Virtual chromatography laboratory module. In 2009 NBC² worked with ATeL to develop a virtual laboratory module for production. Specifically, chromatography was chosen as the subject matter for the first module because of its prevalence in and importance to the industry. The module is based on a Chromatography SOP for Human Serum Albumin and a video of the chromatographic process (Document #122).

NSF ATE Regional Center Re-Funding (September 2009 – August 2012)

The New Hampshire Community Technical College applied for an accomplishment-based renewal of the NBC² in 2008. Subsequently, the institution declined a funding offer from the NSF. Dr. Sonia Wallman worked with NSF officials to relocate the center to Montgomery County Community College in Blue Bell, Pennsylvania (Document #120). Dr. Sonia Wallman retired from her faculty position at New Hampshire Technical College in December 2009. Because Dr. Sonia Wallman was not employed by Montgomery County Community College, she was unable to remain as principal investigator for the renewal grant. Thus, Dr. Linda Rehfuss assumed the role and Dr. Sonia Wallman continued as the executive director of the organization. In August 2010 Dr. Linda Rehfuss resigned from Montgomery County Community College

to take a faculty position at a nearby institution. She was replaced by Dr. Maggie Bryans who still serves as principal investigator for the grant (Document #87).

Although the Center was moved to a new location, the NBC² retained its hub partners from the previous round of NSF funding:

- New England Hub, Dr. Mary Jane Kurtz, Minuteman Regional High School, Lexington, MA
- Upstate New York Hub, Jim Hewlett, Finger Lakes Community College, Canandaigua, NY
- Big Pharma Hub, Drs. Linda Rehfuss (initially) and Maggie Bryans, Montgomery County Community College, Blue Bell, PA
- BioCapitol Hub, Dr. Tom Burkett, Community College of Baltimore County, Catonsville, MD (Document #57)

The NBC² also added three new regional alliances to the organizational structure:

- Southern Alliance, Dr. William Woodruff, Alamance Community College, Graham, NC
- Mid-Western Alliance, Dr. Sengyong Lee, Ivy Tech Community College, Bloomington, IN
- Western Alliance, Dr. Mike Fino, MiraCosta College, Oceanside, CA (Document #57)

Several projects begun during initial NSF ATE regional center funding continued into the renewal funding years. These projects included the development of the *Introduction to Biomanufacturing* textbook; offering the annual BIOMAN Conferences; and implementation of the Protein is Cash workshops that are described below.

Business planning. In 2010 the principal investigator and executive director met with the vice-presidents at Montgomery County Community College to discuss the possibility of the organization incorporating as a non-profit 501(c)3. After a successful meeting, it was agreed that the vice-presidents would have further discussions with the college's president (Document #91).

Strategic planning meeting (2011). In April 2011 nine industry partners and seventeen institutional partners gathered at the Community College of Baltimore County in Catonsville, Maryland for a second strategic planning session. It was an extension of the 2008 Strategic Planning Meeting in that it focused on clarifying objectives and key performance indicators generated during the initial meeting. Partners devoted substantial time during the meeting to the discussion of the need and development of a national certification exam, emerging industry technologies, and curriculum that targets industry needs (Document #92).

Protein is Cash workshops. These workshops provided teachers and counselors from middle schools, high schools, and community colleges with both hands-on activities and information for career paths in biomanufacturing. The goal is for teachers to be able to incorporate the information into the science classrooms. Through these workshops NBC² also desired to catalyze the development or expansion of the local education and training infrastructure to support biomanufacturers' need for a local advanced technology workforce (Document #93).

The curriculum for this workshop was developed by Drs. Mary Jane Kurtz and Sonia Wallman. The workshop included the following sessions:

- Overview of Biomanufacturing, Including Career Paths in Biotechnology/
Biomanufacturing (Lecture)
- Introduction to Metrology (Lecture)
- Metrology (Laboratory)
- Overview of Discovery Research and Upstream Processing (Lecture)
- Introduction to GFP Transformation and *E. coli* Cell Culture (Lecture)
- GFP Transformation and Upstream Processing (Laboratory)
- Introduction to Downstream Processing and Chromatography (Lecture)
- Introduction to GFP Chromatography (Lecture)
- Chromatography (Laboratory)
- Introduction to Sampling and QC Biochemistry (Lecture)
- Introduction to SDS-PAGE (Lecture)
- SDS-Page (Laboratory)
- Introduction to Clinical Trials (Lecture)
- Clinical Trials (Laboratory) (Document #93)

In 2010 six workshops were hosted by four community colleges (NY, FL, AZ, and NH), one high school (MA), and one university (RI). One hundred and two teachers participated in the workshops. In 2011 five workshops were hosted by community colleges in Kentucky, Massachusetts, New Jersey, New York, and Texas. Fifty-eight teachers participated in the second round of workshops (Document #93).

Virtual upstream production module. In continued collaboration with ATeL and Lonza Biologics, a virtual industrial scale upstream processing module is being developed. This module affords students an opportunity to control the biopharmaceutical

production process using an industrial scale bioreactor as well as equipment necessary for the continuous centrifugation, depth filtration, and chromatography processes (Document #77).

Biofuels Production and Analysis Textbook and Laboratory Manual. Dr. Elmar Schmid of MiraCosta College has written an eight-chapter textbook covering three of the most popular processes for biofuels production. These processes include the use of cellulosic enzymes to produce bioethanol, bacteria to produce biohydrogen, and algae to produce biodiesel. Along with an introduction to fuels, the chapters of the text address energy, fuels, gases, molecules and biomass, enzymes, photosynthesis and algae, and biofuels. A companion Biofuels Laboratory Manual has also been developed by Dr. Schmid. The manual includes four labs covering culture media and microbial cultivation techniques, cellobiase enzyme activity, bacterial biohydrogen production, and algae cultivation for biomass and oil production. The textbook is scheduled to be released in 2012 (Document #87).

Evolutionary Progression of the NBC² Partnership

In this section the evolutionary progression of the NBC² partnership is traced and mapped against Austin's Cross-sector Collaboration Continuum Model. Results suggest that the partnership has progressed from the philanthropic to the transactional stage in its seven-plus years of existence. The seven components defined by Austin (2000a) to capture the organizational nature—engagement, importance to mission, magnitude of resources, scope of activities, interaction level, managerial complexity, and strategic value—are analyzed according to each stage of partnership evolution.

Stage I – Philanthropic (September 2005 – August 2007)

According to Austin (2000b), the philanthropic stage of partnership evolution is characterized as a donor-recipient relationship. Financial resources exchanged are typically “not economically critical to either party” (Austin, 2000b, p. 20). The benefits experienced are modest. The resource donation, be it capital or human, allows the industry partner to fulfill its social responsibility mission. Engagement by top leadership is limited or non-existent.

Early on, industry partners felt that the NBC² operated in the philanthropic stage. Relationships were being established and partners “were getting to know each other” (Industry Participant E). Moreover, it was unclear what the organization “was supposed to do and how industry would benefit from it” (Industry Representative B). Industry Representative D characterizes the organization during this time period as a “start up.”

Level of engagement. During this time period, the number of partners involved in and contributing to organizational activities was relatively low. The partners that exhibited the highest level of engagement within the organization were the principal investigator and five co-principal investigators. These individuals met quarterly through video conferencing and annually face-to-face. During and between these meetings, co-principal investigators planned professional development opportunities such as BIOMAN and the Community College Program at the BIO Conference, discussed action plans for curriculum development projects, developed instructional modules, and planned for a gap analysis of existing materials (Document #s 3, 22, and 23). To communicate their activities, these partners wrote blogs and presented at the national conferences of several professional associations, including the American Society of Microbiology, League for

Innovation, BIO, and the American Association of Community Colleges (Document #s 3 and 22).

Industry representatives provided input to organizational activities through two managerial committees of the NBC², the Advisory Board and the National Visiting Committee. Both the principal investigator and co-principal investigators participated in meetings of each committee (Document #s 2, 5-10, 12-19, and 24).

The Advisory Board met face-to-face annually during this time period and quarterly via teleconference (Document #2). Six industry representatives from five biomanufacturing companies attended the first annual board meeting (Document #2). Only two of these industry partners participated in the second annual meeting as well, along with six new industry representatives (Document #12). In 2007 one additional industry member was selected for the committee and one industry member was replaced (Document #24). Thus, the committee experienced constant flux during its first few years of existence.

The primary role of the Advisory Board during this time frame was providing advice, especially in the area of curriculum development initiatives. For example, in 2006 the committee provided input on the core skills for the Environmental, Health, and Safety instructional module as well as the Validation module (Document #12). The board also had a lengthy discussion on the approach to the Quality Control (QC) module and prioritizing the QC skill set (Document #21).

The National Visiting Committee (NVC) has three main responsibilities: advise the grant funded organization regarding its goals, objectives, and outcomes; assess the progress of the organization; and advocate for the program with the external community.

Four of the eight members of the NVC represented biotechnology/biomanufacturing companies (Document #4). Although the NVC did not specifically comment on the level of engagement in their Plaudits and Recommendations document, the NVC recognized that the organization had a vast network and strong connections with industry. The organization was commended because it leveraged existing biotechnology infrastructure to “establish effective collaboration at [the] onset of [the] project” (Document #20). In addition, the NVC believed a high degree of organization existed between the partners early on in the project (Document #20).

At the end of this period the NBC² hubs counted 65 educators among their members. Nearly one-half (32) represented community colleges, and approximately one-fourth (18) represented four-year colleges and universities. The remaining educators were affiliated with high schools or other educational initiatives (Document #24). Although it is not explicitly stated as to how these educator partners were engaged, it is known that 39 educators attended the 2006 BIOMAN Conference and 43 attended the 2007 conference (Document #127).

Interaction level. In general, during the philanthropic period the interaction level among all partners was infrequent. While interaction among the co-principal investigators was intensive, interaction with industry and education was sporadic. During this time the co-principal investigators employed a variety of communication methods, including listservs, video conferences, teleconferences, e-mail, phone calls, and face-to-face meetings. Indeed, the external evaluator commented on the organization’s “effective use of technology for communication” (Document #4).

The organization interacted with a handful of industry representatives on a regular though infrequent basis. This was accomplished primarily through the Advisory Board and the National Visiting Committee. The highest level of interaction with industry partners was experienced at the local level between companies and community college partners rather than on an NBC² organizational level. For example, multiple concentrated reciprocal interactions occurred between Lonza Biologics and Great Bay Community College and between Bristol-Myers Squibb and Mount Wachusetts Community College (Document #24).

Likewise, the interaction level with education partners was more of a push rather than a two-way interaction. This does not diminish the impact of the activity but is rather characteristic of the newly formed organization. For example, during this period the organization mentored several colleges, including Ivy Tech Community College. The NBC² helped the college add a biomanufacturing component to its existing biotechnology program. Other colleges mentored included Hagerstown Community College, Northern Virginia Community College, Bristol Community College, Southern Maine Community College, Bunker Hill Community College, and Mount Wachusetts Community College (Document #24).

Scope of activities. During the first two years of its existence, the organization's scope of activities was somewhat narrow. The organization focused on developing twenty-seven individual instructional modules targeting the ten biomanufacturing jobs and then piloted those modules during their annual BIOMAN Conference. The organization also coordinated a one-day professional event, the Community College Program at the BIO Conference, and offered local workshops at each hub. Three

institutions—The Community College of Baltimore County, Montgomery County Community College, and Minuteman High School—created articulation agreements with other high schools and universities. In the dissemination arena co-principal investigators presented at one conference per year. In addition, the organization built a website to disseminate information (Document #24).

Strategic value. For this organization value is generated through three major outcomes: creation of a pipeline of qualified technician-level candidates for the biomanufacturing workforce, improvement of biotechnology programs at the local community colleges, and development of educational and training products to support the two-year degree biotechnology/biomanufacturing programs and the industry. Indeed, industry recognized the strategic value in partnering to build a qualified workforce. A spokesperson for Vaccinex explained the importance of the project: “It is important to build the necessary skills and capabilities to create jobs for the region, and ultimately, to benefit Vaccinex, which will someday need skilled workers to manufacture its products” (Document #117).

Concerning the pipeline of students, the six hub institutions reported 146 and 164 students enrolled in programs for the 2005-2006 and 2006-2007 academic years respectively (Document #s 4 and 24). Although the organization aided existing programs and mentored numerous new programs, the benefit of increased student enrollment in those programs had not been realized. Company expansions planned in the New England region in 2007 necessitated 1,000 new skilled workers (Document #131). Thus, the pipeline could not fulfill the needs of the region.

Furthermore, although the organization was developing instructional modules that “targeted future industry needs” (Document #20), the materials had not been produced in sufficient quantities to warrant being categorized as generating major strategic value either for the institutional or industrial partners. Thus, the partnership generated modest benefits and little strategic value.

Magnitude of resources. During the philanthropic stage, the magnitude of resources deployed by educational and industrial partners, other than the governmental funding organization, was small. A faculty member produced the BIOMAN keynote speaker videos under a grant from the United States Department of Education. Bristol Community College donated supplies and equipment to the Rhode Island Hub.

As for industry resource support, the most obvious was a time commitment to the Advisory Board and National Visiting Committee meetings. In addition to the time commitment, Lonza Biologics supported the monthly teleconferences of the Board, and Eli Lilly supported the video conferencing option for an NVC meeting. RenaMed Biologics donated consumable supplies to the Rhode Island Hub, and the New England Chapter of the International Society of Pharmaceutical Engineers provided an exhibit table for NBC² at their annual conference (Document #24).

Managerial complexity. Because the scope of activities was limited, the administration of such was simple. For the most part, co-principal investigators managed the curriculum development activities and professional development opportunities. The Advisory Board and the NVC provided input and advice regarding the activities undertaken.

Stage II – Transactional (September 2007 – January 2012)

The transactional stage of partnership evolution is defined as “a mutually beneficial relationship in which there are two-way benefit flows that are consciously identified and sought” (Austin, 2000a, p. 74). The resource exchanges at the transactional stage are performed during discrete organizational activities. Partners are more engaged and experience more frequent and deeper interactions. The partnering relationship coincides more visibly with business operations as “strategic fit becomes closer” (Austin 2000b, p. 23). The managerial complexity of the partnership increases and the benefits experienced proliferate (Austin, 2000b).

In general, industry representatives place the NBC² organization within the transactional stage from September 2007 through January 2012 (Industry Representatives A, B, C, D, E, H, J, and L). Providing further explanation, Industry Representative D noted that the organization still operates on a quid pro quo basis. “I can do *this* for you but you have to do *that* for me” (Industry Representative D). It should be noted that three industry partners classified the NBC² as currently operating on the low end of the integrative stage (Industry Representatives F, I, and K).

Level of engagement. During this time period, industry representatives felt the level of engagement had increased, becoming more characteristic of the transactional stage. Although increasing, the level was inconsistent. One industry member described the level of engagement as “waxing and waning, having peaks and valleys” (Industry Representative B). When asked to explain why the level of engagement was not classified as having reached the integrative stage, Industry Representative A stated that

“oodles of people from the company” were not yet involved in the initiative. This supports later discussions about the need for a multi-tiered involvement by industry.

Number of partners engaged - During this stage, NBC² positively impacted the seeding and maturation of local learning communities in biomanufacturing. This occurred through the addition of new partners and the deepening of relationships. For example, since 2005 the number of partners in NBC² has grown significantly from 73 to 403 partners, a 552% increase (Document #73). The addition of several new industry partners has strengthened the partnership. New industry partners include companies such as Western New York Energy, Regeneron Pharmaceuticals, Abraxis, BioConvergence, CookPharmica, Baxter Biopharma Solutions, Advanced BioHealing, International Immunology Corporation, SkinMedica, and Precision Antibodies (Document #75).

Joint industry and education engagement - The organization engaged both industry and education partners through three intensive activities implemented in rapid succession from September 2007 to September 2008. First, the partners met to harmonize the numerous biomanufacturing industry skill standards, creating a common framework for developing curricula and instructional materials. Fourteen industry and fourteen faculty members from eight institutions in nine states and Ireland participated (Document #42).

Second, NBC² members gathered in May 2008 for a strategic planning meeting. Fifteen industry partners from nine states and thirteen education partners from ten states participated. The partners created a shared vision, mission, goals, and performance outcomes for the organization (Document #58). Partners met three years later to continue their strategic planning efforts. In April 2011, nine industry partners and seventeen

institutional partners gathered at the Community College of Baltimore County in Catonsville, Maryland. The meeting focused on clarifying objectives and key performance indicators generated during the initial meeting (Document #91).

Finally, the organization began development of a biomanufacturing textbook in September 2008. Industry and education authors and reviewers were recruited to write the 12 chapters of the book (Document #73). This intense pattern of engagement to address issues that could substantially impact biomanufacturing education propelled the organization forward.

Co-principal investigator and educator engagement - Two professional development opportunities served to engage the greater educational community with co-principal investigators. Offered in 2010 and 2011, the Protein is Cash workshops engaged 160 educators in 8 states. Instructors for the workshop included a combination of co-principal investigators, the organizational leadership, and local educational representatives associated with the host sites. For the majority of the workshops, industry provided tours for participants (Document #92).

The BIOMAN Conference served 169 participants from 2008-2011 (Document #s 73 and 88). Typically, industry partners presented the keynote addresses and provided tours for participants. The organizational leadership or educators from within the hub/alliance institutions conducted the hands-on workshops and panels. Periodically industry facilitated the hands-on workshops. Four industry partners offered workshops in 2010 and one offered a workshop in 2011 (Documents #s 77, 88, and 132).

Co-principal investigator engagement - During this time period, co-principal investigators were primarily involved with the creation of curriculum, planning of

professional development opportunities, and dissemination of organizational information through presentations. For example, curriculum efforts included the development of 32 additional instructional modules, the *Pichia pastoris*-HSA Core Production Lab Manual, the Biomanufacturing Lab Manual, and the virtual chromatography and upstream production lab modules (Document #s 73, 76, and 86).

Advisory Board engagement - During the transactional period, the Advisory Board expanded to include representation from several global companies. Several members were also replaced on the board. The board membership included the following:

- Dr. Niall Carolan, Manufacturing Operations Training Manager, Human Genome Sciences, Rockville, MD
- Olga Mollin, Upstream Manufacturing Manager, Lonza Biologics, Portsmouth, NH (replaced)
- Joseph P. Lingle, Facility Operations Director, GlaxoSmithKline, King of Prussia, PA
- Bryan M. Shingle, Associate Manager of Clinical Manufacturing and Material Services, Centocor Research & Development, Spring House, PA
- John Sauers, Training Manager, Quality Assurance, Abbott Research Center, Worcester, MA (replaced by 2012)
- David Lindsay, Manufacturing Director, MedImmune, Frederick, MD
- Heide Kuch, Training Supervisor, Upstream/Downstream, Wyeth Biopharma, Andover, MA (replaced by 2012)

- David Lewis, Principle Scientist, Quality Control Technical Services, Genzyme Corporation, Burlington, MA
- Wayne Wilson, Associate Director of Biologics Quality Control, Bristol-Myers Squibb, Syracuse, NY (replaced by 2012)
- Alex Tschumakow, Senior Manager, Clinical Manufacturing, Shire HGT, Cambridge, MA (Document #42)
- Duncan Ross, QC Microbiology Supervisor, Lonza Biologics, Portsmouth, NH (replaced Olga Mollin)
- Terry Corzine, Executive Director, Quality, Amgen, West Greenwich, RI
- Dr. William Trompeter, Executive Director, Process and Analytical Services, Regeneron Pharmaceuticals, Rensselaer, NY
- Aaron Pilling, Senior Scientist, CookPharmica, Bloomington, IN
- Chad Johnson, Manufacturing Manager, and Dr. Lee Landeen, Research/Process Development Associate Director, Advanced BioHealing, La Jolla, CA
- Lisa Stillwell, Product Development Manager, Synthetic Biology and Cloning Business, Carlsbad, CA (Document #81)

Despite the increase in industry board members, industry participation has waxed and waned. Nine industry members attended the 2009 meeting date and only two attended in 2010. More than ten educators participated in both meetings. In addition, a representative of the funding organization attended both meetings (Document #s 66 and 79).

National Visiting Committee engagement - At the beginning of the grant re-funding phase (September 2009), one new industry member was added to the committee

(Document #84). The committee has four industrial, six educational, and one governmental member representing seven states (Document #81). Attendance hovers near 50%—two industry and three education members in 2009 (Document #67), three industry and four education members in 2010 (Document #80), two industry and four education members in 2011 (Document #90).

Requests for engagement - In 2010, when educators were asked how the NBC² could better support their efforts in biotechnology/biomanufacturing education, four specifically mentioned engaging the local community and industry in partnership efforts and three mentioned help in developing a program. Partners envisioned NBC² as a connector, facilitating the partnering of high schools, colleges, and universities in a locale. One partner explained, “Come to my area to help engage the local community in what you [NBC²] are doing.” Moreover, one respondent specifically asked for the organization to be more involved at the secondary level. Three educators also requested aid in developing a biomanufacturing program: “I have had difficulty initiating an advisory board for the program. I feel it would be beneficial for NBC² to share recommendations from other institution's advisory boards to help build biotech programs which lack this input” (Document #73).

Interaction level. Although interaction increased during this time frame, industry partners still characterized the level of interaction among all organizational members as infrequent (Industry Representatives A, B, C, G, J, and L). Partners recognized that the interaction level was more intense at certain evolutionary points (e.g., during the development of the textbook), but these bursts were viewed as temporary rather than sustained.

Interaction among education and industry partners - The entire partnership was invited to participate in three face-to-face meetings during the defined time period—at the Skill Standards Harmonization meeting in 2007, as well as the Strategic Planning meetings in 2008 and 2011. According to the National Visiting Committee, the NBC² organization listened to the industry input provided during the harmonization effort and altered programs and curricula to reflect this input (Document #57). For example, industry representatives suggested that the standards focus on four key biomanufacturing jobs: upstream processing, downstream processing, quality control microbiology, and quality control biochemistry. The group also suggested (a) a separate career track for a combined facilities and metrology job under the job title Maintenance/Instrumentation Technician and (b) that competencies addressing validation, environmental health and safety, and quality assurance be infused throughout these five jobs. The subject matter experts also felt that the process development job would likely continue to require a bachelor's degree (Document #s 55 and 128). These changes were made to the standards prior to publication.

Regarding the interaction during the development of the textbook, the first discussion of a textbook development project occurred during the 2008 Advisory Board meeting. Members approved a list of chapters and a corresponding master set of objectives based on previously determined requirements from industry and education. After the meeting, project leadership began recruiting authors and reviewers for each chapter (Document #128). In addition, the organization hired a consultant to manage the development process.

In November 2008 at the leadership retreat, the co-principal investigators reviewed the list of authors who had agreed to write chapters and denoted the chapters that needed a sponsor (Document #59). The consultant developed a basic style and format guide. The leadership group discussed these preliminary materials and decided to develop one chapter as a prototype on which to base other chapters. The Validation chapter was initially selected as the prototype chapter and the development of it began (Document #128).

In January 2009 a virtual, Internet-based workspace was created for all authors and reviewers to use as a common place to store and view files, post questions, and check assigned tasks and milestones. Authors were introduced to this virtual workspace in an e-mail communication. During this time frame the Validation chapter first draft was circulated for review (Document #s 67, 71, and 128). In May 2009 the first draft of the Operational Excellence chapter was submitted to the group for review (Document #128).

In September 2009 the authors met face-to-face during the Advisory Board meeting. During this meeting, the textbook development group appeared to be in the storming and norming stages. The storming stage was characterized by confusion and an intense discussion regarding timelines, processes (e.g., decision-making), content standards, progress assessment, and communication strategies and preferences (Document #128).

According to the external evaluator, group members felt comfortable enough to bring forth their concerns and seek resolution during the meeting. Furthermore, the group chairperson did not avoid or suppress the conflict but rather focused the group on resolving the issues. Although the discussion may have been uncomfortable for some

members, the evaluator believed that this was a crucial step in the evolution and growth of the partnership. Indeed, during the meeting the ownership of the project seemed to migrate from the grant leadership to the larger group of subject matter experts responsible for writing the chapters. Initially, the co-principal investigators made decisions regarding the activity (e.g., they solicited chapter writers early on). In the evaluator's opinion, taking ownership of the textbook project was critical for its success. Moreover, the relatively pain-free process of doing so indicated a healthy industry-education partnership, one that listens and responds to all partners at the table (Document #128).

From the viewpoint of the external evaluator, securing industry sponsors to write certain chapters also proved difficult. For example, the list of sponsoring authors changed substantially in the first 18 months of the development process. Depending on job assignments, some authors who originally committed to authoring a chapter had to decline late in the process. Thus, new authors had to be solicited for several chapters (Document #128).

As a result of the September 2009 meeting, a series of monthly teleconferences were scheduled to track the textbook development progress. Five industry representatives and two educators participated in the first teleconference in October 2009, during which the consultant reviewed the development process for new industry authors (Document #134). At the November 2009 teleconference, four industry partners and one education partner reviewed the progress for each chapter (Document #135).

In mid-November 2009, a face-to-face meeting of the industry and education authors and reviewers was held. Participants reviewed and discussed the content for each chapter; the division of the textbook into clusters; and information to include in the

introduction chapter (Document #137). Another brief teleconference was held in December 2009. Progress towards completing chapters was discussed by three industry and four education partners (Document #139). The consultant sent additional e-mails to authors during 2010 to remind them of critical deadlines (Document #140).

In June 2010 a third face-to-face meeting of industry and education authors and reviewers was convened. During this meeting, authors divided into cluster groups to discuss chapter content and define tasks needed for completion (Document #141). At the conclusion of the meeting, a process development evaluation survey was conducted. Results indicated that the group experienced several challenges in implementing the textbook development process:

- Lack of clear vision and process structure at the beginning—the scope, timelines, target audience, and accountability changed numerous times or were vague
- Harmonizing topics repeated across multiple chapters
- Communication
- Size of group (Document #142)

To improve the process, authors suggested the following:

- Set expectations at the beginning of the process (e.g., style guides, writing templates, target audience, responsibilities, scope, timelines, and communication plans); one representative suggested creating a steering group to handle these issues and be responsible for final editing of the product
- Two representatives specifically mentioned more face-to-face time was needed, especially on the front-end (Document #142)

Interaction among educators - Two professional development activities provided educators a valuable opportunity to interact both with each other as well as the organization. According to participants, the BIOMAN Conferences provided them with a valuable opportunity to network with other educators, vendors, and industry representatives. Indeed, all conference participants were either very or moderately satisfied with the networking opportunities. In fact, 68% of participants singled out networking as the most valuable aspect of the conferences. One participant stated, “The opportunities to meet people and to create helpful relationships with folks that know more than me about the biotech industry [was invaluable].” Several participants also mentioned the value of sharing ideas and curriculum during the conferences (Document #73).

This sentiment was shared by participants of the Protein is Cash workshops.

Participants identified networking as one of the most valuable aspects of the workshops:

Making connections to people who prepare students for industry and those that work in industry [was valuable]. (2010 respondent)

The networking with NBC², community college faculty, and guest speakers [was valuable]. (2011 respondent)

The discussions I had with other participants regarding frameworks, curriculums, and internship possibilities were valuable. (2011 respondent)

Conferring with my colleagues about science teaching was useful. (2011 respondent) (Document #92)

Interaction to communicate partnership progress and activities - To advertise the BIOMAN Conferences, the organization distributed a postcard at conferences and meetings and placed a banner on the organizational website. Advertisement for the Protein is Cash workshops occurred primarily at the local level through website advertisements, flyers, and e-mails. The organization itself did not send targeted e-mails

or mailers to the membership at large. The only interaction with the entire participant population has been a newsletter on the BIOMAN 2010 Conference and follow-up evaluation activities (Document #s 92, 132, and 143).

The co-principal investigators continued to make numerous presentations to inform the greater industry and education community about their activities. For example, investigators presented at the Council of State Biotechnology Associations, National Association of Biology Teachers Professional Development Conference, Workforce Development Institute Annual Meeting, Biotech Workforce Development Summit, Bio-Link Summer Fellows, Manufacturing Education Transformation Summit, STEMTech Conference, PITTCON, American Association for the Advancement of Science Conference, and Hi-TEC Conference (Document #s 86 and 127). Folders containing information about the center were distributed during these presentations (Document #86).

Interaction among co-principal investigators - The primary forum for communication among co-principal investigators from 2007-2010 was the annual three-day fall leadership retreat (Document #s 41, 59, 72, and 85). The group also interacts at various organizational meetings and events such as BIOMAN and strategic planning meetings. In addition to face-to-face time, the investigators communicated as needed via teleconference and e-mails (Document #71).

Interaction with the Advisory Board - The Advisory Board met annually during the transactional period. In 2009 the Board held a joint meeting with the textbook development authors. According to the evaluator, during the meeting the group exhibited several characteristics identified by McGregor (1960) as being effective team operation:

- For the most part, the atmosphere was informal and relaxed.
- Discussion was pervasive and virtually everyone participated.
- Participants listened to one another.
- There was conflict but it was civilized and constructive.
- The group had a broad spectrum of team players, including those who emphasized tasks, those who emphasized processes, those who facilitated decision-making, and those who provided emotional support (Document #62).

Requests for more frequent and regular communication - At several points during the transactional period, partners requested more frequent and regular communication from the organization. Communication strategies suggested included a newsletter and e-mail updates (Document #s 73 and 88).

Scope of activities. The majority of industry representatives interviewed characterized the organization's scope of activities as indicative of the transactional stage (Industry Representatives A, B, C, F, H, and K). It should be noted that four representatives deemed the scope as broad (Industry Representatives D, E, I, and J) and one as narrow (Industry Representative L). In general, industry partners agreed that the scope of activities undertaken by the organization had broadened during this period.

Program improvement - In the area of program improvement, the organization implemented several activities, including the skill standards harmonization effort, program mentoring, articulation agreement creation, and apprenticeships (Document #s 74 and 96). In 2008 the organization mentored programs at Genesee Community College, Jamestown Community College, Onondaga Community College, and Erie Community College in New York (Document #47). Since 2009, new programs have

been established or biomanufacturing components have been added to programs at Overlea High School in Maryland, Dover High School in New Hampshire, Hudson Valley Community College in New York, San Diego City College in California, Middlesex County College in New Jersey, and Quincy Community College in Massachusetts (#74).

In addition to these high school and community college programs, the organization has worked with the Southern California Biomedical Council to help them establish a regional effort in biotechnology. The region has more than 900 biotechnology companies (Document #86).

A baseline for the number of articulation agreements in place through education partners was established in 2009. Sixty agreements existed at seven high schools, thirty-two community and technical colleges, and eight four-year colleges and universities (Document #74).

Curriculum development - In the area of curriculum development, the organization focused on creating the *Pichia pastoris*-HSA Core Production System Laboratory Manual, Biomanufacturing Laboratory Manual, *Introduction to Biomanufacturing* textbook, virtual chromatography and upstream production modules, and *Biofuels Production and Analysis* textbook and laboratory manual (Document #s 73, 96, and 127). By March 2009, 95 individual instructional modules had been developed (Document #67).

Curriculum development efforts also involved the creation of the first biomanufacturing online course, offered to eight Merck incumbents in 2009-2010. Online course students had between 2 and 30 years of experience but did not have a

degree. The course consisted of a pre-test and post-test, PowerPoint lectures with Camtasia voice overs, journal articles, and videos. Students used the *Pichia pastoris* lab manual and the virtual chromatography lab in the course. Company representatives instructed students in hands-on laboratories such as probe calibration; fermentation sample preparation and analysis for wet cell weight and metabolite and protein-of-interest analysis by HPLC; purity testing of in-process samples; bioreactor trends analysis; testing of solids removal during centrifugation; and SDS-PAGE set up and running (Document #84).

Professional development - Professional development activities focused on the BIOMAN Conferences, Protein is Cash workshops, and Community College Program at the BIO Conference (Document #s 66 and 79).

Dissemination and evaluation - In the area of dissemination, the organization continued to make improvements to its website and made numerous presentations at professional association conferences as indicated in the previous section. Discussions about the evaluation plan and activities began in earnest in late 2008. At the annual leadership retreat, co-principal investigators created several surveys including the biomanufacturing education survey and industry needs assessment survey. The group also reviewed guidelines for writing project evaluation reports for each activity (Document #59, 72, and 85).

Strategic value. Although industry representatives recognized that the potential strategic value of the organization was major, the majority believed there is a disconnect between potential and realized value. Three industry members rated the realized value as minor (Industry Representative G, J, and L). One explained that the company hired a few

program graduates that have excelled but that this was the exception rather than the rule (Industry Representative G). Another representative believed that if his company's core competencies included education and training, then the organization may be more central to his company's strategic efforts (Industry Representative J). Two industry representatives classified the strategic value to their company as indicative of the integrative stage (Industry Representatives F and K) and five as indicative of the transactional stage (Industry Representatives A, B, C, D, and H). The analysis that follows examines strategic value generated during this time period in three areas: creation of a pipeline of qualified technician-level candidates, improvement of biotechnology programs, and development of curriculum materials.

Program improvement - According to industry representatives, NBC² has positively impacted program development at the national level. One industry partner explained: "In the industry, there is a need for everyone to be on the same page--from lab meetings to boardroom meetings. The NBC² regional collaborative has made this possible on a national level for all involved biotech programs" (Document #58). Another industry representative noted that his relationship with the local community college has improved: "I definitely have a better relationship with my local academic campus. We interact weekly and I often contact other industry partners with whom I built a good working relationship [through the partnership]" (Document #58).

Bio manufacturing programs have experienced substantial growth during the past few years both in terms of the number of programs and number of student enrollments. Of the fifty-one institutional respondents to the Trends in Biotechnology Programs survey, one four-year college and three two-year colleges do not offer biotechnology

programs. Of the remaining forty-seven that do offer biotechnology degree programs, thirty-four (seven four-year colleges, six high schools, and twenty-one two-year colleges) offered a biotechnology degree program with at least one biomanufacturing course. The other thirteen institutions (eleven two-year colleges, one high school, and one four-year college) offered biotechnology degrees without a specific biomanufacturing course (Document #73).

According to education partners, the NBC² has made a significant contribution to the quality of biotechnology/biomanufacturing education. According to results from the Trends in Biotechnology Programs survey, nearly 7 out of 10 education partners agreed that the NBC² has made a significant contribution to program quality. Only four percent slightly disagreed with this statement. If one considers only those respondents that either agreed or disagreed with this statement (disregarding those that selected not applicable), then the percentage who agreed with the statement is more than 94% (Document #73).

In another study hub leaders discussed ways in which the organization has promoted program improvement. These leaders stated that their engagement with the organization has led to accelerated development of their programs. In individual interviews hub leaders indicated that their involvement with the organization has been positive, allowing their institutions to develop stellar programs rapidly. In addition, their involvement has led to increased biomanufacturing knowledge and skills for themselves and provided opportunities to connect with others interested in biomanufacturing (Document #73).

Through the BIOMAN Conference and Protein is Cash workshops, the NBC² has positively contributed to the professional capacities of teachers and faculty across the

nation. Participants specifically mentioned the hands-on nature of workshops and the learning of both new information and techniques as valuable. Participants explained this by stating that “real time live lab sessions” and “new teaching tools” contributed to their learning. Equally important, participants readily agreed that they will implement the new knowledge, activities, strategies, techniques, and pedagogical approaches learned in their programs (Document #73).

Two examples illustrate the importance of the organization to biotechnology program improvement efforts. The first example details the story of program establishment at Mount Wachusett Community College in Massachusetts and the role of the NBC² organization in that development.

In June 2006 Bristol-Myers Squibb committed to build a new biopharmaceutical manufacturing plant in Devens, Massachusetts. The company selected the site location for several reasons, including the accessibility to an educated workforce. The facility is located on an army base that was converted to a business park in 1996. In May 2007 construction began and the facility was operational within two years. The project cost an estimated \$750 million. Approximately 350 employees were hired during the first project phase, with more than 550 being hired for subsequent phases (Document #144).

Following the announcement by Bristol-Myers Squibb, the community college decided to construct laboratories to support a biomanufacturing program. The campus engineer and architect of the proposed project visited Great Bay Community College to observe the lab design and equipment requirements. In the end, Mount Wachusett built a lab that mimicked the one at Great Bay Community College. The learning and development manager from Bristol-Myers Squibb also visited with NBC² leaders at Great

Bay Community College to tour the biomanufacturing lab and discuss the NBC² curriculum.

In 2009 the program at Mount Wachusett Community College adopted and implemented the NBC² curriculum to train entry-level and replacement workers at the company. In the spring of 2010 they began customizing the NBC²'s laboratory curriculum. Now that the new program has been established, faculty and students of the Mount Wachusett's program are providing NBC² with important evaluation data on the textbook and virtual chromatography lab module (Document #s 121 and 127).

The second example of program mentoring traces the improvements in a science course at Berlin Central School District in New York. Following his participation in a Protein is Cash workshop, teacher Matt Christian was funded to attend the 2010 BIOMAN Conference in Bloomington, Indiana and the 2010 Bio-link Summer Fellows program in Berkeley, California. Christian incorporated instructional materials and information learned from these conferences into his curriculum. He informed students of the curricular changes during the summer break and his course enrollment soared from 6 to 19 students. One student recalled the following:

Mr. Christian called me over summer to tell me that the class was going to grow its own coral, modify bacterial genes, learn lab procedures, and work with the [Atlantis] aquarium on projects. I signed up and I'm glad I did. (Document #98)

Ted Hennessey, the Program Manager for the Tech Valley Career Pathways Consortium added: "We are extremely pleased when teachers are able to take full advantage of the professional development opportunities offered through our consortium to help students see the relevance and importance of taking science classes" (Document #98).

Pipeline of qualified technician-level candidates - Nationwide more than 2,350 students were enrolled in 30 biotechnology/biomanufacturing programs and courses

offered in 21 states during the fall 2010 semester. The average number of students enrolled in programs or courses was 78.6 during the same semester. This is an increase when compared to the Fall 2009 enrollment average of 64.3 and the Fall 2007 enrollment average of 41.1 (Document #145). Furthermore, the total number of students in Northeast hub programs grew from 146 in 2005 to 167 students in hub programs in 2011 (Document #s 73 and 86). The three new alliance institutions posted enrollments of 346 in 2011 (Document #86).

Graduate success - According to the Trends in Biotechnology Programs Report, 23 programs that responded to the survey had graduates in fall 2010—461 students with a college degree and 61 students with a high school degree. Of the fall semester graduates from a community college program, a large percentage (41%, 95 of 232) matriculated to universities. An even greater percentage (64%, 148 of 232) entered the biotechnology workforce (Document #145).

In general, students believe that the program successfully prepared them for placement in the biomanufacturing industry or matriculation to a four-year college. Both current students and graduates agreed that the program was preparing (or had prepared) them to enter the biomanufacturing workforce. Graduates considered the program alone adequate preparation for an entry-level operator position in biomanufacturing, and those with some other relevant background, such as another degree or previous employment in the sciences, were often able to parley the knowledge gained through the program into a new career direction. A number of participants singled out the biotechnology certification among the reasons they were hired by industry (Document #73).

Industry partners also indicated satisfaction with the quality of graduates hired from two-year biomanufacturing degree programs. According to the results from the Industry Needs Assessment survey, 70% of industry partners responding (n=23) had hired graduates from a community college biomanufacturing program for a technician-level job. Of the 16 who hired community college graduates, all were satisfied with the quality of graduates hired from these biomanufacturing programs. Furthermore, when asked if their company would hire graduates from a community college biomanufacturing program in the future, 96% (22 of the 23) responded in the affirmative (Document #73).

Curriculum development - The development of curricula and instructional materials has been well documented in previous sections. It should be noted that the textbook has the best potential to rise to the level of joint value creation. Other materials such as the virtual lab modules may also achieve joint value creation status.

When asked about the value of partnering with the organization, educators provided the following insights:

NBC² helped us with our overall course offerings in the program, curriculum in the biomanufacturing program, design of new laboratory space, and help in attending a conference [*sic*].

[The value is in] well-developed, relevant, and tested lab and class activities.

The use of the model biomanufacturing curriculum and professional development opportunities has been critical to our program.

NBC² gave us early guidance as we established curriculum and has established ongoing benchmarks. It has also allowed us to establish networks within the Biotech education community.

Without the NBC² materials, we literally could not teach this course. (Document #127)

Importance to mission. More than one-half of the industry representatives characterized the importance to mission as transactional (Industry Representatives A, B, C, G, H, J, and L). Industry Representative C views the organization as important to his company's hiring strategy. However, it is not viewed as central to the company's mission because companies are "still very reliant on any and all applicants" (Industry Representative G).

Magnitude of resources. During this phase of evolution, the magnitude of resources deployed by educational and industrial partners was viewed as small but increasing (Industry Representatives A, B, C, H, J, and K). Two additional industry partners classified resources between the first and second stages of the model (Industry Representatives G and L). It should be noted that the organization received renewal funding from the NSF ATE program in the amount of \$2,694,236 in 2009 (Document #68).

Educators have made a substantial time contribution to the organization due to involvement in both strategic planning meetings. The organization also garnered significant financial support from education sources for their Protein is Cash workshops. In fact, external funding accounted for more than one-half of the workshop costs (\$38,052 internal funded costs in 2010 versus \$40,425 external funded costs).

From an industry standpoint, the most significant resource contributions have been in the area of human resources. Industry partners donated copious amounts of time to the strategic planning, skill standards harmonization, and textbook development efforts as well as to participation in the managerial committees of the organization. Unfortunately, the organization has not quantified these contributions in dollar amounts.

Hub partner institutions also continued to be the recipients of generous donations from industry. For example, Sanofi-Aventis, Bristol-Myers Squibb, Emerson Resources, Centocor, and Biorexis made equipment donations to Montgomery County Community College. Another partner, North Montco Technical Career Center, received equipment from Bristol-Myers Squibb (Document #43).

The Protein is Cash workshops secured a company sponsor during this time period; Bio-Rad provided two of their lab kits and equipment for each Protein is Cash workshop. The company has also donated raffle prizes for the workshops. In addition, Bio-Rad instructors have participated in several workshops (Document #86). The financial sponsorship by Bio-Rad for the Protein is Cash workshops signifies that the NBC² has garnered national credibility in the high school biotechnology community (Document #73).

Managerial complexity. The managerial complexity remained simple during this stage of organizational evolution (Industry Representatives A, C, F, G, J, and L). According to Industry Representative J, it is easier to work with a simple managerial structure for this type of organization. He summarizes his thoughts by stating, “The flatter, the better.”

Several activities were managed by the co-principal investigators, including curriculum development, professional development, program development, and dissemination. The general membership of the organization provided input through two strategic planning meetings and evaluation processes.

At this stage the organization had two primary committees that provided input. The Advisory Board and the National Visiting Committee provided both strategic and

tactical advice to the leadership. For example, the NVC first suggested that the organization develop a business plan that focuses on self-sustainability in 2008 (Document #57). In the following year the committee supported the establishment of a non-profit organization to sustain the organization's activities (Document #70). In 2010 committee members discussed the slow progress towards becoming a non-profit organization. This was due, in part, to the transition of the grant from Great Bay Community College to Montgomery County Community College. The committee also conversed about protection of intellectual property generated during the grant period (Document #80). Finally, at the last committee meeting members again recommended that the organization formalize their structure in a business plan and suggested that the business planning process might be "carried out in the context of the development of a 501(c)3 organization" (Document #97).

Stage III – Integrative

According to Austin, a partnership reaches the integrative stage when the relationship mimics "a highly integrated joint venture that is central to both organizations' strategies" (Austin, 2000b, p. 26). The organizational partners exhibit a *we* mentality rather than an *us versus them* mentality. The scope of activities is broad. Organizational activities are conceptualized and implemented with multiple levels of partner input and support. Joint value is created through the organization's activities and services (Austin, 2000b).

Several industry representatives agreed that the organization has not yet reached its peak (Industry Representatives A, B, D, H, and L). When the organization has an established model that consistently delivers a sustainable output, "a cadre of graduates

[that] are placed well within the industry [and] a portfolio that is the baseline for biotech training in general,” then the organization will reach the integrative stage (Industry Representative D). The industry recognized that the organization has experienced short-duration bursts of effectiveness but that the intensity has not been sustained (Industry Representatives B and L). Two industry partners mentioned activities that they believe were the most effective as far as production output. These activities included textbook development (Industry Representative C), skill standards harmonization, and strategic planning activities (Industry Representative F).

Partner Benefits Most Highly Valued by Industry

When asked what partner benefits were most highly valued by their companies, industry members identified six benefits: providing skilled workers, improving biotechnology programs at the local community colleges, developing educational and training products, creating opportunities to network and benchmark, providing an avenue to fulfill their social responsibility mission, and catalyzing learning about the industry. These motivations align with those described earlier in the literature review.

Skilled Workers

For ten industry representatives (A, B, D, E, F, G, I, J, K, and L), the primary benefit of the partnership was in the form of skilled workers. One industry partner cited the benefit of the curriculum that can be used to upskill the “incumbent workforce” (Industry Representative B). Another highlighted the benefit of “a readily available pool of trained technicians that are coming out of the program and are available to us to place into our workforce” (Industry Representative K).

Beyond this, industry recognized that the graduates have “a better, more direct understanding of the industry” (Industry Representative E) and underscored the benefit that students are “trained not on theory but on actual processes,” educating students that “don’t just have ideas of science, but also applied science” (Industry Representative I). Thus, program graduates acquire “a broad knowledge base” plus good documentation practices, Good Manufacturing Practices, and compliance knowledge (Industry Representative G).

Industry Representative A also noted the benefit of skilled workers to a company’s bottom line. “Being able to bring in staff for the skilled jobs where they can hit the road running a lot faster” and “reduce the time to get to a state of adequate productivity” are critical benefits (Industry Representative A).

Improvement in Biotechnology Programs at the Local Community Colleges

In response to the most highly valued benefit that the NBC² partnership provides, six industry representatives (C, D, E, F, H, and K) discussed some aspect of improving the biotechnology program at their local community college. Simply stated, the benefit is industry’s “ability to influence how folks are getting trained and what the topics are that they are getting trained on, to make sure that they’re industry applicable” (Industry Representative E). Moreover, it is their ability to influence the balance of theoretical versus applied science that is taught in a technician-level program. The vision is to “integrate industry and academia at a practical level, not at the Masters and Ph.D. levels...but much more at the biomanufacturing or bioresearch level for people that will actually be doing the work” (Industry Representative D).

Industry representatives noted the devastating consequences when programs were not industry applicable. Industry Representative H stated the following:

There are a lot of community colleges that like to think they are doing great things in meeting industry needs but a number of them haven't grown over the last decade when industry got involved with gene jockey activities, and those sorts of things. There is a case of that in the local region because there are still community colleges that are doing what they were doing fifteen years ago in preparing research technicians. But it completely eliminated or avoided the applied manufacturing advanced technology arena. (Industry Representative H)

Another concurred, citing the difficulty in securing local community college partners that really embrace the program:

They [the programs] go off and do their own thing. We've had success with some of those folks when we bring them in, and they usually know the basics. I don't think they know as much; I think the NBC²'s program has [been] developed with industry in mind, and some of these other programs haven't necessarily been. (Industry Representative K)

Thus, it is apparent that industry recognizes the differences among programs.

Two industry representatives also pointed to the benchmarking opportunities as a benefit, being able to compare "what's going on in another state to help refine what we've set up here locally with the community college" (Industry Representative D).

Another industry partner highlights the skill standards harmonization meeting in Indianapolis as an event that "elevated and energized the whole conversation about what these programs need" (Industry Representative F). He concludes the following:

So although I had a really good idea of what we needed to be teaching at a local level, having that conversation with people running programs from throughout the country opened my eyes to other things that would work at a local level, and I think it was true of other people. So just the collective sharing of best practices led to an up swell of the collective knowledge. (Industry Representative F)

Educational and Training Products

Three industry representatives (C, F, and H) pointed to the availability of various educational and training products as a benefit of their involvement in the partnership. For example, one representative states, “an identification of skill sets and industry skill standards...are an extremely valuable thing for industry” (Industry Representative H). Industry Representative C points to the textbook recently developed and the lab manuals as “quite helpful for us to essentially blend into our existing training programs.”

Networking with Other Industry Representatives and Benchmarking Industry Practices

The partnership has provided the perfect opportunity to network with other industry representatives. “Of course, our [company’s] success is in knowing who the biotech users are out there. I was introduced through this involvement to a couple [of representatives] that we, as a team, benefited from my getting to know [sic]” (Industry Representative J).

Still other representatives commented on their ability to benchmark industry practices as a result of networking opportunities. Information-based outcomes “such as hiring practices of other biopharmaceutical companies” are also beneficial (Industry Representative C). “Being able to network across the country and to see what the patterns are of biotech development, of where the jobs are happening, that is a big benefit to having a regional or national organization” (Industry Representative F). This provides companies with a better snapshot of the big industry picture.

The Opportunity for Social Responsibility

Two industry representatives (H and J) commented on the opportunity afforded through the partnership to fulfill their company’s social responsibility mission. Industry

recognizes “a good citizenship component” to partnering (Industry Representative H).

Industry Representative J summarizes his thoughts as follows:

In a sense, it is giving back to the local community. I realize the community for NBC² is much larger, much more than just this local region but that’s kind of how I viewed it...it was a way for my employer...to also get credit for good community relations. (Industry Representative J)

Catalyzing Learning about the Industry

Representatives also noted the benefit of providing visibility of the industry sector to several important populations, namely college and K-12 students as well as the workforce investment system. The partnership benefits companies by “introducing” and “exposing” college students “to some of our products and technologies...early in their career involvement” (Industry Representative J). Similarly, the organization has brought “our technology and biomanufacturing jobs to the forefront of students coming up through K-12” (Industry Representative B). Generating interest in the field with younger kids and stimulating their thinking on what type of career options are available is also viewed as a benefit to industry (Industry Representative B). Finally, these types of partnerships increase the understanding of workforce investment boards, “changing the way they are thinking” about “the high tech” industries and ultimately impacting “the better distribution not only of NSF monies but Department of Labor monies” (Industry Representative H).

Alliance Drivers and Enablers

This section addresses the research question regarding the major drivers and enablers that lead to the development of an effective academia-industry-government partnership. As part of his Cross-sector Collaboration Continuum Model, Austin

identified four drivers: “alignment of strategy, mission, and values; personal connection and relationships; value generation and shared visioning; and continual learning” (Austin, 2000a, p. 71). He also identified four enablers for managing the partnering relationship: focused attention and concentrated engagement by key players of the collaboration; effective, efficient, and frequent communication utilizing multiple channels; an organizational system that identifies partner relationship managers for each organization involved in the collaborative; and a mutual understanding of expectations and accountability for results (Austin, 2000a). After defining the drivers and enablers that lead to effective alliance development, the cultural differences between the educational environment and the business world that may impede a partnership’s evolution are highlighted.

Drivers Aligning with Austin’s Model

Alignment of strategy, mission, and values. Austin (2000b) states that this “task involves meshing missions, matching needs and capabilities, and overlapping values” (p. 61). It is important to note that mission alignment may not be obvious at first, and the fit may focus on “operating needs” (Austin, 2000b, p. 66). Furthermore, while the values do not need to be congruent they do need to fall “within acceptable limits” (Austin, 2000b, p. 68).

For the NBC², the primary driver according to industry representatives was that “the partnership has a collective vote of common needs and wants...” (Industry Representative E). More specifically, the need as defined by industry is a skilled workforce (Industry Representatives A, B, D, E, F, G, H, I, J, and K). Industry Representative B explained the following:

I have found senior management to be very good at dealing with pain, and at one point our pain was we couldn't find enough workers with the skills that we needed to be successful. That's a serious pain and if you have that pain you're going to deal with it. (Industry Representative B)

Another industry partner calls attention to the fact that the need focused on a skill set that did not exist at the time (Industry Representative A). The needs of industry were not being met by an academic-focused university or college because the graduates produced from these programs were "academic generalists" who "couldn't plug and play in our workforce" (Industry Representative B). Although community college programs better balanced applied science with theoretical concepts, programs also need "access to reasonably scaled equipment and/or facilities," a lab scale format does not necessarily prepare students for biomanufacturing (Industry Representative D). Another key component to the need was that industry expected new hires to be immediate contributors to the workforce (Industry Representatives A, B, F, and I).

From the educational perspective, the partnership allows colleges to offer a biomanufacturing program in which industry is actively involved (Industry Representative E). Furthermore, program graduates are viewed during the hiring process as having the relevant experience required by many companies (Industry Representative F). Industry does recognize the cyclical nature of the business, remarking that companies experience "ebbs in flow of hiring" (Industry Representative G). Since industry cannot always predict when an upswing in hiring will occur, it is important that institutions produce a constant pipeline of qualified graduates.

Personal connections and relationships. According to Austin, "partnerships are created, nurtured, and extended by people" (Austin, 2000b, p. 55). Relationships between these people serve to bind a partnership together. While it is important that the

partnership engages employees from all levels of the partnering organizations, the attention given to the partnership by top level management is indicative of the strategic importance of the partnership. Indeed, the involvement of top level management confers legitimization to the organization (Austin, 2000a).

To the biomanufacturing industry, relationships are absolutely critical in the development of effective partnerships. Without a collaborative atmosphere, Industry Representative D believes the project is doomed to failure. “It’s the wisdom of not trying to do it on your own” (Industry Representative D).

With whom to connect - Connecting with the right person within a company or institution is paramount to successful relationship building (Industry Representative A). The organization must leverage the relevant functions within a company to solicit their input. The partnering relationship should be defined in terms of a hierarchy of contacts (Industry Representative L). Indeed, active engagement with the Human Resources department and Operations group (Industry Representatives A, G, and L) as well as the Training department (Industry Representative L) is important if this collaboration is to be successful. Furthermore, the partnership should be cognizant of the business arrangement some companies have with internal temporary agencies for hiring purposes (Industry Representative K).

Prior relationships - Several industry members strongly believe that relationships can be cultivated, that prior relationships are not necessary to develop an effective partnership (Industry Representative B, C, D, I, and J). In fact, one industry representative (B) cautions that prior relationships “can help or hinder [partnership development] depending on the quality of that [prior] relationship.” He further explains

that growing the relationships makes all partners responsible for the network. Another industry partner reminds that cultivating relationships takes time and requires a long-term commitment (Industry Representative I). “It’s just like watering a lawn or watering the bamboo, where you just keep watering it for years and in the fifth year it finally sprouts” (Industry Representative I).

In the opinion of one industry partner, it is easier to develop an effective partnership if solid prior relationships exist. Citing his work with a biomanufacturing program at the local community college as an example, Industry Representative F details the role that relationships play. Because he had worked for four biotech companies in the area and had developed strong ties to professionals at each company, he was able to secure adjuncts for the program from multiple companies with a few phone calls. This was important for the program in that it provided the broadest knowledge base possible as well as multiple company perspectives and engagement (Industry Representative F).

Methods to cultivate relationships - As for how one goes about cultivating these relationships, industry representatives offered numerous suggestions. Regardless of the method, the organization must actively pursue and recruit partners that will be engaged in the partnership (Industry Representative D). The personal connection is tantamount to ensuring success in establishing a relationship (Industry Representative D). Rather than distributing the impersonal brochure, a “human connection” should be made to introduce potential partners to the program and Center leadership (Industry Representative G). Indeed, it is important that potential partners be able to match a face with the name. An act as simple as “breaking bread” can lead to establishment of a powerful network (Industry Representative J).

Industry Representative I suggests visiting potential partners at their offices multiple times, knowing that it may take several visits before the contact remembers your name and actually listens to what you have to say. As an example of previous success in the development of a relationship with another Center, a face-to-face meeting between organizational leaders opened the lines of communication on multiple levels within both organizations (Industry Representative J).

Once cultivated, these relationships must be nurtured if they are to remain mutually beneficial, responsive, and flexible. Partners must “continue to come to the table” offering input and resources (Industry Representative D). As with all relationships, some “give and take” is to be expected. Partners must evaluate what they are giving and what they are getting in return (Industry Representative D).

Benefits of solid relationships - Strong strategic relationships provide a host of benefits to participating parties as well as the partnership. The connectedness motivates individuals to be engaged where there is not a strong incentive for their involvement (Industry Representative C). If partnering is not a job responsibility and it is more a labor of love, then motivating individuals to be involved and keeping them engaged is a delicate balance. Relationships help solidify a partner’s commitment to the goals, objectives, and activities of the partnership.

Solid relationships also foster both a more responsive environment relative to the needs of the partnership (Industry Representative A) and “more in-depth conversations” (Industry Representative B). Eventually, if relationships are cultivated and maintained, industry will rely on and feel vested in the Center (Industry Representative G). Over time

the relationship's proven value, as far as the quality of the program and the work products, will be realized (Industry Representative D).

Importance of leadership in cultivating relationships - An essential ingredient to building personal connections and relationships that underpin an effective partnership is having the right leaders at the Center (Industry Representative G). It is essential for industry to recognize the leader driving the partnership and understand their capabilities and motivations (Industry Representative F). Dr. Sonia Wallman “was tireless in her ability to find the appropriate forums, the appropriate opportunities to work with industry representatives and give them that comfort level that the program she was representing was strong” (Industry Representative F).

The leader must also aggressively strive to make necessary connections (Industry Representative G) with top management and levels throughout an organization. Relationships bloom at the higher levels of management (Industry Representative C).

First contact with NBC² - With two exceptions, the first contact between industry representatives and the Center was initiated by Dr. Sonia Wallman. In the case of one exception, the industry partner was introduced to Dr. Sonia Wallman by a local community college faculty member. Two industry partners specified that Dr. Sonia Wallman sought them out at a professional meeting or conference (Industry Representatives F and K). Thus, the majority of connections created in the establishment of this partnership are pulls from the institutional side.

Value generation and renewal. As part of the Cross-sector Collaboration Continuum Model, Austin theorizes that value generation and shared visioning are important enablers of partnership development. Generating value is defined as

“mobilizing and combining multiple resources and distinctive capabilities to generate benefits for each partner” and goes beyond philanthropy (Austin, 2000a, p. 84). The source of value can be characterized as generic resource transfer, core competencies exchange, or joint value creation. Moreover, value exchanges must be balanced so that partnership evolution is not hindered. “A sense of equitable reciprocity is essential to partners’ continuing interest in investing in the relationship” (Austin, 2000b, p. 179).

The benefits to industry for involvement in this partnership are highlighted in the preceding section. The realization of these benefits generates tremendous value for the industry partners. The benefits identified by industry partners include skilled workers, improvement in biotechnology programs at the local community colleges, educational and training products, networking with other industry representatives, benchmarking industry practices, opportunities for social responsibility, and catalyzing learning about the industry.

When asked to identify drivers of an effective partnership, Industry Representatives G, I, and J spoke about the value generated by having access to a well-trained biotech workforce. One representative explains his position as follows:

From day one, these people are valuable to the company. They’re not a potential asset that you have to train for say another six months. They’re a value-added resource from day one; they are working on day one and you’re getting more bang for your buck. (Industry Representative I)

Understanding the need for an investment of resources was also identified as a driver by Industry Representative E. He speaks to the “time and effort to shape the curriculum” as an investment and states that the investment has to be made first and then the benefit is realized (Industry Representative E). He adds that it is critical that partners have an appreciation for the amount of time and money “that industry may or may not

have.” Industry Representative B is also aware of the investment cost in a partnership of this type. Initially, the cost-benefit ratio was low; now the organization has progressed to a point where industry is realizing more benefits for the cost (Industry Representative B).

Building on the cost-benefit analysis, Industry Representative I noted that the value generated must have a tangible quality. When partnering with business it is essential that an investment of time and resources generates assets that positively impact the bottom line. The industry partner must be able to justify participation to management (Industry Representative I).

Magnitude of resources - Of those indicating the magnitude of resources the NBC² currently possesses, the majority of industry representatives believe the magnitude to be small (Industry Representatives A, B, C, H, J, and K). Explaining his thinking behind this rating, Industry Representative C comments that he is the only one from his company that is consistently involved in the effort. To the contrary, two partners feel that the organization enjoys resources on a large scale (Industry Representatives D and F).

Generic resource transfer - In partnerships such as this, monetary transactions between industry and education are not significant (Industry Representative J). In contrast, industry has donated substantial amounts of equipment and facility time to local programs (Industry Representative F). Not only is industry allowing courses to be taught on location, but in some situations students also have access to the biomanufacturing facilities (Industry Representative F).

Equally as important, grant funding is viewed as the catalyst for partnership evolution. According to Industry Representative E, grant funding allowed infrastructure development as well as consistent community college and industry participation. In

general, grant funding “opened doors that probably wouldn’t have been [opened] otherwise” (Industry Representative E).

Core competencies exchange - The skill standards harmonization effort is an example of a core competencies exchange. Industry provided the input for the harmonization activity, and education partners used the results in the subsequent design of a biomanufacturing course focused on the ten jobs identified by industry (Document #42).

Joint value creation - Industry Representative E noted that the textbook project was an example of joint value creation within the partnership. “Everybody had a stake in it [the textbook] and everybody was taking a different part of it. It brought together one curriculum that could be shared across all the colleges” (Industry Representative E). The collaborative technical input provided by multiple company experts was the favorite part of the process for Industry Representative A. Because he had not previously experienced this type of collaborative effort between academia and industry in developing a textbook, the process was described as innovative by Industry Representative I.

Continual learning. According to Austin (2000b), continual learning is an important driver of partnerships and fosters continuous improvement within an organization. Continual learning applies to the process of partnering and how this process can create additional value (Austin, 2000a). The ultimate goal is to develop “an ever deeper and richer relationship” (Austin, 2000a, p. 85). Continual learning also applies to knowledge and skills exchanges between partnering organizations. Austin (2000b) posits that when an organization reaches the integrative phase of evolution then systematic learning and innovation are standard practice.

Although industry partners did not declare that continual learning was a driver of effective partnerships per se, two did indirectly refer to organizational learning as important. Industry Representative G spoke of “keeping up with current trends and needs of the industry” in order to successfully launch the partnership. Industry Representative D remarked on the willingness on the part of academia to listen and respond to industry feedback regarding alterations needed for classes, programs, or “their thought processes.”

Other representatives, during different points of their interviews, underscored the importance of organizational learning. Although stressing the significance of systematic learning to an organization (Industry Representative A), one representative could not say that the NBC² had actually reached that level of learning (Industry Representative B). He did point to the textbook development project as being a “learning experience for everybody,” especially as it related to the management and process approach taken (Industry Representative B).

Another industry representative highlighted the importance of the leader in promoting continual learning. The leader must understand the value generated and power produced when the collective partners engage in problem solving and continual learning. Dr. Sonia Wallman did an outstanding job by bringing pioneers in the field together to discuss both what had and had not worked. She promoted an atmosphere of openness and candidness (Industry Representative D).

Suggestions from industry representatives on how to improve the process of partnering are provided in the Areas for Partnership Improvement section. Both continuous improvement and innovation are highlighted as factors that impact sustainability of an organization.

Drivers Not Aligning with Austin's Model

Focused attention. Although Austin classified focused attention as an alliance enabler, industry representatives of this case study categorized it as a driver. According to Austin, “strong alliances have the focused attention of partners. They must capture sufficient mind share among key leaders and implementers to command and deploy the resources required to achieve impact” (Austin, 2000b, p. 122). Austin categorizes each phase on the Cross-sector Collaboration Continuum Model according to the attention given to the partnership by top management. In the philanthropic phase, little attention is given to organization by top management. In the transactional phase, top management is engaged during the formation of the alliance and periodically thereafter. In the integrative phase, the organization is viewed as a priority relationship and top management gives considerable ongoing attention to the organization (Austin, 2000a).

Although focused attention by top management is critical to partnership evolution and effectiveness, Austin recognizes the need to engage representatives from all levels of partnering organizations. He refers to this as institutionalization. He further posits that focused attention is best achieved when partners designate a “partner relationship manager” (Austin, 2000b, p. 123).

Commitment of education, industry, and government to the NBC² organization was viewed as a driver rather than an enabler (Industry Representative D). The commitment to put some level of effort into the partnership must be long-term (Industry Representative E). For example, in his opinion commitment from community college administration at the dean level or higher is required for the program to be successful (Industry Representative H).

A multi-tiered engagement approach is also important with industry partners. “If your customers don’t want to come to the table, you will not put together a product they are willing to use” (Industry Representative D). Plus, sufficient numbers of industry partners must be involved so that a “certain hit rate on participation” can be achieved (Industry Representative J). Industry Representative A feels that different levels are needed either at different times during the partnership evolution or for different project aspects. Industry Representative I enlightens further:

You can’t just get people with a great title because whoever it is, unless they’re the CEO, there’s someone above them. To be effective, you have to really go after those two tiers, people that will actually probably be doing most of the field work in terms of your program and developing it and doing what they can. But then you also have to get the approval of the people that they report to so when they need to step away or just to support an advisory meeting, they [top management] are on board. They [top management] like it and they are glad that you’re taking part. (Industry Representative I)

Some partnership aspects had involvement at the vice-presidential level in the beginning but “were not sustained at that level, and so it got handed off. Now I think it might have been better if the interest had stayed at that high level in the organization...” (Industry Representative B).

According to Industry Representative B, sustaining involvement from the top management level is difficult for two reasons: (a) senior management and their teams change over time and (b) the need to generate a skilled entry-level biomanufacturing workforce was addressed and the “pain” went away.

They [senior management] became ambivalent based on the success of what they had already done, which was to start building this type of consortia, start building relationships with the university and the public sector and so on. That helps keep them successful. But then the tides will turn, it will go back the other way, and then suddenly the pain will come back and you get senior management’s attention again. (Industry Representative B)

Industry Representative D adds a third reason for lack of commitment to an effort of this type. “It’s a distraction; we all have a business to run...I am interested because I think the network is really critical. But you have to look at it this way—it is extra work and time for industry partners to dedicate” (Industry Representative D).

Not only must industry and education from multiple levels within an organization be engaged, they must also be passionate about their involvement (Industry Representatives B and I). In addition to passion, a strong partnership has “somebody who’s kind of the cornerstone to it...and is invested in it” (Industry Representative E). Furthermore, the leaders must be able to inspire partners to become and remain engaged (Industry Representative I).

I have immense respect and admiration for what Dr. [Sonia] Wallman has done....She made the NBC² a highly effective program because of her passion, her knowledge, her ability to network with industry representatives, and being an advocate for the program and for the industry. I guess I would see the leadership, either as an individual or a representative of a committee, as a major [driver]. (Industry Representative F)

Enablers Aligning with Austin’s Model

Communication. According to Austin, partners must employ “means of communicating effectively, efficiently, and frequently” to realize the full complement of partner benefits (Austin, 2000a, p. 86). Both formal and informal communication channels are used in the process. Communications should be characterized by openness and forthrightness among partners and constructive criticism employed as needed (Austin, 2000a).

Two industry representatives (C and I) view clear lines of communication as a key enabler. Because communication keeps partners engaged in the organization

(Industry Representative C), this function should be an assigned responsibility within the organization (Industry Representatives I and L). Companies must be made aware of the presence of the NBC² organization and its ability to provide skilled workers. Industry Representative L further explained, “Our manufacturing group...is always complaining that it’s difficult to fill positions.” The communication director should seek to “understand the need...of industry, which is not just generating curricula for many colleges, it’s also...providing the workforce the industry needs” (Industry Representative L).

Partners must also be made aware of events and opportunities prior to their occurrence to encourage maximum participation (Industry Representative I). Keeping partners in the loop helps an organization avoid “out of sight, out of mind” issues (Industry Representative A).

Other representatives, during their interviews, highlighted the significance of routine, two-way communication to partnership evolution. Interaction cannot be solely a push relationship; it must be one of push-pull between two parties (Industry Representative G). Communications must explain how the information is relevant to the overall NBC² vision and mission. Furthermore, strategies should be “tailored to how industry people think and routinely work, which is around goals and targets” (Industry Representative C). Finally, information distribution should be more coordinated rather than “individual random e-mails on certain events” (Industry Representative C).

Because communication preferences are varied, it is important to employ multiple methods within a single communication plan (Industry Representative I). Three industry partners prefer e-mail when communicating (Industry Representatives B, G, and J).

Industry Representative B explains that everyone is so busy, and e-mail provides a mechanism “to get a thought out quickly” and allows one “to check the history” of a conversation. Other representatives identify telephone calls (A and F), newsletters (C, D, F, and J), and face-to-face meetings (F and G) as their preferred means of communication. Industry representatives advocate face-to-face communication when a project is beginning (Industry Representative B) and the organization is regrouping and defining future goals and objectives (Industry Representative C).

Industry Representative D suggests that annual reports and meeting minutes are effective communication tools; after reading them he has “a sense for the progress being made” (Industry Representative D).

Industry Representative D also proposes that a portfolio may be an effective communication tool for this type of organization. Although he knows about the partnership, the majority of his company’s representatives do not. Thus, an electronic portfolio containing accomplishments, offerings, and potential collaboration opportunities would be helpful.

Organizational systems. Organization of a partnership includes the development of systems and procedures. The concept of a partnership is first formed in the minds of its founders. As these thoughts are put into action, “the processes through which an alliance does its work must gain stability” (Austin, 2000b, p. 122). According to Austin, appointing a dedicated partner relationship manager at each corporation is essential if the partnership is to enter the integrative phase. These processes, as well as the partnership, must also be institutionalized so that the partner organizations, “not just the leaders...own the alliance” (Austin, 2000b, p. 122). As the level of engagement expands, “the demands

on the partners to execute their commitments effectively” increase (Austin, 2000b, p. 136). The partners must ensure that capabilities are congruent with commitments. If an execution gap exists, then necessary resources should be mobilized or commitments modified (Austin, 2000b).

The NBC² organization is a “very fluid, very dynamic, complex, multilevel organization” (Industry Representative B). Partnering is a difficult process; “you have to work at it continually (Industry Representative H). Furthermore, “it has to be organized and run from the perspective of a constantly changing dynamic” (Industry Representative H). Regardless of whether the change is technological or whatnot, the organization and the relationship must be continually reevaluated (Industry Representative H). Learning to collaborate well with NBC² partners is applicable to other partnering situations (Industry Representative B).

Governing structure - Two industry representatives (B and D) recognized governance as an important enabler of effective partnerships. The organization’s governing structures such as the National Visiting Committee and the Advisory Board, promote the realization among partners that “they are all marching toward the same goal” (Industry Representative D).

If you’re successful and organized with clear governance, you can tell people what you need from them, how you need it, and they’ll usually be willing to provide it much more than if it’s a messy, disorganized relationship with poorly designed objectives and very little to show for the time you devote to it. (Industry Representative D)

Central resource structure - A “central resource or hub to lead or champion this type of initiative” is critical to organizational success (Industry Representative C). Because industry personnel often have a desire to support these initiatives but lack the time, resources allow a central hub to spearhead the projects with input from industry.

Partnerships led by industry without a funded staff tend to “stop or move very slowly” because industry tends to get distracted by business goals (Industry Representative C).

In 2009, when the second round of NSF funding was awarded, the fiscal responsibility was shifted from Great Bay Community College in New Hampshire to Montgomery County Community College in Pennsylvania. This generated some confusion within the ranks and wreaked havoc, if only temporarily, with project management. As Industry Representative A noted, no one knew who was in charge. “How can it run efficiently if you’ve got [a situation where] nobody knows whether or not they can do something because they might step on somebody’s toes” (Industry Representative A). Industry Representative B agreed, indicating that the change of leadership disrupted the flow of the textbook project for example.

Business processes and procedures - Industry Representative D pointed to good business practices as necessary for organizational management. According to one industry representative (A), the organization has not embraced the business planning process and is still being run as an academic partnership.

Clearly defined decision-making processes are also central to an organization’s effectiveness. Citing the textbook development project as an example, Industry Representative B opined that frustrations grew when decisions made in previous meetings were changed later on, explaining that “Suddenly the path would veer again” (Industry Representative B). It is important to him that ground rules for projects be established so that the team is able to work together most efficiently and effectively. In addition, if projects are managed well, then project outcomes and results serve to foster continued engagement by industry (Industry Representative C).

Mobilizing resources - Industry Representative C discussed the importance of mobilizing resources to bring in the “right outside consultants.” Especially needed when the organization is entering unknown territory, a person with the right skill set can create the desired outcome. This also involves a process to select a consultant with the skill set which best fits that desired outcome. Industry Representative A concurred that the organization must ensure that skills evolve with the partnership.

Cultural differences between business and educational environments - To achieve project goals, cultural differences between business, educational, and government environments must be brought to light early on in the process (Industry Representative D). Indeed, commingling three separate cultures is a bit challenging (Industry Representative B).

Academia is viewed as “a very free form environment” (Industry Representative B). Although recognizing that free thinkers are beneficial in society, Industry Representative B comments that “it just kind of clashes...when you overlay that with a business perspective [that is] more linear...” The creativity of academia and its ability to ponder what *could be* as opposed to what *must be* manufactured today was also viewed as a strength of the alliance (Industry Representative B).

Industry Representative A characterized academia as “scatterbrained” in the respect that there appears to be no order to their thinking. Much of this is due to the fact that, in general, academia and industry do not speak the same language. “If you have pure academia partnered with pure business, where everybody is talking about something and nobody knows what anybody is talking about,” then it is difficult. Academia must be

able to speak, communicate, and behave in a manner that business is going to understand” (Industry Representative A).

To add to their cultural differences, industry is more interested in efficiency rather than creativity when it comes to the way work is accomplished (Industry Representative B). Industry is much more focused on project management, goals, and delivering products versus discussing them (Industry Representative C). Industry focuses on getting as much work “done for the least amount of involvement,” while as a general rule educators are givers by nature (Industry Representative B).

Other differences mentioned include the following:

- Profit motive and funding mechanisms - The funding mechanisms of business and higher education are vastly different (Industry Representative D). In a capitalist society, business is driven by the bottom line and outcomes are measured quarterly. The business system is rigid compared to higher education that “tends to be less aggressive in as much as timelines” (Industry Representative B). He acknowledged that the community college system is more adept at interfacing with industry. But overanalyzing rather than progressing to outcomes “drives industry people crazy” (Industry Representative B).
- Core competencies - According to Industry Representative B, business, academia, and government “march to the beat of a different drummer” in that they have different missions. Training is not a core competency of biomanufacturing companies. It is, however, a core competency for higher education institutions.

Ultimately, from the business standpoint, it’s just cheaper to get skilled people than to train people internally. Internally we’re always constrained with resources...Training can sometimes go by the wayside at the expense of the day-to-day deliverables of the business. (Industry Representative G)

- Applied emphasis - One of the key cultural differences is a focus on applied scientists versus theoretical scientists. “Academia tends to generate theoretical scientists” (Industry Representative D). Certain programs have focused entirely on the traditional biology, chemistry, and microbiology, and that is one of the greatest barriers to success for biotech programs. Students must be energized by what is happening in the industry—not in classical theoretical science. The real benefit of the program is student immersion in biomanufacturing processes and “to see the industry application of the science” (Industry Representative F).
- Protection of intellectual property - In general, industry has a greater motive and need than higher education to protect its intellectual property. However, because of the sheer number of research institutions now “involved in patenting their technologies,” the cultural divide has diminished (Industry Representative J). However, mechanisms must be in place within the partnership structure to protect intellectual property shared or created (Industry Representative J).
- Reward systems - Progression to complete a degree program is generally a known entity whereas career progression timelines are highly varied. Industry Representative G, referring to the point when one enters a program, states the following:

You have this known set of courses in this known amount of time...and you have something at the end of it. Whereas you could go into any job and it could be years before you get a promotion....So I think it’s that whole different reward [system]. (Industry Representative G)

Mutual expectations and accountability. According to Austin, high performance partnerships inevitably incorporate clear expectations regarding deliverables assigned to each partner. This in turn defines execution parameters and fosters accountability. To be

successful, the partnership must demonstrate their effectiveness in meeting the identified needs (Austin, 2000a). Partnership expectations should be “recalibrated from time to time as relationships broaden and deepen and other forms of strategic cooperation are contemplated” (Austin, 2000b, p. 165).

Industry Representative C agreed with Austin in that defining clear, tangible goals and conducting regular performance assessments are enablers to developing an effective partnership. Defining expectations and how things will work upfront is important to organizational success (Industry Representative B). Industry Representative A believes that some expectations for the partnership have not been made clear. This includes expectations around the business model and communication strategies to be employed by the partnership. Especially for new projects such as textbook development, clear expectations are a necessity. The partnership must impart to industry partners what is needed from them. If industry does not know what is needed, then they cannot determine “whether or not we can support it” (Industry Representative A).

Industry Representative C also adds that the partnership should develop mechanisms for feedback and evaluation, specifically measuring performance against the goals and deadlines established. However, this is difficult because the feedback, although direct, is not “to anyone in particular,” so change is dependent on the leadership (Industry Representative C).

Another industry partner recognized the role that feedback from the board plays when requesting continued funding. Basically the partnership is accountable to its customers through the board membership. The process is not incestuous and provides a balance between industry and education customers. The partnership must demonstrate

that they are living up to the customer's expectations. If the board is satisfied with past performance, this can be relayed to the funding organization and the board can support the partnership's request for continued funding (Industry Representative D).

To demonstrate accountability, Industry Representative F suggests that the partnership might wish to create and distribute an annual report targeting industry partners. This scorecard would indicate the number of meetings with industry, results of conversations regarding meeting industry needs, adjustments made to the program because of industry contacts, and evidence of the impact of graduates on companies (Industry Representative F).

Enablers Not Aligning with Austin's Model

Shared visioning. Although Austin classified shared visioning as a driver in his model, the industry representatives interviewed categorized it as an enabler. A shared vision is central to productive partnerships (Austin, 2000a). "Periodic strategic visioning exercises in which the partners collectively consider the possible future path and benefit opportunities of the collaboration" is important to partnership evolution and contributes to value renewal (Austin, 2000b, p. 179).

The keeper of the vision must be able to scan the broader needs of all partners and "effectively translate the need into a program...[that] balances the academic piece and the applied piece" (Industry Representative A). Initially Dr. Sonia Wallman had a vision that entailed more than "a single community college offering some practical classes for people to get a job" (Industry Representative D). The key draw was in tailoring the vision such that partners viewed it as common to all. He concludes that "they have a very strong vision of what they want to be" (Industry Representative D).

Areas of Partnership Effectiveness

When asked what partner aspects either met their company's expectations or were working well, industry representatives were, in general, satisfied with the partnership's program and products. "Industry, just as I am, seems to be quite happy with their involvement with NBC²" (Industry Representative I). Furthermore, the effort has given one industry representative "some hope and belief that my tax dollars do fund things that aren't necessarily wasteful" (Industry Representative I).

Achievement of Goals and Outcomes

Several industry representatives (B, C, and D) feel that both the partnership focus and related outcomes have been good. "I think it actually has delivered on its promises" (Industry Representative C). Although he stated that the partnership has not achieved every goal, he does believe that goals have been reasonably scoped. Thus, the expectations were not too high. More importantly, the partnership did not overreach in its intended outcomes and fail.

Skill Sets of Program Graduates

In general, industry is satisfied with the skill sets of program graduates (A, C, G, and I). Industry Representative G describes the importance the skill set plays in the career of the biomanufacturing technician:

The few applicants that I am aware of that have directly come out of the Center are definitely qualified. They have been good additions to the team. They're people that have not only stayed around, they've advanced within the organization. So, I think that's definitely met the expectations of getting those qualified applicants in. (Industry Representative G)

Industry Representative I compared the skills he obtained from his four-year degree program in the field to those being acquired by students in the NBC² two-year

degree program. Although he graduated with honors in biochemistry, he had not been exposed to Good Manufacturing Practices or FDA regulations. He stated that his alma mater still does not teach those topics and explains the effect it has on graduate competitiveness in the job market:

Those graduates aren't as competitive as ones that have learned that information, and those coming out of NBC² have learned it. They not only have been taught it in theory, they've used it in the classroom. I know that they're ready to document properly and follow regulations in my lab. (Industry Representative I)

Programs

According to three industry representatives (A, C, and G), the program is exceptional. Industry is pleased with “the information the students are getting” (Industry Representative A) through the program. Industry Representative G believes the program is effective because the program exposes students directly to the industry through “tours of the labs and the manufacturing area.” The tremendous role the program plays in meeting industry's need was also recognized (Industry Representative A).

Curriculum Development

Six industry representatives (C, F, G, H, I, and K) selected the curriculum as an effective aspect of the partnership. Two-thirds spoke to specific curriculum products and one-third to the curriculum design process as being effective. Industry Representative I pointed to the “quantity of products,” including a series of textbooks. The textbook is described by Industry Representative C as being of “very good quality.” Another representative stated that he was excited by “a textbook that could be universally used” (Industry Representative K). Moreover, he recognized that a “standardized curriculum” is the “right path forward” (Industry Representative K). A fourth industry partner

discussed that the “standards set are extremely valuable” in that they save time for others establishing programs (Industry Representative H).

Regarding the curriculum design process, Industry Representative F defined it as “one of the most satisfying, enriching, professional experiences I’ve ever had.” He acknowledged the effectiveness of collaborating with both industry and academia to define the “essential knowledge and skills...for people coming into the program” (Industry Representative F). Another industry partner was struck by the willingness of academia to openly solicit information from industry (Industry Representative G).

Industry Representative C summarized his feelings by stating, “I think it [the Center] has delivered on the curricula and now it’s time to use it.”

Professional Development Opportunities

Industry Representative D explicitly highlighted the professional development opportunities offered by the Center as effective practices. He spoke about the positive impact of the BIOMAN Conference on the chairman of the local biotechnology program and how conference learning is translated to the classroom. According to Industry Representative I, in addition to the BIOMAN Conference, the Protein is Cash workshops have also positively impacted on the knowledge and skills of faculty.

Relationships and Networking

A critical yet effective component of the organization is the building of relationships and consequential creation of networks (Industry Representatives B, C, E, and I). Industry Representative E noted that he doesn’t verbalize the benefits of establishing relationships within the organization often enough. Another industry partner commented that although forming relationships is not necessarily a goal of the

organization, he perceives it as a spontaneous, unintended benefit (Industry Representative I). Industry Representative L provided additional information on the subject, “There is a palpable sense of humanity and true honest drive [among partners]....There is no lack of desire or commitment.”

Two representatives described the benefits of networking in regards to benchmarking. Industry Representative B feels that networking allows industry professionals to discover how other regions, be it institutions or companies, approach current issues within the field. Although some industry members are in a constant state of flux regarding their involvement and engagement, others have demonstrated continuity and thus “There is a very strong network....As an industry member, I value [the network]. I like to hear what other people are doing. That’s been very good” (Industry Representative E).

Explaining the importance of relationships established through the NBC² and their impact when attending professional conferences, Industry Representative I related the following:

[These meetings are] a chance to go and interact with other individuals that you know are at different companies, but instead of maybe being stand-offish because you’re the competition, you know that you have something to share. You can talk, you can communicate, and then you will probably have a connection at that company in the future. (Industry Representative I)

Leadership

Industry Representative C described the leadership of the organization as “great people” with “a lot of energy” and “great to work with.” He also commented on the continuity of the leadership during the past four to five years stating that this is “a nice characteristic as well” (Industry Representative C).

Center Evaluation

According to Industry Representative C, the evaluator “has been great.” He noted that the evaluator has “created a sense of accountability and a nice snapshot of where we are at [*sic*] and where we’re going” (Industry Representative C).

Areas for Partnership Improvement

When asked what partner aspects were not working well or how the organization could improve their relationship with industry, representatives described ten areas. The first two aspects mentioned below may or may not be attributed to ineffectiveness of the organization itself or may be a by-product of a technical education program in general. Regardless, the researcher presents a description of each so that the reader may judge.

Quality of Candidates Entering Programs

Industry Representative C highlighted the struggle to interest qualified candidates in the degree program. The representative cautioned the community colleges against “overselling their candidates and their capabilities” (Industry Representative C). If the college vouches for the new hire’s abilities and subsequently the new hire does not work out for the company, then the trust between the company and the college could be damaged.

Number of Candidates Entering and Graduates Exiting Programs

Recognizing that it is not necessarily a case of ineffectiveness, Industry Representative E was surprised “that the number of people that we’re getting out of the program doesn’t seem to be as high as I would have expected.” The industry member attributed this situation to two things. First, the company draws heavily on the university

graduate population. Second, the program “is not attracting as many people as we would have anticipated, so they’re not selling it to the students enough” (Industry Representative E).

Process and Talent Management

Several industry representatives (A, B, and C) described a particular project in which process and talent management was an issue that threatened to thwart the project. In one project the “skill set” of the consultant and the lack of “accountability” appeared to present serious issues for the participating industry (Industry Representative C). Industry Representative B described it as a lack of facilitation, leading, and planning skills:

I always got the sense that there was just a vague agenda, that there weren’t really deliverables and outcomes that were expected at the end of each meeting. Maybe there were but perhaps they were not quite as hard and fast as what I might expect. Again, from [the] business [perspective], business takes a very different look at the way work is done. (Industry Representative B)

Adding to our understanding of the situation, Industry Representative A provided his viewpoint:

From my own perspective the disappointment [was] in the whole evolution of the project, because it wasn’t clear what they were really going for from the academic side to balance off what the folks on the industry side thought it was going to be. I think the expectations weren’t clear so it was very hard to work with it sometimes because it was, “What are we doing this for?” (Industry Representative A)

The process and talent management issue led to frustration (Industry Representative B) and a general feeling that project meetings were “somewhat a waste of their time” (Industry Representative C).

Noting a broader issue, Industry Representative A attributed the issues with process and talent management to a lack of business planning. According to this industry

partner, “it wasn’t clear what the real plan was. We would jump from thing, to thing, to thing, and all of those things were good but it was not really clear what the real plan was” (Industry Representative A). The business plan also has implications for the Communications Strategy issue cited below in that developing a communication plan is generally part of the business planning process.

Levels of Industry Engagement

Regarding the NBC² improving their relationship with industry, seven industry members (F, G, H, I, J, K, and L) suggested the organization engage additional or different levels of industry members. One industry member commented that, in general, the organization should solicit additional input from companies regarding “their courses and the content,” asking about the “hot industry trends...or new technology” (Industry Representative G).

The majority of industry partners—five of the seven—focusing on increasing industry engagement explained the need for multiple individuals from a single company to be involved in the effort. Industry Representative I termed it “two-tiered engagement” or “second tier involvement.” Illuminating the current situation, Industry Representative G explained that the NBC² is “looking to have someone in the company [engaged]. They’re happy to have that [single] connection.”

Several industry partners concurred that engaging additional industry members in the organization is critical. One partner focused on the necessity to “bring in more VPs from manufacturing” (Industry Representative H). Cautioning that time is money, this partner believes that the vice-presidents “have to be convinced that this is not a typical

academic endeavor...[but one that] brings collective thoughts and solutions to a problem” (Industry Representative H).

In another partner’s opinion, additional levels of engagement will supplement “these islands within the company that are the cheerleaders for these organizations,” providing visibility “across the board so all the different departments [within the company] know about it” (Industry Representative G). He further commented that with the Human Resources department, it is imperative that the NBC² “just keeps rattling the cage so that people don’t forget about them” (Industry Representative G). To explain how engagement of Human Resources aids him in his role, he continued:

I’m one of probably 40 managers and...100 hiring managers, so it’s not just enough for me to know these things work. It’s really going to be that site-wide field of things. So, if we could really get something more site-wide like HR involved, they [the NBC² organization and their local community college partners] would be the ones bringing us these applicants, almost that relationship-building so that they [the NBC² organization and their local community college partners] would become our go-to. At first it would be them [the NBC² organization] kind of having to knock on the door, but then it would become known across the site that anytime I need help I can go down the street first before I go to monster.com or whatever. (Industry Representative G)

Describing what he should have done to improve the engagement level, one representative stated the following:

I’ve worked at three different companies at one time having something to do with NBC². At one company, I had semi-involvement of the level above me. [At] the other two I did not, and I did not get them involved. I should have stopped trying to inspire them. I should have brought in the NBC² leadership and they could have inspired them or I should have brought in other people from NBC² to teach or show what they were doing. (Industry Representative I)

Another representative suggested the following:

[It] might be good to have the Center be more proactive in their outreach in that they’ve always been very open in inviting us to come take a look, come to their meetings, but to get on the road and set up meetings, and to come to us...for example, the organizational leadership [has] never called me and said, “Can I come take a look at your company, give me a tour in your manufacturing areas,

let me meet with you at your convenience at your place.” (Industry Representative K)

Industry Representative L agreed that site visits to company partners were essential. He also suggested that the organization should “reach out directly to the community colleges of relevance to the company,” those located within some radius of the site. According to the industry member, it is important for the organization to determine if community colleges are “on the same page” as the Center or if they are “doing their own thing” (Industry Representative L).

One difficulty lies in the time available for industry to be engaged. Industry Representative F illuminated the dichotomy of loyalty between local programs and a regional or national effort by stating, “We have two programs right here locally that if anybody has the time and energy to devote, they would devote it to those programs.”

Communication Strategy

Six industry representatives (B, D, I, J, K, and L) focused on the organization’s communication strategy as one aspect that exhibits some degree of ineffectiveness and suggested improvements to its communication strategy. One industry representative recognized that now is the time for the organization “to become more aggressive in promoting itself” (Industry Representative D). Another industry partner emphasized that it is important to not only make “the customer happy but then advertise that the customer is happy” (Industry Representative I).

Improving the relationship with current industry partners was described as simply “more routine communication” (Industry Representative J). This may take the form of e-mail blasts or a newsletter that prioritizes for industry those events and activities on an

annual basis for which their participation is critical. Moreover, this approach may allow scheduling to be more successful (Industry Representative J).

Two industry representatives (B and I) stated that more product visibility would be helpful. Industry Representative I specifically mentioned the need to disseminate the textbook nationally. He further explained that it may be difficult to get institutions to adopt the text if promoting it strictly to the academic side of the partnership. This representative felt that academics may suffer from “not invented here” syndrome. He suggested instead that the organization should target industry members serving on the advisory boards of local programs and let industry recommend incorporating the text into programs (Industry Representative I).

Industry Representatives I and L also drew attention to the lack of messaging with regard to the organization’s strategic value, primarily the benefits of graduates to companies. Industry Representative I stated that the organization is “not getting their message out that their graduates will be an asset to any company.” He described his viewpoint in more detail:

The CEOs will say, when it’s time to hire the grads, at least for some entry-level positions, that they want to pay the cheapest person...I recommend this person from a [biotechnology] program...Because they have this training, [this person] probably expects a few more dollars an hour, and so he’d [the CEO] rather go with the person that doesn’t have the training... If they [the NBC²] would just do a six-month case study following a few companies that would provide some basic anonymous information, I would guarantee that study would show individuals that complete the program and can start working from day one will save any company time and money. And so they [the companies] should, instead of hiring a cheap labor force that might be gone in six months, they should hire that person that showed the dedication toward biotechnology or life sciences. (Industry Representative I)

Industry Representative K suggested the organization could improve its relationship with his company by providing information regarding community colleges

who have adopted the NBC² program. At least one local community college established a program in his area of which he was unaware.

Another representative described the need for communication in a broader sense. Industry Representative L pointed to the need to know what the organization has planned for the next year, five years, and ten years. Furthermore, strategies to achieve these plans should be communicated, including how many meetings are planned and how frequently, who should be involved and provide input, and what the minimum number of representatives should be (Industry Representative L).

Finally, one industry partner highlighted the issues created by geographical distance from the northeast-located NBC² organization, citing the need for the organization “to reach across the country” (Industry Representative D). “There is not much of an outreach effort I have seen from the Center going across to the Midwest...and...to the West Coast” (Industry Representative D). The point of the outreach would be “to explain the benefits to people that are not partnered yet and explain to them why they should be partners” (Industry Representative D). This representative suggested that the outreach effort could be done through public relations or perhaps a portfolio. “A portfolio of accomplishments, of offerings, of possibilities for collaboration I think would be very, very helpful, and that portfolio should be updated on a regular basis within NBC²” (Industry Representative D).

Establishment and Mentoring of Community College Programs

From the perspective of Industry Representative K, it would be helpful if the Center built a relationship with his local community college and fostered the establishment of a program. He has made a connection to the local college and discussed

the possibility of the college offering a biotechnology program. Although the college is receptive, he believes the college would benefit from a connection with the NBC². In fact, the industry partner has given the organization's contact information to the college.

Incumbent Education and Training

Two industry representatives (G and K) highlighted their need for “training and continuing education” for “existing employees” (Industry Representative G). Industry Representative K further illuminated the topic:

Our training department [has] talked about trying to do on-the-job training for some of our technicians who don't necessarily have some of the theory or any of that in their skill sets. We've always struggled with the time to do it, the resources to set up these programs...If the program got set up and we had a readily available instructor who could come in and teach some one [*sic*] or two-hour sessions on various things—like how to take a pH measurement, what's the science behind it, how does it work, those types of things— [it would be beneficial]. Internally, we struggled with how do we [*sic*] set that up, who is going to teach it, and how do we develop the curriculum. So I guess what I'm thinking here is if some of the teachers involved in this program during their off times, summer or when they're not teaching a class, could make themselves available to do stuff like this I think that might be a beneficial thing. If they could come in, go on site, and help companies do some of these more targeted trainings, [it would improve the relationship with industry]. (Industry Representative K)

Internships

Industry Representative J suggested that one option for increasing the beneficence is if the “academic institution...encourages low-cost options of sharing personnel,” primarily through internship programs. He explained that there are jobs within a life science company that even a lightly-trained or partially-trained individual could perform that would contribute to a company. He theorized that if interns could be hired “at a discounted hourly rate or sort of on a volunteer basis” that the “smaller, less financially well off industry partners would really go for that” (Industry Representative J).

This sentiment is not shared by all industry partners. Industry Representative C cited the nature of the biopharmaceutical business as a roadblock to establishing internships. He explained that a two-month internship in a GMP environment where multimillion dollar batches are involved is not productive for the company or the student:

It takes them at least a month before they are really ready to go on the production floor with a lot of training requirements, and then they're not really going to be trained on much of anything. But in a two-month window they really won't add that much value back to the organization....It's very risky. You might put them in the warehouse or somewhere but then they're not getting much of an internship. (Industry Representative C)

Highlighting Industry Trends

According to Industry Representative G, the Center could improve its relationship with industry by providing trend analysis and information. He noted that industry is sometimes not informed regarding the “fresh new technologies” or those on the “cutting edge” (Industry Representative G):

I think that's often taken for granted that we're always on the ball. To be blunt...we kind of get lost with the bottom line, get it done with what you have on hand and not taking a step back and saying, “Here's this new regulation or here's this new technology that a lot of other companies are using.” (Industry Representative G)

Additional Project Funding

Industry Representative E pointed out that improving the NBC²'s relationship with industry is as easy as “continuing to do the things that it's been doing...but don't stop doing it,” especially if the activities are dependent on external funding. He informed that in the past the Center was able to implement more activities with his company specifically than they are doing now, in part because they had grant funds that supported those distinct activities:

Our association had dollars that were available to us so we had the ability to be a little bit more connected through that. I think as far as industry goes, I think everybody thinks industry is loaded so that we can always spend all this money. But if the Center can continue to try to generate available funds, and I'm not saying they have to pay for everything, but still find ways to generate funds to allow industry to come together...I think that that's also something that would be good. (Industry Representative E)

Sustainability

This section addresses the third research question, which regards the definition of sustainability and the major factors that lead to sustainability of an effective academia-industry-government partnership. When asked if the sustainability of both the NBC² organization and its products and services was desirable, every industry partner interviewed responded in the affirmative. One industry representative summed up his beliefs by stating, "We all need something that is just not a one off that will disappear in 2012. It has to be something that has significant longevity" (Industry Representative D). He added that the organization's demise would be a shame because "it would force somebody else to step up and essentially recreate the wheel" (Industry Representative D). There is the belief on the part of one industry member that the partners and community college programs will persist (Industry Representatives A and E).

When asked if the organization was at a point of sustainability, Industry Representative B responded, "Probably not just yet" but was also quick to affirm that the organization "could get there pretty quickly." Industry Representative A agreed, stating that it would not take much; "Just...opening up to a couple of other basic elements that fit in" and then the Center would be "phenomenal."

Regarding a definition for sustainability, industry representatives offered the following insights. Sustainability is viewed as the state of providing essential services to

meet the ongoing needs of the customer (Industry Representative F) and “being able to stay in the black” (Industry Representative I) after NSF funding ceases.

The major factors, from an industry perspective, that lead to sustainability of an effective center are described below.

Strategic Planning and Business Planning

According to two industry partners, strategic planning and business planning are essential to sustainability (Industry Representatives A and C). Indeed, Industry Representative D referred to the organization as a business. In order to be sustainable the organization has “to get down to the nuts and bolts, bread and butter” (Industry Representative A). Business planning allows an organization to scrutinize what resources are available and identify those goals that are achievable (Industry Representative A). This scenario is preferable because in his opinion “the leader [of the organization] believing it’s going to happen...is not sustainable” (Industry Representative A):

If you’re going to run a business you have to have a strategic plan. What is the strategic plan, and from that you then translate it into your business plan for the next year. How can you take on new activities if you haven’t defined what your strategic plan is? It’s great to have these really great forward thinking ideas. It’s fantastic, but at some point in time you’ve got to translate it into tangible nuts and bolts. How are you going to get there? Then, in doing that you can also look at what your resources really are that you can spend, what you can actually achieve...You have to have that mix of that real visionary out there, [deciding] where are we going that’s going to be bigger than whatever, but without actually being able to bring it down to basic strategic planning, your annual business plan, your decision making on what are you taking on next, what programs to drop, it’s got to move into that kind of realm or it will probably sustain just because it is. It won’t necessarily be as vibrant as it is perhaps right now. (Industry Representative A)

Financial Sustainability

As part of the business plan it is critical that the organization create a financial plan, including the organization's revenue and profitability model. There was a general understanding on the part of industry that the "charter for the sustainable organization...is [congruent with being] a non-profit" organization, realizing that the motivations behind forming non-profit organizations aligns with the views of the current NBC² partners (Industry Representative C). In talking specifics, Industry Representative B put forth several questions that need to be answered during the financial planning process, including "How much money do they need, and what kind of things can they do to produce revenue, or if bridging finances, where else can they get money outside of the NSF?"

Products and services. There is some thought on the part of industry that, as Industry Representative D described, "the collaboration should generate some revenue" from products (Industry Representative A, B, C, and D). Industry Representative D believes strongly that to remain viable the organization must develop useful products and services for industry to purchase. These products may be "new product lines" (Industry Representative B), "industry validated text materials...virtual software" (Industry Representative H), "certifications" (Industry Representative C), or training courses and manuals for incumbents (Industry Representative I). Regardless, it is important that the products "be held to a standard" and be professional and attractive (Industry Representative C).

Industry Representative D summarized his thoughts regarding the marketing of products and services to industry:

I don't think a program or collaboration would remain viable if academia is always coming to industry saying, "I need more money." There is a point at which the program has to become almost self-sustainable. Certainly, infusion of cash through grants is important but there has to be a work product that has financial value, and it's actually easy. Industry will pay very reasonable amounts of money for well taught classes for incumbent workers, because it's much cheaper for us to go outside and train fifteen, twenty people in classrooms for two weeks than it is for us to create the same programs in our own training system, then maintaining the program and delivering the program and finding people to teach those classes who may not be the best qualified people for that particular educational activity. So, it's so much easier to open a catalog and buy it. (Industry Representative D)

Other funding sources. Four industry representatives (B, C, D, and H) spoke to the importance of funding outside the NSF. Funding sources may include charitable foundations (Industry Representative B), donations (Industry Representative C), or other grant-funded initiatives (Industry Representative D). Industry Representative H went so far as to offer the possibility that industry members pay to sit on an industry advisory group that "has direct input into what is really an NSF certified, validated, and anointed Center to insure that their workplace development needs are going to be met...in the future."

Proven Track Record

According to Industry Representative J, sustainability is only achievable if the organization's "reputation gradually increases, or its influence gradually increases. You need success stories to build on. You need success to build more success." Industry Representative F believes it is a matter of demonstrating a strong record of purpose, commitment, and passion.

Other industry partners defined a proven track record as providing a relatively constant supply of qualified students over time—a pipeline of potential employees

(Industry Representatives G and K). These same two representatives also felt that a successful placement rate for graduates is necessary for sustainability. Furthermore, the new hires must demonstrate competency in the workplace:

A gauge of sustainability would be actual statistics and metrics on retention and advancement within the company because...you want to see that you're getting people that not only come in with a baseline, they then advance within the organization and by advancement, like I said, whether that's up or sideways.
(Industry Representative G)

Industry Representative L also stated that initiatives should be HR driven and measurable. Furthermore, he commented that efforts should, perhaps, be linked to social responsibility and measured in terms of community engagement (Industry Representative L).

Industry Representative F also mentioned the need to show others how well the organization is integrated with the local industry. The organization can demonstrate a proven track record when they have some number of industry representatives upon which the organization can call.

Currency and Relevancy

Six industry representatives (C, E, F, G, K, and L) believe that the organization must be current and relevant to be sustainable. Their perspectives focused on the currency and relevancy of either curriculum materials or the program itself. If instructional materials are not updated, Industry Representative C stated, then customers will stop using them. He further posited that deciding who would keep the materials current, if not the Center, would pose a challenge. In the same vein Industry Representative G noted that "actual up-to-the-minute relevance" of the curriculum

regarding “current topics, technology, industry trends, and regulatory trends” is necessary.

Regarding the currency and relevancy of the program, Industry Representative K explained that programs should not be static but rather dynamic. Industry Representative F described the process of “ongoing program development” as constant evaluation and assessment of the program against industry needs. This may result in an addition of courses and curriculum that targets an area of specialization (Industry Representative G). The delivery of program content should also be assessed, especially in light of rapid technological advances and the new delivery methods available (Industry Representatives C and F).

Continuous Improvement

Beyond relevance, Industry Representatives G and L pointed to continuous improvement as a factor that underpins sustainability. Industry Representative G described continuous improvement in terms of “the active improvement of programs, services, and relationship building” to show or renew value.

Adaptability and Flexibility

“You don’t want to create something that is sustainable yet static” (Industry Representative B). The organization must exhibit flexibility and adaptability if it is to be sustainable (Industry Representatives A, B, C, D, and K). Forward thinking is crucial for the organization to stay ahead of future advances in technology and communication (Industry Representative A), and it is incumbent on both industry and academia to continually ask “what-if questions” (Industry Representative B) so that changes can be

made in a timely manner. In this situation timely is defined as either quickly or in the right time frame (Industry Representative A).

Industry Representative D stated that changes in industry focus, such as a movement from cell culture products to microbial products to stem cell research, may affect the organization. “There are so many branches of biotech that are blooming or growing at a very, very rapid rate; it’s very difficult for anybody to stay ahead of the game so sustainability has to be at a technical level” (Industry Representative D).

Another example of technological advancement to which an organization must adapt can be found in the growing use of e-learning. Industry Representative C encouraged the organization to ponder how it will incorporate this delivery methodology in the future and what skill sets are needed to support it.

If the organization does not anticipate the needs of industry five years out then it will “probably...be less useful” (Industry Representative B). Regardless of the revenue generated by such an organization, Industry Representative B felt that the non-adapting organization “will eventually fall out of favor.”

Innovation

In the opinion of Industry Representative H, innovation is a critical component to achieve sustainability. He explained that the organization was in “a rocket phase in the beginning” and now its growth curve is “tapering off.” Some catalyzing event such as a change in strategy or mission is necessary to shift the organization from an “equilibrium position to a new growth curve position in order to remain viable” (Industry Representative H).

Maintaining Close Ties with Industry

Three industry representatives (A, B, and F) noted that maintaining close ties with industry is essential if the organization desires to achieve sustainability. Industry Representative F felt that thus far Dr. Sonia Wallman has done well in her “constant cultivation of relationships with industry partners.” In the future, Industry Representative B stated, the organization must not only “maintain or strengthen the relationships with their existing business clients,” but they must constantly strive to engage other business and academic partners. Reflecting on how best to accomplish this task, Industry Representative A felt that it is important to stay connected through “industry and trade groups.”

Consistent Engagement with Partners

Two industry representatives (A and L) suggested that in order to create a sustainable organization, consistent engagement with partners is important. Industry Representative L noted that engagement must go beyond volunteer participation. Industry Representative A further illuminated, “You can’t run hot and cold” with partners. If partners are not engaged then it will be more difficult to “warm them up,” but if they are already engaged and you need more input, then “it will be easier” to “heat things up” (Industry Representative A).

Continuity among Staff Members

For two industry representatives (E and J), continuity among staff members is an element promoting sustainability. The Center needs a cadre of staff who view their role as supporting the Center over the long haul and their dedication reflects this viewpoint (Industry Representative J). Interestingly, more than one industry representative

pondered what would happen if Dr. Sonia Wallman exited and how this might affect sustainability. “Where it stands today, it’s tough sometimes to see is it because of her or is it because we’re...[moving towards] sustainability?” (Industry Representative E).

Industry Representative J addressed the need for succession planning to provide continuity. “You can afford to lose the head as long as there are some lieutenants ready to succeed them. If there are leaders in training or missionaries in training to step in, you need to plan for that” (Industry Representative J).

Physical Presence in the Right Locale

For Industry Representative J, having “a physical presence in the right place” adds to sustainability. He recognized the difficulty of serving such a broad geographic area. Industry Representative H concurred and also cautioned the organization that it must embrace service areas outside the northeast region and seriously consider the “recommendations to change the Northeast [in the organization’s name] to National.”

Summary

The first section of Chapter Four presents a chronological history of the case. The three periods (i.e., pre-NSF regional center funding, NSF ATE regional center funding, and NSF ATE regional center re-funding) are defined by funding cycles. Long before the center was funded in 2005, the northeast portion of the United States flourished with biomanufacturing industries. In fact, the largest biomanufacturing facility in the world was located in Rhode Island; and many companies were experiencing rapid growth. Unfortunately, the companies experienced difficulty in finding qualified technician candidates for jobs in the biomanufacturing facilities.

To meet the needs of a skilled workforce, several community colleges in the Northeast were offering Biomanufacturing degree programs. However, the number of graduates was not sufficient to meet industry needs. Furthermore, most programs in the area focused on biopharmaceutical research rather than manufacturing. Compounding the issue was the lack of instructional materials to support the programs.

The New Hampshire Community Technical College was a recognized leader in biomanufacturing education. The program, which was established in 1994, graduated 195 students with a one-third industry placement rate during its first ten years. In 1998 the college was designated as the Northeast Regional Center of the national Bio-link center. The college received grant funds from the NSF ATE program in 1994 and 2003 as well as from the United States Department of Labor in 2004 and 2005. The foci of these initiatives were two-year degree programs for biomanufacturing technicians.

In 2005, with funding for a regional center from the NSF ATE program, the New Hampshire Community Technical College established the Northeast Biomanufacturing Center and Collaborative. Dr. Sonia Wallman served as the principal investigator. The center was organized into five hubs; each hub represented a geographical area in the Northeast region.

During the first regional center funding cycle, the organization focused its efforts on improving biomanufacturing degree programs for technicians, developing curriculum and instructional materials, providing professional development activities, and disseminating biomanufacturing workforce and education information. NBC² partners convened to develop a Harmonized Biopharmaceutical Manufacturing Skill Standard for

ten biomanufacturing jobs. The standards provide the foundation on which curriculum and instructional materials are built.

The group also gathered in 2008 to develop a national shared vision and mission for biomanufacturing technician education. In the process, partners developed the goal, objectives, and outcomes for the continuation of the organization.

Hub leaders created 59 individual instructional modules that were published as collections in several laboratory manuals. In addition, the group developed a virtual lab module based on a Chromatography SOP for Human Serum Albumin and a video of the chromatographic process.

The organization also began work on a 12-chapter introductory biomanufacturing textbook. For the most part, chapter authors represented industry companies. This effort has continued into the re-funding cycle.

In the area of professional development, the NBC² conducted an annual BIOMAN Conference, targeting biomanufacturing educators from colleges, universities, and technical high schools. More than 250 representatives from 23 states and Puerto Rico have participated. The organization also extended its reach within the hub areas by offering local workshops to faculty. Dr. Sonia Wallman continued to coordinate the Community College Program at BIO during this time period. The primary means of dissemination was through the organizational website and conference presentations by hub leadership.

In 2009 the organization was refunded by the NSF ATE program as a regional center. The New Hampshire Community Technical College relocated the center and its grant to the Montgomery County Community College in Blue Bell, Pennsylvania.

Although Dr. Sonia Wallman continued in her role as the organization's executive director, the previous co-principal investigator from Montgomery County Community College was designated as the principal investigator. Another shift in principal investigator occurred in 2010 when Dr. Linda Rehfuss resigned from the college.

Although the Center was moved to a new location, the NBC² retained its hub partners from the previous round of NSF funding. The organization added three new regional alliances to represent the southern, mid-western, and western regions of the country.

The four goals of the center remained as well, including improving biomanufacturing degree programs for technicians, developing curriculum and instructional materials, providing professional development activities, and disseminating biomanufacturing workforce and education information. A fifth goal on self-sustainability was added.

Two projects begun during initial NSF ATE regional center funding continued into the renewal funding years. These projects included the development of the Introduction to Biomanufacturing textbook and offering the annual BIOMAN Conferences.

In the area of program improvement, the partners convened in 2011 to continue their strategic planning efforts for the organization, clarifying objectives and key performance indicators generated during the 2008 meeting. Partners devoted substantial time to the discussion of the need and development of a national certification exam, emerging industry technologies, and curriculum that targets industry needs.

Hub leaders have also concentrated on mentoring new programs during this time period. The organization has mentored more than a dozen high schools and community colleges.

The organization has produced a *Biofuels Production and Analysis* textbook and laboratory manual. The eight-chapter textbook covers three of the most popular processes for biofuels production. The accompanying lab manual includes four activities on microbial cultivation, cellobiase enzymes, bacterial biohydrogen production, and algae cultivation.

The organization started work on a virtual, industrial-scale upstream processing module. This module affords students an opportunity to control the biopharmaceutical production process using an industrial scale bioreactor as well equipment necessary for the continuous centrifugation, depth filtration, and chromatography processes.

Regarding professional development opportunities, the organization offered numerous five-day Protein is Cash workshops, targeting teachers and counselors from middle schools, high schools, and community colleges. The workshop content combines information for career paths in biomanufacturing with hands-on lab activities. Throughout 2010 and 2011, 11 workshops reached 160 teachers.

In the area of dissemination, the organization has collected and distributed information concerning the state of biomanufacturing degree programs, the choices and influencers of students before entering the program, industry needs, and graduate successes. The organization continues to revise and update the website as well as present at national meetings to disseminate their products and findings.

The second section of Chapter Four traces the evolutionary progression of the organization against Austin's Cross-sector Collaboration Continuum Model. Results suggest that the partnership has progressed from the philanthropic to the transactional stage in its seven-plus years of existence. The philanthropic stage lasted from September 2005 through August 2007 and the transactional stage from September 2007 through January 2012.

During the philanthropic period, the number of partners involved in and contributing to organizational activities was relatively low. The partners that exhibited the highest level of engagement within the organization were the principal investigator and five co-principal investigators. While interaction among the co-principal investigators was intensive, interaction with industry and education was sporadic and infrequent. The organization's scope of activities was somewhat narrow and generated modest benefits and little strategic value. The magnitude of resources deployed by educational and industrial partners, other than the governmental funding organization, was small. Because the scope of activities was limited, the administration of such was simple. For the most part, co-principal investigators managed the curriculum development activities and professional development opportunities.

During the transactional phase, industry representatives felt the level of engagement had increased but was inconsistent. The organization engaged both industry and education partners through three intensive activities—the skill standards harmonization effort, the strategic planning meeting, and the textbook development project—implemented in rapid succession from September 2007 to September 2008. Two professional development opportunities—the BIOMAN Conference and the Protein

is Cash workshops—served to engage the greater educational community with co-principal investigators.

Although interaction increased during this timeframe, industry partners still characterized the level of interaction among all organizational members as infrequent. Partners recognized that the interaction level was more intense at certain evolutionary points (e.g., during the development of the textbook), but these bursts were viewed as temporary rather than sustained. In general, industry partners agreed that the scope of activities undertaken by the organization had broadened during this period but had not reached the integrative stage.

Although industry representatives recognized that the potential strategic value of the organization was major, the majority believed there was a disconnect between potential and realized value and rated the strategic value as falling within the parameters of the transactional stage. The magnitude of resources deployed by educational and industrial partners was viewed as small but increasing. The managerial complexity remained simple.

In the third section of the chapter, industry members highlighted those partner benefits that were most highly valued by their companies. These benefits included: providing skilled workers, improving biotechnology programs at the local community colleges, developing educational and training products, creating opportunities to network and benchmark, providing an avenue to fulfill their social responsibility mission, and catalyzing learning about the industry.

The fourth section, *Alliance Drivers and Enablers*, addresses the research question regarding the major drivers and enablers that lead to the development of an

effective academia-industry-government partnership. Several drivers identified by industry partners aligned with Austin's Cross-sector Collaboration Continuum Model, including "alignment of strategy, mission, and values; personal connections and relationships; value generation and renewal; and continual learning" (Austin, 2000a, p. 71). Although Austin classified focused attention as an alliance enabler, industry representatives of this case study elevated it to driver status.

For the NBC², the primary driver according to industry representatives was that "the partnership has a collective vote of common needs and wants..." (Industry Representative E). More specifically, the need as defined by industry is a skilled workforce. From the educational perspective, the partnership allows colleges to offer a biomanufacturing program in which industry is actively involved.

To the biomanufacturing industry, relationships are absolutely critical in the development of effective partnerships. Industry Representative D believes that without a collaborative atmosphere the project is doomed to failure. Connecting with the right person within a company or institution is paramount to successful relationship building (Industry Representative A). The organization must leverage the relevant functions within a company to solicit their input. An essential ingredient to building personal connections and relationships that underpin an effective partnership is having the right leaders at the Center (Industry Representative G). It is essential for industry to recognize the leader driving the partnership and understand their capabilities and motivations (Industry Representative F).

Strategic value can be generated through a generic resource transfer, core competencies exchange, or joint value creation. In partnerships such as this, monetary

transactions between industry and education are not significant (Industry Representative J); however, the industry has donated substantial amounts of equipment and facility time to local programs. The skill standards harmonization effort is an example of a core competencies exchange. Industry provided the input for the harmonization activity, and education partners used the results in the subsequent design of a biomanufacturing course focused on the ten jobs identified by industry. The textbook project was an example of joint value creation within the partnership. “Everybody had a stake in it [the textbook] and everybody was taking a different part of it. It brought together one curriculum that could be shared across all the colleges” (Industry Representative E).

Although industry partners did not declare that continual learning was a driver of effective partnerships per se, two did indirectly refer to organizational learning as important. Industry Representative G spoke of “keeping up with current trends and needs of the industry” in order to successfully launch the partnership. Industry Representative D remarked on the willingness on the part of academia to listen and respond to industry feedback regarding alterations needed for classes, programs, or “their thought processes.”

Commitment of education, industry, and government to the NBC² organization was viewed as a driver rather than an enabler. “If your customers don’t want to come to the table you will not put together a product they are willing to use” (Industry Representative D). The commitment cannot be viewed as a short-term engagement. Furthermore, the organization must engage multiple levels of a company or institution.

The section *Alliance Drivers and Enablers* continues by citing those enablers identified by industry partners that align with Austin’s Cross-sector Collaboration Continuum Model. These enablers included communication, organizational systems, and

mutual expectations and accountability (Austin, 2000a). Although Austin classified shared visioning as a driver in his model, the industry representatives interviewed categorized it as an enabler.

Clear lines of communication were viewed as a key enabler. Because communication keeps partners engaged in the organization, this function should be an assigned responsibility within the organization. Companies must be made aware of the presence of the NBC² organization and its ability to provide skilled workers. Partners must also be made aware of events and opportunities prior to their occurrence to encourage maximum participation.

The NBC² organization is a “very fluid, very dynamic, complex, multilevel organization” (Industry Representative B). Industry representatives recognized governance as an important enabler of effective partnerships. The organization’s governing structures, such as the National Visiting Committee and the Advisory Board, promote the realization among partners that “they are all marching toward the same goal” (Industry Representative D). Regarding organizational systems, it is also critical that a central hub exists that champions the partnership.

Defining clear, tangible goals and conducting regular performance assessments were identified as enablers to developing an effective partnership. Defining expectations and how things will work upfront is important to organizational success (Industry Representative B). The partnership must impart to industry partners what is needed from them. If industry does not know what is needed, then they cannot determine “whether or not we can support it” (Industry Representative A).

Regarding shared visioning, the keeper of the vision must be able to scan the broader needs of all partners and “effectively translate the need into a program...[that] balances the academic piece and the applied piece” (Industry Representative A). Initially Dr. Sonia Wallman had a vision that entailed more than “a single community college offering some practical classes for people to get a job” (Industry Representative D). The key draw was in tailoring the vision such that partners viewed it as common to all.

The fifth section of the chapter, *Areas of Partnership Effectiveness*, denotes those partner aspects that have met industry’s expectations. In general, industry representatives are satisfied with the program and products of the partnership and specifically mentioned eight areas of partnership effectiveness: achievement of goals and outcomes, skill sets of program graduates, programs, curriculum development, professional development opportunities, relationships and networking, leadership, and center evaluation.

The sixth section highlights areas for partnership improvement. Industry defines partner aspects that are not working well and suggest how the organization could improve their relations with industry. Several areas were identified, including the quality of candidates entering programs; the number of candidates entering and graduates exiting programs; process and talent management; levels of industry engagement; communication strategy; establishment and mentoring of community college programs; incumbent education and training; internships; highlighting industry trends; and additional project funding.

The final section of the chapter addresses the third research question regarding the definition of sustainability and the major factors that lead to sustainability of an effective academia-industry-government partnership. When asked if the sustainability of the

NBC² organization and related products and services was desirable, every industry partner interviewed responded in the affirmative. Sustainability is viewed by industry partners as the state of providing essential services to meet the ongoing needs of the customer (Industry Representative F) and “being able to stay in the black” (Industry Representative I) after NSF funding ceases. When asked if the organization was at a point of sustainability, Industry Representative B responded, “Probably not just yet” but was also quick to affirm that the organization “could get there pretty quickly.”

From an industry perspective, eleven major factors lead to sustainability of an effective center: strategic planning and business planning, financial sustainability, a proven track record, maintaining currency and relevancy, continuous improvement, adaptability and flexibility, innovation, maintaining close ties with industry, consistent engagement with partners, continuity among staff members, and a physical presence in the right locale.

Business planning allows an organization to scrutinize what resources are available and identify those goals that are achievable. In order to be sustainable the organization has “to get down to the nuts and bolts, bread and butter” (Industry Representative A). As part of the business plan it is critical that the organization create a financial plan, including the organization’s revenue and profitability model. There was a general understanding on the part of industry that the “charter for the sustainable organization...is [congruent with being] a non-profit” organization, realizing that the motivations behind forming non-profit organizations aligns with the views of the current NBC² partners (Industry Representative C). Furthermore, there is some thought on the part of industry that, as Industry Representative D described, “the collaboration should

generate some revenue” from products. The organization must develop useful products and services for industry to purchase to remain viable. Industry also recognized the importance of funding outside the NSF; funding sources may include charitable foundations, donations, or other grant-funded initiatives.

Another factor in sustainability is a proven track record. According to Industry Representative J, sustainability is only achievable if the organization’s “reputation gradually increases or its influence gradually increases. You need success stories to build on. You need success to build more success.” Some industry partners defined a proven track record as providing a relatively constant supply of qualified students over time—a pipeline of potential employees. These representatives also felt that a successful placement rate for graduates is necessary for sustainability.

In order to achieve sustainability, one-half of industry partners interviewed believe that the organization must be current and relevant. Their perspectives focused on the currency and relevancy of either curriculum materials or the program itself. Industry Representative F described the process of “ongoing program development” as constant evaluation and assessment of the program against industry needs. This may result in an addition of courses and curriculum that targets an area of specialization.

Beyond relevance, two industry representatives pointed to continuous improvement as a factor that underpins sustainability. Industry Representative G described continuous improvement in terms of “the active improvement of programs, services, and relationship building” to show or renew value.

The organization must also exhibit flexibility and adaptability if it is to be sustainable. “You don’t want to create something that is sustainable yet static” (Industry

Representative B). Forward thinking is crucial for the organization to stay ahead of future advances in technology and communication. It is incumbent on both industry and academia to continually ask “what-if questions” so that changes can be made in a timely manner (Industry Representative B).

Innovation is another critical component to achieving sustainability. One partner explained that the organization was in “a rocket phase in the beginning” and now its growth curve is “tapering off.” Some catalyzing event such as a change in strategy or mission is necessary to shift the organization from an “equilibrium position to a new growth curve position in order to remain viable” (Industry Representative H).

Maintaining close ties with industry is essential if the organization desires to achieve sustainability. The organization must not only “maintain or strengthen the relationships with their existing business clients,” but they must constantly strive to engage other business and academic partners (Industry Representative B). Consistent engagement with partners is equally important. The engagement must go beyond volunteer participation.

Continuity among staff members was also identified as an element promoting sustainability. The Center needs a cadre of staff who view their role as supporting the Center over the long haul and their dedication reflects this viewpoint. Succession planning was deemed important to provide continuity.

Finally, although it is difficult to serve such a broad geographic area with only one office location, having “a physical presence in the right place” adds to sustainability (Industry Representative J).

CHAPTER FIVE

Findings, Conclusions, and Recommendations

Introduction

The increasing demands on community colleges to broaden access and provide for the community's economic welfare, while maintaining its traditional role in the educational system, have served as a powerful impetus for institutional change. Community colleges have turned to partnerships as an avenue to ameliorate the challenges faced in the current economic and educational climate (Eckel et al., 2003). The onus is often placed on institutional administrators to structure these partnerships to ensure success. Although scant, the literature does provide analyses from the academic perspective. However, the industry perspective is generally lacking. This unbalanced representation has the potential to thwart the successful development and sustainability of these types of collaboratives.

The purpose of this study is to discover the major factors contributing to the successful development and sustainability of an industry-academia-government workforce education partnership from the industry perspective. The qualitative methodological approach focused on the application of Austin's Cross-sector Collaboration Continuum Model to the Northeast Biomanufacturing Center and Collaborative. The model provided a prominent boundary for data collection. With an NSF ATE-funded biomanufacturing center partnership as a context for analysis, the research study addressed the following questions:

- What are the major drivers and enablers that lead to the development of an effective industry-academia-government partnership?
- How well does the evolutionary progression of the Northeast Biomanufacturing Center and Collaborative align with Austin’s Cross-sector Collaboration Continuum Model?
- What are the major factors that lead to sustainability of an effective industry-academia-government partnership?

The three sections of this chapter serve to distill the findings of the study as well as provide recommendations for practice and future research.

Findings and Conclusions

Drivers and Enablers Leading to Development of an Effective Partnership

To answer the first research question (What are the major drivers and enablers that lead to the development of an effective industry-academia-government partnership?), the researcher collected data from industry partners through an interview process and analyzed data according to adaptive theory (Layder, 1998). Results indicated that the eight drivers and enablers defined in Austin’s Cross-sector Collaboration Continuum Model— “alignment of strategy, mission, and values; personal connection and relationships; value generation and shared visioning; continual learning...focused attention; communication; organizational systems; and mutual expectations and accountability”—align with those cited by industry representatives (Austin, 2000a, p. 71). The two minor exceptions in alignment resulted from the elevation of focused attention by industry partners to driver status and the demotion of shared visioning to enabler status.

Alignment of strategy, mission, and values. Regarding alignment of strategy, mission, and values, the message consistently delivered by industry partners focused on an urgent need to build a skilled and educated workforce, whether incumbent or new hire employees. At the time of organizational conception, the typical theory-based educational degree programs did not produce the applied technicians and scientists that industry desired.

According to industry partners, the organization and the biomanufacturing program also addressed the educational mission of institutional partners. DeLuca (2008) posited that consistency with the institution's mission is important to the development of the partnership. Not only was industry actively involved in both the definition of the program and instructional materials developed, but program graduates were viewed as having the relevant experience required by many companies for technician-level jobs.

These needs are consistent with Sharfman, Gray, and Yan (1991), who asserted that competitive forces such as a shortage of workers are drivers for organizational development. From the institutional viewpoint, partnering with industry allows institutions an opportunity to "play a unique role in providing the academic and applied learning that seeks to satisfy the demand for skilled employees" (Soares, 2010). In addition, the partnership serves to improve instruction within these programs (Powers et al., 1988) and strengthen faculty scholarship (DeLuca, 2008).

Research findings did not support the widely held tenet that core values are necessary for sustaining organizational greatness (Collins, 2001). Collins believes that it is essential that the organization has core values, that partners can identify the core values, that organizational decisions do not contradict the core values, and that the core

values are preserved (Collins, 2001). Interestingly, in this situation industry partners did not explicitly comment on the core values of the organization at all. In reviewing historical documents of the organization, the researcher did not find any references to the organization ever having formally identified its core values. Thus, this may provide the rationale for why industry partners did not comment on core values.

Personal connections and relationships. Successful partnerships “require a dense web of interpersonal connections....that enhance learning” (Kanter, 1994, p. 2). In the case of the Northeast Biomanufacturing Center and Collaborative, relationships were critical to the development of the partnership. Initially the principal investigator cultivated relationships with industry and education at professional meetings and conferences as well as in her laboratory. While it is critical to maintain the initial relationships, industry representatives stressed the necessity of connecting with a number of individuals at multiple levels within companies and institutions. From a company perspective, these individuals may represent the Human Resources, Operations, or Training functions.

When the organization reaches the integrative stage of evolution, Austin denoted that an *us versus them* mentality is replaced with a *we* mentality. It is interesting to note that on several occasions during the interview process, industry partners referred to “them.” For example, during a discussion about the organizational vision, one industry representative stated that “they have a very strong vision of what they want to be” (Industry Representative D). This is congruent with findings that the organization typically operates in the transactional evolutionary stage rather than the integrative stage.

One industry representative stressed the importance of trust in the relationship. He stated that if the college vouches for a new hire's abilities and subsequently the new hire does not work out, then the trust between the company and the college could suffer. This finding is consistent with MacMillan (2001) and DeLuca (2008), who asserted that trust is an essential feature of relationships. MacMillan (2001) further posited that trust must be built with each individual within the partnership and is based on the individual's character and competence. Thus, trust is built when an individual partner follows through with a commitment while focusing on excellence, honesty, and right motives (MacMillan, 2001). In the aforementioned situation, college personnel must fully understand a graduate's skill set and accurately represent it to industry if the trust is to remain intact.

Value generation and renewal. Austin defined value generation as “mobilizing and combining multiple resources and distinctive capabilities to generate benefits for each partner” (Austin, 2000a, p. 84). He also classified the value source as a generic resource transfer, core competencies exchange, or joint value creation.

In addition to a skilled workforce, industry partners recognized several other potential benefits of the partnership, including improvement in biotechnology programs, development of educational and training products, networking with competitors, and benchmarking industry practices. Although the realization of these benefits would generate tremendous value for the industry partners, the majority believed a disconnect exists between the potential and realized value. For example, industry is still dependent on multiple sources for qualified candidates. Those industry partners that have hired

graduates from a community college biomanufacturing program indicated satisfaction with the quality of graduates hired.

The organization has also created value for institutional partners through sharing program models, curriculum, and laboratory designs, as well as through offering conferences and workshops for faculty. Although the motivations for establishing the alliance, along with the benefits desired as a result of engagement, may vary, Amey, Eddy, and Ozaki (2007) posited that this is not problematic as long as all partners benefit from the efforts.

Research findings are also consistent with Kanter (1994), who emphasized that successful alliances involve joint value creation rather than mere exchanges of resources and competencies. Recently, the organization has taken positive steps towards joint value creation, most notably through the development of the textbook. Industry partners recognized that this product has the potential to impact curriculum and training at both institutions and industry companies.

Continual learning. In a visionary organization, “the drive for progress arises from a deep human urge—to explore, to create, to discover, to achieve, to change, to improve” (Collins & Porras, 1994, p. 82). The drive cannot be quenched, even if the organization is highly successful (Collins & Porras, 1994). To satisfy this desire, the learning organization examines current reality in light of the shared vision (Senge, 1990).

According to Austin, continual learning applies to the process of partnering (Austin, 2000a) as well as knowledge and skills exchanges between partners (Austin, 2000b). Industry representatives provided examples of both of these types of learning when discussing the Northeast Biomanufacturing Center and Collaborative. For

example, partners cited the importance of learning about hiring practices, patterns of biotech development, and job creation throughout various regions.

Although learning occurs at both the individual and organizational levels, individual learning does not necessarily translate to organizational learning (Senge, 1990). Industry indicated that learning occurred either during or as a result of the skill standards harmonization effort and textbook development project, but a distinction was not made between individual, team, and organizational learning.

Organizational learning also promotes creativity and innovation (Senge, 1990; Argyris, 1994; Austin, 2000b). When an organization reaches the integrative stage, systematic learning and innovation become standard practice. Furthermore, this learning fosters continuous improvement within the organization (Austin, 2000b). Collins concurs with Austin. According to Collins, transitioning a company from “good to great” relies on the organization’s capacity for discipline, “to do whatever it takes to become the best within carefully selected arenas and then to seek continual improvement from there” (Collins, 2001, p. 128). Research findings indicated that continuous improvement and innovation are viewed as essential elements for sustainability of an organization of this type. Indeed, forward thinking allows an organization to stay ahead of future advances in technology. Thus, it is essential that partnerships regularly schedule time for organizational learning (e.g., project autopsies, meeting evaluations, strategic planning).

Focused attention. To facilitate organizational progress, partners must exhibit a high level of commitment (Collins & Porras, 1994). Strong partnerships capture the focused attention of top management and key implementers to execute the organization’s goals, objectives, and activities (Austin, 2000b). Industry representatives recognized the

impact of committed partners but described the level of engagement within this organization as “waxing and waning” (Industry Representative B). The most consistent engagement of all partners was during the one-year time period from September 2007 through September 2008. During this time the organization convened the skill standards harmonization and strategic planning meetings and began developing the textbook.

In order to achieve success, the organization must engage sufficient numbers of partners and at multiple levels within partner organizations. In concert with the terms “committed” and “engaged,” industry partners listed desirable attributes such as “passionate” and “invested” to describe the champions that become the cornerstone of a workforce education partnership. These findings are consistent with Amey et al. (2007), who stated that “as with any other institutional endeavor, there is often a champion that pushes for and sustains the collaboration” (p.7). Senge (1990) also noted that committed partners exude energy and passion.

Communication. As a key enabler to partnership success, industry representatives pointed to clear communication as a means of keeping partners engaged in the organization. MacMillan (2001) agreed, noting that high performing organizations “have mastered the art of ‘straight talk,’ ...characterized by clear, straightforward communication that could be described as open, honest, timely, and accurate” (p. 166).

Industry partners characterized the level of interaction among all organizational members as infrequent. Partners recognized that the interaction level was more intense at certain evolutionary periods, but these bursts were viewed as temporary rather than sustained.

Industry Representative D noted that now is the time for the organization “to become more aggressive in promoting itself.” Due to the varied preferences for communication among partners, employing multiple methods is suggested. Indeed, various communication strategies should be employed to impart the organization’s ability to provide skilled workers to the industry, provide evidence regarding the value of those graduates to companies, create more product visibility, and keep partners informed of organizational events and opportunities. Communications must explain how the information is relevant to the organizational vision and mission. According to industry partners, the communication function should be an assigned responsibility within the organization.

Organizational systems. Industry partners recognized the NBC² organization as dynamic and complex. These collaborative organizations have been described in the literature as “living systems that evolve progressively in their possibilities” (Kanter, 1994, p. 2).

If the organization is to “prosper far beyond the presence of any single leader and through multiple product life cycles,” then the focus must be on the creation of the organization itself (Collins & Porras, 1994, p. 23). In the case of the Northeast Biomanufacturing Center and Collaborative, more than one industry representative pondered what would become of the organization if its leader departed.

Building a great organization is not a one-time event but rather a “cumulative process—step by step, action by action, decision by decision...that adds up to sustained and spectacular results” (Collins, 2001, p. 165). As the mission and vision are implemented, the systems and procedures providing a frame for the partnership’s actions

should become more stable (Austin, 2000b). However, as MacMillan (2001) noted, business thought processes such as decision-making, meeting management, and planning “are often ill-defined or missing entirely” (p. 37). High performing organizations consciously design, master, and continually evaluate key processes. Absent well-defined processes, the effort results in frustration and a feeling that time was wasted (MacMillan, 2001). The organization faced this type of frustration during the textbook development project. The team experienced confusion regarding project vision, target audience, timelines, processes, content standards, accountability, and communication strategies (Document #128). These challenges threatened to derail the project. Indeed, an organization’s effectiveness is limited by its work and thinking processes and its ability to execute such (MacMillan, 2001; Levi, 2007).

Mutual expectations and accountability. In a sustainable organization, partners are accountable for their collective goals as well as performance (Zimpher, 2009). High performance partnerships inevitably incorporate clear expectations regarding deliverables assigned to each partner (Austin, 2000a). Goals must be clear, compelling, and drive the progress of an organization (Collins & Porras, 1994). Industry partners agreed that defining clear, tangible goals and conducting regular performance assessments are enablers to developing an effective partnership. Furthermore, industry understands that cultural differences among partners may impede the partnering process. Thus, illuminating those differences early in the partnering process provides a solid foundation for identifying mutual expectations.

Although mutual accountability is an indispensable relational feature, it is rarely defined and seldom employed (MacMillan, 2001). One industry representative agreed,

stating that feedback, although direct, is not “to anyone in particular” so responses are dependent on the leadership (Industry Representative C). This was particularly evident during the textbook development project, when a consultant displayed a lack of accountability and industry had to rely on the leadership to handle the issue.

The evaluation system implemented has provided some structure for accountability. It has “created a sense of accountability and a nice snapshot of where we are at [*sic*] and where we’re going” (Industry Representative C).

Shared visioning. Shared visioning is a matter of the heart rather than an idea. It is a force that connects individuals together through an important undertaking (Senge, 1990). In this situation, the principal investigator tailored the vision such that partners viewed it as common to all and thus committed to the cause. This aligns with Senge (1990), who asserted that commitment is realized when the shared vision is an extension of each partner’s personal vision. According to industry representatives, the shared vision for this organization takes into account the partner needs and translates them into a workforce education program that balances theory and application.

Evolutionary Progression of the Partnership

The researcher’s analysis of the second research question (How well does the evolutionary progression of the Northeast Biomanufacturing Center and Collaborative align with Austin’s Cross-sector Collaboration Continuum Model?) supports the utility of the model in determining the progression of an advanced technological education partnership between industry, education, and government agencies. An analysis of documentation and interview transcripts revealed that the partnership has progressed from the philanthropic to the transactional stage in its seven-plus years of existence.

The organization operated in the philanthropic stage from September 2005 through August 2007. The level of partner engagement was relatively low and the level of interaction classified as infrequent. Because the organization focused on development of individual instructional modules, offering professional development activities, and establishing the organizational infrastructure, the scope of activities was defined as somewhat narrow. Significant strategic value had not been realized by partners. Other than governmental funding, the magnitude of resources deployed by educational and industrial partners was small and the administration of such was simple.

The organization operated in the transactional stage from September 2007 through January 2012. Industry partners noted that the level of engagement has increased but has been inconsistent. Similarly, the level of interaction has increased but industry partners still characterized it as infrequent. Industry representatives placed the scope of activities and the strategic value in the transactional stage. The magnitude of resources was viewed as small but increasing. Although the managerial complexity remained simple during this phase, industry did not view this in a negative light.

An examination of the characteristics for drivers and enablers in each of the three evolutionary stages produced results consistent with the organization operating in the transactional stage. For example, the organization exhibits a partnering mindset and the relationship is viewed as a tactical rather than strategic tool. Several instances of core competency transfer have occurred. Moreover, attention from top management is periodic rather than consistent. These characteristics are indicative of an organization operating in the transactional stage.

These findings serve to validate the utility of Austin's Cross-sector Collaboration Continuum Model in mapping the evolutionary progression of an industry-academia-government workforce education partnership. Determining where on the continuum an organization lies provides partners with a snapshot of their evolution and aids in their decision-making as to whether there is value in progressing to a higher stage. The seven variables that define the nature of the relationship provide easily understood reference points to understand the organization's evolution. Austin acknowledged that an organization may not exhibit characteristics from one evolutionary stage across all the relational variables. Thus, minor overlaps and inconsistencies may exist with the application of the model. This is true for the case studied.

Factors Leading to Sustainability of an Effective Partnership

In order to answer the third research question (What are the major factors that lead to sustainability of an effective industry-academia-government partnership?), the researcher interviewed industry partners and analyzed data using adaptive coding. The study identified 11 factors considered essential for sustaining an effective partnership. These factors are described within the context of four of the model's drivers and enablers:

Value generation and renewal. Sustainability is only achievable if the organization's "reputation gradually increases, or its influence gradually increases. You need success stories to build on. You need success to build more success" (Industry Representative J). A proven track record promotes an organizational reputation and increases its influence. In this study the track record focuses on providing a pipeline of qualified program graduates, placing these graduates in the industry, and having new hires that demonstrate competence once they enter the workforce. The track record is

also proven by the breadth and depth of the organization's relationship with and engagement of industry. DeLuca (2008) agreed that addressing the needs of partners contributes to trust and sustainability.

Continual learning. Continuous improvement of programs and instructional materials is necessary for the organization to remain relevant. Both must be constantly evaluated and assessed against industry needs. The organization must be able to quickly adapt and innovate to stay ahead of future advances in technology, equipment, or processes that impact the biopharmaceutical industry. This is consistent with DeLuca (2008), who found that maintaining relevancy supports problem-solving efforts and contributes to sustainability.

Focused attention. Although Austin emphasized the importance of focused attention from top management in sustaining a partnership, industry representatives underscored the necessity of consistent engagement of numerous partners at multiple levels within partner organizations. The organization must strive to strengthen relationships with existing partners as well as engage new business and academic partners. Moreover, retaining close ties with industry is vital so that relevancy can be maintained. DeLuca (2008) found the same regarding sustainability factors: (a) the relationship must not be solely dependent upon one individual from each partner organization; (b) top management must commit to the partnership for the long-term; and (c) senior leadership from partner organizations must actively participate in the partnership.

Organizational systems. Industry representatives stressed the significance of business planning processes to an organization's sustainability. As part of the business plan, the organization should plan for its financial stability; this includes identifying revenue streams and the profitability model for the organization. Revenue streams may include sales of products and services as well as other funding sources such as donations and grants. This is consistent with DeLuca (2008), who found that funding stability is a necessary element underscoring sustainability.

Industry partners also recognized the need to maintain continuity among staff members, those that will support the Center during its life cycle and dedicate themselves to its mission. DeLuca (2008) found that retention of champions representing education and industry is central to sustainability. The importance of having "a presence in the right place" was also cited as an element of sustainability. Moreover, this central resource must embrace all regions across the country equally such that it is perceived as a national effort rather than a regional effort.

Recommendations for Practice

This study provides information to guide practitioners and scholars during their decision-making processes related to strategic alliance formation, implementation, and sustainability. In addition, research findings illuminate refinements to Austin's Cross-sector Collaboration Continuum Model to improve its utility for tracing the evolutionary progression of an industry-academia-government workforce education partnership. The following section outlines ten recommendations for practice that emerged from the study:

- *Do not be your only customer* - By its definition, a partnership implies more than one party. In this situation the need for a skilled workforce was the primary

driver for strategic collaboration. Thus, it is incumbent on institutional partners to invest the time necessary to understand industry needs as industry defines them. Institutional partners must also understand the business culture and discuss the differences between the educational and industrial environments with all partners upfront.

- *Have a product and stay focused on delivering it* - Because this partnership focuses on workforce development, industry input is essential to create a useful product. The product, whether it is a program, graduates, or instructional materials, must be an improvement of existing alternatives.
- *The partnership exists in the relationship and not on a piece of paper* - This study illuminates the role that relationships play in the establishment of the partnership. In fact, without the persistence of the principal investigator in building and maintaining relationships, the organization may not have existed or perhaps not existed in its current state. Furthermore, relationships must penetrate all levels of partner organizations. “The more points of connection, the stronger the relationship (Austin, 2000b, p. 129).
- *Build trust by committing and then following through* - Trust is a critical factor in developing collaboratives. It is created through confidence in an individual’s competence and character (MacMillan, 2001). Although trusting relationships do not necessarily assure partnership success, the converse is true. “Trust is fragile because it is always subject to betrayal” (Kahane, 2006, p. 52). Moreover, although it takes a significant investment of time to build, trust can be destroyed almost instantaneously.

- *Recognize that a successful partnership is a long-term commitment* - Cultivating relationships and achieving goals takes time and requires a long-term commitment. Partners must display a willingness to stay in the partnering dialogue. “It’s just like watering a lawn or watering the bamboo, where you just keep watering it for years and in the fifth year it finally sprouts” (Industry Representative I).
- *Identify the organization’s champions* - The positive impact of passionate champions on partnership development and sustainability cannot be understated. These individuals generally do what is necessary to achieve organizational goals and further the organizational mission. Prior to changing the leadership structure, practitioners must carefully consider the possible impacts that the disruption will have on the organization.
- *Solicit the opinion of all partners* - Engaging partners is crucial to building and sustaining the organization. Within the business community, input must be solicited from several departments, including Human Resources, Operations, and Training. At the higher education level, input should be provided by faculty, department chairs, and deans. Input from levels higher than that of the dean is recommended.
- *Be prepared to give more than you receive* - Initially an investment has to be made in the partnership—the cost-benefit ratio will be low. As the organization progresses, partners should realize more benefits for their investment. Furthermore, joint value creation is often not experienced until the organization

reaches the integrative stage, and this could take several years in a workforce education partnership of this type.

- *Share the success stories* - In order to be sustainable, a workforce education partnership must demonstrate a proven track record and then, communicate the successes to its partners. A proven track record promotes an organizational reputation and increases its influence. In this study the track record focuses on providing a pipeline of qualified program graduates, placing these graduates in the industry, and having new hires that demonstrate competence once they enter the workforce. Communicating success in these areas promotes continued partner commitment and engagement.
- *Forget what has been done in the past; find out what is needed in the future* - The organization must exhibit adaptability and flexibility in order to respond to advances in the industry. The advances may be technologically, equipment, or process related. Not only must the organization respond to the current environment, it must be able to anticipate future innovations. The organization should devote substantial time to forward thinking and then be innovative in creating solutions to future issues. Indeed, continuous improvement and innovation are essential elements for sustainability of an organization of this type.

Finally, practitioners must regularly assess the evolution of a partnership to determine if the organization should progress and, if so, how this could best be accomplished. To aid in this determination, the researcher made slight adjustments to the language used in the model, incorporating business terminology instead of that used by the non-profit sector. Moreover, the characteristics used to define the drivers and

enablers at each of the three evolutionary phases were clarified. Since overlap existed, the nature of relationship categories was integrated with the driver and enabler categories. The revised model (Table 13) and the accompanying tool (see Appendix) will be helpful to industry-academia-government workforce education partnerships in the evaluation of their progression.

Recommendations for Future Research

The field of industry-academia-government workforce education partnerships is burgeoning and is a significant topic for additional research. In the spirit of this study, further research should be conducted that fosters partnership progression and sustainability. Recommendations for future research include the following:

- In light of the number of centers that have varied levels of industry engagement and are operating at different times in their funding cycle, it is important that the study be replicated with industry partners and the model repeatedly applied to a variety of regional and national NSF ATE-funded centers. For example, data collected during the pilot phase of the study indicated that centers do not always exhibit a linear evolutionary progression but indeed can and do revert to a lower stage if the delicate relationships among partners are not maintained. The pilot study reinforces trust as an essential element in maintaining and strengthening alliance relationships.
- In addition to examining the evolutionary progression of centers with different characteristics, future research should highlight best practices for developing and sustaining an effective partnership from the perspectives of other partners. For example, alliance evolution should be examined from the perspective of

Table 13

Revised Version of Austin's Cross-sector Collaboration Continuum Model

Nature of relationship	Philanthropic	Transactional	Integrative
Alignment of strategy, mission, and values (complementary needs)	Minimal fit required beyond a shared interest in a particular issue area Gratefulness and charity orientation	Complementary needs addressed through core competency transfers Partnering mindset Partnership as tactical tool	Complementary needs addressed through joint value creation Shared values Partnership as strategic tool
Personal connection and relationships	Minimal personal connection to cause or people	Strong personal connection at leadership level Expanded personal relationships throughout the organization Increased understanding and trust	Expanded opportunities for direct employee involvement in relationship Deep personal relationships and trust across multiple levels of organization <i>We</i> mentality replaces <i>us versus them</i>
Value generation and shared visioning	Generic resource transfer Typically unequal exchange of resources Minimal collaboration in defining activities Corporations respond to specific requests from nonprofits	Core competency transfer More equal exchange of resources Shared visioning at top of organization Projects of limited scope and risk	Joint value creation Value renewal through innovation Culture of each organization influenced by the other Projects identified and developed at all levels within the organization, with leadership support Broader scope of activities of strategic significance Numerous products and services integrated into multiple partners' strategic and/or resource sourcing plans Proven track record demonstrated that matches partner needs
Continual learning	Minimal or informal learning	More active learning about partnering process and industry	Systematic learning, continuous improvement, and innovation Spirit of adaptability and flexibility to maintain organization/product currency and relevance

(Continued)

Table 13 (Continued)

Revised Version of Austin's Cross-sector Collaboration Continuum Model

Nature of relationship	Philanthropic	Transactional	Integrative
Focused attention and level of commitment and engagement	Little top leadership attention Commitment and engagement is highest with small group of partners	Top management engaged at start-up and periodically Sporadic engagement of single individual at partner organization	Significant and ongoing attention from top management Consistent engagement of numerous individuals from multiple levels at partner organization Close ties with industry maintained
Communication and interaction level	Generally annually around grant process	More frequent communication between partners and externally	Explicit internal and external communication strategies and processes Individual assigned responsibility for organizational communications
Organizational systems	Corporate contact usually in community affairs of foundation; nonprofit contact usually in development Simple managerial structure	More people involved with responsibilities for specific collaboration activities Managerial complexity increases	Partner relationship managers Organizational integration in execution, including shared resources Organization implements good business practices, including strategic and business planning Continuity of key leaders and staff maintained Complex managerial structure
Mutual expectations and accountability	Use for stated purpose but minimal other performance expectations	Explicit performance expectations for targeted collaboration activities	High performance expectations and accountability for results Incentives for collaboration

Note. Adapted from "Strategic Collaboration Between Nonprofits and Business," by J. E. Austin, 2000, *Nonprofit and Voluntary Sector Quarterly*, 29, p. 72. Copyright 2000 by the Association for Research on Nonprofit Organizations and Voluntary Action.

community college partners and perhaps government partners. The added viewpoints of these alliance constituents will provide a more holistic understanding of partnering dynamics.

- Research specifically targeting each driver and enabler would be beneficial. This would facilitate a better understanding of the importance of each factor as well as provide a suggested course of action to reach the integrative stage of evolutionary progress in the topic area. Research might involve the evaluation, assessment, and refinement of questionnaire tools that target a single driver or enabler and help a partnership determine in which stage it currently operates.
- Research should focus on demonstrating the proven benefit of partnering. Specifically, the impact of hiring two-year degree ATE program graduates to a company's bottom line is of interest to the researcher. From an industry perspective, partnerships with academia are justifiable as long as continued value generation and renewal exists. In this situation, value is viewed as creating a pipeline of potential qualified candidates for technician level jobs in the workforce. Thus, in order to collaborate with education in the development of programs and curriculum, along with the offering of professional development opportunities for faculty, the company must be able to provide evidence of the impact of program graduate new hires to their bottom line. A study that documents the return on investment experienced when companies hired graduates from the national two-year degree program could include indicators such as job post qualification time, post-hire training time, attendance, operating incidents attributable to error, punctuality, and number of near misses and safety-related

incidents. The works of Kirkpatrick and Kirkpatrick (2006) and Phillips (1996) provide a useful conceptual framework for evaluating return on investment. This type of study would be invaluable to demonstrating a proven track record for these partnerships.

Final Comment

Many receive advice, only the wise profit from it. ~ Publilius Syrus

By three methods we may learn wisdom: first, by reflection, which is noblest; second, by imitation, which is easiest; and third, by experience, which is the bitterest. ~ Confucius

One aim of this research study was to illuminate the evolutionary progression of the case, the Northeast Biomanufacturing Center and Collaborative, from the industry perspective. Furthermore, the research study was designed to provide insights to practitioners and researchers on how to best structure and support partnerships among industry, academia, and government agencies to achieve sustainability. Duderstadt (2006) observed the following:

The modern university interacts with a diverse array of constituencies that depend on the university in one way or another...students, faculty, staff and alumni, the public and their elected leaders in government, business and labor, industry and foundations, and the full range of other public and private institutions in our society. The management of the complex roles and relationships between the university and these many constituencies is one of the most important challenges facing higher education, particularly when these relationships are rapidly changing. (p. 52)

To rise to the challenge, individuals and partnerships must reflect on their experiences, as well as the advice offered by others, and profit by applying the learning to their situation.

APPENDICES

APPENDIX A

Table A-1

Case Study Database

ID	Name	Source category	Source format	Words	¶
1	2004 NSF ATE Grant Proposal	Grant Proposal	PDF	23955	1161
2	2005 Advisory Board Minutes	Advisory Board	Doc	889	25
3	2005 Leadership Team Video Conference Minutes 11-16-05	Leadership Team	Doc	139	30
4	2006 Annual Report	Annual Report	PDF	6763	261
5	2006 Annual Report - Big Pharma to NVC	Visiting Committee	Doc	1919	157
6	2006 Annual Report - Metro Cambridge Boston to NVC	Visiting Committee	Doc	2894	235
7	2006 Annual Report - Mid-Atlantic to NVC	Visiting Committee	Doc	3777	324
8	2006 Annual Report - Northern New England to NVC	Visiting Committee	PDF	4079	151
9	2006 Annual Report - Rhode Island to NVC	Visiting Committee	Doc	3199	105
10	2006 Annual Report - Upstate New York Region to NVC	Visiting Committee	PDF	4426	172
11	2006 Evaluator Presentation to NVC	Visiting Committee	PDF	224	34
12	2006 Advisory Board Minutes	Advisory Board	Doc	3407	290
13	2006 Presentation to NVC	Visiting Committee	PDF	1332	119
14	2006 Presentation - Big Pharma to NVC	Visiting Committee	PDF	1221	120
15	2006 Presentation - Metro Cambridge Boston to NVC	Visiting Committee	PDF	922	111
16	2006 Presentation - Mid-Atlantic to NVC	Visiting Committee	PDF	1631	182
17	2006 Presentation - Northern New England to NVC	Visiting Committee	PDF	1242	104
18	2006 Presentation - Rhode Island to NVC	Visiting Committee	PDF	1278	156
19	2006 Presentation - Upstate New York Region to NVC	Visiting Committee	PDF	942	121
20	2006 NVC Recommendations	Visiting Committee	Doc	349	44
21	2006 Advisory Board Teleconference Minutes 1-17-06	Advisory Board	Doc	936	28
22	2006 Advisory Board Teleconference Minutes 2-15-06	Advisory Board	Doc	523	90
23	2006 Leadership Team Video Conference Minutes 1-18-06	Leadership Team	Doc	180	51
24	2007 Annual Report	Annual Report	PDF	13141	398
25	2007 Annual Report - Big Pharma to NVC	Visiting Committee	Doc	2255	187
26	2007 Annual Report - Metro Cambridge Boston to NVC	Visiting Committee	Doc	4461	518

(Continued)

Table A-1 (Continued)

Case Study Database

ID	Name	Source category	Source format	Words	¶
27	2007 Annual Report - Mid-Atlantic to NVC	Visiting Committee	Doc	3226	265
28	2007 Annual Report - Northern New England to NVC	Visiting Committee	Doc	5658	326
29	2007 Annual Report - Rhode Island to NVC	Visiting Committee	Doc	3590	134
30	2007 Annual Report - Upstate New York to NVC	Visiting Committee	Doc	6354	473
31	2007 Evaluator Presentation to NVC	Visiting Committee	PDF	1042	67
32	2007 Advisory Board Minutes	Advisory Board	Doc	1137	116
33	2007 NVC Plaudits and Recommendations	Visiting Committee	Doc	764	76
34	2007 Presentation - Big Pharma to NVC	Visiting Committee	PDF	1047	93
35	2007 Presentation - Metro Cambridge Boston to NVC	Visiting Committee	PDF	383	59
36	2007 Presentation - Mid-Atlantic to NVC	Visiting Committee	PDF	302	38
37	2007 Presentation - New York Region to NVC	Visiting Committee	PDF	384	51
38	2007 Presentation - Northern New England to NVC	Visiting Committee	PDF	2068	156
39	2007 Presentation - Rhode Island to NVC	Visiting Committee	PDF	578	62
40	2007 TECHcitement	Public Relations	PDF	7793	241
41	2007 Leadership Team Retreat Minutes	Leadership Team	Doc	1570	222
42	2008 Annual Report	Annual Report	PDF	20378	565
43	2008 Annual Report - Big Pharma to NVC	Visiting Committee	Doc	2511	222
44	2008 Annual Report - Metro Cambridge Boston to NVC	Visiting Committee	Doc	6233	822
45	2008 Annual Report - Mid-Atlantic to NVC	Visiting Committee	Doc	6838	776
46	2008 Annual Report - Rhode Island to NVC	Visiting Committee	Doc	3072	145
47	2008 Annual Report - Upstate New York to NVC	Visiting Committee	Doc	7442	522
48	2008 Strategic Planning Meeting Presentation	Strategic Planning Report	PDF	3930	236
49	2008 Presentation - Big Pharma to NVC	Visiting Committee	PDF	627	65
50	2008 Presentation - Metro Cambridge Boston to NVC	Visiting Committee	PDF	282	35
51	2008 Presentation - Mid-Atlantic to NVC	Visiting Committee	PDF	916	119
52	2008 Strategic Planning Meeting Presentation - NBC2 Overview	Strategic Planning Report	PDF	857	58
53	2008 Presentation - New York Region to NVC	Visiting Committee	PDF	385	70
54	2008 Presentation - Northern New England to NVC	Visiting Committee	PDF	1245	90
55	2008 Presentation - Rhode Island to NVC	Visiting Committee	PDF	248	24
56	2008 NSF ATE Grant Proposal	Grant Proposal	PDF	42860	2373

(Continued)

Table A-1 (Continued)

Case Study Database

ID	Name	Source category	Source format	Words	¶
57	2008 NVC Recommendations	Visiting Committee	Doc	341	28
58	2008 Strategic Planning Report	Strategic Planning Report	PDF	7628	318
59	2008 Leadership Team Retreat Minutes	Leadership Team	Doc	3201	655
60	2009 Leadership Team Meeting Minutes 5-11-09	Leadership Team	Doc	1759	289
61	2009 Annual Report	Annual Report	PDF	24221	882
62	2009 Advisory Board Meeting Report	Advisory Board	PDF	6218	337
63	2009 Advisory Board Meeting Transcript Part 1	Advisory Board	Doc	13333	261
64	2009 Advisory Board Meeting Transcript Part 2	Advisory Board	Doc	16876	527
65	2009 Advisory Board Meeting Transcript Part 3	Advisory Board	Doc	10342	531
66	2009 Advisory Board Minutes	Advisory Board	Doc	1925	219
67	2009 NVC Minutes	Visiting Committee	Doc	1603	88
68	2009 Advisory Board Presentation - NBC ² Phase 2 Plans	Advisory Board	PDF	358	38
69	2009 NVC Presentation	Visiting Committee	PDF	1297	187
70	2009 NVC Recommendations	Visiting Committee	Doc	327	24
71	2009 Leadership Team Teleconference Minutes 1-15-09	Leadership Team	Doc	608	84
72	2009 Leadership Team Retreat Minutes	Leadership Team	Doc	3296	579
73	2009-2010 Annual Evaluation Report Phase 2	Evaluation	PDF	11907	625
74	2009-2010 Outcomes Snapshot	Evaluation	Doc	716	172
75	2009-2011 Outcomes Snapshot	Evaluation	Doc	749	171
76	2010 Annual Report	Annual Report	PDF	8162	205
77	2010 BIOMAN Evaluation Report	Evaluation	PDF	18679	1553
78	2010 NVC Evaluation Presentation	Visiting Committee	PDF	1406	87
79	2010 Advisory Board Minutes	Advisory Board	Doc	2406	221
80	2010 NVC Minutes	Visiting Committee	Doc	2698	276
81	NBC2 Website About Page	Advisory Board	PDF	1741	91
82	2010 Advisory Board Presentation	Advisory Board	PDF	2457	205
83	2010 Advisory Board Evaluation Presentation	Advisory Board	PDF	868	65
84	2010 NVC Presentation	Visiting Committee	PDF	3663	331
85	2010 Leadership Team Retreat Minutes	Leadership Team	Doc	3458	246
86	2011 Annual Report	Annual Report	PDF	28868	1113
87	2011 ATE Centers Publication	Public Relations	PDF	28768	1716
88	2011 BIOMAN Evaluation Report	Evaluation	PDF	21579	1912

(Continued)

Table A-1 (Continued)

Case Study Database

ID	Name	Source category	Source format	Words	¶
89	2011 NVC Evaluation Presentation	Visiting Committee	PDF	976	77
90	2011 NVC Minutes	Visiting Committee	Doc	2167	253
91	2011 Strategic Planning Meeting Minutes	Strategic Planning Report	Doc	1911	237
92	2011 Protein is Cash Workshop Evaluation Report	Evaluation	PDF	30083	2268
93	2011 NVC Presentation	Visiting Committee	PDF	3194	330
94	2011 Strategic Planning Meeting Pre-Survey Results	Strategic Planning Report	PDF	962	102
95	2011 Strategic Planning Meeting Pre-Survey Results with Industry Filter	Strategic Planning Report	PDF	1391	125
96	2011 NSF ATE Grant Proposal	Grant Proposal	Doc	9342	248
97	2011 NVC Recommendations	Visiting Committee	Doc	408	22
98	21st Century Biotechnology Underway in Berlin, NY	Public Relations	Doc	978	49
99	7th Annual Community College Program Day	Public Relations	PDF	5437	128
100	8th Annual Community College Program Day	Public Relations	PDF	4591	82
101	Apprenticeship	Public Relations	PDF	956	23
102	ATETV Apprenticeships	Public Relations	PDF	754	41
103	Biofuels Production and Analysis	Public Relations	PDF	1168	124
104	Biomanufacturing Job Fair	Public Relations	PDF	455	11
105	Biomed Industry Growing	Public Relations	PDF	401	16
106	Bioscience Industry Stakeholders Convene at SoCalBio	Public Relations	PDF	1163	29
107	Biotech Resource Line Apr 2006	Public Relations	PDF	2764	69
108	Biotech Resource Line Jan 2007	Public Relations	PDF	2702	49
109	Biotech Resource Line Mar 2006	Public Relations	PDF	2997	67
110	Biotech Resource Line May 2006	Public Relations	PDF	2402	57
111	Biotech Resource Line Sep 2006	Public Relations	PDF	2726	57
112	Biotech Training in Practical Terms	Public Relations	Doc	—	—
113	Blurring the Biotech Line	Public Relations	PDF	842	29
114	Community Colleges Working to Develop a National Alliance for Biomanufacturing	Public Relations	PDF	2312	78
115	Cutting Edge of Biotech Education	Public Relations	PDF	1306	41
116	Getting the Most Out of Biotech Grants	Public Relations	PDF	520	18
117	Grant to Boost Biomanufacturing Training at FLCC	Public Relations	PDF	1009	47
118	Innovation and New Programs in Biotechnology and Biomanufacturing	Public Relations	PDF	1550	118

(Continued)

Table A-1 (Continued)

Case Study Database

ID	Name	Source category	Source format	Words	¶
119	Just In Time - Colleges, Biomanufacturers Teach	Public Relations	PDF	943	34
120	MCCC Earns Science Grant	Public Relations	PDF	832	65
121	NBC2 Builds the Biomanufacturing Infrastructure for the Bioeconomy	Public Relations	PDF	1750	187
122	New \$3 Million Grant Strengthens Northeast Biomanufacturing	Public Relations	Doc	520	60
123	New Hampshire Focuses on Education and Training for Biomanufacturing	Public Relations	PDF	0	1
124	Rhode Island High School Teacher Training	Public Relations	PDF	422	21
125	SST Grad Gets Running Start in Biotech Field	Public Relations	PDF	1678	86
126	State of Education Biomanufacturing	Public Relations	PDF	437	17
127	Summative Annual Evaluation Report - Phase 1	Evaluation	Doc	15205	1835
128	The Stem of Biomanufacturing Presentation	Public Relations	PDF	2976	270
129	Training Must Keep Pace with Biotech Industry	Public Relations	Doc	613	28
130	Transition of Biotechnology into Biomanufacturing: Is it a Passage into the Future	Public Relations	PDF	1840	97
131	Will Biomanufacturing Training Be Enough for New Plants	Public Relations	PDF	489	15
132	2008 BIOMAN Evaluation Report	Evaluation	PDF	9293	680
133	Text Chapter Writers	Textbook Develop	Doc	164	45
134	Textbook Authors Teleconference Minutes Oct 16 2009	Textbook Develop	Doc	418	92
135	Textbook Authors Teleconference Minutes Nov 6 2009	Textbook Develop	Doc	236	89
136	Textbook Update Nov 11 2009	Textbook Develop	PDF	323	14
137	Textbook Authors Nov 2009 Meeting Notice	Textbook Develop	PDF	363	10
138	Textbook Teleconference Meeting Minutes Email Dec 4 2009	Textbook Develop	PDF	265	11
139	Textbook Authors Teleconference Minutes Dec 4 2009	Textbook Develop	Doc	273	47
140	Textbook Update Mar 4 2010	Textbook Develop	PDF	372	11
141	Textbook Authors Jun 2010 Meeting Agenda	Textbook Develop	Doc	263	77
142	Textbook Development Process Evaluation	Textbook Develop	PDF	3490	133
143	2010 BIOMAN Journal	Public Relations	PDF	3303	125
144	Bristol-Myers Squibb Manufacturing Plant	Public Relations	PDF	891	44

(Continued)

Table A-1 (Continued)

Case Study Database

ID	Name	Source category	Source format	Words	¶
145	Trends in Biomanufacturing Education Evaluation Brief	Evaluation	PDF	3176	278
146	2005 Biopharmaceutical Manufacturing Industry Skill Standards	Skill Standards	Doc	15702	5096
147	Textbook Table of Contents	Textbook Develop	PDF	1999	128
148	Co-PI Teleconference Audio 1-22-07	Leadership Team	Audio	0	0
149	Co-PI Teleconference Audio 3-14-07	Leadership Team	Audio	0	0
150	Co-PI Teleconference Audio 4-18-07	Leadership Team	Audio	0	0
151	Co-PI Teleconference Audio 5-23-07	Leadership Team	Audio	0	0
152	Co-PI Teleconference Audio 6-20-07	Leadership Team	Audio	0	0
153	Co-PI Teleconference Audio 9-19-07	Leadership Team	Audio	0	0
154	Interview Participant A	Interview	Doc	6896	310
155	Interview Participant B	Interview	Doc	8289	288
156	Interview Participant C	Interview	Doc	5654	219
157	Interview Participant D	Interview	Doc	6687	171
158	Interview Participant E	Interview	Doc	5165	236
159	Interview Participant F	Interview	Doc	4889	179
160	Interview Participant G	Interview	Doc	5859	164
161	Interview Participant H	Interview	Doc	9718	127
162	Interview Participant I	Interview	Doc	4796	114
163	Interview Participant J	Interview	Doc	4273	120
164	Interview Participant K	Interview	Doc	3051	110
165	Interview Participant L	Interview	Doc	5996	128
166	National Advisory Board Teleconference Audio 12-14-06	Advisory Board	Audio	0	0
167	National Advisory Board Teleconference Audio 3-29-07	Advisory Board	Audio	0	0
168	Strategic Planning Meeting Audio Part 1 4-7-11	Strategic Planning Report	Audio	0	0
169	Strategic Planning Meeting Audio Part 2 4-7-11	Strategic Planning Report	Audio	0	0

APPENDIX B

Pilot Study Interview Transcripts

First Pilot Interview Transcript

Thinking about it from your company's perspective, what partnership benefits are most valued by your company?

Answer: I believe that the benefit that would be most beneficial as an industry representative would be the knowledge base that we receive for either current, incumbent employees, and/or a new hire employee that may be selected by our company.

Were there additional benefits or reasons for partnering with the educational institutions?

Answer: I believe that it becomes a case of allowing that institution to develop specific courses and/or programs that meet criteria associated with an employee who would work, not just in my company, but who would work in that particular field or a field that is similar to that. So that helps my company in regard to associated cost of training a new hire employee. You hate to relate it to money, but obviously, a better-educated person is a better employee because they are more cognizant. They understand what you're talking about when you talk to them about specifics. I would say they are a safer employee; in the industry that we work in, in any kind of manufacturing environment, you always have that inherent possibility of safety issues. You have equipment that moves; possibly you have flammable materials. So in regard to that, safety probably would be the number one issue. Cost effectiveness would be highly rated next to that. The third, obviously for the

new hire person in regard to that company, they just make a better employee right away. You have issues of teamwork, the issues of discipline, punctuality, and timeliness in regard to completing work on the job. If I just came off the street and sold tires for a living all my life and then I suddenly go into a manufacturing facility in that regard, what am I going to know? So, I think all of those factors combined create a much better advantage for the employer in the long run.

Are local programs that fit these needs with your previous company?

Answer: Yes, there are but in the case of my company, the original program was actually begun by my company at the request of my company in soliciting that from that school.

So why join with something bigger than your local area?

Answer: Because we actually didn't know about it until there was some promotion on that alliance's part to let us know. They actually contacted the school after we were teaching classes in regard to that manufacturing job—the job description for that manufacturing position in that company, and the alliance approached the school. If I remember correctly, it was a letter that was sent to them in the mail and the education department chair brought it to the advisory committee meeting of which my personal supervisor at that time chaired that committee. He brought it back to us and we looked at it and said, "Why re-invent the wheel?" If these people are working this why can we not help them out in this regard? And so that created, I guess, a cohesive bond among a number of industries of like-type and schools who were trying to promote the same thing. How many minds are better than the one? You know, a lot of minds are better than a single mind.

What are the major factors that lead to development of an effective academic industry partnership?

Answer: I would first say, obviously, they recognize the need in regard to the specific educational program; there is a need. Industry recognizes it. You may or may not have someone on the education side that has been in that position. In our business a lot of the instructors, professors, whatever their title may be as they go to work, move from industry to education and because of that, right away they see a need for a specific partnership in that regard. Some major things that you have to have on board are a very strong industry presence; they need to be committed. You must have strong support from not just your department, your particular department at the school or college that you are working that with, you must have strong support from that administration. If you don't have both of those working in tandem it will not work, number one. Generally in institution examples that I have seen, if they do not work together, then the school is not really listening or in tune with what is needed for the program. They try to draw the program instead of listening to their advisory committee needs and wants, in regard to specific course offerings. When you do that, then your industry will pull back and you need them for support in regard to possible donations, whether that be money or whether that be equipment that they can use as a show-and-tell piece. It doesn't necessarily have to work, but you have to have that and that generally comes from industry in regard to and related to the program course content and/or running equipment. You need someone from industry who knows how to do this—to come in and help you, to set those things up, or at least to advise you, even if you have to go to a vendor to purchase some of that. But you have to have great industry support. Back to that, you have to have strong

support from the administration of that school in regard to allowing the program chair, division chair—whatever they're called—to work in regard to what the industry needs on the advisory committee.

For example, if you have an advisory committee working on a manufacturing or other program, industry support is great. And sometimes they may be the initiating factor in trying to work in this realm of that program. But you need other input from industry. I have just seen so many times that if you only have that one industry person attending. What that tells that industry person is that your program, your educational program, is not working to bring anybody else in. It's just the nature of the business. If you only depend on me—you get all your money from me, and you get all your equipment from me, and you depend on me to set you up with running equipment and I provide the labor to get those things in place to help you in regard to the school needs for that program—at some point in time I'm just stretched too thin. Enough is enough. So you need more than one company; you need a number of industry partners. They don't have to be exactly the same. You'll have a lot of facets of this type of manufacturing process in regard to a number of different companies. So it doesn't have to be all one industry sector. You could have a lot of those members in the same, all of those members from different industries on the same advisory committee, but you need not be the only industry sponsors there because then it becomes your program. It actually just becomes a way of you training your people for on the job. That is essentially what it is, but you do not necessarily have what I would consider a well-rounded program that could be used in number of other places.

The local program that I work with the most in that regard is College A. I actually, a number of years ago, worked in that program. I attended their advisory committee meetings, and tried to listen to needs in regard to what they have and what they need and what they are doing with their program. Their enrollment is very low and the enrollment is low because they are still trying to get equipment simulation, hands-on, any of those things in regard to teaching principals. You can't just lecture. I mean you can sit and talk about things all day long but if you can't show somebody what you are talking about, if you don't have anything in regard to example, it just doesn't make sense. And sooner or later that becomes known in the community so College A has a very, very low enrollment because they are still asking for the same equipment that I was asking for in a number of years ago. And all of that is because of their administration and management. No money is funneled into that program.

What level from within the company is involved in the partnership?

Answer: Typically what I have seen and what happened in the company that I worked for, all the way up through the head of the training department, they have an on-site apprenticeship program. But obviously the need for education is real for them, so helping to pre-educate some of those people in that regard was very helpful. So they understand that. The manager of the training department and also the HR people were involved. So, you have HR representatives, hiring representatives at that level involved in the programs as well. And they were involved in several of the local programs.

If you were making suggestions to a new partnership on how to be most effective, how high of a level of engagement from industry would you say there needed to be?

Answer: I would say at least through the top echelon or the top management of their training arena, and that generally to me has fallen in HR. I do know some companies do that differently, but basically that is under the umbrella of the HR division. And I would say as high up as you can get someone involved in that and on board with you, the better off you are. And if you don't get your HR people involved, what I have seen in my experience, is that you are not going to have, you may have involvement at a very low level—as in an instructor attend a few meetings—but you will not have anybody on board who's a mover and shaker, who can delegate funds, who has the authority to delegate funding.

If you had to explain to a group that was just starting a partnership, how best to be effective, what would you tell them about the relationship as far as resources goes?

Answer: I think that the first thing that is really important in the way that we addressed it early on, we formed what we called at the time a “bubble-team”, which later became the advisory committee and comprised that team of different members—your education representative for the program, possibly the instructors if available, and as many industry representatives from your local area as possible. If they're food service or if you are setting up a program for something in the way of manufacturing—it could be any place where you have equipment instrumentation and those type applications—get those people together. Explain the need. Explain the vision, if you will, of what you want to do. And try to get those people behind you because they will end up being your resources, or at least you are able to garner funding from someone else.

Explain what you mean by the term resources.

Answer: When I think of resources, I think of money number one. I think of equipment. I think of even places on loan. I have actually taught classes on site at a facility when I had no equipment. I would do my lecture at the school and then hold my labs at this facility. If that facility is not located within a particular facility gate, so that you don't have to sign some kind of release form, if it is located off site, then a lot of times they will allow you to use a training facility. And that just gives a real time or what I call a real world learning experience to a student. What better way to learn about a pump than to go line up a pump, start that pump even if it is just pumping water, than for me to just show them a video in class and say "this is what it does." So, resources could be money, resources could be a facility, or resources could be equipment. I consider all of those things the teaching tools that you need in place to create or enhance common sense learning. People learn in different ways. Some people can sit and read a book, and go look at a piece of equipment and do that. But there are so many different learning styles that it's just almost impossible.

What were the other roles of industry in that partnership?

Answer: I guess depending on what is happening, how the partnership is set up or what the expected outcomes are of the partnership, industry or representatives from industry must also at some point provide subject matter expertise. You know, hopefully your professor or your instructor has a lot of that because they were in that field at one time. That is not always the case. I currently work right now with a school in this area that has two young instructors. They're balls of fire. They're really good. They are very creative. Neither has ever set foot in the field. So you have to have the subject matter expertise. Those company industry people may be called upon to be mentors, train the

trainers, be guest lecturers in class if needed, or provide a learning opportunity for that instructor/professor. We used to call them externships, take that instructor during the summer or during the winter break or whenever time can be made available and work with them for a month. Allow them to come to that facility site. They should have their criteria set up of what they need to know in regard to what they are teaching, but give them that experience of seeing really what they are doing in regard to teaching about a manufacturing process. And you can't get that unless you get people who have been in the field.

If you were involved in a partnership that you consider to be ineffective versus effective, what would you expect in the realm of communication?

Answer: I think an effective partnership provides clear-cut expectations in the beginning. If it's not clear-cut in the beginning about expected outcomes, responsibilities associated with outcomes, and delegation of those responsibilities in regard to that, sooner or later you're going to fall behind. There's always a timeline associated with these things. Most communication—whether that be telephone, e-mail, hard copy, teleconferencing, there are many software programs that you can use for meeting with people—you don't have to meet in the same room where a person is, but you really need a tremendous amount of communication in regard to what's expected, when it's expected, and how it's expected for delivery to be an effective partnership between both parties, between both sides.

What about accountability?

Answer: You must keep a reporting function and a very detailed reporting function in regard to those timelines. If you do not, then you become confused in what you are doing and what happens when. And sometimes you get so caught up in the details because you

have to do that in order to get particular pieces of the project completed that you lose that realm of the big picture. So that reporting function and the reminders of that reporting function help serve to keep you grounded and in line with those goals.

Any thoughts on how an effective partnership is organized?

Answer: I would think that somebody has to be the boss, obviously. You have to have someone that really oversees the project, basically oversees the project. You need the knowledge piece. Let's see if I can break that down better. Somebody has to work on the side of knowledge, looking at the end result, and trying to maintain the end result. Then you have the operational piece of that, who these people send direction to, to say we have to have this and then your operational group makes it happen. They're the ones that are in the trenches to ensure those communication lines are open, number one, from the knowledge, visionary side to the subject matter experts—whatever it is that is happening for this particular project, and make sure that those two pieces are well-meshed and are communicating and understanding. So the operational side and the visionary side, I guess, or the knowledge side.

Let's go back to the original question. It states, "What are the major factors that lead to development of an effective academic industry partnership?" So I heard you say that there has to be a need, there has to be a strong industry presence, and that there has to be strong educational support. Anything else you want to add to that?

Answer: I think that at some point—it may not be the initial piece—I believe you also must involve some type of service provider who can work with you to determine or to help your advisory committee determine needs in regard to equipment and other types of learning processes, whether it be a software application, whether it be a simulation of

some sort, but you're going to have to involve some type of service provider. Industry can't provide it all; they can't build it all; they don't have the money for all of it. But when you have that group work in process and they have been able to determine what they want to do and how they want to set up the learning experience or the program of experience, then you're going to have to involve some kind of service provider in that regard. Commonly we call them vendors.

Is one of the factors that you mentioned more important than the others?

Answer: I would say if you do not have the industry support, if you do not have the industry heavily involved your program is going to flounder. You may start off really well but your educational endeavor will flounder, because you can't keep it evergreen. You can't keep technology up-to-date. They're the people that you seek. You exist to serve those people, and I think industry is the critical piece.

How can a Center, such as a NSF ATE Center, improve and maintain its relationships with your company?

Answer: I'll go back to the communication again. If I never hear from those people—and I don't mean the e-mail blast—if my input is not solicited, if I'm not critically involved in what they're doing—they don't give me some kind of report on a quarterly, a bi-annual or an annual basis—I feel like, number one, I don't know how to help them. I don't know how to be a good partner, because I don't really know what's going on. It's as though they're there but you just don't really know what's going on, so I always go back to communication. I think communication is critically important in those types of partnerships. What are we doing now? What do I need to do? Here's our report for this period, and those kinds of things. I really believe that's a critical piece of it.

Have you ever had a situation where they solicited your input and then they didn't do anything with it, or they solicited your input and they did something with it?

Answer: No, I've had instances in some of the current work that I'm doing. We currently work with or partner with a group out of a college. I know that those folks have had a lot of administrative issues and turnover in help and a lot of what I call floundering because nobody knows what to do. There's no direction. There's no focus, and someone who should be communicating with me at first point never contacts me. Now in the last couple of months, I've had some communication from a person as I solicited information, but basically not hearing from anyone just tells me that they are not doing anything. If you're not involved, if you're not communicating and keeping people involved, then I have no idea what you're doing and I have no way of supporting you if I don't know what's going on. So yes, I would say that trying to work with that Center has been kind of a lose-lose situation for everyone in regard to that.

Was it always that way?

Answer: No, it was not always that way. When the Center was created, that Center had, and I don't know the time frame for that, but at one point in time that Center had several active alliances that they work with around the country and everybody was on the same page. That is no more. In fact, most of the alliances have basically gone defunct.

What factors was it about the early funded organization that made it effective as opposed to the less effective version today?

Answer: Their strong attempt to partner with and to receive input from these other organizations or alliances. Some of them are not called alliances and some of them have different names but that's basically what they were. And this early organization

attempted on every front to be involved in regard to their critical needs and for education in relation to what their industry asked for—their local industry.

Thinking about the NSF ATE Center, and this can either be previous or current, what Center aspects, if any, did not or have not met your company's expectations, or are not working well?

Answer: I know of two pieces: the curriculum that they've helped to design with subject matter expertise from a regional alliance. Those were the subject matter experts that they used and when they became a national entity, they of course brought in the other subject matter experts from these other alliances as well. They don't do that. That's not happening. There is nothing there in regard, to my knowledge, that the alliances are in the process of revising and updating objectives in regard to course curriculum. To my knowledge, nobody else is involved in that. The other thing that I would say is online course work that was provided through that particular Center was pulled. It was just pulled out from under, like you pull a rug out from under people. A number of the local colleges who used that, who have been using that interface without charge, were then required to pay and I think the timing of this was really bad because it was at the beginning of a semester and no one could get that funded. Budgets are set at that point in time. Everything is in place in a fall semester and these people just had to start from scratch. It was an extremely painful transition for those colleges that used that online course work because they were just left hanging. I really don't know what they did about particular courses that were in place unless they cancelled them for that semester or went to a different format. But those two pieces right there I think really created some terrible

issues and some terrible relationships between, if not the institution itself, a number of the instructors, program chairs, and division chairs in regard to that.

In your opinion, is there a place for relationships in developing a good partnership?

Answer: I believe that you have to have a relationship on some level. I'm not necessarily talking about close friend relationships, but you have to have a working relationship.

You have to be able to trust people. Very often companies are sharing proprietary information in regard to that. They have to trust and understand that that information is being used to the greater good, or the purpose of the development of that course objective or program status. In that example, there has to be a relationship associated with that.

You just can't talk to somebody one time; industry doesn't do that. If I called an industry representative right now that I didn't know and said, "Hey, I need borrow your Six Sigma." What do you think they're going to say? You have to have some kind of good working relationship in which those industry people understand your goals. They understand your drive in creating this partnership and the reasoning behind it, and you can't do that without some kind of good working relationship.

If you look at the beginning of funding of the Center, have the relationships grown stronger or have they diminished?

Answer: It's diminished at this particular Center that I am thinking of. They're very diminished.

In your opinion, has the effectiveness of the Center grown stronger, has it been more effective or is it less effective now?

Answer: It's much less effective. As I said, many of these alliances that partnered with them were in other states away from this region and when you have an organization that flounders and there's no communication, I can't sit and wait. If I have people with needs, if I have industry with needs, if I have colleges with needs, and I have semesters imminent upon me, I have to do something. I can't sit and wait for someone to get their act together. And so in that regard, I believe all that support was lost and that diminishes the effectiveness of the Center.

Were they ever effective at any point in time?

Answer: The organization was extremely effective and growing in its first year, two years of inception. At that point because of situations that happened regarding the college who hosted the Center and other monetary problems surrounding that, I believe that Center was greatly diminished in effectiveness and has continued to decline as such. I think in the last 12 months, I would say they've had multiple leaders and now they don't even have one. They have one staff person, but it's not a person that has any authority to make change, to create change. And when you have that, who's running the show? Nobody's running the show. So they're much less diminished over time because of that.

What happened that resulted in this ineffectiveness?

Answer: I believe when this Center became self-sustaining the college administration did not work with the Center on their becoming self-sustaining. And, in the end, the leadership changed and that change led to the downfall of that Center. They had nobody that could take over, that had that cognizant understanding, the vision and the knowledge to run a Center on that level.

What factors within the higher education realm may inhibit or impede the development of a partnership with a company such as yours?

Answer: I think that very often higher education—we're talking about the presidential office, that level of administration at the school or the board of directors in regard to that—is not knowledgeable about the ongoing situation. They're not in the day-to-day situational challenge of running the Center or the program. Just by the very nature of how they serve and where they come from, these people are in other walks of life. Very often that depends on if they're located on the same side of campus. But those people are not really in touch; they're not informed; and things are never really given to them until it becomes a problem of some sort. Then they have to make a determination based on what other information is given to them. I don't think that sometimes they get the entire situational picture.

When the partnership was effective and then again when you considered it to be less effective, was there any difference in the level of engagement from the companies?

Answer: With very few exceptions, and I believe that some of the companies that are involved now, the industries, are involved just recently, but with very few exceptions, I think a number of the other companies have pulled away. I know that a company I work for does not have any relationship with that group. It's my understanding that another company is no longer supportive, but I know they were a big supporter of this group at one time and I think they have, I don't know if they've entirely pulled their support but I know they do not fund anything. They used to fund scholarships. The Center worked to get scholarships funded and professional development funded for members or partners

with that Center and none of that is happening. I think that a number of the companies have pulled away.

Was there ever a time in the life of this Center that management at a higher level than Training Coordinators or Human Resources Directors was involved?

Answer: I can't speak for anyone but the company that I work for and to my knowledge it never went any higher than the site level president or vice president or whatever that title would be, but the overseer of that local site. In other words, I don't think it ever went to corporate.

To your knowledge, did any of the companies involved in that partnership ever use or ever integrate the Center's products or services into their strategic plans?

Answer: I only know of one company, and they have done that just in the last maybe two years. They used them, almost exclusively, for whatever online training that's been developed. I don't know of other companies who have done that.

How would you, as an industry person, define sustainability?

Answer: In my mind, when I think about that, these Centers are non-profit organizations, or typically are non-profit organizations, and they have to find some way to get funding to pay employees who do that operational piece. You can have a director; you can have a president whatever you want to call that person who's the visionary. People who do that day-to-day work of making the operation run smoothly, of creating materials if you will— graphic designers, instructional designers, secretaries—those people are typically paid employees. I don't care if it's the Red Cross or the United Way; those people are paid employees. You have to find a way to sustain that payroll. That's a part of

sustainability. The other piece to me is that you have to reach out and continually broaden your vision to encompass needs in regard to future needs. You have to solicit that feedback and that's generally your visionary or your director or that team if you will. You sometimes have a steering committee in regard to that and many places call it different things but those are the people who in that regard help sustainability because they go out to see not what's needed right this minute but what are we going to need ten years from now. What's the piece going to look like twenty years from now? To me, that's what helps to make any organization sustain itself or to become an entity as opposed to just an overnight sensation and then we're done.

Is there any products and services from the Center that should be sustainable?

Answer: Actually, I think all of those pieces should be sustainable but I can tell you they're not. The reason I say that is because I get requests on a regular basis for them. I get questions regarding professional development opportunities. They're not doing that. There will be no more of these conferences that they had for industry and education. There's just no money, no money to do it. I get constant questions about projections. I really need to solicit information about this stuff from the Center because I get requests all the time.

Is there one product or service that's more important than the others to sustain?

Answer: I would think that the textbooks, the student materials, the instructor materials. I would think that those things should be updated on a regular basis, and they never even completed all the textbooks. They never completed everything. There are several courses associated with this particular program I'm speaking of. They've never completed all of the materials for that so people just pick and choose from authors who

have written books either locally in their region or that they're very familiar with on a national basis from publishers.

In your opinion, is there one product or service that falls low on the totem pole?

Answer: I guess if I had to pick one before, I probably would've picked the statistics, the hiring projections, but I find now that I get a lot of requests for that from colleges who are trying to justify in writing a grant for funding, they're trying to justify that. So before I would have said probably hiring projections, but I'm not sure I can really tell you that one of those falls out. You hate to see in regard to manufacturing. I think it has fallen behind, but I'm not necessarily sure that it's the last thing in working with the schools, the K-12, and working with those groups. I think they have sadly fallen behind and I think they have decided that it's less important. But I don't think that if you had to rank those, I hate to say that because if you don't start pre-education or pre-interest for those younger students, they never know the availability of how much money they could make in the manufacturing world with a two-year associates degree. And the fact that that degree can be articulated into a number of things now like engineering and things like that, who knows what the future will bring.

What are the major factors that lead to the sustainability of this type of Center?

Answer: I think there are and I think I'll go back again to the issue of administrative support and communication surrounding that support. I believe given that most Centers are housed on a college campus or near a college campus, that there should be at some point clearly defined goals associated with that Center becoming self-sustaining. To that end there should be documentation signed on both parts, taken to the board of directors if needed, wherever it needs to go, that documentation should be in place. Then there's no

reason to ever be any question about that. So I would say the administrative support, the communication between all parties.

I think the Center has to do the work to make it self-sustainable, but I believe that if I've gone out and I've earned the right to do so, I need to have that support behind me to understand that this is what we're going to do, this is where this is going to go, this is what is going to happen with this group.

What factors lead to a Center being able to support themselves financially?

Answer: Being able to create an income to be able to pay staff members to complete the work that is needed for curricula, professional development, statistics, or awareness for the K-12. You have to have the money to do that. And if you are funded and that money is being funneled into those efforts, that to me is self-sustaining financially.

What happens when the funding goes away from the federal government?

Answer: By that time, you have enough of those colleges or industry partners or whoever you set that piece of it up to begin with, you have enough of those people who are then subscribing to you in that regard. You're selling technical and other materials at a rapid rate.

What attributes do you need in a Center to be able to achieve that kind of sustainability?

Answer: I think you need a highly motivated staff. I believe that you need a visionary leader. I believe you need someone with much experience in regard to issues surrounding the communication between industry personnel and education personnel. I think you need someone who is cognizant and educated in documentation and aspects

surrounding the ability to communicate with the members or the partners of that organization.

Who initiated the first contact between the Center and your company?

Answer: That would have been the Center.

Looking at the Collaboration Continuum Model, where would you say the Center is now on the collaboration continuum?

Answer: Probably on some of these it may be; I don't know anything about anything integrative other than the one company. I'm guessing right now if I had to summarize, looking at all of these—levels of engagement, importance to mission, magnitude, scope of activities, managerial complexity—I would have to say philanthropic.

Are there any of those listed there that you haven't considered? You've talked about the level of engagement of the company to the Center right now, you've talked about how many resources the Center has right now, you've talked about the diminished scope of activities that they have, and the low level of interaction. What about the others like importance to mission?

Answer: Even what you just said about those four—the level, the magnitude, the scope, the interaction—I think that in relation to my company, the importance to mission, that's negated all of that. All of that has lapsed to such a point that I would not turn to simply the Center at this point in time for anything in regard to something that my company would see as needed in order to complete a strategic endeavor.

Their managerial complexity at this point in time, they don't have any management that I know about. I'm not really sure what the structure of that is.

Strategic value, I'm sure that there are a few companies out there that may be placing their value with them. I can't speak for a lot of the other colleges.

Was there ever a time when the Center operated at a level higher than what you would consider stage 1?

Answer: I would say that at the Center inception and probably a year into it. My time is kind of a little bit off. I would say yes, at some point their level of engagement was high. I would call that integrative. I believe that the importance to the mission, I believe that was central for a number of companies and/or schools who partnered together. We thought they had tremendous resources. I know the scope of activities was broad because I was able to participate in some of those activities. They offered a lot of those things. I have kits that I give in demonstrations to middle schools students. I've got these little kits that were made up by this Center that had little hands-on activities that were a way of showing and teaching about advanced technologies. Yes, I would say that they were integrative in the one to two-year period there before everything fell apart, I would say that that Center could be considered a stage 3 integrative Center.

Are there any aspects of the partnership, the Center's evolution, that are not adequately addressed by this model?

Answer: I think there might be something needed here. I don't know how and it might already fall under this, but something in the nature of communication in regard to reporting or showing progress. Something in regard to process management so that projects, strategic endeavors that are being worked on are being completed. I'm not sure where that would be captured here in regard to that. I'm not sure if that's necessarily appropriate but if we're talking about relationships between a Center and its partners,

somewhere I need a piece that tells me I can look right here and find out what's going on and that they're doing it.

In what ways has your partnership evolved in a manner different from the model?

Answer: I'm saying it's not occurred in a liner progression. I would say it has not occurred. I would say at one point, importance to mission was central in stage 3, but not anymore. And I can for sure say level of engagement at one time probably was high or very integrated. Not anymore.

What do you mean by "high" level of engagement?

Answer: That the Center was working as it should to promote or to provide those four major pieces. I don't know if I ever remember any statistical piece at all. I don't remember that because that's really hard, that's generally for proprietary information and it may be hard for anybody to get. So I don't know if there was ever that piece involved at all.

Did you ever consider the level of engagement of the company back to the partnership to be high?

Answer: I think early on, yes. My company provided individuals who support them by attending conferences and/or meetings. They provided subject matter expertise in relation to a number of employees who worked, who helped develop curricula. They also provided proprietary information. They actually gave them all, on one particular course for sure, gave them all of the developed materials to review. They let them review all those materials that were copyrighted and then to sit down and develop a course, basically using, I'm sure they probably used some other input as well, so propriety

information. That's a high level of engagement for an industry when they will share proprietary information in that regard.

Do you have any other comments or anything you'd like to add that you think would be pertinent to the development or sustainability of effective Center partnerships?

Answer: I think that when any Center begins the process of partnership and involves anyone other than the immediate partner—as in if their immediate partner for example is going to be the NSF, that kind of partnership in the beginning—and then you bring in other people to work with you in that regard such as industries, schools, technical schools, vendors, other service providers whatever they are, I believe there needs to be a charter. I believe that the charter needs to reflect the entire structure from management down to operational and that needs to be disseminated before anyone is ever asked to become a partner. Those people need to understand who they're really working with and working for.

Do you have anything else you would like to add?

Answer: Only that I think that it is a travesty of the worst magnitude that this particular Center that I was involved with set back the ability and the integration of our program by a number of years because of particular incidents that happened in regard to the sustainability or the Center's effort to become self-sustaining. I believe that the ensuing problems that happen in regard to all sides, because you had a number of people just come back out and do nothing, and I think we lost a tremendous amount of time in effective management and in effective update and/or change for the program.

Second Pilot Interview Transcript

From a company perspective, what would you say were the benefits that were most valued by your company?

Answer: The most highly beneficial would be that the Center produced educated students or candidates that we could hire in our jobs in our industry, and that would increase effectiveness for our job completion, cost savings, and quality of candidates that we had before.

What major factors would you say either support or lead to the development to an effective partnership?

Answer: One of the most important ones was the fact that the industry drove the partnership to meet their needs. They have to have a need so it's very important that they would be in charge as the majority vote. You would have to get key players that are interested in those industries to participate on the board because they are usually responsible for that need. So it's very important that you have players from industry that have a need for that or are part of that responsibility that will participate. So that would be the most important. It would be nice to have experienced industry people that have been in this type of situation before—committees or involvement with an association—that would drive or give you the things you can do. So some past experience of at least a leader or driver that would drive everybody else to make sure it moves forward. The educational side would take a secondary role providing the services and requesting resources to help industry figure that out. Having monthly meetings are very important, with the outcomes and objectives to meet the industry needs. You have to meet the industry needs or there isn't any purpose to be there. So it's very important that you have

the partnership relationship. Basically what you do is get champions for your cause. The champions are there because they have a need to fulfill within their company.

So one of the things you hit on was industry participation. Talk to me about when the Center was most effective and the levels of participation within companies and amongst companies. In other words, who was involved from the company's side?

Answer: Again, the person that's involved would be the person that had that assigned responsibility to train people. The last Center I participated in was a training involvement and furnishing new employees that would come into the company with the right skills. They worked with HR, out of a large involvement say of 20-25 people you might have three or four, I call them drivers, and actually they are champions. They drive, attend every meeting, give direction, and are always there. A lot of people don't have the time or skills to participate at that level. They'll come but they don't want to lead that much. Finding the drivers is probably the key important part. We had 4 or 5 main drivers from a pool of 25-30 different companies. They drove the last grant everywhere it needed to go and the buy-in from that grant and the objectives for that.

How do they get that time? Is it because of company culture or job description? How did they get the time?

Answer: There were some with the company culture on activities that the company looks for. In my particular case, the need for the attrition factor of large numbers of employees retiring, we had a large hiring process coming up so instead of re-staffing the training organization and training them ourselves it became very feasible to hire from the local community colleges. So the work relationship with the ATE grant became a really nice package for us to do that.

Within your company was there ever a time when someone outside HR, a higher level of management outside HR and training was involved in the initiative?

Answer: We did have the local area management very supportive of the program because those were the employees they were hiring to run their plants. We actually had one level up into a global training network that was very involved as they were doing a global training initiative and they used this model to set some standards up for hiring people in the future. The key point in this is really not meeting the educator's needs, but if you get an industry that needs your product then they are going to buy your product. In this case you're buying quality educated employees. So you're getting the right person to make those decisions to choose from the college. In our case we gave our local community college so much money a year locally to support that particular program to furnish potential employees for our hiring pool.

What part do relationships play in developing an effective partnership versus one that is ineffective?

Answer: The effective part is that industry is the drivers. They go to meetings and conferences, and they know each other. So it's real easy to bring anybody together from any organization that's in those activities and bring them together to start working together. So the effective partnership is that the industry is doing the driving, working with the local community colleges who are always very favorable working with what you wanted to do. Again, the emphasis was that it was effective because the industry gets what they need out of the program. The industry is very busy; they don't have a lot of time to spend on activities that don't benefit them. We all had a common goal for the same purpose.

Do you think relationships have any role in spurring along a partnership or in the development of the partnership?

Answer: I think the partnership would not be creative or have relationships with the parties—not only industry to industry but also with the educator. If you don't have an education partnership with your local colleges or other colleges that person would not be a team player. They would not work along side with others, or get it started. It's very important to foster those positive relationships. If it turns negative there is no reason for industry to stay.

At the time when this partnership was effective what was accountability for partnership outcomes like?

Answer: By forming a partnership and creating an organization to run the partnership, the industry had high expectations for the educational side to fulfill their needs. If we are going to become involved with something we need education partners to understand that they move a lot slower than industry. So we had to explain to education that our goals and objectives must be met quickly and can't be strung out over a ten-year period. It has to be done a lot faster than that. We actually had to change the educators' minds on how things are done because they were doing it at a lot slower pace. There was a lot of resistance at first but the accountability had to be there or it would fall apart because we don't have time wait three, four, five years as things move slowly. We actually had a lot of push-back that people just couldn't believe that we could get what we've gotten done, but again industry actually went to Washington to meet with the ATE and convinced them that we needed a Center grant. And our performance was good, we got things done and moved it along. Basically, we dragged education along for the ride and they wanted

to be part of it because it's a big national event. It worked and everybody got benefits from it—hiring, participation, and a grant for the college. But again, it moved very fast, monumental objectives, hundreds of thousands of people being hired. So it benefitted educators that have a lot of enrollment and quality people coming out of their training program, and it benefitted industry. If we can't meet those goals for industry and can't get those objectives done, then we're not going to sit on committees for years and have no outcomes. We've got to have outcomes now, and it can be done with manpower, initiatives, and drivers.

At the height of effectiveness what kind of communication was going on within the system?

Answer: A lot of organizations meet for lunch once a month. They have some presenters, and they talk about stuff and we actually went through that for the first six months.

People were coming together. We'd sit down and meet. More people joined. We would talk about the issues and needs; we would talk, talk, talk and nothing was getting done.

We actually had to create an organization that had a chairman, secretary, and treasurer involved. We wrote down goals, mission statements, and expectations to move it along and hold people accountable. And then people would join up. We set up committees which I think was the most effective thing; we set up subcommittees of that organization and actually started working on the issues and outputting, and the expectation was that they would meet and actually produce. That's the whole key thing you produce something and move on. Then as the organization grew we needed grant money to pull it all together—staff at that point to work 40 hours a week. As industry people, my company isn't going to give me that. They actually gave me 10 percent of my time,

which is 4 hours a week but what you need is someone working 40 hours a week. As the organization grew it went from one person to several people because the project was so big, so large, and so fast moving that you actually needed a separate staff that would come in and report on the progress and give a status report. Basically the committee becomes an advisory committee—managing the project, pushing it along with the expectation the job will get done. When people worked on this 40 hours a week, 160 hours a month, product was being produced. Activities were moving on and we went from instructor books to student textbooks to web-based training to national conferences to setting up other alliances, just a tremendous amount of things that has never been done before. When you get an organization moving that large you have to have a new body of people that manage and work the program. Because I work for my industry, I don't work for all of these other industries and some of these third parties have to do that for you. That's where the grant money comes in—to help hire a team, the expert people. But again even there, that person has to be an educator; it won't be an industry person unless he's retired. But again you need a driver in that group of people that manages the work flow, moves things along, and gets things done.

If you were to mentor a new partnership and explain how often and the best method to communicate with you, what would you tell them? How frequent do you want them to communicate?

Answer: I actually mentored a college. I went up there and we cranked that up. I worked with the local college that was very excited about doing this and the local educator which was the two drivers. They brought the industry and the education in from the local colleges and industry. I showed them how beneficial a partnership can be as well as all

the do's and don'ts. If you want this thing to move you're going to have to communicate, meet monthly. That can be a quarterly meeting for the steering committee as you set up, probably monthly teleconference calls on the agenda items, and progress status reports as the committee moves along. We set up a yearly conference for the nation and people would attend the conference and workshops focused on success stories—what other regions were doing, how they were managing products, how they were getting money, how they were getting buy-in from industry and education. Everybody's not going to be a leader or driver but you do have drivers around and they'll lead in every area. You've got to find those people; you've got to set up an organizational structure. If you're meeting once a month on e-mails or teleconference calls and nothing ever gets done you can't expect industry to get it done because they're working. They have another job to do. Their company is not going to give them 100 percent of time to go do this. What you have to do is get a staff of people together, whose sole purpose is this as it grows and gets everything done. You need grant money to have these organizations and get the money to hire people to get things done from the steering committee, which consists of education and industry in a 2 to 1 ratio. Industry being in charge because they have the need. They're your customers. If you don't meet the needs of your customer they're not going to come and buy your resources, your product. It works very well, so communication is very important. You need to find out what you need. People will come on, they might not be a driver in a major league role but they don't mind being drivers in subcommittees. We had a subcommittee on education development and a subcommittee on funding. We had several, three or four different committees, one that focused on student recruitment. They wouldn't mind driving that, being a team leader on

that and reporting back in the main steering committee reports. So they would be held accountable. They would have people join and participate. They wanted to be the chairperson of the subcommittee, but they would participate and you would get input. They are held accountable by the steering committee with the direction that they must go out in between the monthly meetings and produce. They would have their own meetings. There might be teleconference calls because it would stretch across that large region and they would work the issues in between the conference calls. The thing is you put a time line together of product expectations. Working with industry, they need a pretty aggressive one to meet their needs or they aren't going to participate.

Did either your company or any other companies actually integrated products or services from the Center as part of their company's strategic plan? Did anybody ever get that far?

Answer: Yes. There are actually several companies as the products rolling out that had the need to change out their existing training material to the newer updated material, and that became their training program. Some of it was classroom taught, some was web-based taught, some was refresher training used to come back to refresh train the incumbent workforce, and they switched completely over to those programs. There were three or four I can remember doing that. And some also went to the community colleges and taught their new-hire classes there with the college instructors using that material and incorporating CBT. So several people were moving that way, making major jumps and switching to an updated training material program.

So of all of these factors that you've talked about, was there one that was more important than all the rest of them?

Answer: I think the number one important factor is that you have to have the need. Industry has to have a need for the product because their industry is real conservative budget wise—people's time and resources. They aren't going to throw people's time on a project that doesn't reap rewards for them to meet their needs. The one I worked for was to train the attrition workforce coming in from attrition factors. Some aren't going to participate; they don't have the need to participate. They don't have the time; people are fully loaded up in their 40-hour work week. So you have to have that need and once you have that need you need to identify the resources. The resources being your drivers, and somebody that will come in and work and they'll come. When we first started out we had six people sitting in a room together and we would meet every other week and the numbers grew. Today there are two or three hundred people meeting on a regular quarterly basis and working on subcommittees all between the quarterly meetings, to talk about the product and the needs. It just grew by word of mouth. It needs someone to start it, to crank it up. You need a very special person to foresee the need and to go out there and pull the people together because they're there. I think in any field this would work. So you find those people and that's where the relationship comes in. You have to have a good partner relationship between the industry and the educators to pull it together. If you can do that, that's the most important part and the rest will fall from that. If there's no need for industry to participate and you don't have a good relationship with people, they won't participate at that point either. So you have to have some strong leaders and all the followers will come.

How could the Center improve or maintain their relationship with your company?

Answer: We had a good relationship and a great project manager. We worked with her and communicated a lot with her. We did very well with her communication in giving us direction and we convinced her to extend our scope from a project to Center grant. And she supported that, came and attended our meetings. She did that really well. Everything worked really well until we had a problem with the main fiscal college, who actually wanted to own everything. So that became a very negative effect on the Center.

Has the Center maintained its effectiveness?

Answer: Not that I know of. This attitude with the college took over and tried to pull the Center back and take full control away from industry. They lost most of the industry's support because it wasn't about one region or one local area, it was about the entire United States. We grew considerably from our beginnings. It gave everybody a bad taste, what they did, and a very negative effect. I think the Center basically fell apart. They're still there locally, small, and with very little industry support. If they don't have support they're walking away. In my personal opinion I think that is what's happened. I don't participate anymore and a lot of our friends don't participate.

What factors within the higher education community or realm may inhibit or impede the development of a partnership with your company?

Answer: Going back to our initial start of our initial association or alliances, which formed the Center...when we first started in this several local community colleges attended. Their reps in the field had the attitude that I can't do that at my college. It won't work here. I can't change my hours, my titles, and my courses. They were there but they didn't want to change what they did. We dragged on six or seven months, and they attended but nothing was getting done. We finally changed our direction and

formed a leadership team with officers, and we all came to a point where we told them, “This is the direction we’re moving. If you don’t want to participate that’s fine. You don’t need to come to these meetings anymore. But we’re going to make one standard curriculum.” The title of the courses they were teaching was the same basically but all the courses were different—what they designed, and developed, and the way they taught it was different. I’ve been an adjunct at the local community college for several years and I know once you get your lesson plan made out, you teach it that way. It’s a lot of work to change that over, learn a new lesson plan, and all the test questions, and I didn’t think some of those people wanted to change that. They were negative about moving in a new direction. As we moved to a new direction, no one dropped out. We all mumbled about it but we didn’t gripe anymore about what we cannot do. It was all about what we can do. They slowly came on board. Three or four of them became major champions that were on the main advisory board, maybe more. Once the Center grew in activity that just became the way. It was easy because new colleges didn’t have a program; they just adopted and put people there. That was just the direction they were told. Go contact these people, be part of that team, and get the program from there. The initial part was the first half dozen that had programs. They weren’t real receptive to this idea because it was different from what they were doing. And it really wasn’t, it was just standardizing what they were doing. It was just making it transportable from one college to another. But it was changing the curriculum to a standardized curriculum that industry can accept from one college to another. So the academic side at the instructor level wasn’t that excited at first. As we got larger and more successful everybody got excited. More people got on board, the presidents and deans got on board, and everybody was excited about the

program then because this was a successful winner. Everybody likes to be part of a winning team.

How would you define sustainability for a Center partnership? What does that mean to you as an industry person?

Answer: For an industry person to be part of a project or Center, what that means for us is that we have to provide subject matter experts from our industry to participate in the development of training material. We are spending hundreds of hours of company time of employees between 35-75 dollar per hour employees to participate, give their knowledge in the development of course workbooks and instruction manuals, and proving and validating them. We spend thousands of hours of time in validating this material so it's very important—the sustainability of the product we are producing—and in this particular case, that that material will stay evergreen, meaning forever up-to-date. We have noticed in colleges that a lot of the books are written by the instructors. They write the books and keep it up. You have an attrition problem in industry with baby boomers retiring and new people coming in. That was one of the issues of having one college owning the product. If they own it, then they can pack it away. And then new people come in. When you're talking about millions of dollars' worth of hours from other education facilities, multiple colleges, ten-twenty other colleges, maybe 50-100 industry imputing hours and years of work to develop material and then for it just to disappear just because someone didn't up keep it, or didn't think it was valuable because they didn't offer the course anymore to the college, it is an issue. As our attrition faction goes down we'll be hiring throughout the years. And then five or six years when we have the next major hiring, we want the material to still be there and up to date in a process to

get it, not to be discarded by the college because they didn't have a factor locally for that need. It just disappears and the grant funding invested, the thousands of hours of company's employees' time, as well as college members' time throughout the country, it disappears because it's not up to date. If it's not up to date, we won't use it ten years from now. That's the major factor. We could foresee that as being a major problem for sustainability. With college programs, if you don't have enough attendance they get sunsetted. If they get sunsetted and do away with instructors that program might slow down here to the local college who we had the issue with for three or four years. And if no one owns it, it just disappears and that local area attrition factor picks up again. They need to start hiring people. We're not talking about one area. We're talking about the United States, colleges all over the country. This was a business-magnitude size. It needs somebody there all the time running it, not a college running it with instructors. The material takes a lot of time and money to get validated. That's what somebody does for a living. They don't teach classes and do this. They run this organization. So if you don't have the sustainability then why am I going to put in my resources and people's time to validate the material. It doesn't make sense. So sustainability on the regional side but we had the entire United States and going around the world. People wanted the material, which would sustain the project forever. Evergreen is very important. There was a standard worldwide for the program. With a great relationship of the people you had that ran it and saw the vision of having this product forever to where it's at now, it's almost dead in the water. Nobody cares to work with it; it totally destroyed it. It's terrible. So it goes to show you the importance of industry support and meeting their needs and their needs are to have it evergreen, up to date for the next time they do their

hiring every five or six years. There is continuous hiring going on. We were just looking at one industry sector. You have other sectors that weren't even tapped into yet that will grow and no way a college department of any local college in the world takes this on as a sideline job. This became a full-time business with a dozen people running it. They just didn't get it and now we've lost it, in my opinion.

Is sustainability of the ATE Center products and services that they had desirable? Did you want the products and services to continue and be sustainable?

Answer: Yes, very much so. So much that we fought it to the very end. That's one of the major factors that it has to be sustainable for the time I put in. I personally have put hundreds of hours, probably in the neighborhood of thousands of hours personally in, and my company's still hiring. They'll hire for the next ten years and then it'll be sporadic and in large hiring groups in about fifteen years. That product was supposed to still be there for that.

So in your opinion, this NSF ATE Center has not become sustainable?

Answer: I'm not sure if it has or not. I know it has no more grant funding. All the drivers, which were a key point, are isolated and none of them wants to work with them. The Center was for all the colleges in the United States not one college. I don't live in the region of the area of that college, so why would my company...my company is not going to let me work for a company that's out of my area, let alone out of my state. That's crazy. We don't do that. It was for the bigger picture, and the bigger picture was that this Center would supply all colleges and industries in the United States with a product for them. It's still there. I'm not sure how functional it is. I don't see much of it. A lot of people don't want to participate. They've killed their main client, which is a

lot of industry. There's probably some that still work it but I'm not sure how successful it is.

Given what you know, if you were to tell another Center what elements it needs in order to be sustainable what would you tell them? What elements, factors and characteristics would make them sustainable?

Answer: Sustainable means that you have people buying the product. If they had no need to buy the product that the Center is producing it would not be sustainable. So to buy the product industry wants it evergreen to use it continuously as they need it. And you might have a thousand industries around the country that use that product, and if you don't keep it evergreen for the next management team that comes in they pull out, say the stuff is out of date, and won't buy it anymore. I would make sure the Center's by-laws and rules, what they're developing, their outcomes and objectives, if their objective is to have a long-term Center to meet that industry need for years to come they have to have control of the Centers resources or be part of the management team to make sure that the Center maintains the material, keep it evergreen. Come back and revisit every three to five years for changes and manage the business, unlike the other Center, I was told, where people placed orders and people couldn't get them filled. They had technical problems, and they couldn't get an answer. Industry moves at a very fast pace and if that doesn't meet your need you'll go someplace else and some people did. So that's the whole part of the Center, the main business. So I would take the lessons learned from the past Center. If you want the Center to be sustainable how do you get it to where that one college doesn't control it. You sit down and write the grant. They're the fiscal agent and they think they control and own it. They thought they owned all the product; they know what's best.

Those people that had never been involved in any part of the Center; never were there and hadn't been involved for fifteen years that the whole process has been working. Then they just wanted to hijack it and take it over and keep it for one college. What you're going to have is other colleges that are participating around the country say, "I'm not going to participate to benefit College X down here in this part of the country when I'm over here." Colleges don't do that. They have to have a stake in the product and why it is there. If not they will create their own product. So that's their stake in that and it's not going to be just one college going to be the shining star. So people need to understand that so they don't go down the same road we did and not have the Center anymore or a successful Center. If it's just a local city and they just keep running the city then that's fine. They can control it. It's their bailiwick. And it's not going to make a difference. But when you start going beyond the city to multiple cities in a state they own it just as well as everybody else. That was our perspective, that everybody owned it through the Center. That's why we had a team of people working on it all the time. This is not part-time. When you get something really good going it's not a part-time thing. It's a full time job with several people. It's not my job; I work for my company but I need somebody else that works for the Center that is answerable to the advisory committee that has direction and control to make sure the Center stays on course.

Who initiated the first contact between Center personnel and your company? Did you contact them or did they contact you?

Answer: It was actually industry that did the first contact. In our case the industry brought it to the college and said, "We have this need. Can we work it?" We had some pretty proactive college people saying, "Yes, this is what we can do" and financing this

and that. That's how we got off the ground running. But that doesn't happen all the time. So you really can use people who understand the process, understand relationships between education and industry and understand how to move fast. Colleges don't move fast; they move real slowly on their time frame. If I can't get it in this year, you're moving too slowly and I'm going to go somewhere else. I have to have it now. We actually went through that same process when we applied for our first grant. They came back and had it stretched out over several years and we told them over and over if you can't get it to us at the end of this year and the next four years finish it up, we don't need you here. They got the picture at that point but industry ran the project.

Think about the partnership as it exists today and tell me where you think it falls on that Collaboration Continuum right now, and why.

Answer: I think the level of engagement is low. I haven't been involved in the last couple of years and what I hear and see is low because the level of engagement is down.

Question: Is the Center important to your company's mission?

Answer: It's very low now because we backed off and took a different direction. We had a regional manager level involved, looking at using some of the resources. So my company has totally dropped it. I don't participate anymore so it's non-existent. My company is one of the majors and none of the local facilities are playing in that field anymore. Management of resources is none; we don't furnish any resources.

Question: What about the resources they have on their own, comparatively; the amount of resources they have as far as funds go?

Answer: I hear it's really low. The crazy part is that you have to have resources as an industry person to revisit and keep the material evergreen, up to date. If you don't have

money for resources you cannot hire technical writers to meet with subject matter experts provided by industry on their industry time to keep material up to date. Without resources you can't keep it evergreen, you can't function, and you can't keep staff to order it. You would call up and can't get someone on the phone. You get someone that can't help you with a technical problem. You can't place an order when you need it because of lack of resources.

Question: What about their scope of activities? Is it the same as it was?

Answer: No, they were developing workbooks, had instructors involved, and were developing alliances. Now those alliances are falling apart. Some of them completely shut down. Some are real low in involvement because the central organization is not there to support them. The scope of activities—there is no more development to actually move it into other areas. Additional stuff that we needed, development, some of the models weren't even fully developed at the very end and the projects still aren't done. Other people might be taking them on but not the Center, so they are not there. The national conference that we used to have—people aren't coming like they used to. It's not there.

So based on that, which one of these stages would you say that the Center currently operates in?

Answer: In my opinion, it currently operates stage one.

At the height of its effectiveness, where would you say it operated?

Answer: Stage three, there's no doubt about it. You had several regional alliances and a national alliance. You're pushing out textbooks every year. You had 150 plus customers in the industry participating and mentored many colleges. I think the colleges are still

there but my biggest worry is if they start doing their own thing and not a standardization thing. It makes it very hard on an industry person when you want to start hiring and you start looking at products, and they're apples and oranges. I want a standardization of products and new products are not coming out. I have no place to go and say, "I have this need" and other stuff.

If you look at this list of criteria that Austin's developed called nature of the relationship, are there any that are missing that would help someone at a center figure out where they are in the continuum?

Answer: Many educators have a problem with being a little narrow-focused and they thought that our people would get an associate's degree and then a couple of years later enroll in a bachelor's degree program. It was very hard for them to understand that not everybody wants to go to four-year institutions. People can go to school for two years, get what they need and come out into a high-paying job. Then that becomes very desirable. In our case, people were coming out and going into \$65,000-\$75,000 jobs. Why would they go for two more years at the university? With the two-year degree, they can make \$100,000-\$120,000 including overtime. Not unless you are a lawyer, doctor or professional, why do you want to do that? And they had a hard time understanding that. I just gave up and said okay. They just really thought all these people were going to quit their job and go somewhere else after they got their four-year degree to become a \$35,000 a year school teacher, or \$40,000 a year dental assistant, or whatever it is. Sixty percent of the kids don't want to go to school. They need to understand that having these types of careers for them gives them a pathway into a high-paying, high-secure job that they never would have achieved without the program. That was one of the biggest things

that I had a hard time trying to make educators understand. It's like everybody at the college thought that everyone was supposed to go for a four-year degree. There aren't enough jobs in the market for the four-year degree graduates. Sixty-seven percent of students don't want a four-year degree. So you have to appeal to them—a high-paying, high-benefit job, a long secure job like NASA, the automobile industry, something of that nature that they can go to locally and be very happy with. So their perception of thinking everyone is going to move on.

Do you have any other comments or something to add?

Answer: Yes. I attended every PI conference in Washington, showcasing the products. There must have been a hundred different products, different grants on different nights. What was interesting, of all the times I went, was that we were frequently the only industry people participating. Nobody else ever brought industry people with them. So it kind of gives you the impression of how involved was their industry in the program. You can get a college and get money to put a program on they think is good and then nobody comes. I think the involvement was low. Every time we were there we had three or four industry people attend, and just one person from the Center would come along, maybe two. They would ask every time how do you get your industry people to be involved like this and come? It makes me think they were not having a successful Center or organization or grant back where they came from. They did it all themselves at the college and just participated and brought the college people and never brought any industry people. We attended a lot of the meetings and conference groups and were the only two or three industry people there and there were hundreds of educators. Nobody brought their industry people and it makes me think did they really have a partnership.

They ran the Center not industry. The industry did not have the ownership; there weren't stakeholders in the Center. That's my opinion. I don't think NSF ATE understood this. I don't think if you asked questions, "Why it was too big, too much about the college and what they're doing?" If you look at some of the stuff that was put up there, I wouldn't agree with. I wouldn't agree how they got it or was it beneficial. If I had that at my local community college I wouldn't have supported that. It was crazy some of the stuff they did. Some of the stuff was very good. But again it never took it to the next level of industry, getting people hired in jobs as a need; more of a local need and that was it. Then when the grant money ended, it ended. The money was just gone and it wasn't successful. Ours was very successful to the point where we had a problem with the local college. The questions is: "Why weren't those other Centers successful?" I don't think NSF has taken enough or any time to evaluate the industry participation in the grants. I think the college does it all, and that's why they have those outcomes for products they produce. The industry wasn't driving it. Once the grants were over I think their Center goes away because you didn't have any stakeholders in to drive it. I think the NSF in the future needs to actually question the participation of industry. Not where they come one time and they invite a dozen people that never show up again for another year. That's not how you run a Center or project. I've seen a lot of colleges use their advisory committee. You come in; they feed you a meal; ask your opinion; and then you go home and they never implement. You never see them again. They never ask their question again until the next year when they want to ask your opinion for feedback. I think NSF really needs to develop a process for getting feedback from industry on these grants and Centers about their participation and what they're going to use.

Third Pilot Interview Transcript

What partner benefits or Center outcomes were most valued by your company?

Answer: Well, what it did was give value to the employees being hired because what it did was give us a benchmark that we could look at and say yes, I can define this is an individual that meets a certain criteria that we've set coming into our facility where we didn't have to spend as much time, money and frustration, one, doing interviews, two doing the training once we've hired them because we had a general understanding of the foundation that the Center provided to the colleges that were partnering with the Center. What curriculum they provided so that we understood the general basic knowledge that these people had coming into our facilities. That's what it helped and it was really, really beneficial to us because one, it cut down on our interviewing process, it gave us a better reference to better candidates, it gave us opportunities to recruit from the colleges and partners that partnered with the Center so that we understood what was coming out of those curricula. And going forward when we got them into our facilities we had to do less training with them.

What are the major factors that lead to development of an effective partnership such as this and by factors we mean forces that provide the primary power to collaborate or factors that facilitate the effective management of the relationship in the process?

Answer: First and foremost, the one thing you have to have is a champion within a facility or company or organization that is willing one, to put in the time both personally and company-wide. Secondly, that individual has to be empowered by their management to be able to participate and champion that cause. They have to be willing to champion the company's point of view and what they would like to see as a benefit from

participation. The third thing is, that champion has to be not only a champion for his or her company, it has to be a champion for his or her facility, his or her college association, his or her team, because then it becomes a team effort it doesn't become an individual effort. In other words, each champion has to recognize that although their individuals in/of their own right championing what I was saying about their facilities and their colleges, they have to be able to subjugate themselves to the team. It becomes a collective effort. Do we make this organization successful, maybe it doesn't give me everything I'd like to see but it gives me the majority what we would like to see. In other words, it becomes collectively beneficial to the whole as they move forward.

If you were telling somebody that was just starting up a partnership and they wanted to know how to be effective, what would you tell them in general?

Answer: First of all, I'll go back to what I said earlier, it has to be more than just a personal thing. It has to be a commitment to; I want to see a successful venture by everyone that's participating in this. I can give you an example of an organization that we put together where the person that was actually at the head of the organization that was put together had a very personal commitment, but his company didn't have as great a commitment as he did personally. In other words, he didn't have the total support of his company. So in essence he wasn't able to participate as much as he really wanted to, but as an individual, working collectively with the other individuals working as an organization made it successful.

Outside a company role, the individuals that participate on both sides of the aisle if you want to put it, and I say both sides of the aisle because it becomes more than just college administration and company administration and personnel, what happens is that

individual that participates has to be willing to make sacrifices. And when I say sacrifices, it means that you have to sacrifice personal time, you have to be willing to give up your time because it's time consuming. You have to realize at some point, and I say this from a personal point of view, at some point it could hurt you career-wise, because I've seen that happen to individuals. I've seen that happen to individuals and I've seen that happen personally, and I'm talking from a point of view that you can make personal sacrifices that may not be beneficial personally, but it benefits not only your company outside but it benefits the industry as a whole. That's making a difference in the industry that you're supporting.

You mentioned company support at different levels. When they were at their height of effectiveness, what level from within the industry companies was involved in the partnership?

Answer: I want to say, probably second line management, you know maybe a step above what you would call a line supervisor, probably a supervisor, superintendent type roles, some with titles with coordinator, some with titles of supervisor, some with titles of training foreman. They were all different levels. But probably second level supervisors were participating in spearheading the organization and what they were doing is getting support from their line supervision, but they were also getting support from those individuals that they reported to such as managers of operation, managers of training, HR superintendents, HR managers, that type of thing. In my case, from plant management and from corporate management, because they knew what our participation was and were encouraging that because they saw the benefits to the facility where I was employed and the individuals coming into our facilities, and I don't want to say the more intelligent, but

the more informed individuals. In other words, they came with rudimentary foundations in things that they wouldn't ordinarily come into our organization with and we'd have to remediate them in a lot of different things and once we started there was no remediation of individuals. What we got were good employees that were willing and able and understood what we were trying to import to them in their training.

How would the company or managers encourage participation of lower level management in these types of organizations?

Answer: It was not only verbal but willingness to allow individuals time off to participate, time off to attend conferences, time to work with the development of the materials necessary to support the programs that were being developed. In other words, it was time and talent that they were able to say, yes, you can do this.

So, these, what you called earlier, resources—time, subject matter, expertise and talent—compare for me an ineffective partnership with an effective one as far as the distribution and giving of resources.

Answer: In my case the company that I participated with was not only willing to allow me to participate and give me time off and allow me to lend my talent, if I can say my talent, to the organization, they were willing to fund it. They provided funding; in other words, they put dollars up front, they were willing to make those donations to help the organization be successful.

So do you think that's indicative of most companies that are part of that kind of effective partnership?

Answer: Those that have good champions in their facilities, or in their organization; yes, they are willing to put their dollars where their mouth is. And that's an important part because you have to have some type of funding to move forward. You can't expect just one side of it to provide all the funding so industry has to be willing to step up and say yes, we're willing to fund this, and this is how we'll do it. We'll not only do it with the time and talent of the individuals participating, we'll put our dollars forward with that. And it varies in the amount of money they're willing to donate but the organizations that I was affiliated with initially, all of them were willing to, up front, put their dollars where their mouth was. Initially, over time, as the champions diminished, the champions retired, or the champions that went away, I think the funding went away. And I think it goes, and this is part of the ineffectiveness that you're talking about. If you don't have a continuum, almost a hand-off of the baton, this is what we've started, this is what we need to continue and somebody picks up that champions torch, and continues to encourage their management and their company to provide time, talent and funding, then you're looking at ineffectiveness. You may have a very effective organization that becomes ineffective because they've lost their voice, their champion, or their wherewithal, the support, because either management has changed, or something has changed where the value of what it brings is not kept in the forefront. So let's talk a little bit about an effective partnership from a communication standpoint because you just talked about communication within the ranks of the company and how important it is to continue to bring to bear the value of the partnership within your own company.

What do you as an industry person, expect from an effective partnership regarding the level of communication? How best should they communicate with you, as an industry person and how frequent should they communicate with you?

Answer: I think the lines of communication if they're not kept open, then what happens is you wind up almost in limbo, an industry not understanding what an organization is trying to deliver. What happens is your organization becomes ineffective, in essence. If you lose that communication route, the supposition is well they know what we're doing, and they ought to be supporting us. And that's not the case. I think the organization needs to maintain that communication either to individuals, through companies, through an additional organization whether it be an alliance or an association. In other words, the communication is, this is what we're doing, this is what we're able to do for you, but we've got to do it in concert, as a partnership. We need you to be effective but we also need to understand what you need from us for us to be effective so that we can provide to you, what your needs are.

So, when you talking about this level of communication, give me an example if you were an industry, and I was on the Center side, how should I communicate with you? What method is the best way to communicate with you?

Answer: Face-to-face. In other words, it has got to be personal contact. The most effective organizations that you have, is those individuals that are willing to have face-to-face relationships with the individuals, they're soliciting not only funding but they're soliciting participation from and soliciting ideas of how that organization can meet the needs of the industry and what happens there is, there's a trust factor. It's individuals that learn, I understand what this individual's doing but not only what this individual's doing;

I personally have a relationship with this individual and I can trust this individual. This individual has shown me that one, they're interested in what I need, they're interested in what I know, and they're interested in what I have to have.

When this partnership was at its peak of effectiveness, were there times when there was higher-up management involved in this Center?

Answer: I think if you're going to have a Center representing an industry sector, then it has to have key players. And when I say key players I'm talking about high up key players from the companies sitting probably on their National Visiting Committee. I think that's extremely important. I think that lent a lot of validation to the Center I was associated with. In other words, it not only had the impact from regional organizations but it had impact from shakers and movers from major companies within the industry that said yes, I can commit to this, I can commit at this level, and these are the things I would like to see focused on so that it will ripple through my company and make a difference in how I do business and how we can better serve our constituents.

Should that be an expectation of a brand new Center, to have that level of participation in your opinion?

Answer: Not to begin with because I think what happens is one, you have to have a track record. Two, you have to show that you can deliver. Three, you've made a difference and how much more of a difference can you make, if there's that national recognition. At the level of a company that says yes I want this in my company, and this is why I want this in my company because it's been shown. At this level it works really well so if I can shove this up, not shove it down, but if I can shove this up then it can make a difference in my overall company's, not only bottom line but also my overall company's success.

So I don't think you can expect that right off, all right? If you expect it right off I think you're going to be disappointed. I think you will truly be disappointed. I don't think we could have had the level of commitment that we had the first couple of years.

Interviewer: So, to recap, we talked a little bit about relationships and in the case of this particular Center, you mentioned the importance of trust and relationships between the Center and the partners.

Do you think it's absolutely essential to have prior long-term relationships to achieve as high a level of effectiveness as possible or do you think that you can grow those?

Answer: I think you can grow them, because in our case you know, we had the relationship there. It had been there and fostered over the years. So we knew one another as individuals.

Question: But not within the Center?

Answer: Not within the Center. Individuals within the Center that's a relationship that has to be developed and built over time and it requires face-to-face meetings with individuals, understanding their needs, understanding regional needs, because sometimes national needs are not the same as regional needs and if you fail to recognize that then the people within the region feel like somebody's trying to force feed them something that doesn't necessarily fit within their regional area. So you can develop relationships over time; we did it. We met new people; we developed relationships with new people over time. But you have to work at it and you have to be willing to work at it, and you have to be willing to listen, and you have to say hmm, that's not what I thought, but if that's what you need we'd be willing to do that for you. I think that's important.

Would you say in this particular partnership that having those prior relationships benefited the Center?

Answer: I think it did because there was such a collective trust of individuals that were willing to go out on a limb and say this is what we can do and we can guarantee we can do it. And beyond saying, that's never been done, that's not in the vocabulary. We can do this and we will do this given the opportunity because we not only believe in what we want to accomplish but we believe in one another and our companies believe in our organization so we can move forward. Yes, we can push that forward.

Interviewer: So you talked earlier about the height of this partnerships effectiveness, you talked about the fact that there were some very high level management involved in the National Visiting Committee for this particular partnership.

Was there a time when this partnership was at the height of its effectiveness that the Center's products or outcomes was part of the strategic plan of a company partner?

Answer: Yes, in fact more than one company; in fact major companies from multiple industry sectors. The individuals had made the commitment that this would be part of their organization going forward. In other words, it would be meaningful to their company to have what the Center provided inculcated into their culture.

Question: Okay, what does that mean?

Answer: In other words, they were committed to using the developed curriculum, they were committed to using the developed skill standards; they were committed to using certifications to validate individual's progression in learning.

Do you think that the integration of a Centers outcomes or products into a company's strategic plan is an indication of being an effective Center or part of becoming an effective Center?

Answer: Absolutely. I think it's both. When I say becoming an effective Center, I'm thinking beyond just, I'm talking about sustainability, in other words going forward. Where is this Center going to be 2, 3, 5 years out beyond their funding. In other words, have I impacted the industry I'm representing such that they have taken me on in a relationship that we're not only in partners, but we're an integral part of their company's focus and planning. That's what I see an effective Center being, over a period of time. I mean, you can be effective initially, because you start making an impact if you indeed have the right partnerships and alliances in place. But once you become effective, to stay effective and move forward you have to inculcate yourself into the culture of the company that you have a relationship with. They need to see you as value added. They need to take you along to where they're going. You need to go with them.

In terms of outcomes, give me an idea of what you expected as an industry person in regard to accountability for those outcomes.

Answer: As an industry individual you're going to support an organization, then you not only have to understand what they're capable of delivering but you have to demand that they're going to deliver certain criteria. In other words, they're going to have to deliver to a certain need. The only way that you can validate that is what impact does it have on the individual that you're bringing into your company to put to work? And the responsibility is, if I'm going to give you my time, my talent, my funding then I expect these deliverables to meet this standard. That standard needs to be deliverable not only

by the Center but by what the Center disseminates to their college partners. It has to be homogenous across the board. They have to be able to deliver a certain standard and there has to be a barometer by which you measure that standard. In other words, are these individuals capable of attaining this level of knowledge and can they bring that into the industry as we hire them? That's what I see as the responsibility of the Center but it's also the responsibility of the partnership. It can't be just the Center; it has to be the partnership insisting that we expect this. This is when we expect it and how we expect it. You can do better than that but you can't do worse than that.

If you look at the factors needed to develop an effective partnership, are there any that are more important or that really stand out?

Answer: Unequivocally I don't think a Center can be effective without having good leadership but it can't be effective unless it has champions on the other side. I think that's first and foremost. You have to have individual champions because it's the individual that gets that momentum moving, it's not just the company. And it can't be just a job. When it becomes just a job it becomes ineffective because that individual will only do the minimum of "what the job becomes." So it has to be a commitment beyond just a job. "I don't see this as my job I see this as an opportunity." And I hate to use the word legacy, but opportunity to leave a legacy, that I did the very best I could for my industry while I was there, not for personal or company gain but for industry gain. The other thing that I see is on the other side in college administration it has to become more than just "students in seats." It has to be a commitment that I can deliver the very best trained, talented, educated individual I can to whatever realm of study that this individuals matriculating through. It has to be beyond, I have to have a certain number of

seats filled or I can't do this, or I can't make this commitment with this individual to deliver this curriculum because there aren't enough students. They have to look beyond the normal. They have to say okay, I'm not there immediately but I can see where I can be there in the future. The reason I can be there in the future is because there is a commitment and a need from those individuals and champions that are saying this is beyond my job, this is an industry need. We've got to mean it. A lot of times educational administration gets in the way. They are their own worst enemies. They don't see the value added down the road. It's always the immediacy of what impact does it have? And the impact to say, ok I can grow this, I can support this. And the reason I can support this is I can see the value in the future. It may be one or two years down the road but you build those relationships with the champions, companies, and administration. They all move forward and say this is a "we" accomplishment, not a "me" accomplishment, and it works if they're willing to make that commitment but far too often you get individuals that say it's not making me look good.

Looking at it from a company's standpoint, how could a Center have improved upon its relationship with you, or how could they have maintained it?

Answer: Well, if I look back as an individual it's hard to say because I believe because I was an integral part in participating that the communication was always there. I think at times the Center might become less focused on what they might perceive as lesser value participants and not maintain that communication as well as they should, and not encourage it as much as they should, and sometimes they lean more towards their champions. If they're not careful it becomes they only exist to serve that particular need, or that particular individual company's need, or that particular individual's need. In other

words once as organization loses focus on what the primary focus ought to be, then they become less effective and that can happen. It takes a concerted effort to make sure that doesn't happen. The most effective thing I think we had as a Center was a well-rounded yearly conference. That was the most effective tool we had. But the other effective tool we had was the opportunity to have built-in commitment, I will travel to where you are and talk to who you are about what you need as regularly as we possibly could. But at least once a year if not more, because if you don't maintain that personal contact then what happens is, you become just an organization out there. In other words you aren't personal any more, you're not delivering "my" needs, you're not personal to "me," therefore I'm not sure whether you're really meeting "my" needs or not. Come tell "me" how you're meeting "my" needs and come hear what "my" needs are. I think that's one of the most effective tools we have, the conference and that personal contact, that willingness to go where you are. How deep is the snow, that's okay, I can get there. I think that's one of the things that made us so effective, that personal contact.

What aspects, if any, did not or have not met your company's expectations or did not or are not working well? Was there ever a time when they did not meet your expectations?

Answer: I can't think of any to be honest with you. Whether it was that Center or the organization we initially founded I think that aspect moving forward was always okay. We're going to get there. It was a progression. In other words we grew together. Expectations and deliverables grew together.

What are the factors within the higher education community or realm that may inhibit or impede the development of a partnership with your company?

Answer: One of the major things is not invented here. We didn't develop it; therefore, it can't be what you need because we know what you need. We're educators so we understand how to educate people. How can you say we're not educating people to your needs? In other words, the higher administration, not willing to listen to hey, what you are teaching what you are delivering is arcane. This is how we need it, and this is why we need it so let's work together and let us help develop it so you can deliver it. We're not telling you how to deliver it, we're telling you what needs to be delivered so that we can be successful. And I think a lot of times what happens is part of the administration is committed but part of this administration hierarchy above maybe a department head, or chair, or a dean, doesn't see the value of the relationship so therefore it becomes less successful. I think it needs to be integrated all the way up to the chancellor or the president. That individual at least has to have an understanding and say yes, I can and will support that; I will support the individuals that are willing to participate. I will not only support it from an educator's point of view but from a funding point of view. I will allow that to be funded on a certain basis recognizing it may not meet certain criteria but I'm willing to say I can overlook these criteria for "x" number of semesters because I have an understanding that it's fledgling, it has to get off the ground and has to be communicated. People have to see the value of it and understand that it will give them an opportunity to have good employment. So I have to be willing to advertise it and recognize that I have to be willing to grow the program, and that it's not going to be flooded automatically by individuals, that they can pile in and say I want this particular curriculum so I can go get a job.

Are there differences between industry culture and educational culture that may cause problems for a partnership that's just beginning?

Answer: Industry is set up to make decisions based on information immediately and the problem with academics is they almost have to make decisions by committee and therefore they are lacking in, I think, good functional leadership. There's better leadership in industry by far because they are willing to make decisions and commitments based on information almost immediately.

From your viewpoint as an industry person, what does self-sustainability of a Center mean to you?

Answer: What it means is that the organizational Center that I'm dealing with in a funded position is basically the same organization I'm going to be dealing with after they are defunded. There has to be continuity of deliverables, relationships, and on-going development. In other words, there has to be an aspect of, I'm willing to deliver and develop curriculum, standards, or testing based on what I was funded for with your help. There's going to have to be a willingness on the partnership of industry to say I can help you by one, purchasing your products but also helping keep you funded. I will provide some level of funding to see that there's a continuance of what you've established.

Is sustainability of the products and services of the Center that you work with desirable from an industry perspective?

Answer: Yes, I think it is desirable especially to make sure that it stays evergreen because there are changes. There are changes in technology, equipment, and knowledge. And if that's not continually upgraded and addressed then what happens is you lose your rudimentary foundation in the individuals coming out of the programs.

If there was a new ATE Center being formed, what would you tell them are the major factors or characteristics that need to be in place that they need to have in order to be sustainable?

Answer: They have to be more than an immediate need. They have to be a long-range benefit to a long-range industry, an industry that's going to be around for years to come, not a fad. If you've got a Center focused on a short-range need that meets an immediate need that goes away or has no long-range projection then it's almost doomed for failure to begin with, it's not sustainable.

Can you tell me who initiated the first contact between the Center and your company?

Answer: I had a different relationship in the beginning because I was involved from the inception of the organization that saw the focus and the need to have something in existence such as the Center for curriculum development and development of other deliverables for the industry.

Who was the initial driving force for this whole effort?

Answer: I think the industry was because we saw a valid need for standardization of curriculum. Once we saw the valid need for standardization of curriculum and understood how governmental funds could be leveraged to provide that with the assistance of support from industry, then industry helped drive that. Industry was the major factor I believe in the establishment of the Center that I was associated with. I don't think a Center of excellence would not have been granted without the organizational stubbornness of industry.

If you consider the partnership that we've been talking about, where does it fall now on Austin's Collaboration Continuum model, and why?

Answer: I think it has an extremely low level in engagement and that's due to a number of factors. The importance of the mission has not diminished. If anything it has escalated.

Question: So that's the importance of the Center in the role of the company?

Answer: Exactly.

Question: So what you're telling me is that all those companies that used to have this as part of their central strategic plan are still using it as part of their central strategic plan.

Answer: No, I think that's diminished. I think that comes from not only the level of engagement that the Center has with the partners but I think it comes from an interaction level. In other words, I think it has diminished because of the lack of champions and commitment, and it has become more of, I want to make money with it more than I want to maintain what the initial mission was. In other words, I want it to be a moneymaker for me where it's located. I think it's become a matter of dollar signs rather than an understanding of the real need. I think there's a trust factor that's been lost that I don't think can ever be regained and that's due to a number of different reasons. I think it's because of loss of focus, loss of understanding, loss of direction, loss of champions and loss of company commitments. Strategic value still has a place but I don't think they understand that place, and I think what has happened because of that industry has lost focus of the strategic value.

What would you say about their magnitude of resources in terms of funds and in terms of subject matter expertise? Is it the same now?

Answer: No. I think they've lost a great deal of funding and a monumental amount of expertise. In other words, willingness to provide the expertise and continue to upgrade the products that were developed, and I think that's sad because what's going to happen is the curriculum is going to become nothing more than books on shelves, back to the 1990s where it was when we had the vision to say we need to go beyond where we're at, I think we're going to lose that in the next few years.

What about the scope of activities? Do you think they are doing the same level of activities they were doing at their height?

Answer: By no means, I think those are so diminished that they are starting to lose their strategic value because of that.

So what would you say is their stage?

Answer: I'd almost put them at a minus one and not philanthropic. I see philanthropic as something that there's a willingness to fund it because of the importance of the mission and the strategic value that it provides and all of that is going away. Maybe if he didn't use the term philanthropic, I'd say they are almost back to stage one.

What stage did the organization operate in at their height of effectiveness?

Answer: Stage three; it was an integrative force and a collaborative effort amongst industry, education, and government. It was a collective effort of a number of individuals and organizations and alliances across the United States, which really made it a very value added entity that I think no longer exists.

Question: So these people all in the ideal world see this natural progression and this getting better until the organization is no longer needed, which you don't describe it as no longer needed. You describe it as it's still needed. It's just not working like it is.

Answer: It's not working like it is and the need is progressive.

Question: What one thing happened to diminish the effectiveness of this organization?

Answer: Loss of leadership.

So if I had an ATE Center, and I was asked to figure out where on the Collaboration Continuum model my Center fell, are there any categories in your opinion that are missing from this nature of relationship? Is there anything else that would be telling as far as how far the partnership has progressed?

Answer: I don't like this interaction level; I like interpersonal relationships. I think that's missing. Interpersonal relationships and I focused on it to begin with, champions. I think those are two integral parts of insuring success of any Center.

Do you have any other comments or additions that would be germane to someone that is beginning a Center and their desire to become effective or sustainable?

Answer: Yes, if I didn't learn anything else one of the things I believe wholeheartedly that led to this Center not being as effective as it should be was the belief of the college administration that that Center belonged only to them. While it was housed there and funded through the college it did not belong to that particular institution. It belonged to the collaborative effort and they failed to understand that. The end result was that they lost the leadership, they lost a commitment, and they lost the majority of champions. That helped doom it, in essence.

APPENDIX C

Interview Questions

During this interview, we will discuss the Northeast Biomanufacturing Center and Collaborative (NBC²) partnership in which you are involved and at times, industry-academia-government workforce partnerships in general. I will clarify when we are speaking specifically about the NBC² partnership (hereafter referred to as the “Center”) or when we are discussing a generic partnership. Please keep in mind that, at all times, we will be discussing regional or national partnerships rather than a partnership between one institution and a local industry company.

The following are terms and their definitions that are relevant to this interview:

- Effective is defined as being “successful in producing a desired or intended result” (Oxford University Press, 2011).
- Ineffective is defined as “not producing any significant or desired effect” (Oxford University Press, 2011).
- Development is defined as “a specified state of growth or advancement” (Oxford University Press, 2011).
- Evolution is defined as “the gradual development of something, especially from a simple to a more complex form (Oxford University Press, 2011).
- Drivers are defined as those variables or “forces that provide the primary power for strategic...collaboration” (Oxford University Press, 2011).
- Enablers are defined as those variables which facilitate the “effective management of the partnering relationship and process” (Austin, 2000b, p. 71).
- The Advanced Technological Education (ATE) Program is an undergraduate education funding program of the National Science Foundation (NSF) established in response to the Science and Advanced Technology Act of 1992, whose mission

focuses on technician level education at two-year community colleges in advanced technology fields. The NBC² is funded by this program.

1. As an industry partner of the NBC², what partner benefits (i.e., Center outcomes) are most highly valued by your company?
2. What are the major drivers that lead to development of an effective NSF ATE Center (or if you have not observed an effective NSF ATE Center, then an academic-industry partnership in general)?
3. What are the major enablers that lead to development of an effective NSF ATE Center (or if you have not observed an effective NSF ATE Center, then an academic-industry partnership in general)?
4. What could the Center do to improve its relationship with your company?
5. What Center aspects (traits, behaviors, characteristics), if any, either have not met your company's expectations or are not working well?
6. What Center aspects (traits, behaviors, characteristics), if any, either have met your company's expectations or are working well?
7. What factors within the higher education community or realm may inhibit or impede the development of a partnership with your company (i.e., Are there culture variations between industry and education which may cause problems for an industry/education partnership that is just beginning and, if so, what would they be?)
8. When submitting a grant proposal to the NSF ATE program, NSF requires that regional and national Centers have a realistic plan for achieving sustainability. How would you define the "sustainability of a Center?"
9. Is sustainability of this partnership's products and services desirable?
10. What are the major factors that lead to sustainability of an effective NSF ATE Center?
11. Who initiated the first contact between Center personnel and your company?
12. Looking at the cross-sector collaboration continuum model found in the attachment, where would you place the Center on the collaboration continuum at this time?
13. Looking at the cross-sector collaboration continuum model, where would you place the Center at the time that you joined the partnership?
14. When did the Center operate at the peak of its effectiveness?

15. If the date given in Question #14 is different than those times given in Questions #12 and #13, then where would you place the Center when it operated at the peak of its effectiveness?
16. In what ways, if any, has the Center evolved in a manner that deviates from this model?
17. Are there any aspects of the Center's evolution that are not adequately addressed by this model?
18. Company and Subject Information:
 - a. What is the Standard Industrial Classification for your company?
 - b. How many employees are located at your site?
 - c. How many employees does your company have corporate-wide?
 - d. Where is your company located (for example, U.S. + 60 countries)?
 - e. Is your company involved with other academic-industry partnerships that address technical workforce issues?
 - f. If the answer to Question #21e is "yes," can you name some of those other partnerships?
 - g. What is your job title?
 - h. How many years has your company been involved in this Center?
 - i. How many years have you been involved in this Center?

NOTE: The answers to Question #18 will not be linked with any of the other questions asked; the answers will be stripped from the subject's transcript and reported only in aggregate form.

19. Do you have any other comments regarding the development and sustainability of an effective partnership of this type?
20. Is there anything else you would like to add?

APPENDIX D

Partnership Evolutionary Progression Tool

Directions: For each row, select the alternative which best describes the current organization.

	A	B	C
1.	The collaboration has required minimal fit beyond a shared interest in a particular issue and involves a <u>generic resource transfer</u> .	The partnership has addressed complimentary needs through <u>core competency transfers</u> .	The partnership has addressed complimentary needs through <u>joint value creation</u> .
2.	Partners exhibit <u>minimal personal connection</u> to the cause or other partners.	The partnership exhibits strong personal connections with individuals from multiple organizations. The partners view the relationship as <u>us versus them</u> .	The partnership exhibits strong personal connections with numerous individuals at different levels from partner organizations. The partners view the relationship as <u>we</u> .
3.	There is <u>minimal collaboration</u> in defining activities. Partners respond to specific requests. Top management involvement is limited or non-existent.	Projects are of <u>tactical significance</u> and are limited in scope and risk. Top management from partner organizations contributes to a shared vision. Products and services are incorporated into a handful of partners' sourcing and/or training plans.	Projects are of <u>tactical and strategic significance</u> to partner organizations. Projects are identified and developed at all levels within the organization, with top management support. Numerous products and services are integrated into many partners' strategic, training, and/or sourcing plans.

A	B	C
4. The partnership has <u>minimal/informal individual and organizational learning</u> .	The partnership takes a <u>more active stance toward individual and organizational learning</u> about the partnering process and industry.	The partnership implements a <u>formal, systematic learning plan</u> and seeks opportunities for continuous improvement.
5. The partnership garners <u>little top leadership attention</u> of partner organizations.	Top management of partner organizations is <u>engaged during start-up and periodically</u> during its lifecycle.	The partnership receives <u>significant and ongoing</u> attention from top management.
6. The level of commitment and engagement is <u>highest with a small number of individuals</u> .	The partnership experiences <u>sporadic engagement of an individual from numerous partner organizations</u> .	The partnership experiences <u>consistent engagement of numerous individuals from multiple levels</u> at partner organizations. Each partner organization has an established contact hierarchy and a partner relationship manager.
7. Communication and interaction occur <u>annually</u> , usually according to grant funding timeframes.	Communication and interaction are <u>more frequent than annually</u> , occurring among partners and with the external community. The organization does not have a formal communication plan.	The organization constructs <u>explicit internal and external communication strategies and processes</u> (communication plan). Typically, an individual is assigned responsibility for organizational communications.

A	B	C
8. The partnership has a <u>simple</u> managerial structure.	The managerial complexity of the partnership <u>increases</u> as the number of partners involved increases. Partners take responsibility for specific activities.	The partnership has a <u>complex</u> managerial structure due to the broad scope of activities and number of partners engaged. The partnership implements good business practices including strategic, business, and succession planning.
9. The partnership has <u>few</u> performance expectations other than the simple stated purpose.	The partnership has <u>performance expectations</u> for targeted activities.	The partnership has <u>high</u> performance expectations and accountability for results.

Interpretation: Add the number of alternatives selected for each column.

Total for Column A = _____

Total for Column B = _____

Total for Column C = _____

If Column A was selected most often, then the partnership generally operates in the philanthropic stage. If Column B was selected most often, then the partnership generally operates in the transactional stage. If Column C was selected most often, then the partnership generally operates in the integrative stage.

APPENDIX E

Letters of Support



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October 26, 2011

Dear NBC² National Advisory or National Visiting Committee Member:

Please accept this letter by way of an endorsement of Joanna Kile's dissertation *Exploring Industry Perceptions of the Development and Sustainability of Academia-Industry Advanced Technological Education Partnerships*. This is a valuable, significant study in which the NBC² will serve as the case study to more closely examine the inner workings of partnerships. The study will greatly benefit the NBC² by providing information regarding how our partnership can function more effectively. In addition, the results will be applicable to many situations where partnerships are an important key to success.

I, and others at the NBC², look forward to disseminating the results of the study at local, regional, and national conference presentations. I also believe that this dissertation has exceptional publication potential. A study of this kind is, as I think you will agree, long overdue.

Please give her request every consideration. If you have any questions, please do not hesitate to contact me.

Sincerely yours,

Sonia Wallman, PhD

Executive Director of the NBC²



National Energy Center of Excellence

February 27, 2012

Joanna Kile
Baylor University
One Bear Place #97312
Waco, TX 76798

Dear Joanna:

Congratulations on reaching this point in your academic studies. Established in 1939, Bismarck State College (BSC) is comprehensive community college located near the center of North Dakota's coal country. In addition, North Dakota is one of the top four states leading the nation in oil and gas production. Since 1976 BSC has worked in partnership with industry to provide education and training for the workforce in the generation, transmission, and distribution of electricity as well as the production and processing of fossil fuels. Graduates can earn Certificates and Associate degrees and since 2008, a Bachelor of Applied Science in Energy Management.

As one of the first colleges in the nation to offer technical degrees for the energy industry, BSC received funding from the National Science Foundation as well as other federal, state and local grants to offer entire degree programs for the industry online. Pressure from industry to "grow their own" local workforce has challenged the college to respond to industry's demands for state-of-the-art education and training. The National Energy Center of Excellence is located on BSC's campus and currently offers twelve academic programs related to Energy which can be completed on campus or online. The NECE labs are used by industry for specialized training when not in use by students enrolled in the degree programs.

The data resulting from your proposed research would be very beneficial to our students and industry partners. We would welcome you to our campus to present your study findings as well as distribute the findings in our newsletter to our industry partners.

Sincerely,

A handwritten signature in black ink that reads 'Dan Schmidt'. The signature is written in a cursive style with a large, looped 'D' and a long, sweeping tail.

Dan Schmidt
NECE Program Manager
Bismarck State College



February 25, 2012

Joanna Kile
Baylor University
One Bear Place #97312
Waco, TX 76798

Dear Joanna,

I am writing to support and utilize information from your doctoral dissertation entitled "Exploring Industry Perceptions of Factors Influencing the Development and Sustainability of Academia-Industry Advanced Technological Education Partnerships."

I was very excited to learn about the topic you have chosen for your dissertation because it is closely tied to my work as a community college faculty member, a National Science Foundation (NSF) grant investigator and as an external evaluation consultant to several colleges with current STEM-related NSF grants.

I learned quickly from starting biotechnology programs at two community colleges the importance of having commitment from industry before launching the program as one of the most important factors to the program's success. My colleagues and I met with industry before the curriculum was developed and throughout its deployment so that the program would produce graduates who have the knowledge and skills attractive to those very employers. As an evaluator, I am now assisting projects in medical devices, biomanufacturing and the energy industry and I am eager to draw upon your doctoral work to help my clients achieve sustainable partnerships with their industry colleagues.

I transitioned to an academic career after having spent a decade in the pharmaceutical industry, and I was still amazed at how difficult it was to gain and sustain commitment for my program development from industry colleagues, some of whom I had known for years. This was due in part to their extremely busy schedules, but it also stemmed from a perception that their companies would only hire employees with bachelor degrees or higher. I learned that by keeping my industry colleagues constantly engaged with every step of development and delivery of the programs, they were able to break down those preconceived notions and change the culture of their companies (albeit slowly) to see the valuable education and training received by community college graduates, and this resulted in those graduates finding satisfying and high wage jobs in the industry.

Therefore, I am pleased to partner with you in spreading the word about your dissertation findings. I will use your data to help the colleges for which I serve as the evaluator build better and sustainable partnerships, as well as share your data with other professional evaluators of NSF, NH, Department of Labor and other grant-funded projects looking to build and keep their connections to industry strong. I also hope to have the opportunity to invite you to speak about your dissertation findings to the projects for which I serve as well as national organization meetings, such as the 2012 AACC/NSF Principal Investigator's Annual Conference in Washington, D.C. this coming October, where I am serving on the conference's Steering Committee.

Thank you again, Joanna, for your willingness to share your dissertation findings with me and I look forward to continuing to work with you.

Sincerely yours,


Linda R. Rehfuß, Ph.D.

phone: 215-205-0563 | 866 Black Road, Collegeville, PA 19426 | www.inedcon.com

APPENDIX F

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Publication: Nonprofit & Voluntary Sector Quarterly

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Frey, Lohmeier, Lee, Tollefson, & Johanning (2004) Article

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Joanna Kile

From: Frey, Bruce B [bfrey@ku.edu]
Sent: Friday, January 06, 2012 12:30 PM
To: jkile@consolidated.net
Subject: RE: Reuse Permission Request

Hi Joanna,

Thanks for your note. Sure, you may use the figure!

Best wishes,

Bruce

=====
Bruce Frey, Ph.D.
Associate Professor
Psychology and Research in Education
Faculty Fellow, Center for Teaching Excellence
Room 643, 1122 West Campus Road
University of Kansas
Lawrence, KS 66045
785-864-9706
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=====

From: Joanna Kile [mailto:jkile@consolidated.net]
Sent: Thursday, December 29, 2011 11:15 AM
To: Frey, Bruce B
Subject: Reuse Permission Request

Dr. Frey,

I am seeking reuse permission for a figure found in your article entitled, "Measuring Change in Collaboration Among School Safety Partners" published at http://web.ku.edu/~spear/Documents/Measuring_Change_in_Collaboration_Among_School_Safety_Partners figure is titled, "Stage Models of Collaboration" and found on page 10 of the article. I respectfully request reuse/adaptation of the table in my doctoral dissertation to be submitted to Baylor University's Higher Education Administration Degree Program. Please advise.

Sincerely,

Joanna Kile
Baylor University

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Joanna Kile

From: Stephen Thorpe [journal.editor@iaf-world.org]
Sent: Thursday, December 29, 2011 7:41 PM
To: jkile@consolidated.net
Subject: Re: Reuse Permission Request

Hi Joanna,

I would love to hear more about your PhD research. I keep a list of group facilitation-related doctoral research on the IAF Forum:

<http://www.iaf-forum.org/showthread.php?t=1338>

Is yours looking at the group facilitator role or other aspects of group work in particular?

Perhaps the Group Facilitation Journal may also be a possible venue for future publication of your work.

In terms of permission our guideline is: Excerpting for classroom use and course readings is permitted with the following notice: "Excerpted from Group Facilitation: A Research and Applications Journal © 2001 International Association of Facilitators. For full information visit www.iaf-world.org."

I'd say your doctoral dissertation would fully qualify as educational purposes, so if you include the above wording that would be terrific. You could also reference the editorial note to Sandor P. Schuman too.

We've also republished the updated Tuckman & Jensen (1977) article "Stages of Small-Group Development Revisited" in our 2011 issue of *Group Facilitation* if you would like a copy of that also - please do let me know.

Best regards,
Stephen Thorpe
Editor
journal.editor@iaf-world.org

--- On Fri, 12/30/11, Joanna Kile <jkile@consolidated.net> wrote:

From: Joanna Kile <jkile@consolidated.net>
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To: journal.editor@iaf-world.org
Date: Friday, December 30, 2011, 6:08 AM

Dr. Thorpe,

I am seeking reuse permission for a table found in your article entitled, "Developmental Sequence in Small Groups" by Bruce W. Tuckman with editorial additions by Schuman. Specifically, it appears Schuman created Table 1: Stages of Group Development found on page 66 of Volume 3 printed in the 2001 article. I respectfully request reuse of the table in my doctoral dissertation to be submitted to Baylor University's Higher Education Administration Degree Program. Please advise.

1/11/2012

Sincerely,

Joanna Kile
Baylor University

Joanna_Kile@baylor.edu

1/11/2012

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