Transdisciplinarity on Paper:

How do interdisciplinary faculty translate university initiatives into the classroom?

Desen Sevi Ozkan

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

In

Engineering Education

Diana Bairaktarova

Lisa D. McNair

Holly M. Matusovich

Alejandro Salado

May 13, 2020

Blacksburg, Virginia

Transdisciplinarity on Paper: How do interdisciplinary faculty translate university initiatives into the classroom?

Desen Sevi Ozkan

ABSTRACT

University-level transdisciplinary initiatives have become prevalent as institutions reorient disciplines around complex problems that are relevant to society. Transdisciplinary research initiatives, like those of interdisciplinarity in the previous decade, are reinforced by federal funding agencies because of their potential to yield technological innovation, and in turn, economic growth. However, the sustained development of transdisciplinary or interdisciplinary curriculum design remains limited due to the multiple competing factors that govern the curriculum.

This dissertation research focuses on the implementation of the transdisciplinary initiative as it pertains to interdisciplinary curriculum design. I use public institutional documents to trace the transdisciplinary institutional initiative as it is enacted at different university levels and interviews to understand the initiatives in practice, drawing from administrators, faculty, and staff experiences as they develop interdisciplinary courses.

Many university-level initiatives that purport transdisciplinary and interdisciplinary education fall short in their implementation because of academic structures that directly or indirectly inhibit sustainable interdisciplinary curricula. Instead, administrative organizations like the Registrar's Office, Office of Integrated General Education, and Transdisciplinary Initiative Office develop networks and artifacts that connect faculty who have experience bypassing academic structures with faculty who seek out these forms of institutional support. These emergent practices are an adaptation to the university system rather than a proactive measure that facilitates the large-scale structural change claimed by university-level transdisciplinary initiatives. This study contributes to the understanding of potential long-term implications through the examination of interrelated university initiatives as they exist through metrics and incentives provided by the upper administration and experiences of faculty and staff in developing interdisciplinary courses.

Transdisciplinarity on Paper: How do interdisciplinary faculty translate university initiatives into the classroom?

Desen Sevi Ozkan

GENERAL AUDIENCE ABSTRACT

There is a trend in universities across the United States of implementing initiatives that incentivize departments to focus their research and teaching on complex problems that span different disciplines. These initiatives are attractive to potential university donors due to their perceived societal relevance and reinforced by external funding agencies because of their potential to yield technological innovation. These initiatives can be short-lived, however, as they seek to disrupt the traditional university structure. The purpose of this study is to examine how faculty and staff translate and negotiate the complex university structures and initiatives as they design interdisciplinary courses. I use public institutional documents to trace the transdisciplinary institutional initiative as it is enacted at different university levels and interviews to understand the initiatives in practice, drawing from administrators, faculty, and staff experiences as they develop interdisciplinary courses. The findings show that even for faculty and staff working to create interdisciplinary classes in alignment with these initiatives, they are faced with challenges as the initiatives are limited in their structural reorientation. Instead, mid-tier administrative organizations have developed networks and artifacts that connect those who have experience bypassing academic structures with those who express interest in following their lead. This study includes a discussion of broader socio-political and economic factors that contextualizes layers of faculty and staff experiences, administrator perspectives, and the university's public messaging through the historical legacies of academia, the economy, and society at large.

Acknowledgements

I first thank my graduate advisor, Diana Bairaktarova, who has shown me unconditional support as my work has progressed. Never once did she make me feel as if I had taken on too much and instead introduced me to people who could help me take on big projects. To Lisa McNair, thank you for opening my eyes to this world of interdisciplinary curriculum design and then helping me to connect the dots once I was submerged in data. Your deft use of analogies pulled me out of the bottom of the data sea. An especially helpful comment was this,

> *"My overarching suggestion for this section is that it needs to rise, like bread, which means you need to take the ingredients and knead them together."*

I will keep trying to knead the bread.

To Holly Matusovich, thank you for introducing me to engineering education research in my first semester in the program. Thank you for the guidance and the humor throughout these four years. I hope to be a mentor like you have been for me. To Alejandro Salado, I thank you for challenging my use of language through each of my research milestones. Your feedback made me more confidence in my work and pushed me to be intentional in my research design and communication.

Thank you also to my interview participants who were patient and accommodating in answering my many questions. I could not have completed this work without you all being so generous with your time.

I must also give thanks to my engineering education mentors in the department: David Knight, Nicole Pitterson, Walter Lee, and David Gray. David Knight, thank you for your invaluable expertise on organizational theory. Your classes laid the foundations for this dissertation. Thank you also for showing me what exemplary leadership looks like in the department (I have to thank Jenni Case for this as well). Thank you to Nicole Pitterson, my self-proclaimed campaign manager, who is witty as she is supportive and has become a trusted friend. Walt Lee has been an incredible source of practical realism and has mastered the art of hallway mentorship. When hallway chats re-open, I'll be back. Lastly, David Gray, who I got to know recently through co-teaching an interdisciplinary course, quickly became the type of teacher I hope to become, not even including his unbelievable organizational skills.

To Liesl Baum, thank you for trusting me with your class and for helping me become a better teacher. Your ability to devise creative class activities and assignments in the span of short conversations is incredible. Thank you for imparting your pedagogical wisdom to me.

I also want to thank Lee Vinsel, Matt Wisnioski, and Giselle Datz for pushing me to deepen my understanding of social, political, and economic factors and for teaching me to value history. Thank you for asking me to read many books in short amounts of time.

I have to give my thanks to the coffee shops of Blacksburg, specifically Idego and Next Door Bakeshop, for the motivation and fuel to keep me writing and editing. I am thankful for these places as they offer a melting pot of Blacksburgians, students, faculty, and staff. I am honored to have followed in the foot/type/draw-steps of countless others who have used these spaces to create and think.

I must thank my fellow graduate student community in Engineering Education. It is rare to find an environment that has a motivating balance of supports and challenges. I'm grateful to the graduate students in Engineering Education for making this that space. I would also like to thank Mara Knott for the behind-the-scenes work you do in our department and for helping me sail smoothly towards a degree. I can't imagine the amount of work this takes for each student (among all the other things you do!), so I thank you for your time and your efforts.

I have to thank my mother for her infinite food knowledge and for being patient with me after I killed my second sourdough starter. She has since helped me to start a new one. Her love of creative cooking has been a recipe for the way I inhabit the world; first by referring to noodles as 'frog eyes' and then by never letting me say no to new things. My mother is the first person to teach me that art and engineering go together, which seeded my interest in interdisciplinarity.

I thank my father, who was my first role model for self-regulated learning. His quest for specialized and general knowledge laid the foundation for my interests in larger systems. His confidence in my decisions has been unwavering as he barely blinked when I decided to live out of a backpack in Colorado or work in an Alaskan salmon factory after getting my chemical engineering degree. He even listened intently when I could not stop talking about the fish factory. I still can't, so thank you for continuing to listen to my stories. To my brother, Evrim, you are one talented human. Thank you for the messages of encouragement and for creating the music that became the playlist to which I wrote my dissertation.

Finally, thank you to my partner, Janet. These past few years have been a journey for both of us. Because of you, I was able to read and digest such a broad array of disciplinary knowledge. Your vast library and extensive knowledge guided me as I expanded my engineering epistemology. Thank you for supporting me in my research and encouraging my teaching ideas, all the while bringing me along in your Blacksburg bike community pursuits. Blacksburg is lucky to keep you. For now.

Table of Contents

Chapter 1 – Introduction

1.1 Introduction

In 2016, Virginia Tech announced a new transdisciplinary initiative designed to integrate expertise from different disciplines. The initiative called for a new era of interdisciplinary collaboration "to address complex problems that impact the human condition." The rhetoric emphasized that people would work "across disciplinary boundaries." The siloes and boundary language in higher education is ubiquitous in interdisciplinary literature as proponents for interdisciplinarity challenge the societal relevance of disciplinarity (Klein, 2005). However, interdisciplinarity's justification as societal relevance is not without certain economic incentives as well.

> *"Disciplines, it is charged, inhibit communication, stifle innovation, thwart the search for integrated solutions to social problems, inhibit the economic contributions of universities, and provide a fragmented education for undergraduates. Amidst these varied lines of criticism, the central complaint is that disciplines have become isolated "silos." This fundamental weakness is a premise that undergirds the other main charges levied against disciplines"* (Jacobs, 2014, p. 13).

From a research perspective, Jacobs asserts that interdisciplinarity is already common practice in disciplines based on the ways in which knowledge is produced. He challenges the large investments from the administration toward interdisciplinary centers as futile attempts to expedite and expand these efforts (Jacobs, 2014). But at the student level, these efforts may be warranted.

Increasingly, universities are developing more professional-oriented degree programs to accommodate the rise in student and state demand for practical education (Stark & Lattuca, 1997). In effect, undergraduate education is becoming siloed as these degree programs reduce the curricular flexibility inherent in liberal education programs. Engineering education is an example of the curricular rigidity associated with these applied programs (Wisnioski, 2009). The curricular structure of these degree programs can model for students the boundaries of their degrees, in which students perceive the general education courses and electives as outside of their major (Blewett, 1993). This boundary of what is and is not engineering is a prevalent theme in the engineering education literature and has also been studied at the faculty-level (Pawley, 2007).

Interdisciplinary co-teaching models have been touted as a way to model for students the importance of cross-disciplinary collaboration (T. Martin et al., 2012; McNair, Baum, & Mouchrek, 2016). For the students, these co-teaching models can show them how to value other ways of knowing as their faculty also engage in this epistemic humility (Barisonzi & Thorn, 2003). Riley asserts "*authentic interdisciplinarity* [as] *the third rail of academia: if you cross disciplines on the level of epistemology and mix ways of knowing, you mix rules of rigor, and siloed heads explode*" (Riley, 2017). However, interdisciplinary teaching models have been difficult to implement and sustain due to the institutional structures that indirectly prevent faculty from sustaining the practice. Co-teaching models are costly for departments as they can require a financial sacrifice from the department or the faculty taking on this type of teaching load. The rhetoric at Virginia Tech looked to push past these boundaries.

Through the transdisciplinary initiative, Virginia Tech sought to reorient the traditional university and its insular disciplinary model to focus on interdisciplinary, complex societal problems. In total, nine of these problem clusters were identified and each had goals of research, curriculum, and outreach. New faculty were hired into departments who were identified to work in these interdisciplinary spaces. Virginia Tech sought to change the culture of the university by bringing the interdisciplinary faculty out of the minority. Each of these problem clusters had the power to decide how to split their resources between research, curriculum, and outreach. Some focused heavily on research, others on curriculum or outreach. One cluster, examined in chapter four, focused their efforts on curriculum and built a course between three different colleges with three co-teachers. With the seeming 'blessing' of the upper administration's transdisciplinary initiative, this cluster still faced challenges in implementing their course. Other actors were pulled in to help this course come to fruition. This dissertation examines the way in which faculty and staff translate and negotiate the complex university structures and initiatives as they design interdisciplinary courses. This is as much of a story of evolving institutional structures as it is of the faculty and staff who navigate those structures all in an agreed upon goal of interdisciplinarity.

1.2 Definition of Terms – Multi, Cross, Inter, and Transdisciplinarity

As these terms, inter- and transdisciplinary, become more popular across universities, there is a need to interrogate their meanings and implementation within their institutional context. For the many universities enacting inter- or transdisciplinary initiatives, there appears to be a difference in how the terms are defined in scholarship, how they are purported by the university change agents, and how faculty and staff experience

the initiative. Specifically, this research on research-to-practice provides context on the multiple layers of translation and negotiation between the various university actors.

In the literature, the terms *interdisciplinary* and *transdisciplinary* have different meanings, but in practice have been used interchangeably. Multidisciplinary and cross-disciplinary are other terms also used in this research space. *Multidisciplinarity* refers to multiple disciplinary perspectives coming together but without integrating or changing disciplines. *Cross-disciplinary* is a general term that can denote multidisciplinarity or interdisciplinarity, ultimately meaning that two or more disciplinary perspectives are working together. In scholarship, *interdisciplinary* denotes the integration of disciplinary perspectives, which can result in changes to the underlying disciplinary perspectives (Klein, 2010). *Transdisciplinary* is when disciplinary perspectives are transcended to the point of almost precipitating a new discipline (Klein, 2010).

Faculty engaging in interdisciplinary course design will attribute their work under the university's transdisciplinary initiative in writing so as to comply with the university's overarching mission, but then describe the course as multi-or interdisciplinary to their colleagues. This study does not seek to assess the terms in-use as each term takes on a new meaning in a different context. Throughout the dissertation, the terms, transdisciplinarity and interdisciplinarity will be used as they are used by authors, institutional documents, and interviewees.

1.3 Definition of Terms – Curriculum and Policy

In this research project, I use a variety of terms that can have different meanings depending on their disciplinary context. Interdisciplinarity and transdisciplinarity may be

the most frequently used, but seemingly commonplace terms like curriculum and policy also warrant explication.

The term *curriculum* can have many meanings from the courses that make up a degree program to structure of a single course or even lesson. In this dissertation, I use curriculum in two ways. First, to reference the sequence of courses students take for general education or a degree. In this use, I specify when referring to a degree program. The second and more common in the findings section is my use of curriculum when describing the design of an interdisciplinary sequence of courses. I use interdisciplinary course design and interdisciplinary curriculum design throughout and the former refers to the development of a single interdisciplinary course and the latter refers to the development of a series of interdisciplinary courses that make up a curriculum, much in the way of the second faculty team described in section 5.6.

The next term that needs explanation is *policy*. The term, policy ranges in specificity, for at one organization it can refer to the governing rules that must be abided by or it can refer to the "pedagogical strategies" made by an instructor (Chi, VanLehn, Litman, & Jordan, 2011, p. 137). In this dissertation, policy refers to the institutionally published decisions of the university or government bodies. To use an analogy, policy can be imagined as the decision to pull a lever on a switchboard, in which each decision results in a tradeoff between who benefits the greatest. In each tradeoff there are those who benefit more than others. Policy throughout this study refers to the institutional decisions that leave some stakeholders benefiting more than others.

1.4 Research Design

This dissertation research focuses on the way faculty and staff negotiate and translate university-level goals like the transdisciplinary initiative in their pursuit of interdisciplinary curriculum design. I trace the transdisciplinary institutional initiative as it is enacted at different university levels by administrators, faculty, and staff as they develop interdisciplinary courses. To understand the landscape of the university as it undergoes large-scale change, I use multiple frames of reference that reflect different viewpoints of university policies as they are negotiated in the context of interdisciplinary course design. Specifically, I draw on faculty and staff experiences as they engage in interdisciplinary curriculum design in different contexts.

This work does not espouse interdisciplinary or transdisciplinary activity—research or instruction—but seeks to interrogate and understand the institutional bureaucratic support and staffing challenges or benefits that inhibit or contribute to the design of interdisciplinary curriculum.

The overarching research question guiding this study is, *How do faculty and staff translate and negotiate university-wide initiatives for transdisciplinarity to the curriculum?*

This question is answered through three sub-questions:

1. How do the policies of the institution enable or prevent faculty and staff in creating interdisciplinary undergraduate courses?

2. How are faculty members challenged or supported by institutional structures in developing interdisciplinary undergraduate courses?

3. How do academic faculty and staff experience a university shift toward

interdisciplinarity in curriculum change?

In this study, I take a case study approach of a single university as it attempts to undergo a large-scale transdisciplinary change initiative. I focus on the process of two interdisciplinary course designs through the lens of the faculty and staff teams involved in their development in order to analyze the policies enacted by the large-scale initiative through the lens of those working within them.

1.4a Theoretical Framework

The study is analyzed the frame of trading zones, a theoretical framework established by Peter Galison, a historian and physicist, through his study of the collaboration between subcultures in physics (Galison, 1997). Galison defines trading zones as the boundaries at which actors across incommensurable paradigms can engage in "local coordination despite vast global differences" (1997, p. 138). The theory is rooted in anthropological linguistics, in which Galison draws the analogue of trade in physics with language development, i.e., from pidgins to creole. Specifically, Galison draws the trading zone around the local commonalities that constitute trade.

> "Trade *focuses on coordinated, local actions, enabled by the* thinness *of interpretation rather than the thickness of consensus.* Thin *description is precisely what makes it possible for the experimentalist and the theorist to communicate, albeit in a register that by no means captures the full world of either, let alone both. Thinness is what makes it possible for the surface chemist to work with the atomic physicist, the virologist with the electrical engineer, the computer scientist with the molecular geneticist"* [emphasis kept] (Galison, 1997b, pp. 35–36).

In the framework, Galison outlines five principles that constitute the trading zone: 1) stable entities engaged in the trade, 2) neoliberal reductivism, 3) power and diffusion, 4) language and materiality, and 5) applicability.

In any trade, Galison asserts that there must be stable entities to establish the trading zone. These are entities that may be dynamic but are recognizable—much in the way of academic departments, in which faculty, staff, and students transition through, and the nature of research may evolve—but the department is still recognizable to outsiders. Neoliberal reductivism denotes the value of what is being traded. The value may be different among the actors engaged in trade, but they each attribute significance to the objects of trade. The lens of power and diffusion speak to the different forms of power relations in the trade. These can be evident to traders or not. Diffusion connotes knowledge/power relations by which knowledge is disseminated or transmitted across the trading zone and the involved entities. Limits on diffusion can be indicative of power structures that seek to prevent the spread of knowledge. How diffusion occurs is also reflective of language and materiality, which is the fourth principle. The language and materiality of the trade is another factor that sheds light on the nature of trade itself. Lastly, Galison speaks of applicability, which denotes the artifacts or objects used to facilitate trade. These five principles make up the theoretical framework of trading zones, which is the lens I use to study the academic trades pertaining to the development of interdisciplinary curricula by various 'traders' across the university.

1.4b Research Methods

The research consists of a single case study of a university. The case is bound by the institutional structures and actor experiences relating to interdisciplinary course design.

The case is bound by time in that data is only collected from 2015-2019. However, to understand the single university case, the history of the specific university and universities in the United States is used to provide context to the institutional setting as well as the precedent for university-wide initiatives. The university does not exist outside of its political, social, and economic environment and as such are included in chapter two and chapter five to discuss findings from the case.

The data collection consists of two types, publicly available documents and interviews. The document collection ranges from publicly available institutional data, such as curriculum committee meeting notes, to local newspaper articles. The interviews were conducted with individuals from the two faculty teams involved in interdisciplinary course design as well as administrators, staff, and governance committee faculty members who have been involved in the new budget model, transdisciplinary initiative, and integrated general education program.

The two courses were chosen because of their different paths to development. The first was developed prior to the transdisciplinary initiative and has since adapted into the new university context. The second was developed as a result of the transdisciplinary initiative by faculty and staff involved in the large-scale change. These two contexts shed light on the difference of supports and challenges available to faculty and staff undergoing interdisciplinary curriculum design. Additionally, these two courses comprise a faculty team of co-instructors that span across colleges. Lastly, both course development and teaching teams involve a distinct faculty member from the College of Engineering.

In sum, I take a qualitative case study approach that uses historical accounts of various relations that impact the design of interdisciplinary courses. This includes broad

socio-political, and economic factors, not limited to the interviews and institutional documents but also including the various historical legacies of past trends in academia, the economy, and society at large.

1.5 Implications of this Research

University-level initiatives manifest differently across the various actors who interact within them. At the root of each large-scale initiative is local coordination between actors to put the goals into practice. Consequently, each of the actors' positionalities can be reflected in the initiatives that become practice. This research has connected the various contexts that university actors work within to identify the order of events in which these initiatives have been carried out at the upper and local levels of coordination. The research contributes to the scholarship of teaching and learning and engineering education literature in that it provides organizational context for educational reform. Without an understanding of the structural features that incentivize or indirectly punish those who seek to enact pedagogical improvements—like qualitative assessment, small size classes, or interdisciplinary co-teaching—will require yearly academic sacrifices or have to bring in outside resources to sustain the practices. This dissertation traces the structural features of academic trade across the various actors that inhabit the university such that avenues toward sustainable practices may be understood. In examining the process of interdisciplinary course development of two multidisciplinary faculty teams, this dissertation has drawn a map of events that have brought about university-level change while pointing out their malleability as academic actors engage within them.

Chapter 2 – Literature Review of Interdisciplinary Initiatives

2.1 Introduction

The increasing discourse surrounding transdisciplinarity and interdisciplinarity at Virginia Tech is not an isolated case but reflects a trend across higher education institutions. In fact, universities have sought to create interdisciplinary programs to encourage collaboration across disciplinary boundaries that have existed since the early inception of the modern university (Klein, 1990; Newell, Wentworth, & Sebberson, 2001).

Change doesn't occur within a vacuum. What is particularly interesting is that these broad institutional initiatives transcend various levels of the university: administrators, departmental programs, and the instructors who take on (whether by choice or appointment) implementing such programs. And within each of these of these levels, there are various forces that impact how "successful" or long-lasting these changes are. These programs can be viewed as reflections of the social, political, and economic changes in which programs that are sustained are those that reflect value systems external to the university. For instance, science and engineering disciplines have long held positions of power within the institution since the Cold War-era boom of federal funding and their potential for technological innovation to spur economic growth (B. L. Smith & McCann, 2001). These power dynamics play a critical role in the way the interdisciplinary and transdisciplinary initiatives are carried out in the long term. One way that this manifests is through curriculum change.

2.2 Change in Higher Education

The discrepancies in practice shed light on the different actors involved in the change effort, the existing tradition of the university, and a range of other factors that

surface as the change effort is unveiled. Many change theories exist that seek to explain the various facets of change in practice. Eckel and Kezar provide a framework of transformational change that hinges on five core strategies required for change in higher education. The strategies are: 1) senior administrative support, 2) collaborative leadership, 3) flexible vision, 4) faculty and staff development, and 5) visible action (Eckel & Kezar, 2003). Different frameworks emphasize other facets that contribute to successful change.

DiMaggio and Powell explain institutional change through institutional isomorphism, which gives a broader overview of institutions changing in to resemble similar institutions in "three isomorphic processes, mimetic, coercive, and normative" (1983, p. 147). Mimetic change refers to universities copying each other to face uncertainty. Coercive isomorphism can occur through political influences or modes of standardization. Lastly, normative processes can be attributed to a organizations need to conform to be considered of a specific caliber or identity. The trend across universities to implement inter-, transdisciplinarity at upper levels can be attributed, in part, to each of these processes, in which universities mimic many of the changes that their aspirational peers have implemented, which is also a form of conforming to the normative processes of change. Universities are also under the influence of external political forces that impose change.

2.3 Interdisciplinary Initiatives in Higher Education

Interdisciplinary efforts have been increasing for a few reasons. First, federal funding. Starting in the mid-1980s, Federal funding agencies "used their augmented budgetary appropriations to create a network of interdisciplinary research centers working on new technologies" (Brint, 2005, p.31). In 2004, the National Science Foundation (NSF)

put out a call for proposals, in which they noted, "the goal of [our programs] is to build a well-educated and skilled workforce for these cutting-edge interdisciplinary areas that are primed to drive economic growth in coming decades" (National Science Foundation, 2004). Notably, a university vice president for research is quoted by Brint, "We try to allocate discretionary resources in thematic areas–nano-technology, info technology, biotech, environment–the same as everyone" (2005, p. 31). Brint states that there are some university managers who "describe academic departments as 'silos' or stovepipes and criticize them for being too narrowly specialized to adapt to new research policy environments" (2005, p. 32). The criticism of academic departments in this regard has led to the development of new interdisciplinary centers.

To draw in more federal funding, universities also began to invest resources into interdisciplinary initiatives. Holley cites evidence of several universities that enacted large-scale interdisciplinary change to help secure more funding opportunities (2009). In 1998, Duke University established the Office of the Vice Provost for Research at Duke University to help in "fostering collaboration among units… [for] interdivisional research projects" (Duke University, n.d. cited in Holley, 2009). An additional Office of the Vice Provost for Interdisciplinary Studies was created in 1998 to make up a "significant component of Duke's interdisciplinary efforts" (Holley, 2009, p. 338). Another example is from the University of Washington, in which a 'Network of Interdisciplinary Initiatives' was developed in 2004. According to its website, the project sought to "bring together UW faculty, staff, and students who advocate interdisciplinary teaching, research, and training activities across the University" (University of Washington, n.d., cited in Holley, 2009).

The trend to bring interdisciplinarity into the fold of higher education continues now, albeit sometimes under a different name.

The funding for interdisciplinary activity has increased because it has become frequently associated with technological innovation, which has led economists and policymakers to view it as a driver of economic growth (B. L. Smith & McCann, 2001).[1] As such, external resources that call for interdisciplinary activity largely privilege science and engineering disciplines that already draw in substantial sums of external funds (Skorton & Bear, 2018). In addition to federal funding and internal interdisciplinary activity, industry needs have increased the demands for interdisciplinarity in the curriculum (Clark, 1998).

Interdisciplinarity has been used in efforts to integrate "social concerns and global consciousness within an institution" (Brint, Turk-Bicakci, Proctor, & Murphy, 2008). The engineering curriculum has undergone several swings from design to science and back, with each swing bringing a new set of skills to the forefront. Engineering education in recent literature seeks to integrate engineering fundamentals with interdisciplinary collaboration, holistic thinking, ethical decision-making, critical thought, among other skillsets (ABET, 2014; Claris & Riley, 2012; Graham, 2018; Loui, 2005; National Academy of Engineering, 2005). In the humanities, the integration of computational thinking is increasingly prevalent (Skorton & Bear, 2018).

---

[1] This term, technological innovation, is what Robert Solow attributes as a key component of his theory of economic growth, in which technological innovation is proportional to a country's economic growth.

Different forms of interdisciplinary have emerged in higher education since the emergence of its discourse, which is reflective of societal, political, and economic needs of the time. Notably, the many initiatives or funding sources described above have since been discontinued, (e.g., NSF IGERT) likely a result of the 2008 economic crash. With decreased funds, the problem that interdisciplinary activity set out to solve became less of a priority, and the expected technological innovation did not yield the economic growth that it promised. In any case, the push for interdisciplinarity through the end of the 20th century transformed into a new mimetic trend in higher education, which is that of problem-focused research areas, termed as transdisciplinarity through this dissertation.

2.4 Transdisciplinary Initiatives in Higher Education

At many universities, this problem-focused reorientation is termed as transdisciplinarity. The University of Vermont created a Transdisciplinary Research Initiative (University of Vermont, 2019). Texas Tech University established a Transdisciplinary Research Academy (Texas Tech, 2019). Virginia Tech has called its initiative Destination Areas: Building Transdisciplinary Communities (Virginia Tech, 2019). The University of Texas, University of New Mexico, the University of Denver, and the University of North Dakota have all implemented initiatives that revolve around the National Academy for Engineer's Grand Challenges (Popowitz & Dorgelo, 2018). These are just to name a few examples amongst the many.

Notably, these university-level initiatives fall under the goals of strategic planning, which has become more prevalent since the drop off in Cold War-era federal funding as well as continued decreases in state funding. Universities are publishing five to ten-year strategic plans that describe new university-level initiatives that show adaptations to

economic change. In 1979, near the end of the university's "golden age" of massive federal funding in the United States (Peterson, 2007), Stewart and Dickason wrote about how universities may come to see strategic planning as a need:

> *"Institutions will be more compelled to become more introspective and analytical, to undertake long-range planning, something they did not have to do in good times. They will be forced to set priorities and develop strategies, overcome institutional inertia and make long-overdue choices—for example, to identify areas of growing student interest and create new programs to replace those for which demand may have fallen off."* (1979, p. 23).

Universities are in a position to reorient themselves to draw in more revenue and maintain relevance amid the complex problems of society. Transdisciplinary research initiatives and curricular change to match student demand are two ways in which universities are changing to fit demand.

2.5 Sustaining Initiatives

Many of the faculty and staff who engage in the large-scale transdisciplinary change initiatives seek out extra support as traditional university structures indirectly inhibit interdisciplinary collaboration (Abbott, 2001; Holley, 2009; Rhoten & Parker, 2004). Promotion and tenure criteria are examples of traditional structures that reinforce disciplinary boundaries. Thus, without rewards for interdisciplinary activity in the criteria, junior faculty who work across disciplines often make sacrifices in order to do so.

Notably, some universities have enacted changes to these policies such that interdisciplinary scholarship is rewarded. As an example, the University of Michigan states

in their promotion and tenure guidelines that faculty should "receive full credit for their contributions to interdisciplinary and/or collaborative scholarly projects" (Skorton & Bear, 2018, p. 102). Rochester Institute of Technology and Indiana University, Bloomington have also made changes to their promotion and tenure guidelines to include interdisciplinary scholarship (Skorton & Bear, 2018).

For research activity, there is evidence that institutions are reducing structural and policies that pose barriers to faculty engaging across disciplines. However, for curricular design, there is less institutional support for faculty and staff. In some cases, large influxes of funds have facilitated the creation of new degree programs or interdisciplinary departments. Still, these are exceptions that only exist as long as the funds continue (Abbot, 2001). In addition, there is a reinforcing relationship between faculty in departments and the labor market for new faculty. Most universities in the United States have a similar makeup of departments and professional organizations for disciplines that reinforce the institutional structures across all universities (Abbott, 2001; Skorton & Bear, 2018). In sum,

> *"The mutually sustaining relationship between professionalized discipline and department affects the arrangement of everything, from the allocation of resources to faculty hiring, graduate training, and the characteristics of undergraduate training"* (Skorton & Bear, 2018, p.97).

The era of strategic planning and transdisciplinary initiatives disrupts many of the traditional university structures since departments and colleges were established. Change in research can be more gratuitous because external funding agencies supply support every fiscal cycle but in interdisciplinary curriculum change is more difficult to sustain. For

curriculum change, the rate of return is closer to four to six years of student enrollment, depending on the degree. Consequently, creating an interdisciplinary curriculum that is in line with the overarching initiatives is a slower process because potential data pointing to its 'success' cannot be calculated as quickly or quantifiably as that of scholarship[2] or commercialization.

In addition to a longer 'return on investment,' there are external accreditation agencies that can limit the development of interdisciplinary curricula. For instance, the State Council of Higher Education for Virginia (SCHEV) requires new degree proposals to show evidence of potential employment for the degree's future graduates (SCHEV, 2019). Without empirical evidence, future-focused degree programs cannot be sanctioned. Accreditation agencies can play a major role in curriculum change as it prioritizes curriculum that prepares students for the immediate workforce and, in effect, economic growth.

Inter- and transdisciplinary initiatives at the university-level are challenging to implement. Each initiative is translated by a number of actors who have a stake in the university context, from faculty to students to administrators and accrediting agents; each actor with a distinct perspective that reflects their position at the university. Ultimately, as the initiative manifests differently across actors, it highlights the institutional structures on which the university stands. This research focuses on the actors who reveal those

---

[2] Grant funds and journal publications are easier to quantify than a student's employment. Additionally, the student's employment may be a result of multiple factors that one cannot point to. The interdisciplinary degree program or single interdisciplinary course that a student takes in their academic career cannot be stated as the reason for the student's gainful employment. Yet, even in the event that it does contribute, this data will come 4-6 years after the student has obtained the degree or taken the course.

institutional structures in their pursuit of interdisciplinary curriculum design at a university undergoing three university-level initiatives. Before we dive into the institutional context specific to this study, there is a need to situate the university amidst the historical context that has given rise to such university-wide initiatives. The next chapter focuses on the historical background of universities in the United States.

Chapter 3 – The Building Blocks of Higher Education

3.1 Introduction: Curriculum in Higher Education

Changes to the curriculum can be interpreted as an expression of the societal, political, and economic values of the time. Increasingly, changes to a university curriculum have become reactive as external pressures to the curriculum mount. As the stakeholders involved in curriculum reform are made up of individuals and entities with competing visions (Rudolph, 1977), each of the proposed and enacted changes shows a perspective reflective of the period (Geiger, 2006). Engaging with the history of these competing initiatives is necessary to situate the reform efforts investigated in this study. To understand the effects of a change, one must first understand the context in which this change takes effect.

> *"Universities used to operate as a holistic discipline, where you had colleges like Oxford College that had many different colleges, each with their different specialties-some were more technology-focused, some more art-focused-but they all in modern day language were interdisciplinary."[3]*

The historical precedence for holistic themes reflects the state of knowledge at these points in time. In the 1800s, the university served a different purpose. In the United States, the university in the colonial period served to "prepare a select group of young men for the ministry or gentlemanly status" (Stark & Lattuca, 1997, p. 26). Knowledge had not been as fragmented as it has now (Cohen-Cole, 2014). Looking at the university curriculum, the

---

[3] Interview, Institute Director, Fall 2019

changes over time reflect that of societal values of the time. Clark Kerr, president of the University of California from 1952–1957 states that the

> *"Curriculum is nothing less than the statement a college makes about what, out of the totality of man's constantly growing knowledge and experience, is considered useful, appropriate, or relevant to the lives of educated men and women at a certain point of time"* (Kerr cited in Rudolph, 1977, p. 7).

3.2 A Brief History of Curriculum Change in Higher Education

Up until the 1800s, 'medieval colleges' rooted their curriculum in theology, dead languages, and moral philosophy (Rudolph, 1977). By the early 1800s, students drove change efforts to the classical curriculum, which argued was "dated, inflexible, and dull" (Stark & Lattuca, 1997, p. 46). By the 1820s, "critics of the classical college... in part reflected the success of efforts to bolster the curriculum" (Geiger, 2006, p. 48). Those reinventing the curriculum disparaged the classical colleges' emphasis on extinct languages and lack of education on practical subjects and science. Practicality became a priority for students who were no longer in university to acquire gentlemanly status, but to better their prospects in society.

With the competing initiatives developing across US universities, many of the conservative curriculum proponents were disgruntled with the growing flexibility. To accommodate, Harvard was one of the first that offered parallel tracks of similar programs, which were to "group students according to ability" (Stark & Lattuca, 1997, p. 46). Amidst arguments stating the diminishing prestige of these courses, students enrolled and continued to bypass the institutionally rigid structures by creating new avenues of study, such as "forming literary and debating societies" (Stark & Lattuca, 1997, p. 46). Students

pushed the curriculum to fit their needs and bypassed the university's rigidity that stemmed from competition among universities. There are similar influences on the modern research university, in which prestige is the currency that attracts faculty and students who then bring in research funds or pay tuition, respectively. These influences are similar across universities in competition and lead to institutional isomorphism (DiMaggio & Powell, 1983), wherein universities begin to resemble one another.

Institutional isomorphism can be seen in universities in the 19th century, introduced more flexibility into the curriculum. At the University of Virginia, an organizational feature of the 'college' system made it so that students had the flexibility to choose elective courses from departments outside of their own (Ricci, 1984). As other institutions copied this model, the possibility of electives increased the number of offered courses and specializations. With the rise of electives, curricular choice began shaping the new curriculum. In response, the Yale Report of 1828 came out to proclaim that the classical curriculum was the only form of education that was deserved merit (Thelin, 2011). The affirmations of the report acted as a temporary setback for those advocating for flexible curricula for, after a few years, electives came back to the forefront of curricular reform. The institutional change at each university existed as a network that was strengthened with each university that copied the change. Yet the process to start a large-scale institutional change seemed to require external support.

Technical education was another example that hit many barriers before it was offered in the university curriculum. Donations ensured that Harvard and Yale offered scientific and technical courses. In 1854, Union College had established its civil engineering course, and two years later, Brown had done the same. Dartmouth College

founded its Chandler Scientific School in 1851. The University of Michigan offered engineering instruction in 1852 "under the direction of Brown graduate, Devolson Wood and in 1868, Cornell started the Sibley College of Engineering" (Noble, 1977, p. 37). Donations allowed for the more established universities to enact large-scale change, but technical education became widespread when the Morrill Land Grant Act was passed in 1862. The act brought agriculture and mechanical arts education into universities in each US state.

> *"State legislatures that had been deaf to all appeals for technical instruction now quickly accepted the federal grants and voted to create the new type of school, while established colleges caught the spirit and added departments of engineering"* (Noble, 1977, p. 38).

At the time of the industrial revolution and the expansion of settlements across the US, the public voiced a need for higher education to include applied fields. The federal act funded land-grant universities in each state to provide practical education across the country to foster economic growth. In the first decade following the Morrill Land-Grant Act, the "number of engineering schools jumped from six to seventy. By 1880, there were eighty-five and by 1917 there were 126 engineering schools of college-grade in the US" (Noble, 1977, p. 38). The number of engineering graduates at this time grew from 100 to 4,300 (Noble, 1977, p. 8). Additionally, applied fields other than engineering such as teaching, social work, and nursing became popular as practical education became the avenue of "economic growth and upward mobility" (Stark & Lattuca, 1997, p. 27). The idea of a university for upward mobility both at the individual level and the state or federal level has remained a pivotal aspect of the university.

Change from global influence also occurred in the 19th-century university curriculum. The elective system was developed in part from admiration of the German notion of Lehrfreiheit, an early conception of academic freedom. American universities sought this form of freedom which entailed that professors could "teach whatever [they] deemed interesting and important" and students could "attend whichever courses they judged intriguing and worthwhile" (Ricci, 1987, p. 41).

In 1869, President Charles Eliot of Harvard announced a remake of the curriculum to follow in the German example. He argued that "a student can acquire mental competence by strict attention to any important and challenging field of study" rather than keeping the classical curriculum that sought to train students through the exposure to a set collection of courses (Ricci, 1987, p. 41). Eliot saw the curriculum as the methods of science, which took hold as Science Naturalism after Darwin's Origin of Species in 1859:

> *"Gradually, there came into being the idea that science, which occasionally dazzles by its discoveries—as with Darwin's conclusion that there is an evolutionary process of natural selection—is actually a matter of methods rather than results.36 That is, if the right methods are used, one may expect useful consequences, which are simply a welcome by-product of the methods, with the methods themselves remaining the essence of science"* (Ricci, 1987, p. 39).

Empiricism took hold as a "means of understanding metaphysical truths." Mandsfield Merriman, president of the Society for the Promotion of Engineering Education (predecessor to American Society of Engineering Education) spoke on experimental work and science in 1896 in his presidential address:

"First, the principles of science were regarded as principles of truth whose study was ennobling because it attempted to solve the mystery of the universe; and second, the laws of the forces of nature were recognized as important to be understood in order to advance the prosperity and happiness of man" (Noble, 1979, p. 38).

With the introduction of experimental work, it became "recognized that the truth of nature's laws could be verified by experience alone." The application of these laws of nature to hold in industrial and technical experimentation (Noble, 1977, p. 9). Science had accrued prestige by 1895, but only recently had "many of the academic schools [been] unwillingly forced to add scientific departments in compliance with public demand." (Noble, 1977, p. 38). Applied scientists, however, were still viewed with "second class status within the academy, and ironically, the scientists with their newly won respectability often enough lined up with the classicists against the technical educator across the campus (Noble, 1977, p. 11). Francis Amasa Walker of MIT contested the state of applied science:

"Too long have we submitted to be considered as furnishing something which is, indeed, more immediately and practically useful than the so-called liberal education" (Noble, 1977, p. 38).

3.3 Disciplines in Academia

Interdisciplinarity exists in higher education, from interdisciplinary course development (Lisa D. McNair, Davitt, & Batten, 2015; Sochacka, Guyotte, & Walther, 2016) to university-wide initiatives that reorient departments around transdisciplinary problems (Holley, 2008) to the existence of shared governance as the faculty-driven organization of higher education (Hammond, 2002; Kezar et al., 2019).

The disciplining of knowledge is not a new concept. The natural sciences only began distinguishing their bodies of knowledge, starting in the mid-seventeenth century (Klein, 2005). The creation of the social sciences as a discipline followed that of the natural sciences, then began to specialize in anthropology, economics, psychology, sociology, history, and political science by the mid-nineteenth century (Cohen-Cole, 2014). Through language that "differed from popular and general learned discourse," faculty helped to draw emerging disciplinary boundaries (Swoboda, 1979, p. 72). As specialization became more valued in society due to the increase in professional tasks, general knowledge diminished in importance, which in turn, "decentralized and fragmented general education" (Klein, 2005, p. 15). With this, societal notions of a shared culture diminished.

Disciplinary boundaries permeate all aspects of higher education "from curriculum design to promotion and tenure practices" (Drezek, Doolittle, Brandt, Fowler, & Wildman, 2008, p. 13). Disciplines orient epistemologies and can foster belonging in academic discipline for students and faculty (Lattuca, 2001). Belonging for some can be interpreted as exclusivity for others. Disciplines also develop differing value systems in knowledge production. These are the disciplinary bounds by which "we construct and organize knowledge" and adhere to a specific "set of standards and level of rigor" (Donald, 2002, p. 48). Discipline-specific standards of rigor contribute to explicit and implicit structures that affect the paths that faculty take to design and implement interdisciplinary curricula.

The forces at play differ across disciplines. In engineering, accreditation standards and industry needs drive many of the changes in the curriculum. Departments may be less inclined to support faculty-driven courses that take them away from research and

departmental teaching responsibilities. These departmental structures vary across institutions and disciplines, based on the value systems that have developed historically.

The structures that reinforce disciplinary boundaries in academia reflect underlying philosophies of knowledge formation and classification. Peter Weingart notes that "scientific disciplines…shape not only our perception of the sciences proper but also of the world around us as if they were the given structure of the world" (Weingart, 2010, p. 3). This system draws from Foucauldian power/knowledge relations in which the academic disciplines "reflect, and in turn, structure the production as well as the distribution of knowledge, i.e., research and teaching" (Weingart, 2010, p. 4). These structures then reinforce the bounds of academic disciplines through established standards and implicit ideas of rigor that give the maintain the structures' power.

Following World War II, the explosion of federal funds ignited applied research programs, which gave way to different modes of knowledge production. These external players with economic and political involvement began to determine new research priorities for academic disciplines, thus posing as a new power to overcome existing structures (Funtowicz & Ravetz, 1993). The applied modes of knowledge production soon became specialties, which follow organizational structures of existing fields within disciplines. These 'internal' specializations emerged as new fields of study, drawing from disciplinary actors, but then settled into new fields within disciplines. The electrical and computer engineering discipline is an example of the horizontal fragmentation that has all but resulted in increased specialization but has difficulty bridging experts in the same field (Jesiek & Jamieson, 2017). External forces, such as funding and accreditation, are the main change agents of the university.

3.4 The Rise of Science and Engineering in the Postwar Era

Following World War II, "an avalanche of federal money, primarily from the military and the Atomic Energy Commission, displaced the smaller industrial research projects that had been conducted by a few engineering colleges before 1940" (Seely, 1999, p. 289). Compared to the mere thousands of dollars a year that was brought in from trade associations in the 1930s, federal grants were giving hundreds of thousands of dollars a year to entire graduate programs, funding new state of the art facilities for research programs (Leslie, 1987). Different research agendas were being set by these federal agencies, such that universities created new research programs to compete for the newly available funds. The slow changes led by European-trained engineering deans gained momentum and led certain schools to quickly adapt to a new environment that valued research in cutting-edge militaristic technologies (Leslie, 1987; Seely, 1999; Terman, 1976).

Through the postwar era, direct state investments shaped the fundamental structure of U.S. engineering education (Akera & Seely, 2015). Due to the investment differences from state by state, there was variability among engineering schools across the country — some as autonomous schools, others a part of a general university, and some as "embedded within liberal arts colleges" (Akera, 2017, p. 1835). Additionally, "each school operated with a unique mix of support from philanthropic institutions, regional industries, the dozens of separate state systems of higher education, and both direct and indirect support from the federal government" (Akera, 2017, p. 1835). Ultimately, the

"invisible hand of the market operated alongside state investments and policy in the development and governance of the U.S. system of engineering education" (Akera & Seely referenced in Akera, 2017, p.1835).

Even with some structural differences across universities, engineering departments across the United States were quickly becoming dominated by research and engineering fundamentals.

"Stanford and other American engineering schools began replacing machine shop, surveying, and drawing classes with science and mathematics courses, and hiring faculty who could win research grants" (Seeley, 1999, p. 287).

In this time of hyper-competition for federal grants, "winning the game" became how engineering deans structured their programs (Leslie, 1987; Terman, 1976). Through this period, federal funding demanded research on fundamental science in science and engineering.

The subsequent shift in academic research paralleled the US economy's return to a classical economic paradigm. Technological innovation rose to importance in the post-Cold War era in the form of applied research and commercialization of research. Specifically, US national competitiveness and the Japanese government's rise in state-supported commercial research and development drove US engineers to advocate for similar developments to grow national industrial research.

"Drawing on broader historical currents having to do with the rise of neoliberalism—the extension of free market ideologies, especially into public sector activities—there was a concerted effort to transform federal agencies into

more effective entities for supporting U.S. market institutions, including stronger

partnerships in the area of research and technological innovation" (Akera, 2017,

p. 1839).

3.5 Interdisciplinary and Transdisciplinary Initiatives

Interdisciplinary initiatives, as we know them today, started at the beginning of the

20th century (Klein, 2006). These initiatives have been in response to external drivers such

as funding on interdisciplinary subjects to produce 'innovation' for economic growth and

internal drivers, also striving for technological innovation as well as other large-scale

strategic plans to bring in new sources of revenue.

The Organization for Economic Cooperation and Development (OECD)

cosponsored the first conference on interdisciplinary teaching and research in universities

in the 1970s. In the US, federal funding agencies prioritized interdisciplinary research,

which led to research programs, integrated graduate and undergraduate curricula (Holley,

2009). In the natural sciences and engineering, external funding has

"fundamentally altered the political economy… reducing the internal controls

exercised within the university by disciplinary units" (Miller, 2010, p. 334).

In response, universities increased the number of centers and institutes to assist in

acquiring these problem-focused federal funds. The transformation raised concerns as the

university was increasingly aligning with the "military-industrial complex and its

disciplinary hegemonies" privileging applied disciplines over those that conduct

fundamental research (Casey, 2010, p. 345).

More recently, calls from U.S. policy documents (e.g., National Academy of Sciences 2004; National Institutes of Health, 2006) have pushed universities to adopt interdisciplinarity into strategic plans, research objectives, and course offerings. These changes are portrayed by university new sources to spur technological innovation and enhance global competitiveness, as stated by university officials, government agencies, and accreditation bodies (National Academy of Engineering, 2005; National Institutes of Health, 2006; National Science Board., 2014; Skorton & Bear, 2018). However, these large-scale initiatives require different incentives and structures to facilitate and reward faculty in their interdisciplinary collaborations.

Between 1998 and 2002, the National Science Foundation (NSF) increased funding for interdisciplinary research centers by 76% (Stone, Bollard, & Harbor, 2009, p. 323). During this time, the total budget increase for the NSF was 29% (Brainard, 2002). According to the 2006-2011 NSF Strategic Plan:

> *"Discovery increasingly requires the expertise of individuals with different perspectives — from different disciplines and often from different nations — working together to accommodate the extraordinary complexity of today's science and engineering challenges. The convergence of disciplines and the cross-fertilization that characterizes contemporary science and engineering have made collaboration a centerpiece of the science and engineering enterprise"* (Gorman, 2010, p. 1).

Seemingly, as more extensive funding sources exist for interdisciplinarity, the more investments schools make into such initiatives. However, many of these changes are slow to infiltrate the culture of some departments.

With external support, institutions are provided incentives to bring interdisciplinarity into the fold of higher education. As a result, interdisciplinary programs are becoming more prevalent. In a liberal arts college, Stone, Bollard, and Harbor discuss the development of an interdisciplinary program that addresses many of the institutional barriers outlined above (2009). The institution describes the creation of "college-wide signature areas" that will serve as areas of distinction for the college (Stone et al., 2009, p. 322). According to Stone et al., the initiative,

> *"was used by the dean's office to energize and transform the College by recognizing and encouraging faculty interests while also sparking new collaborations and a vision that would enhance efforts across departmental boundaries and at the same time strengthen and revitalize existing departments"* (2009, p. 322).

Interdisciplinary work can still be viewed as "marginally important" and "faculty members frequently do this work in addition to the work in their home departments resulting in a considerable overload in teaching, service, and research" (Stone et al., 2009, p. 324). These programs face difficulties when there is a turnover from faculty members retiring or leaving the program, for bringing in new faculty advocates can be impossible due to the sacrifices they undoubtedly make (Frost, 2005).

For a program to be sustainable, it must be rooted in the structure of the organization with a network of faculty and administrators who value and are invested in the program (Frost, 2005). Otherwise, faculty working in these spaces are left to devise ways that bypass institutional structures that are rarely sustainable or rewarded (McNair, Newswander, Boden, & Borrego, 2011). Burton Clark notes that each institution must develop a steering

core, which devolves hierarchical decision-making to "a flexible, flat, heterarchical level for decision making" (Clark quoted in Casey, 2010, p. 346). In addition, Clark notes the need for an "expanded developmental periphery and diversified funding base," which consists of centers, programs, and institutes that assist in the interdisciplinary university goals (Clark quoted in Casey 2010, p. 346).

In creating an organizational structure by which the program develops bylaws and goals and mechanisms for achieving said goals, the program can "obtain secure funding, either from the university administration or outside sources" (Stone et al., 2009, p. 325). These signature areas described by Stone, engaged faculty participants in all stages of the initiative, from proposing the subject of the signature areas to voting them into existence.

"Additionally, a new team-teaching policy was approved in the spring of 2008, which allows classes team-taught by faculty members in different departments to count toward both faculty members' teaching loads" (Stone et al., 2009, p. 327).

The support system coming directly from the institution enables faculty to develop nontraditional classes. However, different universities and departments have different values, which make it difficult for this type of top-down change initiative in departmental teaching to exist in different contexts, especially in those in which major requirements are more rigid, like those in engineering (Riley, 2012). According to Casey in the Oxford Handbook of Interdisciplinarity, faculty who teach across departments must be protected by policies that ensure faculty receive "equitable evaluations of teaching, research and service in consideration of merit salary, tenure, and promotion" (Casey, 2010, p. 347).

In an example of developing an interdisciplinary program, Vanasupa et al., highlight the faculty conflicts at California Polytechnic State University, San Luis Obispo that resulted in a "failed transdisciplinary effort to collaborate" (2012, p. 173). In the course, transdisciplinarity is described by "multiple, co-existing viewpoints" that highlight the gaps between views, which are then used as launching points for further research and understanding (Vanasupa, McCormick, Stefanco, Herter, & McDonald, 2012, p. 173). These methods give way to the systemic collaboration necessary for societal problems that have added layers of complexity (Senge, Lichtenstein, Kaeufer, Bradbury, & Carroll, 2007).

In Vanasupa et al., the challenges that arose from faculty collaboration mirrored those apparent in the student team collaboration. Notably, Vanasupa et al., draw parallels between their "transdisciplinary classroom setting" and the dynamics of the larger institution to describe the different structures of power embedded across disciplines (2012). Specifically, at larger universities with a technical focus, there is less institutional funding distributed to those in the liberal arts (Boix Mansilla, Miller, & Gardner, 2000; Vanasupa et al., 2012). The authors' transdisciplinary course is in an institutional setting where the disciplines that leverage more political power comprise epistemologies that are quantitative in nature (Vanasupa et al., 2012). This underlying political structure that the faculty members are part of requires that their collaboration includes ongoing discussions of the differences in their values and epistemologies (Pawley, 2012). Without acknowledging and designing courses that value different ways of knowing and student learning outcomes, interdisciplinary courses can reduce disciplines to handmaiden positions to the field in power.

"When only context matters, the non-engineering discipline's epistemologies and methodologies are abandoned, in the worst cases leading to uncritical substitution of an engineering tool--for example, an art and engineering class that abandons art's understandings of color and light for physical analysis of wavelength and amplitude" (Riley, 2015, p. 140).

A major limitation of this transdisciplinary course was that some faculty were not equal co-creators. Faculty who had more experience in service roles (graphic design and architecture) had a subordinate position on the team. Faculty need to be "equal co-creators" of the course "with shared goals" rather than act as "contracted agents who are serving someone else's goals in exchange for a personal gain" (Vanasupa et al., 2012, p. 178). The institutional power dynamics between the college of liberal arts and engineering were reinforced by individuals from those colleges, which further shifted the faculty team from that of co-creators to a leader-subordinate structure (Vanasupa et al., 2012).

The institutional culture makes it so that only a select few faculty are in the position to pursue interdisciplinary research or teaching–those who feel the safety of tenure or those who believe that their interdisciplinary work is an asset in their bid for tenure (Lattuca, 2001). However, this view on interdisciplinary teaching and research as a pre-tenured faculty is largely dependent on the culture of disciplines. In some disciplines, staying within one's discipline for research and teaching is more rewarding in the promotion and tenure process (Lattuca, 2001c). This institutionally supportive perspective is extremely limiting for the field of engineering and results in few interdisciplinary opportunities for faculty and, consequently, students. In the case of one course seeking to integrate business, industrial design, and engineering, the faculty team described the course design as

"muscling through governance" to cross-list the course in the three departments (Ozkan, McNair, & Bairaktarova, 2019). When the institutional structures prevent faculty from designing and implementing courses that defy tradition, undergraduate education suffers as well (Lisa D. McNair, Newswander, Boden, & Borrego, 2011).

3.6 Liberal Education

A liberal or general education has fallen in and out of favor since the early days of the university curriculum in the United States (Ricci, 1984). The early classical system of education was a precursor for current liberal education programs. In the pre-War period, liberal education held prestige and power of technical and applied education. In the current era, external funding sources give power to applied fields through uneven funding sources. In some examples, liberal education has been adapted to *serve* applied fields such that scholars and graduates are more apt to producing and working in innovative, boundary-crossing manners.

Liberal engineering education is one example in which engineering educators have sought out liberal education for the engineering curriculum. As early as the 1920s and 1930s, there were calls from employers who emphasized that a "liberal education gives power over men" (Noble, 1977, p. 32). Reports from H. P. Hammond in 1940 and 1950 resulted in a humanistic-social division in the American Society for Engineering Education (ASEE). Hammond called for curricula that would help the engineering student "reach his own decisions in meeting the problems of his study, his work and his life; and, equally important, skill in learning from doing this" (E. D. Smith, 1945). Through the Cold War era, general (liberal) education became institutionalized. In 1973, Henry Knepler published a survey documenting over 200 engineering programs with "more meaningful" liberal arts

courses asserting that "neither in basic nor applied science is there a decision devoid of value judgment" (Knepler, 1973, pp. 305–309). Still, the post-war era in the US consisted largely of research-driven university change, which made it difficult for faculty trying to gain credit for novel pedagogies or curriculum changes (Kerr, 1963).

The increase in external support drove engineering to fragment into horizontal specializations and largely isolate itself from liberal and general education. During the growth of technical education and research, enrollments and faculty numbers rose exponentially. At UCLA, the original faculty of seven grew to eighty-six by 1955 (Wisnioski, 2009). The number of undergraduate offerings increased from twenty offerings in 1945 to eighty-five in 1955. Similarly, the number of graduate courses increased from two to twenty-four (Wisnioski, 2009). With a rising emphasis on education, the engineering college won a $1.2 M grant from the Ford Foundation in 1957 to review its engineering curriculum (Borgmann, 1964). This grant resulted in UCLA's Educational Development Program (EDP), which became "the largest local evaluation of engineering pedagogy in the postwar era" (Wisnioski, 2009, p. 765). This program reported its "most startling discovery" as the "recognition that expertise in the applied humanities represents both the outstanding need of the professions and the most exciting challenge of professional education" (Wisnioski, 2009, p. 765). The EDP's findings were met with tension from the UC System's Committee on Educational Policy. The argument was that "pedagogical studies detracted from scholarship," which was the basis for a "first-class university." Multiple factors competed within and upon UCLA. The external industry funds to redesign the curriculum conflicted with the external state pressures to prioritize scholarship. The challenges from the UC system's committee resulted in the delay of UCLA to accept the

grant because the committee had "suggested using the funds to recruit faculty" (Wisnioski, 2009, p. 766).

More recently, programs have again sought to integrate liberal education and engineering education to prepare graduates with the ability to integrate social and technical skills. Largely, these changes have come from a push to fulfill accreditation criteria, industry needs, and to provide an overall benefit for society (ABET, 2014; Bucciarelli and Drew, 2015; Graham, 2018). There has been a call for an organizational restructuring of engineering education such that students come away with a broader and more holistic understanding of authentic problems—integrating the social and technical binary that is the general status quo in undergraduate engineering education (Bucciarelli & Drew, 2015; Klein, Traver, Raucci, & Jones, 2009; Faulkner, 2007). Bucciarelli and Drew (2015) describe an "undergraduate pre-professional degree program – Bachelor of Arts in Liberal Studies in Engineering" to address this problem. In the 2015 special issue of the Engineering Studies, authors responded to their call with shorter articles that built upon Bucciarelli and Drews' call as well as pointed out concerns in the authors' original call.

The driving claim put forth by Bucciarelli and Drew is that the core of any traditional engineering major is narrow. It is "constrained to the application of instrumental methods to obtain the solutions of well-posed problems, which admit but a single, quantitative correct response" (Bucciarelli & Drew, 2015, p. 105). Bucciarelli and Drew argue that the reliance on instrumental methods to solve close-ended problems with single solutions instills in students a need to disregard contextual features that fall outside of the clear boundary of engineering (2015). Critical thinking and creativity are skills linked to liberal arts education that some point to as reasons that the US still outperforms other

countries such as China and India with strong engineering programs (Bucciarelli & Drew, 2015).

Yet at Cal Poly, reflections on the first attempt of faculty coming together to create a liberal arts and engineering hybrid program Cal Poly, reveal how quickly it can "go awry" (Gillette, Lowham, & Haungs, 2014, p. 112). Authors, Vanasupa, McCormick, Stefanco, Herter, and McDonald, discuss their efforts.

> *"Discussions about the revision of general education and major requirements are often highly politicized in this climate, and curricular changes are usually enacted in the absence of meaningful input from the departments that would be significantly affected.[...] Those who work across disciplinary boundaries do so at their own peril as there are no systemic incentives to do so"* (2012, p. 170).

Bucciarelli and Drew discuss a variety of example pedagogies that show the integration between seemingly neutral and 'True' concepts from engineering with societal and political features that question the sanctity of such 'Truths' are limited to exemplar cases (2015). In one course Bucciarelli and Drew discuss a court case that relied on gas chromatography to measure blood alcohol level. The case is against a man accused of drunk driving, and the class assignment is to investigate the experimental errors inherent in gas chromatography. The course designers then address the intersections between science and law, such that students could learn from the actual case study as to why the defendant was released. In this project, the instrumentation that measures blood alcohol level is not considered in isolation from the context in which it is being used. The domains, law and chemistry, come together to focus on a problem that integrates aspects of both. "The way to ensure an interplay of the two worlds is to require the participation on equal terms of a

faculty member of a Department of Chemistry (or Chemical Engineering) and a faculty member of a Law School" (Bucciarelli & Drew, 2015, p. 115). However, the review of these courses lacks a discussion of the institutional structures that faculty negotiate to create these interdisciplinary classroom spaces. In higher education, the institutional context often poses barriers to the development and implementation of potentially integrative courses and projects.

3.7 Liberal Engineering Education Programs

At California Polytechnic State University, San Luis Obispo, a liberal arts engineering hybrid program has been built in a similar vein as the call to liberal engineering education by Bucciarelli and Drew. Not without several challenges, Gillette, Lowham, and Huangs describe the strife that the team endured in bringing this program into existence (2014). The Liberal Arts and Engineering Studies (LAES) program was developed at Cal Poly, which is a California public university. As a state school, they receive yearly funding, but recent decreases have resulted in stronger divisions among departments. The need to "reassess all outgoing expenses" has become prominent and has taken the form of firing or not rehiring many part-time employees. Consequently, the reduction in state funding has pushed departments to become more defensive in the delineation of their disciplines and "pull even tighter inside their silos to protect what they feel are the core missions of their programs" (Gillette et al., 2014, p. 110). As departments solidified their "silowalls," "commercial partners, advisory boards, and state-level review committees" pushed the university to "create more well-rounded, cross-trained graduates who could more easily put to use what they had learned from many different fields to solve new, complex interdisciplinary problems" (Gillette et al., 2014, p. 110).

On a surface level, Cal Poly's mantra, "Learn by Doing" seems to pave the way for institutional interdisciplinarity, however, due to the increasing ambiguity of the term, interdisciplinary collaboration has been defined to encompass a:

"limited collaboration between departments inside the same college or between two faculty members from different scholarly backgrounds working inside the same department; or… two or three faculty members team-teaching a short-term course for students from different disciplines" (Gillette et al., 2014, p. 111).

Unfortunately, these interdisciplinary projects were short-lived due to the expiration of funding sources. The funding system at Cal Poly is structured such that the Deans would be put in positions that required them to compete to compete for funding sources from the Provost's office. Through this competitive structure, sharing and collaboration at a disciplinary level are not strategic if departments seek to receive as much funding as possible. Pursuing funding as joint teams result in less departmental funding than if pursued independently (Gillette et al., 2014). Only through "special arrangements" have short-term sources been acquired to fund interdisciplinary projects that cannot outlive their limited timelines.

A team of faculty and administrators in engineering began developing a new degree that would combine engineering with the liberal arts (LAES). Gillette et al., present the program as a way to "better integrate liberal arts courses into engineering degrees to allow students to more efficiently progress toward graduation" (2014, p. 112). Many of the issues the college of engineering was having was student retention. Students would drop out of the engineering program or switch to "easy" liberal arts majors (Gillette et al., 2014, p. 113). Moreover, the program was deemed "a good way to make effective use of existing

course resources, that would not ask for extra funding from either of the colleges involved, and that could potentially save the university money by speeding students toward graduation" (Gillette et al., 2014, p. 112). According to the authors at Cal Poly, the program was not successful, and the existing divide between departments grew into conflicts. In reflection on what could be saved from the years' worth of planning, the failure of the program was a consequence of the "fundamental misunderstandings of how each college involved in the process defined the other. Additionally, how the colleges saw themselves in this collaborative process was often in direct conflict with how they were viewed by the other colleges" (Gillette et al., 2014, p. 115).

As Donna Riley explains in an article about integrating liberal arts and engineering, the power differences and acknowledgment of other ways of knowing are a "necessary precursor to any Liberal Studies in Engineering endeavor" (2015, p. 140). The effort at Cal Poly was re-energized by a new team, who understood collaboration as a "complex process that could not rely upon simple narratives and ingrained habits of thought; they needed to question all their preconceived notions about their colleagues" (Gillette et al., 2014, p. 116). Only after the failed attempt at an integrative liberal arts and engineering program, was a team able to reflect and learn from the issues that halted the initiative. Riley posits that many of the integrative efforts with liberal arts and engineering are unsustainable due to the power differences that exist between disciplines in the context of higher education.

> *"Through long-term, holistic, reflexive engagement in cross-disciplinary communities, we might share wisdom with mutual respect and humility, arriving somewhere entirely different. We might at last experience liberal education: the*

critical thinking and reflective action that comes from engaging different ways of knowing and doing, connected to the authority of one's experience, and developing the judgment to distinguish among these, knowing when to apply which set of epistemologies, which questions, and which forms of analysis, ever grounded in praxis" (Riley, 2015, p. 140).

Many of the issues with these programs are factors of the different contexts in which departments exist. At research institutions, the funding sources are largely independent of the university, which instills different resource avenues and power structures among departments. The lack of support structures has been pointed to as reasons for short-lived courses that seek to integrate across disciplines (Lattuca, 2001a; McNair, et al., 2011; Vanasupa et al., 2012). As a result, designing an integrated curriculum needs to consider the culture and structures of the university before the program can be interdisciplinary and sustainable.

3.8 Theoretical Framework

Disciplines make up many of the cultures that exist in the university. They can be differentiated by their physical boundaries as well as their languages, value systems, and modes of knowledge production. Issues of curriculum or faculty affairs across the institution are instances that require these cultures to coalesce. Historically, disciplinary differences made up the various cultures across the university, but increasingly there are new divides. For one, the number and type of administrative positions have increased (Wall Street Journal, 2012). Faculty positions have become increasingly divided because of the new teaching, professional, and research positions (Kezar, 2012). There has been a proliferation of new departments, offices, institutes, centers, and academies (among other

institutional denominations) that seek to fragment and unify actors across the institution. In this dissertation, I use the theoretical framework of trading zones to examine the boundaries between these cultures and the local coordination that occurs to facilitate academic trade.

Trading zones was first put forth by Peter Galison in his study of the physics discipline and its subcultures (1997a). His seminal piece, *Image and Logic*, is an in-depth study of the subcultures that make up the physics discipline. In *Image and Logic*, Galison develops an argument in opposition to former movements of logical positivism and antipositivism, including that of Thomas Kuhn's Structure of Scientific Revolutions, by bringing the people to the forefront (Kuhn, 1962). In the early to mid-20th century, logical positivists "argued that unification underlies the coherence and stability of sciences," and later, antipositivists held that disunification implies instability. For logical positivists and antipositivists, there exists a single, reducible protocol language of science. Knowledge is grounded on "the solid bedrock of experience" that is distilled and interpreted to build theory.

However, Galison contends that the *dis*unification of science is its strength not its instability. "*Science is disunified, and—against our first intuitions—it is precisely the disunification of science that underpins its strength and stability*" (Galison, 1999, p. 137). Using methodologies from historical analysis, Galison uses periodization to portray the ideological differences between positivist and antipositivist epistemologies. Periodization is a "methodological commitment that prescribes the breaks and continuities appropriate to the domain under study" (1999, p. 138). With periodization, Galison depicts the breaks and continuities of experience and theory in the two epistemologies. In the periodization

of antipositivism, experience and theory are in alignment, in which each new experience can be distilled to yield new theory.

In Galison's study of physics, he notes that there are three components that make up knowledge: experiments, theory, and instrumentation. In his physics example, these three components reflect the three subcultures of the discipline. Notably, Galison discusses these subcultures as quite insular as the scientists involved in each rarely crosses between the boundaries. For instance, *"while defections from one arena to another are possible, they are rare and discouraged"* (1999, p. 143). In the periodization that denotes the three subcultures, Galison depicts the overlaps between breaks and continuities, in which there are no clear alignments among the three components. He notes the partial autonomy for each of the subcultures, undoubtedly there have been events where they have lined up in past events, but according to Galison, "we do not expect to see the abrupt changes of theory, experimentation, and instrumentation to coincide. These abrupt changes can be postulated as the scientific revolutions Kuhn developed previously. Yet where Kuhn's work is rooted in an underlying current of 'Truth' that is uncovered by the continued experiments, Galison's physics work highlights the constrained traditions of its three subcultures that are not linked together through the unification of science, but by "local coordination" (2001, p. 139)

3.8a Actor-Network Theory

Before diving deeper into the trading zones framework, there is a need to root its discussion in its predecessor, actor-network theory (ANT). Galison's emphasis on local context and communication between the subcultures in physics builds on the work of Bruno Latour on the "assemblages of nature" (2005, p. 2). While Galison focuses on the local

translation and coordination among actors in science from different subcultures, Latour's work depicts the system of people, objects, and environments that Galison builds on. Through a series of ethnographies detailing the inner workings of "Laboratory life" among other studies, Latour focused on the actions of scientists (e.g., Latour and Woolgar 1986, Latour 1987, 1988). In this work, Latour used the term 'translation' to denote the ways scientists make connections between microbes, diseases, the laboratory, and the natural environment.

Latour speaks of the multiple vocabularies that informants use to express their experiences to the researcher. In traditional sociological practice, these vocabularies are translated into a "master vocabulary" that "acts as a sort of clearing house for instantaneous exchanges between goods that all share the same basic homogeneous quality" (2005, p. 36). Latour's work with actor-network theory emphasizes that the heterogeneity of vocabulary is a key aspect of the findings that "invoke invisible entities" of the systems (2005, p. 49). A key element of this dissertation research is to understand the translations made by faculty, staff, and administrators of university-level initiatives across different layers of the institution.

Latour also describes the term 'actor' as is used in actor-network theory to encompass more than a single person or organization, but as "the moving target of a vast array of entities swarming toward it" (2005, p. 46). Drawing from an analogy in theatre-acting, Latour describes actor as an actor on stage who is not alone in "carrying out the action" but involves several externalities that make sense of the action. Ultimately, "it's never clear who and what is acting," but the analysis sheds light on the complexity of the system under study (Latour, 2005, p. 46). In a similar, sense the faculty, staff, and

administrators in this study are not studied in isolation of their contexts but through their relationships with each other, the institution, and the external forces that help make sense of their seemingly individual actions.

3.8b Trading Zones

Galison builds on Latour's point of translation in scientific processes and puts forth the idea of a trading zone to denote the locality of exchange. From the work of anthropologists, trade exists between cultures with completely different value systems and objectives. These cultures can agree upon rules of exchange through local coordination, even though they may exhibit "vast global differences" (Galison, 1997, p. 138). Galison coins the concept of trading zones to focus on the boundaries among subcultures, identifying the evolution of language and the use of 'trading objects' as they become facilitators of the collaboration. With this term, Galison outlines a zone to capture the "disunified traditions of experimenting, theorizing, and instrument building" in the culture of physics (1999, p. 146). These trading zones are how "highly constrained negotiations that proceed within them… bind the otherwise disparate subcultures together" (Galison, 1999, p. 147).

Drawing from anthropological linguistics to depict how trade is conducted, Galison describes that different cultures agree upon the rules of their exchange by "using a stripped-down interlanguage much as traders created pidgins or creoles that operated on the interface between social groups" (Chrisman, 1999, p. 4).

"Cultures in interaction frequently establish contact languages, systems of discourse that can vary from the most function-specific jargons through

semispecific pidgins, to full-fledged creoles rich enough to support activities as complex as poetry and metalinguistic reflection" (Galison, 1999, p. 138).

The interaction between cultures exists in what Galison denotes the trading zone. Trading zone objects are what the two cultures bring to carry out their trade. These objects can be of different significances for each trader. Still, traders can come to "a consensus about the procedure of exchange, and about the mechanisms to determine when the goods are 'equal' to one another" (Galison, 1997, p. 146). Ultimately, "they are traders, coordinating parts of interpreted systems against parts of others" (1997, p. 149).

Highlighting the role of people as traders in a trading zone brings up a discussion of order. Science is ultimately a human endeavor.

"For years, physicists and engineers harbored a profound mistrust of disorder. They searched for reliability in crystals rather than disordered materials, and strength in pure substances rather than laminated ones. Suddenly, in the last few years, in a quiet upheaval, they discovered that the classical vision had it backward: the electronic properties of crystals were fine until-because of their order-they failed catastrophically. It was amorphous semiconductors, with their disordered atoms, that gave the consistent responses needed for the modern era of electronics. Structural engineers were slow to learn the same lesson. The strongest materials were not pure-they were laminated; when they failed microscopically, they held in bulk" (1999, p. 157).

The trading zones frame brings this disorder to the forefront. Through this dissertation, I take faculty, staff, and administrators as the actors who trade in academia. Within the

university, I contextualize processes of academic trade through the activities they are composed of and the multiple value systems in which trade occurs. Academic trade is operationalized as changes to a curriculum, the form of new research programs, or even new departments as the trade becomes institutionally recognized and supported. The next chapter outlines the methodological process that scope and structure this dissertation.

Chapter 4 – Methodology

4.1 Introduction

In this chapter, I explain the research design used to reach the overarching research goal, which is to understand the implementation of the transdisciplinary initiative as it pertains to interdisciplinary curriculum design. Specifically, I draw from the experiences of faculty and staff members who work within interdisciplinary curriculum design in the context of a research university that purports the rhetoric of transdisciplinarity. I use public documentation and administrator interviews to examine the rhetoric and structures regarding curriculum development. Through these various lenses, I trace the transdisciplinary institutional initiative as it is enacted at different university levels by different actors. Additionally, throughout this chapter, I take interdisciplinary courses to mean courses that have been designed and taught by faculty members from different disciplines who designate their course as inter- or transdisciplinary.

Guided by the theoretical framework of trading zones (Galison, 1997b), I frame the university as a collection of trading zones, between departments, colleges, faculty, and administration. The inter- and intra-exchanges between faculty and administration across colleges are examples of trade exchanges that lead to curriculum change. In this study, I seek to understand the university structures that support and prevent interdisciplinary course design. I focus on two distinct interdisciplinary course development processes to understand the differences comprised in the experiences of the faculty and the way each team navigates institutional structures and policy.

4.2 Theoretical perspective

The theoretical perspective that informs the methodology of this study is rooted in trade. Trade as a concept nullifies power differences between entities. In many ways, the invention of money was the first ultimate power equalizer and facilitator of widespread trade. The assumptions that underlie these notions of trade as equalizer posit that the currency and entities are stable. However, the stability of money is a product of social dynamics and government intervention. The nature of trading assumes no power differences, but this disregards the social dynamics that could disrupt the stable notion of trade.

In economic histories, the contagion of fear and distrust of stable entities that have altogether led to the collapse of currencies and governments, which exposes the assumptions that facilitate trade. There is an assumption of rational economics and predictable linear equations that inform any exchange. This study expands on these assumptions by identifying different academic operationalizations of trade across different levels of the university and then focuses on two examples in which the trade regarding interdisciplinary curriculum design is disrupted in practice.

4.2a Trading Zones in Higher Education

Trading zones was further developed into a theoretical framework by a collaborative team from Science, Technology, and Society (STS), history, and the psychology of science that resulted in a volume titled Trading Zones and Interactional Expertise edited by Michael Gorman in 2010. In 2006, the authors of the volume held an NSF funded workshop on Trading Zones, Interactional Expertise, and Interdisciplinary Collaboration to "encourage collaboration among different stakeholders" (Gorman, 2010,

p. 1). The practice of creating this framework stemmed from the participants' own practices of exchanging and integrating expertise.

Galison's work points to the ways that scientific disciplines are developed comparably. Trading zones can be used to frame the integration that occurs between them and various boundary objects produced from these collaborations (Gorman, 2010).

"A trading zone between expertise communities can gradually morph into a new area of expertise — such as biomedical engineering, which is obviously a hybrid of biology and medicine" (Galison 1997, p. 783).

Individual departments have different values and needs than the larger institution, but still, necessitate a form of collaboration to meet teaching and research responsibilities to the university. There are five principles of trading zones that Galison outlines.

1. *Stable Notion of Entities Engaged in Trade*

The first is that entities engaged in trade must have some semblance of stability. In an analogy to the body, Galison notes that "body is constantly replacing cells, but enough of it remains for it to be possible to identify and reidentify yourself as the same person" (Galison, 1997, p. 29). In the same way, for trade to occur, there cannot be too much rigidity or purity, but also enough stability such that the identity of the entities can be understood.

In the higher education context, entities engaged in trade in a stable format can be mapped onto the existing internal structures that make up departments, colleges, and the governance committees that cut across them. These can also be offices or institutes that exist as entities exchanged in trade, whereby trade references aspects of curriculum development. The shaping of a curriculum is largely referred to as being driven by faculty

(Rudolph, 1977) and has existed in this manner since higher education was established in the US in the 1600s. However, the shaping of the curriculum comprises a variety of different entities throughout its process of curriculum development and approval that range from the original ideas for courses to state agreements to logistical technicalities in getting students to enroll in the published courses.

2. *Neoliberal Reductivism*

Trades or exchanges are built on the underlying presupposition of currency. Within any trade exchange, the making of knowledge is reduced to the making of currency. "Trade imposes ideas of profit, universal valuation, and divisibility, and, worse, assumes a calculated rationality of self-interest" (Galison, 1997, p. 24).

In academia, currency can exist in multiple forms. For some actors, currency takes the form of research publications, for others, currency exists as books. With regard to the department or college budget models, currency can comprise student credit hours, with higher values attributed to students who pay tuition as out-of-state residents. For faculty who have teaching responsibilities, another form of currency is the instructional teaching credit they receive for the number of courses they teach. In many models, this teaching credit is reduced for courses taught with other instructors. The promotion and tenure system acts as a legend for what is considered currency for the first six years of a tenure-track academic. These forms of currency do not necessarily coincide with those of the department head and likely not with those of students. This convoluted and often competing value system informs many of the exchanges that are feasible or sought after for curriculum reform.

3. *Power and Diffusion*

The third principle discusses power. Galison asserts that the "nature of trading presupposes that power differences do not exist," which is to say that the act of a trade is a voluntary agreement between entities (1997, p. 37) However, imbalances can create power differentials, which affect the diffusion of knowledge. For instance, the perceived prestige of knowledge can affect how it spreads through centralized one-way channels. In line with Foucault's genealogy of power/knowledge, the relationship between knowledge and power follows that of a reinforcing cycle, in which entities that hold power are able to create and disseminate the knowledge that holds those entities in power. Foucault's knowledge/power relation extrapolates from Francis Bacon's 'knowledge is power' proclamation by contextualizing the source of knowledge creation within power structures that reinforce what knowledge is created and disseminated.

At a university, the diversity of ontologies and epistemologies yield differences in perceived power distances between disciplines. Additionally, there are also the power imbalances that exist across the administrative faculty, administrative staff, research faculty, teaching faculty, and undergraduate students. This list is confined to the context of this research and is not exhaustive of all of the institutional positions at a university. As these groups confer through their organized entities to trade on the curriculum, the actions and decisions that go through are indicative of the different power structures among them.

4. *Language and Materiality*

Within trade zones, the languages used among entities structure what is being traded back and forth. The variability of meaning relates to whether they are specific to disciplines or even institutional contexts and can inform how the trade is carried out. The development of the trading zone framework draws on the formation/evolution of languages

(Foley, 1988). It uses the notion of interlanguages, which is "characterized by their change over time and by their locality" (Galison, 1997b, p. 42).

As the data collection contains large quantities of written documentation that shows a public face of the university, the language and materiality aspect of the data analysis is perhaps the most prominent lens through which to view this work. Institutional documents pertaining to curriculum reform serve a variety of different purposes—from procedural guidelines that faculty follow to more outward-facing prose pieces that approvingly paint university initiatives. The meanings that these different types of documents evoke are different by design but then also can be different for the various stakeholders who interact with them based on their situated knowledge on the topic. This principle will highlight instances of written language-use and the parallel or resultant interpretations from actors who have authored or adhered to the language put forth.

5. *Applicability and Boundary Objects*

In the discussion of trading zones and exchanges, there can be objects that are on the boundary of trading zones and used by the different groups. These boundary objects were first introduced by Star and Griesemer, in the context of vertebrate zoology (1989). In the intersections of different types of knowledge production, actors attach different meanings to the methods and objects that are used. Consequently, these diverse meanings must become communicated if the actors intend to collaborate. Boundary objects have different meanings but maintain a common structure to be recognized by multiple disciplinary perspectives as a tool for translation. Star and Griesemer define boundary objects as "objects that are both plastic enough to adapt to local needs and constraints of

the several parties employing them, yet robust enough to maintain a common identity across sites" (1989, p. 393).

Researchers have used the notion of boundary objects in a variety of disciplines (Levy, 2017; Pawley, 2012; Star & Griesemer, 1989), making a note of the fact that framework regarding boundary objects is a boundary object in and of itself (Trompette & Vinck, 2009). Boundary objects can also play a role in establishing and maintaining trading zones, as introduced by Peter Galison. The stakeholders involved with the boundary objects are also those who make up a trading zone (Gorman, 2010).

Language is another example of a boundary object that is used in daily life. The different types of languages - cultural or disciplinary indicate that differences among them have formed based on the locality of each. In higher education, many of the procedures or practices that occur are isolated to academia. They have resulted in the emergence of artifacts that supplement exchanges among the stakeholders in a trading zone. In academia, these artifacts can pertain to a variety of levels of abstraction from disciplinary language to proposal guidelines.

4.3 Positionality

As the daughter of an engineer and architect, I have navigated interdisciplinary spaces since the beginning. In reflection, this upbringing has paved the way for the trajectory of this study as I have focused on a variety of actors navigating and trying to create their own interdisciplinary spaces. Initially, my research focused on different contexts in which similar concepts were taught, creativity and design being the focus. This research led me to identify creativity as a form of interdisciplinarity, in which actors reach outside their disciplines to adapt ideas into their own contexts (Csikszentmihalyi, 1996). I

set out to find courses that espoused interdisciplinarity by enlisting at least two instructors from different disciplines to teach the class. Remarkably, finding such courses was a difficult endeavor as many of the institution's course listings were split between home departments. Later, the justification for this practice would become clearer.

Ultimately, the courses I focused on were those that had at least two faculty members involved in the design and instruction. These faculty members were to be from different disciplines, and the course itself was described as inter- or transdisciplinary by these faculty members. Systematic methods for choosing the courses failed in helping answer my research questions, as some of the courses that appeared to be inter-/transdisciplinary on the registration system were misleading. One example of a course taught in biomedical engineering, biosystems engineering, and chemical engineering was taught by three instructors from the three departments on a rotational shift, in which one instructor would teach a third of the semester and so forth. The justification was that this course was used to consolidate the costs of offering three similar courses in three departments. Notably, the course is split between three departments in the same college, so this collaboration is cost-effective according to the college-level student credit hour to faculty teaching load ratio (Snyder, Ozkan, Bairaktarova, Staley, & & Biscotte, 2019).

Another example of an interdisciplinary course that appeared through the seemingly systematic inquiry of institutional registration data was one that was cross-listed across three institutions. The course is housed in the mining engineering department at Virginia Tech, an engineering department in Colorado and Columbia. Using technology, the three classes meet synchronously. In this model, each university covers the costs of the

three instructors, as it appears to be a single course with sufficient student enrollment at each institution (Snyder et al., 2019).

As interesting as these cross-departmental teaching models are, they did not lend themselves to answer the questions of this dissertation, which revolve around the university-wide initiatives of transdisciplinarity. The courses described above are largely adaptations to the needs of three departments within one college in the first example and a course built through the network of cross-institutional faculty in the second one. Neither of these courses was specifically adhering or adapting to the transdisciplinary initiative purported at the university-level.

The two courses examined in the dissertation are cases that show different institutional contexts in which faculty and staff negotiated and translated different institutional policies as they developed their course. The first course is one that has navigated university-level initiatives since its early inception in 2010, and the second is one that is a direct result of the 2016 transdisciplinary initiative. These two courses help me to examine the existing structures relating to interdisciplinary curriculum development in practice, as well as how they may have changed based on the recent initiative.

I focused on experiences of faculty navigating structures as they developed their courses and supplemented and contextualized these experiences with institutional data regarding policies of curriculum development. Notably, I focus on different course contexts to show the malleability of policies as faculty and staff interact within them. To this, I expanded my interviews to include actors involved in writing the policies to glean the intentionality behind the policy language that informs institutional structures. My methodology consists of qualitative methods as I sought to examine the experiences and

reflections of actors engaged in interdisciplinary curriculum design amidst the backdrop of institutional policies as purported by the various organizations in the university.

I should also note that I have been an instructor of one of the interdisciplinary courses in this study for three semesters. This experience as one of the 'sustainers' of this course has certainly impacted my research from interview questions to data analysis. It provided context for some of the technical aspects of course registration as well as insight into some of the power dynamics across university actors. In the early stages of this study, during the proposal and prior, I thought of myself as an advocate for interdisciplinary learning. From associating interdisciplinarity with creativity to teaching the course, I found myself as a proponent for teaching integration between disciplines. Especially in fields where there can be power differences between disciplines, I find it increasingly important to teach epistemic humility. One of the main tenets of this course is to bring in faculty from different disciplines to teach students to value other ways of knowing. Interdisciplinary co-teaching is one way to bring this type of disciplinary integration into the classroom to then model for the students.

However, with this research, many of my assumptions of the merits of interdisciplinarity were pushed as the institutional support for interdisciplinarity manifested because of external forces outside of student learning. As the investigation pointed me to the integrated general education program, the merits of interdisciplinarity in engineering education were largely extant in curricula outside of engineering. Consequently, my positionality across this study changed to value interdisciplinarity in engineering to value existing general education programs that engineering students are often unable to experience. Instead, my advocacy for interdisciplinarity changed. From

thinking about the development of interdisciplinary spaces for students for them to learn about other disciplines to learning about different ways of knowing such that students (and faculty) learn to value these different epistemologies. General education programs are difficult for engineering students to fully engage in because of the curricular constraints of the engineering requirements. Students often disregard their general education courses because they see them as 'outside of their major' or as 'GPA boosters.' Instead, interdisciplinary courses that involve multiple faculty members from different disciplines can model interdisciplinarity for students such that students learn to value and find ways to integrate outside disciplinary knowledge into their own understanding of their discipline.

4.3a Epistemological and Ontological Assumptions

In the social sciences, the observer and observed mediate their understandings of one another, in that the thought object and real object become difficult to distinguish. The "thought objects of those who are being studied are not, except in self-reflection, the same as those of the investigator, and it is misleading to imagine otherwise" (Sayer, 1992, p. 5). The existence of social phenomena is contingent upon actors or subjects; however, the phenomena can be independent of the researcher who is studying them (Sayer, 1992, p. 49). Yet ultimately, research is a human endeavor, in which sensemaking happens at various points in the study—by the researcher in formulating questions, analyzing data, member checking, and triangulating findings, but also by the interviewee as they respond to questions and member checks.

With this study, I acknowledge that my interpretations of objects will not "produce the objects themselves" (Sayer, 1992, p. 5), which is why I use multiple forms of data produced in different knowledge/power subjugations—e.g. publicly available data that

reflects an academic organization's goal as well as the personal experiences of actors. In higher education, disciplines have long been organized by academic departments that have varying divisions of labor and resources across distinct universities. The context of faculty collaborations can take different forms based on a variety of physical and cultural features of the setting.

In this dissertation, I do not dispel the existence of objective truths, but believe that the objects studied in different disciplines are imbued in different power relations and can only be understood in the contexts in which they emerge (Flyvberg, 2001; Foucault, 1980). I seek to understand the past and present contexts in which faculty have developed and adapted interdisciplinary curriculum design. The institutional and historical setting provides the context for this study, as many of the structures that faculty navigate are bound by competing influences.

4.4 Research Design

The research design is a single case study of the university structures that inform and govern an interdisciplinary undergraduate curriculum. To understand these structures in practice, I examined two faculty teams who developed interdisciplinary courses. In studying the two processes of interdisciplinary course development before and through the university-level initiatives, I show the malleability of the policies as they existed before and after initiatives were implemented through the experiences of faculty and staff.

Overarching Research Question: How do faculty and staff translate and negotiate university-wide initiatives for transdisciplinarity to the curriculum?

Specific Research Questions:

1. How do the policies of the institution enable or prevent faculty and staff in creating interdisciplinary undergraduate courses?

2. How are faculty members challenged or supported by institutional structures in developing interdisciplinary undergraduate courses?

3. How do academic faculty and staff experience a university shift toward interdisciplinarity in curriculum change?

In case studies, data collection in qualitative studies are primarily cerebral and come through reflective practice (Stake, 1995). Each avenue of data collection, including data triangulation, is guided by research questions. Additionally, the data collection and analysis were done concurrently to ensure that as gaps in the data arose, additional data was collected to answer the emerged questions (Miles, Huberman, & Saldana, 2014). Multiple forms of data were collected. First, institutional documents regarding the curriculum governance committees were collected. Specifically, publicly available governance meeting notes from 2015-2018 were collected. The supplemental documents attached to these meeting notes were also collected. These included proposal plans and revised plans for specific initiatives.

In conjunction with these institutional documents, new sources published by university and regional newspapers were collected as they pertained to the transdisciplinary initiative or the new budget model. The university news source was used to gauge the university approved messages regarding the initiatives. The regional news source articles were used to triangulate these messages and offer a view that was disconnected from the university's public image.

Interviews were conducted with administrators and staff involved in curriculum governance committees and the new initiatives. Lastly, interviews were conducted with the two distinct teams of faculty and administrators who worked on developing interdisciplinary courses. The collection and analysis of data was performed concurrently. Multiple iterations of interviews, document analyses, and member checks were performed as gaps were identified in the analysis, rather than in any repeatable order. Institutional review board approval was obtained for this research study.

4.4a Setting

The study is situated at a public, land-grant university classified as an R1 university, which denotes Highest Research University by the Carnegie Classification of Institutes of Higher Education (Shulman, 2001). Since after World War II, the reward structures for faculty have shifted to prioritize research (Boyer, 1992). Thus, shifts in undergraduate teaching can be challenging to implement and sustain (Vanasupa et al., 2012). Moreover, Virginia Tech has a legacy as a polytechnic university, in which science, technology, engineering, and mathematics (STEM) can be privileged over the liberal arts, via funding, physical space, hiring opportunities (Vanasupa et al., 2012). There has been a recent shift in the organization of research in that transdisciplinarity has driven many of the recent institutional changes.

An institution-wide shift toward transdisciplinarity has been described by the university initiative report to have a positive effect on graduates such that they are prepared

for the economic, social, and technological changes ahead.[4] However, these alleged changes make it difficult to see how the institution's heavy focus on research will affect the ideas asserted in these self-published news sources. Consequently, the top-down changes that have been set onto multidisciplinary faculty teams will influence each faculty member differently. Additionally, their different institutional units—e.g. institute, department—can be further contextualized through other external factors. Each faculty member brings with them a multitude of influences from their department, their disciplinary culture, and their personal teaching and research interests. By setting this study in this shifting network, I seek to understand how faculty in different disciplinary and structural contexts translate and negotiate an institution-wide initiative of transdisciplinarity as they design and implement interdisciplinary undergraduate classes.

---

[4] University Document, Transdisciplinary Initiative Report: "*Preparing Students for the World in which They Will Live and Work*" May, 2016

4.4b Data Collection

Table 1. Data Collection and Timeline

Research Questions	First round of data collection (Spring 2019)	Second round of data collection (Summer/Fall 2019)	Third round of data collection (Fall 2019)
RQ1: How do academic faculty and staff experience a university shift toward interdisciplinarity in curriculum change?	Interviews with faculty and staff	Faculty senate meeting notes	
RQ2: How are faculty members challenged or supported by institutional structures in developing interdisciplinary undergraduate courses?	Registrar's office governance documents Initiative Implementation plans (triad) Faculty and staff interviews	Administrator interviews Faculty senate documents	Local News Articles, University News Articles
RQ3: How do the policies of the institution enable or prevent faculty in creating interdisciplinary undergraduate courses?	Governance committee meeting notes Initiative Implementation plans (triad) Registrars' office governance documents Staff interviews	Faculty interviews Faculty senate documents Administrator interviews	

1. *Institutional Documents*

Documents play an important role in providing the formal discourses in which institutional values are conveyed. Additionally, documents provided valuable insights into the goals and processes valued by the institution (Altheide, Coyle, DeVriese, & Schneider, 2008; Patton, 1990). The document collection consisted of publicly available meeting notes from curriculum governance and the faculty senate (2015-2019) as well as institutional documents relating to the transdisciplinary initiative, integrated general education program, and new budget model. The list of these public documents are detailed in table 2. Additionally, university and regional news articles were used to provide a source of data

with a different intended audience. The varying rhetoric across these documents shed further insight into the intentions of the actors involved.

> *"The very unreliability of sources can be used to study the people who wrote them… the ambiguity in this world lets the fundamental structures of the authors come through"* (Martin, 2017, p. 194).

Through the triangulation of sources, I was able to highlight fundamental assumptions across the different types of documents and interviews (Golafshani, 2003; Mathison, 1988).

Table 2. Institutional Documents Collected

Category	Document Source	Document's Date	Number of Files
University Documents	Governance Curriculum and Policy Meeting Minutes	Monthly from 2015-2018	136
	Governance Curriculum Committee Meeting Minutes	Monthly from 2015-2018	
	Governance Integrated General Education (IGE) Curriculum Committee Meeting Minutes	Monthly from 2015-2018	
	Faculty Senate Meeting Notes	2016-2019	26
	Faculty Senate Constituency Reports	2016-2019	
	Board of Visitor Meeting Notes	2019	2
	Integrated General Education (IGE) Plan	2015, 2016	2
	Transdisciplinary Initiative Documentation	2016 - 2019	8
	PIBB Implementation Plans	2016-2018	3
News articles	Regional News Articles	2015-2018	2
	University News Articles	2015-2018	3
		Total Documents = 184	

2. *Interviews – Faculty, Staff, and Administrators*

"You can use interviews to learn about what life used to be like for some people—but their memories are imperfect" (J. L. Martin, 2017, p. 68).

Within the changing institutional context, interviews provide a humanizing lens that contextualizes the formal institutional literature from the university regarding its changing mission. Interviewing establishes intersubjectivity between interviewer and interviewee, in which their individual thought objects are interpretations of one another, and convergence is an ideal (J. L. Martin, 2017, p. 75). The purpose of interviews is to "re-create ideas and ambiguities" to "preserve more delicate, cognitive structures" (Martin, 2017, p. 79). Specifically, the faculty and staff interviews were semi-structured as to allow for participants to reflect on their courses piece by piece so as to "break up a cognitive task into stages" (Martin, 2017, p. 97).

The administrator interviews were used to contextualize the public documents regarding curriculum development structures and the intentions of the transdisciplinary initiative as conceptualized by those working to implement them as well as the mid-tier administrators working to help faculty work within them. The administrator interviews provided valuable insights into the original intentions of the initiatives and their evolution over the 3 years of implementation. Interview protocols for faculty, staff and administrators are provided in appendix A.

The interview participants are detailed in table 3. The participants are either faculty, staff, or administrators. Some of the faculty members have tenure, others are in the research or teaching faculty ranks which do not have tenure built into their promotion system. It is important to note the differences between tenure and non-tenure for the faculty who worked to develop interdisciplinary courses, because of the currencies they used to implement and

sustain these courses. Other demographics such as gender, race, and departmental home are also important but were not focused on in this study because they could be used to identify the interviewees.

Table 3. Interviews conducted

	Interviewee	Faculty, Staff, Administrator	Length of Interview	Date Conducted
Governance	Governance Curriculum Committee Member	Tenured Faculty Member	60 minutes	Fall 2019*
	Governance Registrar's Office	Staff	30 minutes	Fall 2019
	Governance Registrar's Office, Senior Member	Staff	60 minutes	Fall 2019
	Integrated General Education Program Director	Staff	60 minutes, 40 minutes	Fall 2019
Tri-Initiative Related	Budget Management Office	Administrator	60 minutes	Fall 2019
	Office of the Transdisciplinary Initiative	Administrator	40 minutes	Fall 2019*
	Office of the Transdisciplinary Initiative	Staff	40 minutes	Fall 2019
	Transdisciplinary Initiative Efforts	Administrator	60 minutes	Fall 2019*
Interdisciplinary Course 1	Transdisciplinary Cluster 1, Stakeholder Faculty/Co-instructor	Tenured Faculty Member	60 minutes	Fall 2019*
	Transdisciplinary Cluster 1, Stakeholder Institute Director, Co-instructor	Tenured Faculty Member	30 minutes	Fall 2019*
	Institute associate, Co-instructor	Staff	40 minutes	Fall 2019
	Department Head of Course 1's home department	Tenured Faculty Member, Administrator	30 minutes	Fall 2019*
Interdisciplinary Course 2	Transdisciplinary Cluster 2, Co-chair of TC Curriculum Committee, Co-instructor	Tenured Faculty Member	40 minutes	Fall 2019*
	Transdisciplinary Cluster 2, Curriculum Development, Co-instructor	Junior Faculty Member	40 minutes	Fall 2019
	Transdisciplinary Cluster 3, Co-instructor	Junior Teaching Faculty Member	40 minutes	Fall 2019
	Transdisciplinary Cluster 2, Co-chair of TC Curriculum Committee	Tenured Faculty Member	30 minutes	Fall 2019
	Transdisciplinary Cluster 2, Program Manager	Research Faculty Member	30 minutes	Fall 2019

* These participants have academic backgrounds in engineering and/or work in the College of Engineering.

Throughout the next two chapters, footnotes are used to describe the source of data that is quoted in the text. The types of data collected in this study are listed in detail in the

tables above. They are organized into three categories throughout the footnotes, 1) interviews, 2) university documents, and 3) news source. Each footnote includes the interviewee's position or committee type with the date it was conducted or published. Footnotes aid the reader with chronology and sources as they provide an additional layer of events and actors.

4.4c Data Analysis

The data collection and analysis happened concurrently as analysis preceded data collection as new insights were gleaned. The first phase of my data analysis consisted of understanding the university curriculum process, in which I focused on the existing structures of governance and the role of the Registrar's Office as they are described by public documentation. This data plays less of a role in the findings chapter but informed the majority of the interview questions and document collection that followed.

The interviews of each interdisciplinary course design team were conducted and analyze in a close time frame so as to fill in gaps across each of the faculty and staff involved in the course design and instruction. The first round of coding consisted of contextualizing the interviewee's experiences within the university context. If there were gaps in this integration, I collected data to fill in these gaps, in some cases this was to interview a Registrar's Office staff member to inquire about course registration numbers or to reach out to a department head to understand a faculty member's resource justification through a different lens. This process led me to identify several interview participants that had formerly not been identified.

Once the gaps pertaining to my research were filled, I used an inductive coding strategy (Miles & Huberman, 1994), to identify common themes relating to curriculum

design, institutional structures and policies, resources, and interdisciplinary collaboration. These themes were then organized around the five principles of the trading zone framework described in 3.2a. However, in communicating the findings, I found that the interrelations among the five principles obfuscated many of the significant events in interdisciplinary curriculum design. Consequently, I organize the findings chapter around the significant events regarding the university-level initiatives on a chronological basis, while building out the threads pertaining to trading zones in these sections. The only section that does not follow the chronology is that of existing institutional structures like governance committees and the Registrar's Office. I focus on describing these structures as they become relevant amid the more dynamic structures in the university, such as the three university-level initiatives.

Discussions of currency, power, language, stability, and applicability are pervasive in chapter four but then are pulled to the forefront in chapter five. For instance, in discussing the stipulations of promotion and tenure regarding interdisciplinary course design are directly related to the principles of power and currency. The differences in communication messaging in the university news articles versus those in the regional newspapers show clear discrepancies in how language is used in the university. Or the way the budget model is being implemented is an example of disruptions to the existing stability of the larger university trading zone. Although there are interrelations among the five principles, as some are closely related (i.e. power and neoliberal reductivism), the findings chapter detail the events as an unfolding narrative to help the reader navigate the process of interdisciplinary curriculum design from multiple vantage points. Ultimately, the unit of

analysis for this work is Latour's actor, in which the actor is not alone in "carrying out the action" but includes the external environment which make sense of the action.

4.4d Trustworthiness

The trustworthiness of the concurrent data collection and analysis was strengthened through data triangulation as well as cycling back and forth through collection and analysis to reduce gaps of knowledge (Miles et al., 2014). The triangulation of data involved multiple types of data that provided different perspectives. For instance, institutional documents were used to understand the public vision of initiatives, while faculty interviews were used to gather perspectives regarding the same institutional vision in practice. The data gleaned from interviews were member checked with participants to ensure that insights were not taken out of context. The interview protocols were developed in prior studies with other investigators to offer greater credibility to the questions asked in this study (Ozkan, McNair, and Bairaktarova, 2018; Snyder et al., 2019).

Additionally, methodological triangulation was used in this study through the multiple types of data collected and analyzed. The document analysis shed light on the institutional structures regarding curriculum development, the interviews with administrators provided context and clarity regarding the content in the public document, and finally, the interviews with faculty and staff engaging in interdisciplinary course design offered insight into these structures in action. By using multiple data collection methods with multiple types of data, I was able to reduce "deficiencies and biases that stem from any single method" (Mitchell, 1986, p. 19). The documents provided the public intent of the structures, while the faculty, staff, and administrator reflections and experiences

showed the local human coordination and malleability of the seemingly rigid institutional structures.

4.4e Limitations

This study has a number of limitations that are important to include. For one, many of the meeting note documents are reductions of what transpired in each of the meetings. For context, attending some of the meetings would have helped understand the format in which these meeting discussions take place in relation to what is documented in the notes. However, my access to the meetings in which faculty proposed courses was limited as those facilitating these meetings wanted to make sure not to 'put anyone in an uncomfortable position' because the meetings can be 'a bit stressful for the proposers.'[5] As a research, I wanted to make sure my presence was not affecting any of the data collection or analysis.

The documents and administrator interviews expanding on these institutional documents were careful to present the structures in a positive light, in which the work was there to improve the way faculty and staff work within the university. In this manner, these positive tones that came across in the documents and administrator interviews revealed the externalities in which they carry out (and justify) their actions. Consequently, this study does not necessarily reveal the 'Truth' of what exact events transpired, but the perspectives and interrelations among the actors involved in bringing the initiatives to fruition.

---

[5] Quote from correspondence email, Fall 2019

Next, the three university-level initiatives described throughout the dissertation have yet to stabilize within the university environment completely. Part of this instability was intentional as the study focuses on the malleability of policies put forth by initiatives. Still, there is a limitation in some of the inferences as they may not be transferrable as these initiatives stabilize. There is some degree of longevity to the data collected with data collected from 2015-2019, but for the study to provide additional insight into the long-term impact of these initiatives on interdisciplinary curriculum design, additional sources of data would need to be collected. The meeting notes of the university organizations ranged in availability; the majority of organizations had dates ranging back to 2016, but few, if any, academic organizations had documents that were available from earlier years.

These limitations may have restricted the extent to which the study of specific course design can be generalizable to other contexts but have contributed to the understanding of interpretation by those navigating structures. Through the use of the trading zones framework, the research brings "disorder to the forefront" and ultimately focuses on the local coordination that happens at the person to person level. The limitations, in fact, provided valuable externalities that overall helped to make sense of each of the actors in this study.

Chapter 5 – Findings

The following chapter traces multiple conflicting and dynamic institutional threads through university documents, the experiences of faculty and staff, and news articles amid three large-scale change initiatives: an integrated general education program, a university-level transdisciplinary initiative, and a new incentive-based budget model. The story of these "*big changes*" has been pulled from multiple tiers of administrators, faculty, and staff across a single university.[6] The resultant story is one of interrelated change initiatives that have undergone several transformations and continues to shift as actors operate within them.

The chapter is organized chronologically. Starting with first interdisciplinary course design, the chapter details the early interdisciplinary adopters' method of adapting to various university structures. The chapter ends with the second interdisciplinary course process in which the faculty engage in navigation of a different sort, in that they draw from institutional power in the form of a vice provost to break through what the first team had to creatively bypass. Figure 1 details this cyclical chronology. Each block corresponds to a section in the chapter and progresses clockwise to denote a progression of years. The blocks are color coded to represent courses, initiatives, and events examined in the findings. The visual includes the noteworthy institutional characters that take the focus of each section, for instance in section 5.2, the new president and provost are the main actors that anchor the section. Ultimately, the cyclical representation from the first course to the

---

[6] University Document, Faculty Senate President quoted in Faculty Senate Meeting Minutes, 4/11/2017

second denotes the similarities between these two processes, in which faculty and staff developing these courses are still faced with institutional structures to overcome. The sustainability of these courses is one driven by the faculty developing the course rather than by the institutional rhetoric purporting interdisciplinary activity across all levels of the university. However, as we see in section 5.6, in aligning with the university rhetoric, actors can be strategic in bringing their courses to fruition.

Figure 1. Outline of events pertaining to Interdisciplinary Course Design pre- and post-'big changes
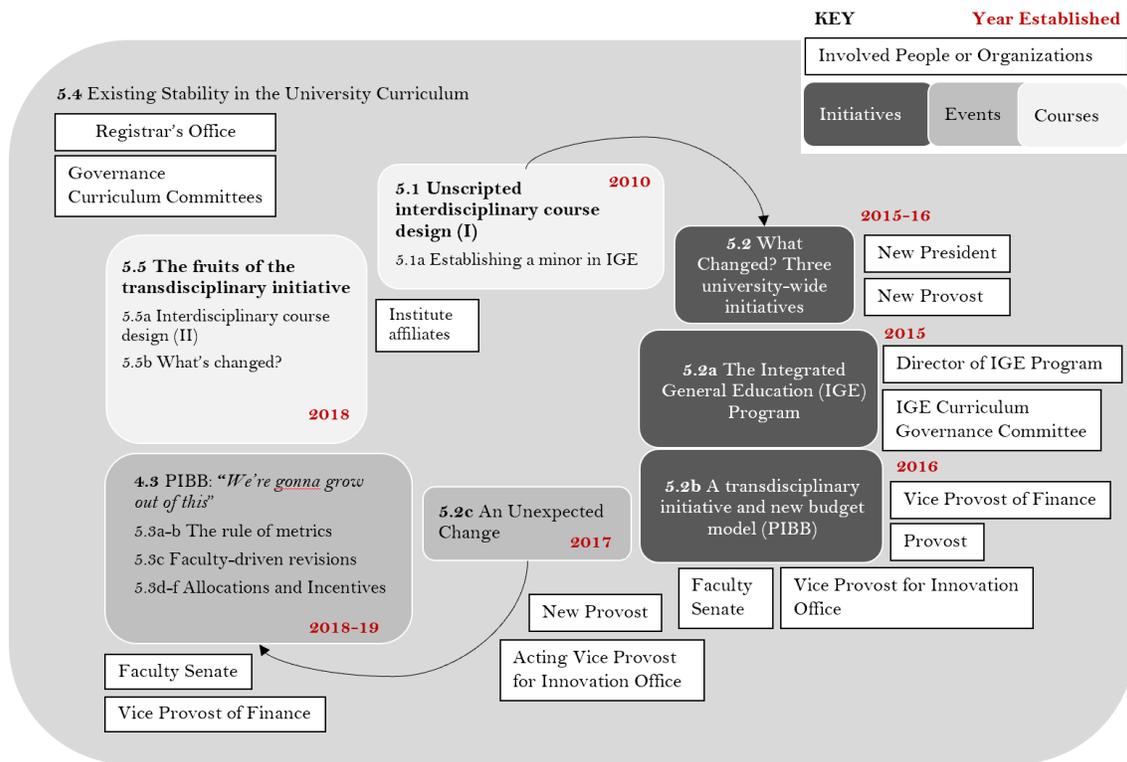
The findings begin in section 5.1 with the development of an interdisciplinary course before any of the three changes. It details the journey of early adopters of interdisciplinarity as they navigate structures to design and sustain their course. Section 5.2 provides an overview of the three initiatives at the university and how they co-evolved in

relation to each other. Shortly after the initiative's implementation, there is a change in administration which is the focus of 5.3. The subsequent section details the new budget model as the change of actors adapt its role, section 5.4. Section 5.5 reveals the relationship between the new structures and the existing policies, focusing on the curriculum governance system and the prominent role of the Registrar's Office. Finally, section 5.6 describes the design process of a second interdisciplinary course, a direct product created by a transdisciplinary cluster team that emerged through the transdisciplinary initiative.

Setting the Scene

While the chapter does not explicitly characterize the role of engineering or engineering education through this study, it remains prominent throughout. Engineering is a dominant actor rooted in the history of this university as well as in its current culture. The university's founding name in 1872 was Virginia Agricultural and Mechanical College later changed to include Polytechnic Institute in the 1890s. Even after University President Charles Hahn expanded VPI to include a liberal arts school, the university still featured its 'Tech' identity of Virginia Tech prominently.

The culture is reinforced by the high percentage of student enrollments and faculty employments in the college of engineering. During the timeframe described in this study, the students enrolled in engineering made up roughly one-third of the total student population—with nearly 11,000 undergraduate and graduate students of the 29,000 total student population.[7] For reference, there are seven academic colleges in which

---

[7] University Document, Office of Institutional Research, Accessed 2019. These estimates are based on Fall 2018 enrollment and employment data.

undergraduate and graduate students are enrolled. The college of engineering made up nearly 35% of the total student composition. Faculty compositions are similar. In the 2018-2019 academic year, there were a total of 1,433 tenured, tenure-track, teaching, and research faculty—381 of those are in the college of engineering. Total, engineering faculty make up 27% of the faculty body. From the 2009-10 academic year to 2018-2019, this percentage increased from 24% to 27%.[8] To understand the implementation of three university-level initiatives that purport interdisciplinarity, there is a need to understand the existing disciplinary composition that these collaborations seeks to disrupt.

In the data collection, there was also a notable engineering presence. Of the seventeen interviewees, seven have engineering backgrounds and/or work in the College of Engineering, even though engineering faculty were not intentionally sought out. Both of the two course design teams include an engineering faculty member, and throughout university governance and faculty senate, engineering faculty play prominent roles. Notably, the university president and provost described through the study both have engineering backgrounds. Engineering culture is pervasive at Virginia Tech and acknowledging the context of change is a necessary precursor to interpreting the initiatives as they unfold.

5.1 Unscripted Interdisciplinary Course Design (I): Pre-Transdisciplinarity

The origins of the first interdisciplinary course were serendipitous. Initially a graduate level course in instructional design & technology, the instructor had flexibility in curating the curriculum. "*In the early days of* [Course I]*, we would schedule the*

---

[8] Ibid.

instructional technology & design graduate course in the same room and same time as a
computer science course about creating video games." In 2010, these two graduate-level
courses shared a space in the recently instated arts center. The instructors were associated
with an institute that embodied arts, design, science, and engineering intersections. In the
early offerings, enrollment of the combined courses was generally ten students and had the
option for students to repeat it for credit.[9] Each semester, each course would be re-
approved within its department and scheduled such that interdisciplinary collaboration
could physically take place.

In these years, the institute was slowly becoming more established at the
university.[10] The instructor who developed and taught the instructional technology &
design course later joined the institute as a postdoctoral fellow. Additionally, a new
administrator with an interdisciplinary background including engineering had recently
been hired to direct the institute.

The new director and postdoctoral fellow "*had an interest in having students*
experience the creative process, in which they actually studied the process" and became
co-teachers for the course.[11] The director notes that when he "*came to* [University X], *one*
of the things [he] *noticed was that entrepreneurship was starting to be a fad at all*
universities. And no one was asking the question, where did the idea come from?" The
main tenets of this class would be to focus on the process of ideation and critique in
response to the entrepreneurship classes that focused on a *"beautiful pitch"* and building a

---

[9] Interview, Former Postdoctoral associate, Co-instructor, Fall 2019
[10] Dissertation, Zacharias, 2018
[11] Interview, Institute Director, Fall 2019

business. Because the director and the postdoctoral fellow "*were the owners*" of the institute, they had the resources to teach it. Initially, the course was housed in the honors program, where there was more curricular flexibility. Because the institute was not set up to offer credit-bearing curriculum, the instructors had no teaching responsibilities, and they were not faced with responses like, *"you're not teaching enough stuff in our department*." In the director's words,

> *"I wasn't in a department; so I could do anything… I wanted, until I got fired.[12] It was complete freedom to spend my time however I wanted to and the school was looking to me for permission. I said, of course, that's okay. So that's why it happened. And also honors gave us the vehicle and* [the institute] *gave us the human resources."[13]*

The process for listing the course in the honors program was simple because of the existing relationship between the institute director and the honors program director. Additionally, and significantly, the honors curriculum was and is flexible because they have approved course numbers do not require new proposals through university governance curriculum committees if they are to change topics. These honors studio courses "*can be a lot more flexible*" and can adapt to different "*hot topics."* [14] Outside of the honors curriculum, this "*topics*" format *"is a lot harder to build into the* [university] system."[15] The "*one option across campus is a rotating topics course, a special topics type*

---

[12] To clarify, the director has not been fired.
[13] Interview, Director, Institute, Fall 2019
[14] Interview, Director, Office of Integrated General Education, Fall 2019
[15] Ibid.

class" that can only be offered for two semesters until it is required to pass through university governance.[16] The honors studio courses allowed for flexibility in offering courses for periods beyond the two-semester special study course number allowed to most other departments. The postdoctoral associate notes that the process for having this course listed in honors was as simple as a phone call and follow-up email detailing the course title, meeting time and place, and description with the honors program secretary.[17]

The faculty who taught and guest lectured in the course were all affiliated with the institute. The classroom was also provided by the institute in its newly built space. The course was offered in this format until 2014. As the institute grew, the director was unable to continue co-teaching the course. A different faculty member from the college of engineering with a research interest in interdisciplinarity had become newly affiliated with the institute. This tenured faculty member soon became a co-teacher with the original postdoctoral fellow who developed the course. There was also an intent for the course to have a permanent departmental home outside of the honors program as this was a semester by semester agreement between faculty. With a permanent departmental home, the course would be able to enroll non-honors students as well.

Prior to this faculty member's involvement with the institute, she studied a different interdisciplinary design course developed and taught by engineering, industrial design, and marketing faculty. These faculty "*were all flying under the radar*" in terms of teaching credit. "*They basically didn't get credit for teaching this course from any of the*

---

[16] Ibid.
[17] Interview, Former Postdoctoral associate, Co-instructor, Fall 2019

departments." [18] This faculty member notes that these instructors "*all had tenure, but* [she] *did not have tenure*."[19] This teaching team cited their tenure when justifying their work: "*We have tenure, we can do this*." But later, "*it turned out that* [some of the faculty] *never got full professor… One did.*"[20] This issue of what is rewarded by promotion and tenure was "*A real threat. If you do your work in engineering in an interdisciplinary way, you might not get tenure.*"[21] This faculty member notes that since her position focused on engineering education research, she had "*more flexibility*." For example, she received a "*three-year NSF grant*" to continue the research in this space of interdisciplinarity.[22] But the other instructors "*were teaching this class solely as a labor of love, because they thought it really mattered.*"[23] The professor notes that with the grant she "*was evaluating them and helping them from a teaching and learning point of view*." Years later, as she was getting tenured, this collaboration led to an introduction to the institute director and institute postdoc.

From there the faculty member notes that she "*sat in with them and then started co-teaching with* [the postdoctoral fellow] *and* [they] *taught together for as long as* [they] *could, while getting credit from honors*." Interestingly, the engineering faculty member notes that she taught the course for the first time "*in* [a] *sabbatical year*" and following year, she "*made a deal with whichever department head I had to be able to teach it*." She notes that this deal may have only been possible because of the integrated general education

[18] Interview, Faculty Member in Engineering Department, Fall 2019
[19] Ibid.
[20] Ibid.
[21] Ibid.
[22] Ibid.
[23] Ibid.

program that was forming at the time. "*The only reason why it was doable at all is because at that same point, the* [integrated general education] *program came out and were giving grants to people. So I actually gave the department head a little bit of money. I paid off part of my entire teaching time, and then all the department head had to do was replace me,*" which she notes is something "*department heads are fine with — your faculty being bought out.*" The transition into the integrated general education program meant that the *"little seminar class"* in honors had to "*be scalable.*" The director who was in charge at this point "*had numbers of teaching 75 students per semester.*" The need to scale the course so that it *"served the whole university"* was clear from the start.[24]

The grant allowed for this professor to continue co-teaching the course with the institute postdoc fellow who created the course originally. The advent of the new integrated general education program meant that there could be a new collaboration with this course and others affiliated with the institute to form an undergraduate minor. These collaborations largely happened organically through interpersonal connections and curricular goals converging around the integrated general education program. The professor notes that the emergence of their course "*happened simultaneously with* [an STS professor] *who now worked at the* [Institute]" and also with faculty who had been teaching an entrepreneurship class across engineering and the business school.

5.1a Establishing a Minor in the Integrated General Education (IGE) Program

At the time, the faculty team teaching the entrepreneurship course was also "*putting the course through governance to have it be a real class*" rather than the former free form

---

[24] Interview, Faculty Member in Engineering Department, Fall 2019

structure it had adopted as a special topics course.[25] Because the special topics course number can only be used for two semesters, the course needed to go through governance to become a permanent course. The faculty team proposing the entrepreneurship class wanted to cross-list the course between departments. This led to the difficulty of finding a departmental home. However, in the process of going through governance, a curriculum committee member from the business department "*flagged the course, saying it was redundant and that there was another course already like it in business*."[26] This event led to a bitter split in the faculty team, "*because one person thought another person let that happen…it was a huge blow-out fight…just awful.*"[27] At this point, one of the faculty members in this team contacted the professor who was working with the course from the institute in search of a departmental home for the course. The engineering professor cited her involvement with interdisciplinary research and the institute course as a reason for agreeing to fit with the proposed startup course.

The engineering professor notes that she "*was already working on proposing the* [Institute] *class… and knew about the startup class…kind of blowing up*." Together, a reconciled interdisciplinary faculty team, graduate student, and engineering faculty member decided to propose a new minor in the Integrated General Education program.

The Integrated General Education program had recently been proposed as a revision to the existing general education program in 2015. As a part of its implementation, the program provided grants to faculty who wanted to develop minors that fit into the IGE's

---

[25] Ibid.
[26] Ibid.
[27] Ibid.

goals which were to help students *integrate their learning for use throughout their lifetimes.*[28]

A minor through the integrated general education program consisted of a different proposal process. The engineering professor remarks that if a minor was to include these two courses, "*it would also need a critical lens*" to interrogate the trends of *"entrepreneurship and innovation."* She notes that when the integrated general education *"proposals came around, interdisciplinarity was all over them back then, now it's not as much."* This professor pulled together a group of faculty members:

> *"I thought well, we'll really do an interdisciplinary minor. I got* [Professor 1] *from industrial design, and* [Professor 2] *from business and* [Professor 3] *from science, technology, and society studies, me, and* [institute postdoctoral fellow]. *I put all of us on a grant. And we're going to meet for a year and create a minor."*

This grant was able to supplement faculty salaries and enable departments to pilot the courses. The postdoc fellow notes this time as when the original institute course she created with the director "*married into business*" around 2014. The minor was designed with a group of "*people who were excited and wanted to design it*." This group was "*meeting pretty regularly*" while also "*creating* [their] *own thing.*"[29] The engineering professor proposed course X through governance. The STS faculty member proposed his course and the business faculty member "*took his course through."* This process did not necessarily happen simultaneously as faculty note that they "*were all just kind of doing the*

---

[28] University Document, Website, Integrated General Education, Accessed 2019
[29] Interview, Faculty Member in Engineering Department, Fall 2019

best [they] *could have."* Additionally, "*direction for the* [integrated general education] *program was not consistent.*" The awarded grant meant that the engineering professor "*had to go to monthly meetings... to try and figure out how this was going to work."*[30] These meetings were run by the director of the integrated general education program.

These meetings were required for grant awardees and were run by staff in the Integrated General Education office. According to the engineering professor, the meetings comprised "*eight or nine people to talk about the logistics of governance, the template for the proposal, learning outcomes*" and "*the whole time* [they] *were talking about it*, [IGE office staff] *were creating it.*" The engineering professor reflects that they "*would do something and then it would change…we were the true believers and early adopters*." This development phase lasted "*for a long time... A couple of years even*" for the engineering faculty member. She also notes that "*by the time I got to the point where I was putting the whole minor through, I was less patient."* [31]

At this point the individual courses from business, STS, and engineering had gone through individual curriculum committees. The next step was to propose a minor through the integrated general education program that connected these three core courses as they had been designed to do. The engineering professor was the one to take the minor through governance. The three core courses went through their own departments and then college curriculum committees to be approved by the university. The minor went through the ad

---

[30] Ibid.
[31] Ibid.

hoc IGE governance curriculum committee that had formed with the integrated general education plan.

The faculty member notes that they *"were aiming for the ad hoc one, too, because the* [IGE director] *said you all are the first. In fact, we were the first for a while. But not really, like, they always call this a first. But there was this other one that the woman had just been, it was really like the same kind of thing. She just been teaching it like this, but all the courses were in her department. And, and she was ready when they invented the whole* [IGE] *thing… She just went through.*"[32]

The engineering faculty member reflects on the actual proposal process as seeming to "*always have weird iterations*," noting several areas of confusion *"like, wow, how did I miss that? Or why did they change that part of the form? What are the words they want?"* [33] The entire process was difficult. Even though she was a part of the team that helped create these forms and procedures she notes that she did not "*know what they wanted… and it was so frustrating.*" [34] Additionally, because the minor proposal process was not necessarily a rewarded part of her position as a tenured faculty member, it could not be the sole focus. Although the team was not "flying under the radar," they were taking on a project that added to their workload.

A tenured faculty member from a different engineering department who serves on the ad hoc committee explains that there is a dual role of the process:

---

[32] Interview, Faculty Member in Engineering Department, Fall 2019
[33] Ibid.
[34] Ibid.

"There's two purposes, in my opinion. One is for archival purposes, you come in as a new faculty member and you want to teach this course. In reality, you're going to talk to other faculty, but let's say someone retired, moved away, and you're trying to learn more about this course. Here's this archival document, so you can see what their goals were for the course. Inevitably, it's going to have some department drive in there. We're not asking you to do that. But it's going to be information for the next instructor—what textbooks they were using, what were the learning objectives? So that's this archival piece. The other piece is that [the curriculum] *is faculty-driven so you have external eyes, peer review eyes to look at it and what usually happens is, if there's issues with the proposal, you go back and say, here's the issues, and we're going to table it, which means we're going to give the* [proposal author] *a chance to go and improve it."[35]*

For the governance member, the point of clarity was deemed very important, because of the cross-disciplinary nature of shaping a university-wide curriculum. She notes that the committee will "*just keep asking* [the authors] *to make clarifications.*" But no one is going to "*come in a disciplinary way* [..,] *even if that is* [their] *expertise.*" The main focus is to understand if "*the questions have been answered in the proposal template.*" Overall, "*you have a bunch of faculty, and you have different departments, but you want to have some sort of checks and balances to ensure that everyone's in order when they propose a course.*" She notes that they as a committee "*aren't judging your course. [They] don't know your discipline. But if* [the proposal author] *can answer these questions, and*

---

[35] Interview, Faculty Member, Governance Curriculum Committee Member, Fall 2019

[committee members] *understand them,* [they] *feel comfortable with it going on as a representative course of the university.*"[36] As an "ad hoc" committee formed to facilitate the new general education initiative, this group of faculty were tasked with promoting an innovation within one of the most stable structures of the university system: the registrar.

With the minor proposal, "*there was also the requirement that you have a capstone. And so* [the engineering faculty member] *had to create this capstone*." The faculty member notes that in creating the capstone, they,

> *"really tried to have it be freewheeling and open because supposedly, this was an interdisciplinary minor, and people can go in and do a capstone that would combine the different courses in the minor at the four core disciplines."*[37]

However, the open nature that was sought for the capstone course was difficult to pass through governance because of traditional emphasis on precise learning objectives and Integrated General Education emphasis on general education credits. The clear outline of what the course would entail was to be preset in the proposal, but the minor collaborators wanted the course to be open such that students could define their own projects and weave together different disciplines. The intention of the minor was that "*anybody from the university should be able to go through the minor so the capstone was the sticking point too."* The capstone posed a hurdle in the governance approval process because the goal was to provide an opportunity for any university student to earn tech-focused general education credits at a capstone level.

---

[36] Interview, Faculty Member in Engineering Department, Fall 2019
[37] Interview, Faculty Member in Engineering Department, Fall 2019

The issue was particularly challenged by the engineering representation on the governance committee, perhaps because the capstone would be based in engineering. Ironically, the institute could not sponsor the minor because "*the minor had to have a disciplinary home, which is why* [the engineering professor] *had to be the lead on* [the proposal]. In reflecting on this process, the professor notes that in the beginning,

"*when* [they] *were signing that MoU, nobody really wanted it. None of the department heads or deans. They were just like, oh, no, you take it. And the* [department head in engineering] *said, okay, we'll take it and what we'll try to do is rotate it every three years or five years. It'll change homes or maybe the university will catch up and interdisciplinary minors won't have to have a departmental home. So anyway, people signed the MoU just on those kinds of good hopes… The MoU wasn't that binding. It was basically saying, we're going to try to do this thing, we will work together.*"[38]

The justification for this rotation agreement between department homes was due to the "*extra work*" that this proposal would entail. Notably, the impression was that it was "*going to take forever, and never be very lucrative.*" Because of its interdisciplinary nature, the minor "*doesn't cohere with* [individual] *field's identities*," which is also the point of the interdisciplinary minor. Overall, the consensus seemed to be that "*if these people want to do it, fine, but it's not going to hurt me either.*" In theory, the revenue that would come from students enrolling in these courses would play a role in driving course proposals, but multiple faculty note that the model is "*amorphous.*" Notably, "*everybody's always joked*

---

[38] Interview, Faculty Member in Engineering Department, Fall 2019

about how it is butts-in-the-seats model" and it has been surmised that "*there's some formula out there for each student, and then people were saying, Oh, and if you have students from other college in your classes, they count more, but there was never a readily shared formula.*"[39] Without clear communication of how to formulate a value proposition, instituting a new course proposal becomes difficult. The engineering faculty member notes this as an issue in her own course proposal:

> *"I remember just asking people, how do we figure it out? I need to tell my department head, if I get 50 students in this class, we'll get this much. I never figured that out. And then they changed it to the* [PIBB][40] *model, which I also don't understand, but also supposedly, you know, gives you more credit."*[41]

The engineering professor notes that what the administrators - departments heads and deans—"*care about is something totally different*" than "*interdisciplinary research, interdisciplinary education.*" She reflects that while developing the minor, she "*was thinking about the workforce; how engineers really need the other skills and how these holistic graduates will be much better for society*." When asked about the plan to support the interdisciplinary course, this professor's department head referenced its small size in relation to the other department courses as a reason for its neglect.[42] Notably, the department teaches every undergraduate student who pursues an engineering degree, with

---

[39] Interview, Faculty Member in Engineering Department, Fall 2019
[40] The PIBB stands for the Partnership for the Incentive-Based Budget
[41] Interview, Faculty Member in Engineering Department, Fall 2019
[42] Interview, Department Head of an Engineering Department, Fall 2019

a headcount ranging between 1,500 to 2,000 students per semester.[43] Thus far, the interdisciplinary course has enrolled 40 students once a year.

The job of the deans and department heads is to "*keep the balance sheet. That is the job.*"[44] The priorities of the administrators' job detract from supporting a team-taught interdisciplinary sequence of courses without a permanent department home. The entire curricular structure is counter to the existing fiscal structure that allots resources based on the number of students who enroll divided by the number of the faculty who teach.

The development of the course and the minor occurred initially without institutional scaffolding. However, as these faculty began to connect disparate course goals, a wave of three largescale university initiatives emerged, holding promise for scalable, sustainable, and stable curriculum. The triple initiative included a revised general education program that encouraged cohesive tracks of electives, a transdisciplinary initiative to reorient research and teaching, and a new budget model to change the reward system and support these shifts. The faculty spearheading the minor emphasized student learning and industry needs, thus preparing students for an increasingly complex job market while providing an institutional credential for their interdisciplinary learning.[45] Thus, reasons for implementing these large-scale changes at the university are indicative of trends beyond academia.

5.2 What changed: Three university-wide initiatives

---

[43] University Document, Engineering Department Website, Accessed 2020
[44] Interview, Faculty Member in Engineering Department, Fall 2019
[45] News source, Transdisciplinary Initiative in University News, 2016

In 2016, the faculty senate described the triad of changes as producing "*a sense of whiplash; everything appears in flux*".[46] The new university president attempts to quell these concerns and proclaims that he *"wishes to move ahead at a 'faculty-driven' pace."*[47] Notably, the term 'faculty-driven' is prominent language that appears throughout the discussion of change and is parroted by actors across university. Indeed, the revised general education plan had begun before the administrative change of guard to a new president and provost. Additionally, the interdisciplinary course examined in 5.1 is also a product of faculty and staff driven efforts. However, those who use the term 'faculty-driven' are institutional actors with more administrative roles in this study.

The two main large-scale changes that the faculty senate referred to when referencing *whiplash* are the transdisciplinary initiative and the new budget model, which were designed to work in tandem to change reward structures such that all the initiatives could be sustained. These will be described in their chronological order, in that the integrated general education program was implemented in 2015 and the transdisciplinary initiative and budget model were proposed in 2016. Incidentally, these three initiatives have evolved over the years and as such the specific year of implementation can be difficult to pinpoint. The dates of the collected data start in 2015 for the IGE program and in 2016 for the other two initiatives.

5.2a The Integrated General Education Program

---

[46] University Document, Faculty Senate Meeting Minutes, 10/18/2016
[47] Ibid.

Introduced in the course and minor development narrative, the integrated general education (IGE) plan was designed and implemented by established faculty primarily representing the college of liberal arts. These actors were also those who were already involved in governance processes pertaining to the undergraduate curriculum. The stated goal of the new general education plan is to help students "*integrate their learning for use throughout their lifetimes.*"[48]

Nine years after the previous curriculum for liberal education had restructured the "gen ed" curriculum, the IGE curriculum was approved by the University Council in April 2015.[49] Starting the year before the arrival of the new president, a university-wide transition period was outlined in the proposal as consisting of two years in which an adhoc governance committee would facilitate IGE course approvals. However, as with any large-scale change, additional challenges have surfaced. Specifically, the "pre-PIBB" 'butts-in-seats' model provided incentives for courses to develop in different ways that counter the goals of the IGE curriculum.

In one example, the IGE director described a course that has turned into a large-scale online course that many students take to easily fulfill an arts credit. The increased enrollment ensures that the department receives higher revenue from each additional student, while overcoming physical limitations with classroom space. However, according to the director, the learning objectives of this course are not well met by the students and this type of course reduces the efficacy of a general education program. For this course to

---

[48] University Document, Website, Integrated General Education, Accessed 2019
[49] University Document, Website, Former General Education, Accessed 2020

become a better learning experience, it *"would mean putting a professor in the class, putting students in a classroom, and then reducing the number of available slots for students… which becomes more resource-intensive."*[50] If this were to happen, then the demand for these art classes would also increase, which would pose more difficulties as the arts departments are smaller in scale at the university. To fulfill these teaching roles, the arts department employ more adjunct professors to meet these demands.

The director notes that one of his efforts is to help the arts departments develop more courses that would meet the IGE fine arts learning outcome. The Office of Integrated General Education has the ability to offer course and minor development grants with a specific focus. Initially, these grants helped to transition courses from old general education to the new through "*professional development funds*." But more recently, this funding source has been used to create curriculum development grants for specific types of courses. In recent years (2017-2020), there have been grants to support the development of "*STEM* [IGE] *Minors for Non-STEM Students."*[51] The funds for these grants come from the Provost's Office on a yearly basis. The director speaks of the decision-making process for specifying these grants.

> *"The grants have moved more specific where I can say we're short on art classes for non-majors. The grants this year are really focused on that. This past year we really focused on art and we have new theater classes…and some of these… studio*

---

[50] Interview, Director, Office of Integrated General Education, Fall 2019
[51] University Document, IGE Website, Accessed 2019

art classes for non-majors. Engineers can finally get in there and paint and do graphic design and things like digital photography as their art requirement."[52]

In addition, the director notes that the grant model allows for collaboration across grantees.

"I bring everyone who's a grantee together throughout the year to meet and do professional development. So there is that sustainability element in there that benefits people and gives them back […] we're giving you money because we know it takes time to build a course or, or revise a course or build a minor. We know all that takes time to run a minor. We know there's advising and administrative stuff and bureaucracy and all that kind of thing. We're investing in that. And while you're, as part of that, the string that's attached is that you then come together with the others and talk about it and work through these issues and finding best practices."[53]

Through the common ground of curriculum development, the new general education program seeks to bridge faculty across different departments. The resources supplied to the new general education program act as seed money that they then provide for faculty which in turn acts as seed money for curriculum development. The funding for these grants was set aside by the former provost specifically for the new general education program. Currently, this resource is replenished yearly, but with a change in upper administration, the sustainability for seed grants could falter. Ideally, once courses are

---

[52] Interview, Director, Office of Integrated General Education, Fall 2019
[53] Ibid.

developed and passed through governance, they can generate their own revenue through the new budget model and sustain themselves in home departments.

5.2b Two for one: The Transdisciplinary Initiative and New Budget Model

The new president and provost introduced the transdisciplinary initiative and new budget model in the 2016-2017 academic year following the approval and initial implementation of the integrated general education plan. The transdisciplinary initiative reorients traditional academic disciplines with nine problem-based themes that draw from academics across disciplines. These themes are referred to as transdisciplinary clusters. The PIBB is an incentive-based budget model in which academic units set their own targeted goals based on set metrics. According to the provost enacting these initiatives, the two changes were two components of one overarching change. The transdisciplinary initiative was to instigate a cultural change, while the new budget model was to reward participation in that shift. From a glance, these university-wide initiatives purporting interdisciplinarity and transdisciplinarity would support the early adopters of section 5.1 as well as build on the Integrated General Education's goals of integrated learning in 5.2a.

Initially, in the spirit of inclusive participatory design, the administrative team *"sent out a survey to each of the departments and colleges to collect regional and global metrics that they would like to measure themselves by."* This survey resulted in 298 metrics, adding further complexity to transition from the existing system, but also interpreted as a great reflection of intellectual diversity by upper administration. *"It showed that the university is pluralistic,"* in that *"not everyone is gauged by the same metrics."* This quantity was reduced to 100 metrics through negotiations due to issues of practicality in 2016. However, in the 2019-2020 fiscal year, less than ten of these metrics have been used in colleges.

The language of the Office of Budget Management and the budget model's communication documents state that more metrics will be introduced in the coming years.[54] These metrics are touted to colleges as a way to *"make your own metrics, your own situation so that then you can decide where to put more resources into."*[55] The productivity of each department and college would be self-identified, whether they focused on research, curriculum, or other modes of production (Slaughter and Rhoades, 2010). In effect, administrators hold that these metrics were designed to *"give colleges power"* and *"flexibility to engage in a transdisciplinary space."*[56]

To solidify and encourage a cultural shift toward transdisciplinarity, an *"additional 300 to 400 faculty were to be hired"* as change agents bridging the transdisciplinary clusters and academic units. Such an ambitious hiring wave could establish a substantial community of interdisciplinary colleagues who would be able to champion the transdisciplinary initiative, whereas *"a minority"* might succumb to the normative disciplinary and departmental expectations. The Office of Budget Management note that the *"funding for these positions begins in the Provost's Office,"* then is reduced over three years and taken over by the department to which the faculty is hired. The process *"is designed to encourage colleges to identify areas of synergy and collaboration so that faculty work across disciplinary lines."*[57,58]

Implementing the Initiatives

---

[54] Interview, Vice Provost for Budget Management, Fall 2019; University Documents, Budget Model Communication, 2018; Strategic Plan: Appendix B, 2019.
[55] Interview, Upper Administrator, Fall 2019
[56] Ibid.
[57] Interview, Vice Provost for Budget Management, Fall 2019
[58] University Documents, Budget Model Communication, 2018; Strategic Plan: Appendix B, 2019.

In practice, the provost's ideals faltered. Resistance to this radical diversion of resources required to quickly hire the quantity of tenure-track lines, coupled with the fear of disrupting the existing faculty community of 1,500, proved too much to overcome. By 2019—three years after the hiring goal was communicated publicly—only 100 new faculty had been hired through the transdisciplinary initiative, with the promise that *"additional faculty will be hired in the next year."*[59]

Additionally, the smaller quantity of hires meant that these transdisciplinary actors were in the "*philosophical minority in the institution. If it had been 300-400 hires, then* [the institution] *would have shifted the power to these people who are mobile between disciplines."*[60] The mobility between disciplines was another driver of the transdisciplinary initiative, which an administrator intoned would encourage faculty to become "*more knowledgeable in their primary domain*."[61] According to this administrator with an interdisciplinary background, domain-specific knowledge is strengthened as people learn about different applications of knowledge across disciplines. Without the tipping point that the 300-400 hires would have precipitated, the few new hires would be vulnerable to struggles through promotion and tenure, adhere to disciplinary norms, and potentially suffer exhaustion and burnout as isolated change agents.

Department Norms and Structures

Disciplinary norms can be seen through promotion and tenure stipulations in departments. In a letter to the deans and department heads regarding 2015-2016 promotion

---

[59] News Source, University News, 9/19/2019
[60] Interview, Upper Administrator, Fall 2019
[61] Ibid.

and tenure decisions, the provost emphasized that a *"focus on enhancing collaborative grant-funded research will be a future expectation consistent with the* [Transdisciplinary Clusters]*."*[62] Yet the specifics of this future expectation were not explicated during this time. In the following year's letter to deans and department heads, the provost more explicitly noted that the "*focus on* [Transdisciplinary Clusters] *and the associated cluster hires will result in greater emphasis on collaborative research.*"[63] Specifically, he noted that "*the* [transdisciplinary clusters*] explicitly encourage transdisciplinary research on major problems and questions of societal importance. For promotion and/or tenure, it will be necessary to convey in the promotion dossier the important contributions of the candidate to the collaborative research.*" In these letters written by the former provost, rewarding faculty for transdisciplinary and interdisciplinary activity is seemingly confined to research activity rather than in interdisciplinary curriculum development.

Another structural feature of the PIBB that caused uncertainty is whether it would support cross-college curriculum development. The focus on college-centric goals may be structurally beneficial for collaboration within a college but could restrict collaboration across colleges because performance metrics of each will be set differently. The authors of the PIBB model point to the "*distributed budget transfer authority*" in answer to questions about budget transfer between colleges and departments.[64] To the question of interdisciplinary instruction, the response is that the

---

[62] University Document, Provost's Follow Up on 2015-16 P&T, May 2016. p. 4
[63] Ibid.
[64] University Document, Performance Budget Communication, 2016

"University-level budget model will allocate resources associated with interdisciplinary programs according to a standard method that can be readily duplicated by all the partners in any particular program. This standard method will provide a firm foundation on which cooperative agreements for shared instruction can be built. If additional reallocation of resources is needed beyond the standard distribution, this can be readily accomplished through additional budget transfers between the participating units."[65]

In other words, the interdisciplinary instruction budget model "*follows*" that of the interdisciplinary program it is housed in. However, for courses that do not stem from interdisciplinary programs, there is not a stated alternative. In the case that the university allocated resources are not enough, then the university reverts to budget transfers as deals between the department heads of the units. The emphasis on interdisciplinary programs shows alignment with the university-level transdisciplinary initiative as the nine synergistic faculty clusters would embody programs that receive university-level funding. However, the faculty hiring for the clusters is said to be "*over and above growth allocated through the incentive budget model.*"[66] The faculty positions will be "*allocated to colleges and departments through the leadership of each* [transdisciplinary cluster] *term and tracked as a specific investment.*"[67]

In part, the justification for adopting the incentive budget model is to help the institution reach its new goals, which are to "*update, revise and expand its curriculum to*

---

[65] University Document, Performance Budget Communication, 2016
[66] Ibid.
[67] Ibid.

better prepare students for careers in growing areas of opportunity."[68] The transdisciplinary initiative process "*also anticipates greater cross-disciplinary collaboration in instruction.*" Consequently, the changes at the university require "*a resource model that adapts to the changing patterns and incentivizes cooperation and expansion as needed.*"[69]

The details of supported interdisciplinary activity are difficult to discern. An interdisciplinary course (like that developed by the early adopters of 5.1) would need to become integrated into an interdisciplinary program that is housed in a department in order to receive institutional support as detailed by the PIBB. Institutionalization would mean that the course flexibility designed by the early adopters would be difficult to keep under the institutional models, because their goals are to support growth areas. Perhaps, if this course focuses its efforts on growth as encouraged by the PIBB, the course would be able to trade its desired flexibility for more institutional support.

According to a news article local to the university from the fall of 2016, the new transdisciplinary initiative "*should bring 2,000 students into the ... [transdisciplinary initiative] program by 2022.*" This metric coincides with university officials' goals of raising "*enrollment by as many as 5,000 students.*" Additionally, "*university officials estimate 25 new faculty positions will be added in five years and that 2,000 students will be in the* [Cluster X] *program by 2022.*" Oddly, the number of hired faculty is a fraction of the provost's intention to bring in 300-400 new hires under the initiative.

---

[68] University Document, Performance Budget Communication, 2016
[69] Ibid.

In the 2016 local news article, the transdisciplinary clusters are described to "*offer* [transdisciplinary cluster] *majors and minors as a voluntary alternative that administrators expect will be popular among students*."[70] In effect, these new majors are said to attract students and will likely increase enrollments. In communication from the Provost in 2016, the Partnership for the Incentive-Based Budget (PIBB) is said to put "*50% of weight on education (for undergrad and grad), with an emphasis on* [semester credit hours] *to promote* [transdisciplinary] *teaching.*"[71] The Provost points to specific incentives for transdisciplinary teaching and transdisciplinary majors that are measured by national benchmarks.

The Faculty Senate Perspective

Following the initial incentive budget communications from May, August, and December and of 2016, the Faculty Senate President addressed the faculty senate during the April 2017 meeting regarding its justification and implementation:

> *"The budget should be used as a control mechanism, so as not to harden upward or downward trends based on simple cost-benefit comparisons. Progress should be factored in and form the base of incentives. There seems to be a clear risk to faculty and no clear accountability to decision makers (from department heads to upper administrators)."*[72]

---

[70] News Source, Local News, April 2016
[71] University Document, Transdisciplinary Initiative Communication, 10/24/2016
[72] University Document, Faculty Senate President quoted in Faculty Senate Meeting Minutes, 4/11/2017

The Faculty Senate President describes the budget model by highlighting resource inefficiencies and inequities with administrative decisions through language designed to provoke faculty. Specifically, he outlines two issues of administrative ineffectiveness like the lack of accountability for administrative decisions to relieve potential risks on faculty.

In a comment directed toward the overall budget model, the Faculty Senate President notes that the "*Budget, Growth, and Incentives should more clearly be the three key parts of the new budget model.*" [73] He continues by questioning aspects of the budget model, "*Will the goals and benchmarks defined be a moving target? All units, plus people within units, move at a different pace, too.*" [74] The localized intentions of the new budget model would seemingly coincide with the notion that units and people "*move at a different pace,*"; however, confusion stems from the mixed messages stable goal-setting and focus on "*Budget, Growth, and Incentives*" versus the decentralization purported by upper administrators.

The caution, the Faculty Senate Vice President states, for this budget method is that there is a "*risk of forcing or artificially encouraging units/people to meet targets that mean little to them. Inflationary expectations may rise.*"[75] Even though performance goals are set by individual units, they become weighed down as university goals are explicit about fostering growth throughout. The system implemented by administration to empower units

---

[73] Ibid.

[74] University Document, Faculty Senate President quoted in Faculty Senate Meeting Minutes, 4/11/2017

[75] Ibid.

and hold administrators accountable falls short of giving power to faculty to set their own performance targets amid the university goals that emphasize and reward growth.

The second point of issue he outlines concerns the balance of resources between academic units and the Institutes, which are research centers that can employ research faculty and staff but have no curricular initiatives. Recall that the interdisciplinary course discussed in section 5.1 emerged from an Institute. According to the Faculty Senate President and a survey conducted in 2016, "*most Institutes more or less abuse their power. Most put barriers that prevent faculty from accessing important resources.*"[76] This is a concern because the incentive budget is to redistribute fund allocations based on performance goals and benchmarks that are set by all units, including the Institutes. The units that perform in line with their targets will be rewarded for their success and growth.

Many of the transdisciplinary clusters build on the missions of the Institutes. As "*massive funds are coming in to fund the* [transdisciplinary clusters]," there is an opportunity to "[change] *the purview of* [the] *Institutes*" according to the Faculty Senate President. He goes on to state that "*This issue is not antagonistic; the President and Provost themselves are open to increasing inclusion and openness. It is especially important now that massive funds are coming in to fund the* [transdisciplinary clusters].*"[77] The Faculty Senate President identifies this influx of funds as "*a small window of opportunity, since big changes are happening.*"[78] He notes the importance of using the

---

[76] University Document, Faculty Senate Meeting Minutes, 4/11/2017
[77] University Document, Faculty Senate President quoted in Faculty Senate Meeting Minutes, 4/11/2017
[78] Ibid.

"big changes" to redistribute resources allotted to the transdisciplinary clusters in a way that overcomes the Institutes' order of operations because as he notes, "*the 'haves' will not support the 'have nots.'"* [79] The '*haves'* in this scenario refer to the resource-rich Institutes and their affiliated people and units and the '*have nots'* refer to the units and people without Institute-resources.

A University's 'Identity'

In discussing these practical issues of risk and resources, the relationship between philosophy and structure in the historical formation of a university was repeated. The structural issues that many actors point to may be described by underlying philosophical issues that are more difficult to ascertain, especially when there is a conflict of epistemologies. However, the philosophical issues also stem from structural features of a university that reinforce these power/knowledge formations. A university is made up of several disciplines that have distinct epistemologies—ways of producing and interpreting knowledge. In a traditional sense, many disciplines posit a single disciplinary way in which to ascertain knowledge. These ways of knowing can be counter to disciplines at the other end of the university.

In any initiative that brings organizational disruption, there is a matter of risk to endure. At this university, there is an emphasis on technology. A public land-grant institution, originally established to disseminate education in agriculture and the mechanical arts, Virginia Tech has not strayed too far from its original identity of the 'Tech' university. This perceived expertise is what the university holds onto as a

---

[79] Ibid.

recognizable trait.[80] Consequently, when trying to bring large-scale change such as the transdisciplinary initiative to shift its established identity, the Provost at the time struggled to elicit widespread faculty buy-in. When reflecting on other universities that brought about large-scale change, such as Arizona State University or Carnegie Mellon University in the era of Herbert Simon, the Provost maintains that those universities were less affixed to their identities and welcomed a change that would give them a stronger image. At Virginia Tech, the intended transdisciplinary change would have required a shift away from the university's technological epistemology, which was too high a perceived risk.

5.3 An Unexpected Resignation

In October 2017, the provost resigned "*amid mounting pressure from a dissatisfied faculty.*" Two "*faculty-driven surveys* [...] *revealed friction between the Provost and faculty.*"[81] The president made a statement following the Provost's resignation that "*now is the appropriate time for* [the Provost] *to step down as Tech continues its attempt to implement ambitious new programs like destination areas and an incentive-based budget model—initiatives of which* [the Provost] *was the prime architect.*"[82]

The interim provost was appointed November 1st of the same year, 2017, just a year after the initial implementation plans for the transdisciplinary initiativeand budget model. "*Much of* [the new provost's] *work will be implementing the programs* [the former Provost] *often touted as Provost.*" Prior to the faculty senate's vote of no confidence, several memos were distributed, of which addressed "*problems with faculty perceptions,*

---

[80] Interview, Upper Administrator, Fall 2019
[81] News Source, Local Newspaper, 11/9/2017
[82] Ibid.

calling for bottom up implementation of changes and improving communication between administrators and faculty members."[83] In the memo, "*the professors made four requests: (1.) Rebuild trust through active listening. Answer faculty concerns directly, concretely, honestly, and respectfully. (2.) Acknowledge and make use of the talent and expertise of the faculty, by seeking their advice and recognizing them as partners in moving the university forward. (3.) Hold regular two-way dialogues with small groups of faculty, such as the Faculty Senate cabinet. (4.) Resume stalled efforts to modify the university's governance structure so that faculty have a real voice in faculty affairs.*"[84] Overall, the faculty senate voiced concerns of communication and inclusion in their requests to upper administration.

In the following months, the Provost's resignation spurred a split between the goals of the two initially coupled initiatives. The need to elicit faculty buy-in had a hand in minimizing the changes that were proposed by the two initiatives. But as the goals diverged—one to value growth and the other to value transdisciplinarity—the structural changes promised by the PIBB no longer rewarded transdisciplinarity, in large part by reducing the performance metrics from 100 to 8. Long term goals of the Office of Budget Management maintain that over time more of these metrics will be incorporated into the PIBB, however there are no actions visible that this is happening other than the say so by upper administrators.

Evolving Institutional Structures

---

[83] Ibid.
[84] Ibid.

Three years after the initiatives were first implemented, the relationship between the three initiatives evolved. Many of the curriculum goals developed through the transdisciplinary initiative have taken advantage of the structures developed by the Integrated General Education program. The IGE structures provide avenues of curriculum development that otherwise would not have been structurally possible. Staff from the office supporting the transdisciplinary communities note the several resources these faculty were provided to fulfill curriculum goals.

For example, faculty creating transdisciplinary communities were "*given access to the* [Center for Teaching and Learning] *to work with and think about their curriculum design*." Additionally, there "*were also workshops that the director of the* [General Education Office] *ran in tandem with the* [Center for Teaching and Learning], *because the university administration more or less made the decision that it would be a* [Integrated General Education] *minor.*"[85] Structurally, course development and instruction pose difficulties when faculty from different departments (and colleges) seek out a departmental home for the courses.

> *"With the destination areas, it isn't always clean. Because a team of faculty says we have this idea, and now we have to find a home for it. And now we have to get that department to buy in to supporting it. And that gets really messy. And it also in addition, they also have to think about how are we going to support faculty from*

---

[85] Interview, Acting Vice Provost, Office of Transdisciplinary Initiative, Fall 2019

multiple departments teaching in this context? Yeah, so that gets even more complicated.[86]

The negotiation process required for these inter-department or inter-college courses involves a variety of stakeholders. The general education office will be involved if the courses are to fit in that program. The Center for Teaching and Learning is involved in a consulting or facilitator role. Each of the department heads of the faculty involved will need to support the course. Additionally, the Vice Provost for Undergraduate Affairs has been involved in some cases to provide supplemental resources for the faculty. Each transdisciplinary cluster receives funds directly from the Provost's office. Some of the communities are closely related with university research institutes, which have different sources of funding. Each cluster has a distinct structure and a different model for how they distribute their funds among the research, curriculum, and outreach goals.

"The majority of the funding for the [transdisciplinary cluster] *has come up to this point from the Provost's office. And then the group can decide what to give to the curriculum... But there is also funding now coming from the Office of Undergraduate affairs, for those that are working on the* [integrated general education] *minor. So a number of the groups got funding from the* [IGE] *minors that they're working on this year."[87]*

There have also been external funding sources from the state that have provided funds for the transdisciplinary communities. However, these sources are all in the form of

[86] Ibid.
[87] Interview, Staff Member, Office of Transdisciplinary Initiative, Fall 2019

grants, rather than sustainable funds that can be promised year after year. The office of transdisciplinary initiatives helps the communities acquire grants such as these to fund small-scale and seemingly short-term initiatives.

> "*Our office works with* [State funding source] *to help identify some resources for a couple of the* [Integrated General Education] *minors this year. And I believe, and there are some external grants that are internal-external grants that we've helped win here.*"[88]

The funds were,

> "*originally sort of all from the Provost office, and the* [transdisciplinary cluster] *would get, let's just say $50,000, and then they could decide what they wanted to do with that $50,000 and that had to be spent in terms of their whole agenda. So it wasn't just their curriculum but a lot of people with them helping to fund their curriculum or buying that time, in fact, to know what the incentives are to focus more on the curriculum, or is it different for each? So there are program managers in the groups that have all been told that by the Provost office that this is a priority.*"[89]

These opportunities for resources are certainly useful to get new programs started, but there remains the issue of sustainability. For the general education minors to pass through governance, there is almost a year of work that is required conception to development to passing in governance. The "*big question mark, that's like, hovered over*

---

[88] Ibid.

[89] Interview, Staff Member, Office of Transdisciplinary Initiative, Fall 2019

everybody is what happens to [the developed courses] *after we teach them for a couple of years? Or what happens with them after like the funding for the* [transdisciplinary cluster] *dissolves?*"[90] The Office of Transdisciplinary Initiative can take these questions *"into consideration when* [they] *speak to the Provost… about the need for sustainable funding.*"[91]

Ironically, a dynamic university willing to shift its image from the higher levels eventually will settle into its new stable image. This "*dynamism then fades away"* which bars new innovations or disruptions to the image.[92] The model of change to adoption follows that of disciplines, wherein new disciplines emerge from an external or internally emergent influence and then become institutionalized into their own discipline. Biomedical engineering and women's studies are two examples of transdisciplinary disciplines becoming a new disciplinarity. Thus, the intention to maintain the dynamism of each transdisciplinary, such that the boundaries remain porous, is difficult when they also seek institutional stability (Holley, 2009). Eventually, fields settle into stable structures and become new disciplines together, much in the way of biomedical engineering, political economy, and engineering education. Those working across disciplines in the transdisciplinary clusters or in building interdisciplinary curriculum seek out stable and sustainable structures to give permanence to their creations, but in doing so recreate the disciplinarity that which they seek to cross between. According to the former Provost, the transdisciplinary initiative sought to allow mobility across disciplines. Actors with

---

[90] Ibid.
[91] Ibid.
[92] Interview, Upper Administrator, Fall 2019

expertise in one discipline would have the structural freedom to cross disciplinary boundaries, learn to apply their expertise in different fields, to strengthen the depth and applicability of their expertise.[93]

5.4 The PIBB in Context

The Partnership for an Incentive-Based Budget, referred to by university actors as the PIBB, is touted as a response to the changing political, economic, and social landscape outside of the university. In some ways, the PIBB is a hammer to the proverbial ivory tower. Universities have become more dependent on student tuition due to diminishing state subsidies (McClure, Barringer, & Brown, 2019). Subsequently, growth now reigns, and state subsidies are reported "*as a percent of total university budget*," which increases each year.

In the PIBB communication, the magnitude of growth over time becomes clear against the diminishing state subsidy. Overall, the total university budget has increased from $574 million to $1.4 billion from the 1998-99 to 2015-16 fiscal years. After inflation, this shows an increase of nearly $60 million or 68% percent increase of the total university budget.[94] Increased tuition costs and enrollment made up the difference in university budget. In 1999, undergraduate tuition and fee costs were $3,620 for in-state tuition and $12,666 for out of state tuition.[95] By 2015, these costs had become $12,485 and $28,525 for in state and out of state tuition, respectively.[96] Enrollment for the total student body

---

[93] Interview, Upper Administrator, Fall 2019
[94] University Document, New Budget Model Communication, 2016
[95] College Board Database, Accessed 2019
[96] Ibid.

was roughly 27,500 in the academic year of 1998-99 and approximately 33,000 in 2014-15.[97] These quantities are shown in Table 4, below.

Table 4. Total University Budget, Enrollment and Tuition Changes from 1998-2016

	1998-99	*2014-15*	*2015-16*
Total University Budget	$574 million	-	$1.4 billion*
Enrollment	27,500	33,000	-
In-State Tuition/ Out-of-State Tuition	$3,620/ $12,666	-	$12,485/ $28,525

*After inflation, the increase is approximately $60 million from 1998-99 to 2015-15.[98]

In the 2016 presentation on the PIBB model, the Vice Provost for Budget Management emphasized the decrease in state subsidies from 1998-99—"*37% of its operational funding*"—to 2015-16, in which the "*subsidy is less than 18% of* [the] *operating budget.*"[99] The argument from the Vice Provost in the 2016 communication is that *"as the organization grows to be larger, more complex and increasingly dependent upon self-generated revenues there is a corresponding need for more decentralized autonomy and decision making."* Administrators use the PIBB to direct the university efforts toward growth even though the outside university landscape is one of federal and state divestment.

As can be seen through the net increase in total university budget from 1998 to 2016, Virginia Tech has continued to grow. Each year, the Board of Visitors approves an increase in the total university budget. In publicized documentation, the budget increases reflect changes in a variety of different initiatives—from the construction of new facilities,

---

[97] University Document, Dataset on Enrollment History, Accessed 2020
[98] University Document, New Budget Model Communication, 2016
[99] Ibid.

to faculty and staff merit compensation programs, to student merit scholarships, and new faculty hires for degree programs.[100]

5.4a Fiscal Changes to the University

The multiple large-scale change initiatives also require an understanding of the external forces on the university. According to the Vice Provost, the increasing reliance on student tuition has shifted the university's business model to adhere to market forces.[101] He referenced the literature on university budget models, by expressing that the university is "*half church, half car dealer.*" The church aspect represents the nonprofit nature of a university and the car dealer signifies that the university also must "*make a good product that is going to give students access to the middle class.*" The university plays two roles, one for the students to gain social mobility and one for the betterment of society at large. This nonprofit identity seemingly turns the university goals outward with the intention of "*improving the quality of life and the human condition within the Commonwealth of Virginia and throughout the world.*"[102]

The Vice Provost notes that a major distinction in what this university is doing with their revenue generation is that they have not reverted to Responsibility Center Management (RCM) (Strauss, Curry and Whalen, 1996). In the higher education literature, RCM and incentive-based budget systems are synonymous (Hearn, Lewis, Kallsen, Holdsworth, & Jones, 2006). This type of budget system has become prevalent in

---

[100] University Document, Board of Visitors Meeting Notes, 2019
[101] Interview, Vice Provost for Budget Management, Fall 2019
[102] University Document, University Mission Statement, 2019. Note: In developing the mission statement, VT refers to the mission statement of Michigan State "as a useful blueprint… to define what a global-land grant looks like," another example of institutional isomorphism.

university management in recent years (Lang, 1999; Massy, 1996; Priest, Becker, Hossler, & John, 2002). In these systems, more authority is granted at the level of academic units, but with the increase in autonomy, there is an increase in accountability, thus autonomy is bounded by the decisions and performance of each unit.

According to the budget proposal, Responsibility Center Management allocates "*revenue like tuition directly to the units that deliver instruction or other fee generating services.*"[103] In the argument for the PIBB, administrators note that RCM rewards high enrollment and high student credit hours which can lead to a siloed university structure that overvalues large class sizes. "*The difference is that those allocations will now be linked to the achievement of agreed upon levels of activity. Those expected levels of activity will be capped and linked to university wide expectations for patterns of growth, thereby avoiding unproductive competition between units.*"[104] The PIBB model is said to involve research and philanthropy aspects in its reward structure as well, thus including the church in the metaphor.[105] Yet the details of philanthropic involvement are undisclosed in any of the publicly provided budget communications.

The faculty senate, a body of faculty representatives, regarded each of the proposals to implement large-scale change with concerns, especially resisting the PIBB. The meeting notes in the fall of 2016 (during the time period of change) describe the PIBB based on the delivery from upper administrators—the PIBB model is a "*growth budget," that seeks to grow the university "through the diversification of resources: endowment, enrollment,*

---

[103] University Document, New Budget Model Communication, 2016
[104] Ibid.
[105] Interview, Vice Provost for Budget Management, Fall 2019

research."[106] "We're gonna grow out of this!" is a quote in the senate notes to iterate the sentiment from upper administration in their presentation on the PIBB. Additionally, the senate note the Provost's emphasis on structural change that will spur this growth because "*colleges will hold most of the decision and funding power, not just the Provost's office anymore.*"[107]

In response, the faculty senate note concerns regarding the challenge of partnering with departments outside of their college, for the decentralized college-centric budget model obscures the details of its implementation. The PIBB model maintains that fund allocations will "*be linked to the achievement of agreed upon levels of activity,*" which "*will be capped and linked to university-wide expectations for patterns of growth, thereby avoiding unproductive competition between units. In this way, the performance-based budget will be closely connected to activity levels but will also have mechanisms for considering not just quantitative but also qualitative factors.*"[108]

These activity levels are to be set by colleges through various quantifiable metrics. The senate notes list several metrics to gauge college-specific targeted activity that are predetermined by each college. The metrics are as follows, "*unit allocations: enrollment, Student Credit Hours, external funding… Plus premiums in all areas (about 60-68%) b. Scorecards: "quality metrics" related to faculty, student, and administrative success (about 32-40%).*"[109] These metrics were identified by each college to yield 298 different

---

[106] University Document, Faculty Senate Meeting Minutes, 11/15/2016
[107] University Document, Faculty Senate Meeting Minutes, 10/16/2016
[108] University Document, New Budget Model Communication, 2016
[109] University Document, Faculty Senate Meeting Minutes, 11/15/2016

metrics according to the Provost at the time. This number was negotiated several times due to practical reasons, but these negotiations did not always get communicated to university stakeholders.

One of the communication frustrations was that the faculty senate noted a near unanimous "*need for the Provost and Budget office to release the much talked-about [40-50] performance metrics.*"[110] With an earlier release, faculty could "*appraise and test things out and get feedback before full implementation occurs; to have a multi-level review; and to cut the perception of top-down management.*"[111] The immediate perception that this change is a unilateral effort from upper level administrators displays a direct difference in power by the faculty senate. Consequently, for this budget model to become readily adopted, the senators note the need for more transparency and communication. In one example, the faculty senate call the budget plan a "*moving target,*" to which they *"are giving feedback on a model which* [they] *only know in parts and which has already been altered significantly!"*

The lack of transparency regarding the scorecard metrics is surprising because they were initially developed from a "*list suggested by* [Department] *Heads, Deans and other parties*" However, at a university steeped in engineering culture and with resources that far outweigh that of the other colleges, there is difficulty in thinking this process was equitable across the university. Ultimately, metrics that favor some colleges will not favor others. The conception of metrics was participatory in nature and according to the former Provost

---

[110] University Document, Faculty Senate Meeting Minutes 10/4/2016
[111] Ibid.

was a way to give colleges autonomy by having them determine their own performance targets. The issues arose when the 298 initial metrics collected from across the university needed to be reduced for practical reasons.

5.4b The Rule of Metrics

The PIBB has two main parts, the *Unit* part which comprises student enrollment ("*dollars coming in*") and the *Scorecard* which refers to student and faculty success metrics. The development of metrics as described by the faculty senate is that the preliminary list still needs to be created and then prioritized (out of the 200+ metrics). The created metrics will "*be verified against the proposed benchmark institution(s)."[112]* Correlation will be required. The guiding question for establishing metrics against benchmarks is "*what areas does your unit wish to establish a regional/national reputation?*" These refer to the "*Areas of Distinction*" that each unit will compare to their benchmark institution(s). According to the Provost, "*the goal* [of the PIBB] *is to generate and analyze data to make decentralized decisions tied to the distribution of discretionary funding - 'a customized way of doing business*"[113] The data collection and analysis will be used in predictive modeling and iterative data analysis. The data analytics regarding these areas of distinction and institutional benchmarks will "*measure national standing and success both for faculty research and student achievements.*"[114]

The response from faculty senate to these seemingly data-laden metrics is that "*every single one of the 200 metrics released comes down to numbers or a dollar amount,*

---

[112] University Document, Faculty Senate Meeting Minutes, 02/07/2017
[113] University Document, Provost quoted in Faculty Senate Meeting Minutes, 02/07/2017
[114] Ibid.

so what about quality."[115] In response, the Provost notes that quality "*is harder to measure,*

but it is measurable."[116] The faculty senate meeting notes also comment on the nature of

"*Academic Analytics* [as] *largely a black box.*" Further concerns note that "*the*

methodology is hermetic if not suspicious. And yet they are supposed to be the main

resource used to verify benchmarking, provide comparative data, and check the

correlations." Faculty senate language implies unease at the imposed top-down initiatives,

which according to upper administrators were supposed to decentralize and empower

colleges to set their own performance parameters. However, the overarching goals of the

PIBB do not align with those of faculty, as they note distrust towards the benchmarking

and subsequent data analysis that is required of them and done unto them, respectively.

Two years later in the summer of 2019, the Strategic Planning Metrics

Subcommittee published an appendix detailing the design and use of metrics in the PIBB.

This document's purpose is to guide the "*Strategic Planning committee as it drafts the*

2019-2025 Virginia Tech Strategic Plan, particularly in terms of the metrics the Committee

will choose to assess progress towards the strategic objectives." In addition, the white

paper "*provides some guidelines for the larger Virginia Tech community, particularly*

administrators responsible for defining and implementing metrics throughout other parts

of the academic enterprise, on how to design and use metrics." Interestingly, this white

paper with a detailed analysis of designing and using metrics in the university context is

disseminated in 2019, which is years after the initial collection of metrics from departments

and colleges. Seemingly, the authorship of this document shows a reset for the metrics to

---

[115] Ibid.
[116] Ibid.

be adopted by the PIBB. In its current implementation, less than ten of the 298 metrics are in effect.

The appendix begins with a discussion on the nature of metrics in university setting, citing a report by Wilsdon et al. (2015)[117] to emphasize that *"Metrics hold real power: they are constitutive of values, identities and livelihoods."* The document draws out multiple definitions of the word metric, ultimately concluding with this definition:

"*METRIC: A quantifiable measure used to track or assess an individual's, organization's, or process's progress towards a specific objective*"[118]

In discussing the use of metrics, the appendix authors state that

"Metrics can be used to assess performance and communicate preferences or as a way to influence organizational behavior. As is discussed in more detail below, designing metrics to influence behavior is the more difficult of the two, both because the measurement becomes less reliable over time as behavior adapts and because it can have unintended consequences potentially leading to unforeseen outcomes."[119]

The overarching plan of the PIBB is to stimulate growth in a variety of ways that colleges determine for themselves through the design and use of metrics. The metrics

---

[117] The Metric Tide: Report of the Independent Review of the Role of Metrics in Research Assessment and Management. The appendix includes mention of the "tragic case of Stefan Grimm, whose suicide in September 2014 led Imperial College to launch a review of its use of performance metrics."
[118] University Document, Strategic Planning Metrics Subcommittee, On the Design and Use of Metrics, 2018, p. 4
[119] Ibid.

subcommittee note several guidelines regarding metrics design, emphasizing the objective of the metric. The emphasis on goal setting mirrors that of quantitative research in that there is a need to formulate research questions prior to collecting data. The authors outline ten principles detailing parameters of metrics. Many of these principles are rooted in literature. Principle One states that metrics must "*measure progress towards the goal*," to which principle two states that the number of metrics relating to each goal should remain minimal. The principles mention types of data to be collected—proximal or direct[120]—as well as the quality of the data—garbage in, garbage out. Additionally, principle four notes that when comparing "*between two or more organizations, the data upon which the metrics are calculated must be equivalent between the organizations*." In the initial discussions of metric identification, colleges were directed to point to several benchmark institutions by which to compare their progress against.[121]

5.4c Faculty-driven revisions

In 2018, the new Provost and other upper administrators revised the communication of the incentivized budget model from 2016. The revised presentation notes the success of the transdisciplinary initiative implemented in 2016 and note that it has "*produced a key differentiator across that university that would allow the university to continue its evolution toward a financially robust internationally recognized university.*" The transcript of this communication speaks to the goals for the university in "*attracting and graduating* [X-T]

---

[120] The appendix authors define proximal data as that which cannot measure the exact quantity. They give the example of SPOT scores to show measurement of student's perception of faculty teaching rather than faculty's teaching effectiveness. Direct refers to measurements that are countable, such as enrollment numbers or the quantity of publications.
[121] Interview, Upper Administrator, Fall 2019; University Document, Budget Model Communication, 2016

shaped individuals". These are *"individuals that have strong disciplinary training, know how to combine the disciplinary expertise in collaboration with other disciplines to solve complex problems, are adept in experiential learning and combining academic knowledge with the real world and focus on societal impact."* The presenters note that the new budget model would "*support the full dimensionality of*" their aspiration and "*incentivizes activity on the vertical, the horizontal and on the* [SHAPE] *and looks at connecting activity.*"[122] In the description of the different types of metrics, these qualities fall under scorecard allocations described in the subsequent section.

The president notes that the "*metrics will be tuned up" and that "the goal remains to 'provide some transparency,' contrary to the old budget model.*" The new budget model follows "*a decentralized, participatory model.*" However, this raises "*a new challenge* [with] *when and how to partner, since Colleges will hold most of the decision and funding power, it's not just the Provost's office anymore.*"[123] The shift in resource control changes the incentive structure for academic trade to take place. Consequently, the fear from the faculty is that potential inter-college collaborations will be disincentivized due to the inability to distribute resources across colleges. This inability stems from the unequal power dynamic between STEM and liberal arts disciplines at a predominately technical R1 university (Vanasupa et a., 2012). Thus, the former modes of academic trade regarding the curriculum will require different processes or major sacrifices by faculty who would not be compensated in the currencies valued at an R1 university that privileges engineering.

---

[122] University Document, Performance Budget Communication, 2016
[123] University Document, Faculty Senate Meeting Minutes, 10/16/2018

Ultimately, the efforts to bridge disciplines in an institutionally supported manner will require sacrifices from faculty in the form of promotion and tenure.

In discussing the PIBB model, the Vice Provost for resources emphasized that there is also a university information system that is connected to the budget model to help with issues of transparency.[124] This system shows individual revenue-based allocations and metrics for the university at large and can be broken down per college and per department within each college. The system garners the ability for faculty to view the "*academic productivity of each department and each college*" that shows faculty "*how resources are being generated and then how they're being distributed back to colleges and then departments*" by colleges.[125] This transparency can be construed as part educational and part competitive. To the note of educational, the system shows departments or colleges that are performing highly and can act as informative for others. The competition can arise from the natural tendency of colleges to want to perform above their peers at the university to attain more resources.

This transparency may quell issues of secrecy as expressed by the faculty senator above, but it nevertheless is designed as a system of surveillance that enables administrators to "*turn the knob*" that controls the balance of performance and resources. This balance, with its emphasis on credit hour and enrollment metrics, may encourage colleges and their departments to focus on growth goals of the upper level administration,

---

[124] As a note, the interview with the Vice Provost for Budget Management took place in the fall of 2019 which was in the first year of the PIBB's implementation. Only a few performance metrics had been implemented for the discussions about what to include were still ongoing.

[125] Interview, Vice Provost of Budget Management, Fall 2019

but always in counterbalance to traditional models of high-quality student learning. The notion of surveillance will be especially operationalized when colleges do not meet the performance targets they set prior to the fiscal year. In these events, the Vice Provost notes that "*they will be able to have conversations with colleges around how to improve and where to orient"* future performance targets.[126]

Overall, the Vice Provost notes that in his conversations with the faculty senate and department heads regarding the PIBB model, "*faculty seem to like the information system*" and inquire whether "*it will remain, even if the PIBB goes away."*[127] This sentiment from the Vice Provost for Finance implies that in their discussions, the faculty senate leaders view the PIBB model as an amorphous not yet permanent fixture.

5.4d The PIBB's Three Allocations: Unit, Scorecard, and Earmarked

In the most recent documentation explaining PIBB metrics, a Strategic Planning Metrics Subcommittee composed of administrators and faculty. Some of the administrators involved are the associate dean for undergraduate programs in the college of business, director of academic resource management, the acting Vice Provost for the transdisciplinary initiative, the Vice Provost for degree enrollment, and the assistant Provost for diversity and strategic planning. The faculty who make up the committee comprise the statistics department, business, humanities, finance.[128] Notably, many of the administrators and staff who work in the Office of Budget Management are members.

---

[126] Interview, Vice Provost of Budget Management, Fall 2019
[127] Ibid.
[128] University Document, Strategic Affairs Site, Accessed 2020

This subcommittee put together a document on the "*Design and Use of Metrics*" "*as a guide for the Strategic Planning Committee as it drafts the 2019-2025 Virginia Tech Strategic Plan, particularly in terms of the metrics the Committee will choose to assess progress toward the strategic objectives.*"[129] Notably, the metrics document is dated June 2018, whereas the entire appendix with the university-level strategic plan was published in June 2019. Thus, the previous collection of metrics that across colleges touted by administrators as a participatory university-wide endeavor is no longer relevant.

Instead, university units—eg. departments, institutes, colleges—are tasked with developing a localized strategic plan that uses the metrics given to them. These will be described in more detail in the allocation sections. The authors note that transition to the PIBB model is "*intended to integrate university strategic planning with the budget process to ensure that resources are allocated in a manner that supports the university's core mission and vision.*"[130] Consequently, with the design and use of each new metric, the university's multiple organizations are to make progress towards their individual but unified goals. This strategy "*imagines a university with greater financial resilience, funded by a diverse resource base and supported by budget models that enable adaptability and innovation in an increasingly dynamic academic environment and shifting financial landscape.*"[131] In the 2019 documentation, the PIBB is described to include three different types of resource allocation—unit, scorecard, and earmarked. These are similar to those

---

[129] University Document, Strategic Planning Metrics Subcommittee, On the Design and Use of Metrics, 2018, p. 3
[130] University Document, Appendix B: Metrics, Rankings, and Partnership for Incentive-Based Budget, June 2019, p. 23
[131] Ibid.

described in the 2016 and 2018 plans but are described with a different diagram that clarifies the organization of each allocation. In the newest rendition, unit allocations, scorecard allocations and earmarked allocations add together to compose the Annual College Budget.

In the 2016 and 2018 communication documents, there were multiple diagrams conveying the breakdown of the Annual College Budget. The additive allocation figure was used but with fewer details on the type of metrics for each allocation. Additionally, there was a large bar of pie chart to convey which percentage of the budget would be composed of which allocation. Lastly, there was a figure that showed expected pie charts for each college with different percentages for each allocation for each college. The simplification of figures shows another effort by upper administration to rework the language and materiality of how this change effort is conveyed across university levels.

Unit allocations

The metrics that fall under the category of unit allocations "are primarily intended to incentivize growth in major revenue generating activities of the institution." Because of the "institution's increased reliance on tuition to support educational costs," student credit hours and enrollments make up a large part of the annual college budget. In addition, external funding is included in this category to include "*new gifts and commitments provided through fundraising, extramural grant and contract funding for sponsored expenditures, and ancillary income generated from university sales and services*."[132] The

---

[132] University Document, Appendix B: Metrics, Rankings, and Partnership for Incentive-Based Budget, June 2019. p. 24

unit allocations are termed as such because each unit of output can be assigned a unit of value. As an example, in the 2018-19 Fiscal Year, the PIBB model allocated $107.75 per student credit hour to colleges.[133]

The new model also introduces "*premiums*": additional budget value which denote a "*subset of the metric's output in order to incentivize strategically important activities that go beyond revenue generation.*" As an example, in the 2018-19 fiscal year, "*student credit hours delivered to students whose majors were outside of the instructing college received a premium of $10.00 per student credit hour to incentivize interdisciplinary instruction. In this example, this $10.00 premium is added to the baseline student credit hour value of $107.75, increasing the per unit budget value to $117.75 per student credit hour.*"[134] As of 2019, SCH premiums consist of other students from other college majors, targeted section sizes, honors courses, and pathways courses. According to the appendix and the Vice Provost for resource management, a premium for destination area initiatives will go into effect in future fiscal years. Currently, enrollments allocations have two premiums, which are for out-of-state majors and students in more than one major. Notably, the document states that "*additional premiums may be developed over time to incentivize activities that support the university's strategic plan.*"[135]

Each year, colleges set performance targets in the budget's unit allocation. These targets are set in consultation with "*university administration to ensure that the university's infrastructure can accommodate projected enrollments, that sufficient instructional*

---

[133] Ibid.
[134] Ibid. p. 24
[135] Ibid. p. 25

resources can be deployed to teach projected class loads."[136] The power difference between the colleges and university administrators in setting and consulting upon annual goals raises questions of intent. Touted as a decentralized model that gives power to the colleges, the PIBB ultimately requires that the university's strategic goals are embedded in every metric that measures performance.

Scorecard Allocations

The PIBB's emphasis on cultivating a diverse resource base is rooted in the scorecard allocations. The metrics in this allocation are categorized by three main bodies of actors: faculty success, student success, and administrative effectiveness. The scorecard metrics are being piloted in the 2019-2020 fiscal year. The appendix states that metrics include faculty activity and composition, and "*will be drawn from teaching data, faculty activity reporting systems, and other sources to include broad categories like faculty teaching, scholarship, engagement, and diversity*." In the student category, the metrics "*will include admissions process metrics, progress to degree metrics, outcomes for graduating students, and student participation in the broad range of curricular and extracurricular experiences that promote the* '[X]*T-shaped' student goals of the Strategic Plan.*" Additionally, this category will "*include measure of student diversity and the opportunity to look at a broad range of outcomes for various populations of underrepresented and underserved students.*"[137] The scorecard allocations specific to students reflect the 'church' aspect of the church and car dealer metaphor used by the Vice

---

[136] University Document, Appendix B: Metrics, Rankings, and Partnership for Incentive-Based Budget, June 2019, p. 25
[137] Ibid.

Provost for finance to describe the goals of a university. Lastly, the administration category will include metrics that "*monitor institutional efforts in continuous improvement and compliance with important external regulatory requirements.*"[138] Yet, specific metrics for administrative effectiveness are still "*TBD*" in this appendix.[139]

Because Fiscal Year 2019-20 is the first year that scorecard metrics are being implemented, the allocation will start with a few metrics. These "*will focus on gender and racial diversity among tenured/tenured track and non-tenured instructional faculty, the 4-year graduation rates for students who enter the university as freshmen, the 3-year graduation rates for students who enter the university as transfers, and disparities in the graduation rates for underrepresented minority and underserved students.*"[140] These metrics are all quantitative while taking care to focus on different populations of students that can be at-risk for dropping out. However, if these metrics can have negative repercussions. For instance, if a college sets a certain target for minoritized student graduation rates and then falls short of that target, they might be incentivized to encourage students to change their degree program within the college to ensure the student can still graduate in three to four years.

In future fiscal years, the intention of upper administration may be to implement more metrics, which would be in line with the emphasis on creating a diverse resource portfolio and a manageable version of the original 298 metrics in the initial cross-college collection.

---

[138] Ibid. p. 25
[139] Ibid. p. 24
[140] Ibid. p. 25

Earmarked Allocations

The third category of allocations is referred to as Earmarked Allocations. These cover the program and course fees that are directly received by colleges, such as special session courses that are taught in winter or summer terms, "*self-supporting, professionally oriented programs that are anticipated to charge a market rate of tuition and enroll sufficient students to generate net income that will enhance the resources for the college, department and the institution,*" among other "*college-specific allocations in support of strategic academic programs and initiatives.*"[141] This allocation provides multiple incentives to colleges to put resources into courses and programs that directly target increased revenue from students.

Overall, each college decides targets for each of the metrics in each allocation. Few metrics have been implemented at this point, but through new documentation that extensively describes 'the design and use of metrics', there are appear to be revitalized communication efforts to task colleges in developing metrics again. The most recent documentation highlights metrics as incentives for colleges to make progress toward their individually set goals, (which are in line with the university's core mission). These metrics are devised with the "*Office of the Executive Vice President and Provost… to refine and, as appropriate, develop new metrics that support the strategic goals of the university.*" The upper administrator's notion of a decentralized budget model may be renounced through

---

[141] University Document, Appendix B: Metrics, Rankings, and Partnership for Incentive-Based Budget, June 2019. p. 26

these consultations, as well as by the information system that plays a greater role in accountability and surveillance.

5.4e Accountability with the PIBB's Information System

The information system that is being pushed through with the budget model is purported as a way to "*provide data for analysis at the department level,*" but the resource "*allocations through the model will be made at the college level.*" It is noted that "*college deans will still have the ability to allocate resources differentially within the component departments of the college to achieve an overall mix of activities that address the college goals.*"[142] The information system is portrayed to make the performance and resource distribution transparent across the university, which will seemingly open the black box formula of resource distribution that had been used in the past. The system is said to show resource distribution by college as well as details on each department in the college. This transparency may also spur competition across the university but the Vice Provost for finance maintains that competition is not a stated goal of the system.

In the event the competition does increase, as is prevalent in Responsibility Center Management (RCM) budget models, transdisciplinarity or cross-college collaboration decrease as it is counter to the incentives that generate revenue. In higher education literature, RCM is another term for the incentive-based budget model which makes up the structure of the PIBB model. Administrators tout the PIBB as different than RCM because of the Partnership part of the acronym. Through *partnership*, colleges work with administrators to set performance goals. Additionally, the information system as well as

---

[142] University Document, Updated Budget Model Communication, 2018

the performance metrics allow the upper level administration to facilitate conversations with the deans if there are issues in the performance of stated metrics as well as to "*tweak the knobs of the model*" to motivate the adoption of different parameters.[143] The *partnership* that is purported to curb negative byproducts of RCM, in effect, creates measure of control that administrators maintain power over.

For instance, in the student credit hour and enrollment metrics, there are parameters regarding the number of out-of-state students, section size, and affiliation with the new general education program or transdisciplinary initiative. When courses fulfill these parameters, there are monetary incentives that go back to the course's college. In this model, college deans hold more power when distributing resources across departments. The decentralization of resources is depicted as a way to put this power into hands who are "*more familiar with the local context.*"[144] Yet if byproducts of this system provide transparency and spur competition, then what effect will they have on the *local context* that upper administrators are trying to empower? Similar to the globalized economy, the more efficiency is reduced, and productivity increased, the more uniformity becomes the normative force on production.

Former processes required deans to submit reports on resource needs to the upper administration which they used to decide the resource allocation. Additionally, when there were frustrations with the resource distribution, these administrators were responsible for

---

[143] Interview, Vice Provost for Budget Management, Fall 2019
[144] Ibid.

the decisions. In the new model, the college deans are given this responsibility, but with the added oversight of performance goals and achievements by the upper administration.

A main theme from the interview with the Vice Provost of finance was that the budget model prioritizes efficiency and productivity. As the university's revenue becomes more dependent on student enrollment, the university has shifted to more "*of a customer model*," where students are the customers in the market for a car. In this analogy, the curriculum, or degree program, is the product of the car dealership discussed previously. In sum, students hold power through their purchasing power.

Through the frame of the regional and national economy, students are also the product who become employed and grow the economy. Stakeholders such as state politicians and industry advisory boards can directly influence the direction of growth at the university to ensure that students leave the university with qualifications that are most beneficial to the state. In other words, the incentive-based budget is rooted in the mass production ideals put forth by Frederick Taylor (1919). The quantifiable metrics on which the budget model is built, mirrors engineering ideologies in that it strives toward functionality which "*prioritizes employability of graduates and reinforces careerist impulses of students*" (Riley, 2013, p. 57).

Although the university's place in society is changing amid decreases in state investment, there is still a need to critique administrative epistemologies as they emphasize the quantitative modes of productivity indicative of Taylor's scientific principles. The field of engineering education, as it spans the nexus of quantitative and qualitative research methodologies, is positioned to interrogate the principles of scientific management that administrators have imposed across colleges. As the university does not exist in isolation

from the social, economic, and political context, unlike the ivory tower analogy suggests, the measures it takes to sustain its identity can be practical compromises.

5.4f Incentives: SCH Baseline and Premiums

The metrics associated with student credit hour are a clear example of how colleges are being incentivized. In the 2018-2019 Fiscal year example, one student credit hour corresponds to $107.75 allocated to colleges. For an out-of-state SCH, this quantity is doubled. However, the additions for small course section sizes and out-of-college SCH are $10. As a result, the incentive to have large class sizes far outweighs any counter incentive to keep sections smaller. Large class sizes can be challenging across many disciplines, specifically in project-based, team-based classes and those with deliverables that require labor-intensive grading. Engineering education literature emphasizes the need to reduce lecture-style classes and multiple-choice question exams (Prince & Felder, 2006; Suskie, 1995), but with incentives to increase class sizes, these pedagogical improvements will be outweighed by the time cost of instructor labor.

There are also similarly small premiums for courses that are in the new general education program and those in the transdisciplinary initiative. The Vice Provost for finance asserts that these are the metrics that can be '*tweaked*' to be better aligned with university initiatives if need be.[145] From a power standpoint, the structures that have been put in place to distribute resources influence the decisions that departments and colleges will ultimately make to structure their courses and recruit students. Consequently, the credit

---

[145] Interview, Vice Provost for Budget Management, Fall 2019

hour and enrollment metrics have created a resource model that encourages market-like behavior with students as the commodity.

Because students are the commodity, or specifically, student time in a classroom, there are incentives in place that encourage efficiency in teaching. For any course that is co-taught, the 80% teaching allocation must be shared. The remaining 20% is allotted to the home department of the course. If the course is cross listed, the 20% department allocation is shared by weighting how many students from each department are enrolled in the course. For example, if a course if cross-listed between the Biology Department and the Fish and Wildlife Conservation Department, and there are ten biology students and twenty fish and wildlife conservation students enrolled, then the resource allotment between the two departments will be 0.33 and 0.66 respectively. There seems to be no incentive for cross-listing courses as these departments will have to share resources. Possibly, this structure can result in higher enrollment, which would increase the revenue from the class, but the number of students necessary to have an attractive cost-benefit analysis will be high and potentially detract from student learning in specific topics like writing, critical thinking (K. Smith, Sheppard, Johnson, & Johnson, 2005). Similarly, in the event of interdisciplinary co-teaching teaching as a way to "engender in faculty, as well as students, the capacity to achieve a sense of the critical limitations of a given disciplinary approach," faculty will have to split the resource allotment for the course (Skorton & Bear, 2018, p. 100).

In the distribution of course enrollment revenue, 20% is allocated to the course's home department and the remaining 80% is allotted to the home department of the faculty member who teaches the course. If these two are the same, then the department receives

the full allocation. If two faculty are teaching the course, each member will receive the 40% of the course allocation. In this equation, co-teaching is not cost-effective.

Because faculty have to obtain a set amount of instructional credit for their teaching load, anything less than full teaching credit is not meaningful. To this end, for co-teaching to become a viable alternative, department heads must buy in to reason for the co-teaching model. This can happen through a negotiation with the faculty member and their department head, small grant funds that can buy out the faculty member's time as shown in the pre-transdisciplinary course development or resources from a vice Provost who supports the model, explained in the post-transdisciplinary course development in the subsequent section. Ultimately, there is not a sustainable method for this form of sharing resources, because these funds are usually in the form of one-time grants and department heads turnover rate is higher than for faculty. Thus, faculty must continue to find ways to bypass institutional structures if they want to co-teach or disrupt the traditional teaching model in other ways. The incentives brought on by the PIBB model bring the story back to the team of early adopters who designed the interdisciplinary course described in section 5.1

Additionally, the ability and need to generate revenue from student enrollment has yielded change in instruction. One example that administrators note is that the "*expansion of 'hybrid' courses allows seat-based and online enrollment, increasing instructional delivery without increasing faculty load.*"[146] Unfortunately, these SCH metrics provide

---

[146] University Documents, Board of Visitor, Finance and Resource Management Committee, March 2019. p. 26

incentives that counter teaching and learning scholarship that emphasizes fair assessment comprised of multiple ways of assessing students (Suskie, 1995, 2008).

In another example of administrative efficiency, different types of faculty positions have been created to make up the teaching responsibilities. The board of visitor meeting notes state a "*continued growth in Collegiate Faculty ranks with higher instructional load and lower start-up costs than traditional tenure-track faculty.*"[147] The instructor, professor of practice, and collegiate faculty position all have a teaching load greater than that of tenure-track faculty. Tenure-track faculty generally have a load of two courses per semester. The various positions that a university teacher can hold also corresponds to how much power they hold as a member of the university.

In many discussions and documents regarding the curriculum, there is an emphasis on faculty-driven change.[148] However, as the nature of faculty positions change, tenured faculty in faculty senate and governance may concede some of this power due to new types of faculty who lack the same permanence of a tenure contract. Overall, the intentions of the strategic plan, supported through the PIBB is that "*enhanced administrative systems and processes allow the university to grow at scale and operate more efficiently.*"[149]

Overall, the different metrics pose as incentives for colleges. By decentralizing the responsibility of resource allocation to the college deans, the upper administration has created a system that seemingly relinquishes the power of allocating resources across the

---

[147] Ibid.
[148] University Documents, Curriculum Governance Committee and Faculty Senate Meeting Notes; Interviews, Curriculum Committee Member and Registrar's Office Staff Member, 2019
[149] University Document, Strategic Plan Appendix B, 2019 p. 26

university. However, the formation of this resource system perhaps sheds some of the responsibility of decision making from the upper level administrators, but still poses as a system that directs decision making in prescribed ways. Additionally, the data information system provides transparency for the colleges and departments that may indirectly bolster competition across them. In turning resource allocation into a competitive decision-making process at the college level, upper-level administrators are able to create a university environment that prioritizes growth and efficiency.

At face value, the inclusion of metrics to give premiums for small section sizes, enrolled students from other colleges, integrated general education courses, and transdisciplinary initiative courses show that the university administration values these assets. Specifically, these administrators point to these metrics in discussions around student learning as evidence that the university values small class sizes, interdisciplinarity and transdisciplinarity. However, in the overall equation of revenue allocation for each college, the value allotted to enrolled students and enrolled out-of-state students is far beyond the value of the premiums listed above. In the 2018-2019 fiscal year, the budget model allocated \$107.75 per student credit hour to colleges.[150] The amount to be allotted for these premiums is on the order of \$8-10 per student credit hour.[151] Thus, more students are financially more valuable than fewer students even with the small section size premium.

In the context of engineering education research to practice, the implications of findings regarding student learning will have even greater barriers to overcome if these

---

[150] University Document, Appendix B: Metrics, Rankings, and Partnership for Incentive-Based Budget, June 2019, p. 23

[151] Interview, Vice Provost of Budget Management, Fall 2019

institutional incentives are not considered. There have been efforts to expand the literature on large classroom teaching as this is the trend at R1 universities (K. Smith et al., 2005), but the research that emphasizes the importance of cross-disciplinary students working together or courses that have faculty co-teachers will remain unfounded without an understanding of the budget allocation that governs curriculum and instructional change.

5.5 Existing Stability in the University Curriculum

> *"All curriculum changes come through the university governance process."*[152]

In an organization undergoing three large-scale changes, there is a need to examine the existing stable structures that influence and are influenced by the efforts of change. The Registrar's Office was perhaps the most prominent stable entity throughout this study. Staff and policies from this office were apparent in each curriculum committee or negotiation in one form or another. The only place the Registrar's Office did not play a role was in the Honors College, which has fewer ties and more resources to overcome existing structures. Perhaps this makes sense as the original meaning of the term, registrar is "an official responsible for keeping a register or official records" (O'Dell, 1938, p. 15). The longevity of these records gives the office stability and as we see later, power.

The other stable structures outlined throughout the interdisciplinary curriculum development process are the multiple governance curriculum committees—at the department, college, undergraduate, undergraduate for IGE, and university level. These are described in more detail throughout this section and make up, perhaps, the most traditional

---

[152] University Document, Curriculum Governance Committee, Meeting Minutes, 10/24/2016

pillars of the institution. Each new proposal relating to curriculum change passes through governance committees. The IGE proposal passed through before it was enacted. Even the faculty senate must pass initiatives through governance. Yet with governance as a such a stable emblem of the university, it is still subject to different influences. In once example, a Registrar's Office staff member recounted the discussion around a new course approval in chemistry. She noted that the justification for the course, medicinal chemistry, was that "*it had become increasingly popular in industry*" and thus was lacking in the curriculum.[153] According to the staff member, the use of industry change as justification for curriculum change was a common and respected avenue for course approval justification.

5.5a Governance Curriculum Committees

There are three central committees that are involved in the undergraduate curriculum. One pertains to the IGE course approval, the other pertains to all undergraduate course approval outside of the IGE courses, and the third oversees the approval of all these courses, in which the first two committees feed into the third. In addition, there are College Curriculum Committees for each college at the university which pass their documentation to the UCC.

Each College Curriculum Committee (CCC) is made up of faculty representatives from each of the departments in the college. Each new course proposal is reviewed by the CCC then one of the upper level committees based on whether the course is in IGE or not. The committee members "*assist the proposal author with feedback that will aid in successful review/approval of the proposal*" and "*anticipate questions/information that*

---

[153] Interview, Registrar's Office Staff Member, Fall 2019

may be helpful to share with CCC during proposal review/approval." In many ways, this embedded peer mentoring process is beneficial to faculty members who are newer to the process but may also pose barriers to faculty members bringing in proposals that may be outside the normative culture of their disciplines. Additionally, faculty in the CCC who are from the same departments are to inform proposal authors of potential overlap with the proposed courses and existing academic curriculum. Seemingly, this distinction connects the curriculum across the college.

Lastly, the CCC responsibilities include mention of "*academic quality, rigor, and relevance of proposed courses and programs in support of college and/or department goals.*" The inclusion of 'rigor' in this document is surprising as the term implies a range of meaning that is largely discipline-specific. In the most optimistic sense, the use of rigor is to show that the quality of students' education is at the forefront of the committee's agenda. But from the engineering education literature on rigor, the term has largely been used as a form of disciplinary gatekeeping (Riley, 2017; Slaton, 2010).

For the proposal to continue through to the next stage, it must be approved albeit with revisions. If it requires revisions that are less than 20% of the proposal, it can be uploaded into the university's software system and checked by the Registrar's Office. If the Registrar accepts it, then the course is processed and offered to students. If the proposal either requires more than 20% revisions or is not accepted by the Registrar's Office, then it goes into a 15-day review process in governance. In this time, the "*University Community*" is tasked with offering suggestions, comments, and recommendations to the proposal. After the 15-day mark, the reviewed proposal is submitted to the Undergraduate Curriculum Committee.

The next stage is to pass through the UCC or UCCGE depending on the type of class. Many of the responsibilities in these committees mirror those in the CCC; however, as the makeup of the committee represents the entire university, the responsibilities are undertaken by different actors. The "*focus of the UCC is to review proposals according to the established guidelines and procedures.*" The review is not to focus on word choice or grammar but "*broad topics relating to curriculum and instruction.*" The comments are then relayed back to the proposal author to then be submitted to the Commission on Undergraduate Studies and Policies (CUSP).

5.5b Registrar's Office

In the vein of stable, existing university structures, the Registrar's Office exhibits vast amounts of institutional knowledge that helps it facilitate and mediate many of the faculty-driven curriculum discussions. The university registrar has been a component of universities officially since the 1500s and in action before even then (O'Dell, 1938). Historically speaking, the "office of the Registrar evolved from the head of the institution, and as the duties of the head became widespread they were gradually passed on to a subordinates" (O'Dell, 1938, p. 15). In the US, the university registrar can be traced back to the 19th century. As the size of institutions has increased, there has been a need for more administrative organization—which includes the office of the Registrar. Notably, "the ancestral tree of the Registrar in America is rooted in the President and has gradually evolved into the present status" (O'Dell, 1938, p. 16).

At Virginia Tech, the Registrar's staff involved in governance play a supporting role for faculty who propose new courses. To start, the Registrar's governance staff develop guideline documents for faculty to make the course proposal process clearer and more

efficient. As the course goes through the approval process, Registrar's staff confer the notes and comments from the governance committee to the proposal author.

The recently revised course proposal guidelines are an example of this work. These guidelines have been developed and revised as faculty engage in the course proposal process. According to a member of registrar's governance staff, the "*guidelines are written based on what we've seen with faculty, good proposals that faculty have submitted. We just did a revision over the summer to our guidelines that... Tried to strengthen what we've learned through experiences to get better instruction on good justification.*"[154] The revision had two goals, it "*provided better guidelines for how to do the justification, but we have also given better instruction for the committees that are reviewing these to be less subjective.*" In one example, the registrar's staff member spoke of changing "*the expectation of the governance committee, so that they're allowing more flexibility to the departments to design their courses.*" In an example regarding course numbers, as to whether a course should be a "*5000 or 6000 level course for the graduate.*"

> "*The committee had pretty stiff standard for what they thought a 6000-level course was. But when we look at the university policy... it gives a latitude for the department to put that course, where they needed in their curriculum, so that the timing of the course is coordinated, and that timing may not be based on having prerequisite So if you're an engineering, everything seems it builds on itself. In a liberal arts curriculum, it's more than their cumulative knowledge that they're gaining at each level...If you look at the content, it might not seem as tough as other*

---

[154] Interview, Staff Member, Registrar's Office Governance, Fall 2019

academic levels. But the breadth and depth that that student needs to move through that, in a skilled way, that's perfect placement is that, in the junior year... Now, when we see something like that, and there's a lot of discussion, we try to get clarity on them."[155]

According to a governance curriculum committee member, the Registrar's staff "*have a lot of insight. We consider them part of the committee, where they give us insights on how things have been done in the past and precedents when there's a choice.*"[156] The Registrar's staff are the constants of the committees who can provide the institutional history as well as insights on how university policies can be operationalized.

Still, a faculty curriculum member notes that the staff "*are in there to assist but they may not vote, but their opinions are well respected... It's really a process by faculty.*"[157] In a system in which the faculty serve temporary (one to three years) terms of service, the registrar's office is seen to provide the structures that remain constant throughout the governance process. But ultimately, the notion that curriculum change is faculty-driven is pervasive. A faculty member reflects on the curriculum governance process as one that

"*is really faculty-driven. and There's representation from all over campus, and obviously, not every departments going to be represented–every college and some of the bigger units are included sometimes... For some of* [governance committees] *the library is on it. So it's really a faculty driven process and the Registrar's Office*

---

[155] Interview, Staff Member Registrar's Office Governance, Fall 2019
[156] Interview, Faculty Member, Curriculum Governance, Fall 2019
[157] Ibid.

is very supportive. There's always someone from the Registrar's Office in that level meeting. They're there to answer questions. And, you know, there's some things that we just don't know, as a committee, right, you know, like, more technical things about well, can they how should they designate this on form for submission to the catalog.[158]

The expertise on curriculum policies are examples of the types of structures that reinforce the composition of the university. The context in which these policies were formed are largely lost in an environment in which actors change every one to three years. The role of the Registrar's Office has adapted to incoming faculty needs as well as maintaining the history and context by which the curriculum can be changed. In situations of large-scale change, these types of structures reinforced by institutional knowledge can be the arbiters that prevent rapid change. In many ways, this stability can be beneficial so as to prevent the curriculum from adapting to every whim of the student market or national call.

5.6 The fruits of the transdisciplinary initiative: Interdisciplinary course design (II)

The institutional structures that maintain the identity of a university often protect it from changing are also the reasons that many large-scale change initiatives fall flat. The Provost's transdisciplinary initiative implemented in 2016 sought to reorient disciplines around cluster areas with the intention that they would be productive in transdisciplinary research, curriculum, and outreach.

---

[158] Interview, Faculty Member, Curriculum Governance, Fall 2019

In regard to curriculum development, the organic process described in 5.1 highlights the many challenges the course endured to remain relevant. In a different case of course design, a team of faculty used the transdisciplinary initiative to develop a course that spans three colleges. The course was offered for the first time in the Spring of 2018 after almost a year of preparation time.

Three co-instructors were directly involved in the course's development as well as the transdisciplinary cluster's program manager who helped in the administrative aspects of course development. One of these co-instructors served as a co-chair to the transdisciplinary cluster's curriculum committee. The other lead of this curriculum committee was less involved in the specific course but played a role in building a degree program for the cluster.

In 2016, the clusters were formed. Two co-chairs were assigned to the curriculum committee arm of the cluster under study. It is important to note that in the time from course development to instruction, one of the co-chairs stepped down and was replaced by a different faculty member. According to the remaining co-chair, the faculty member left because of a high workload. A new co-chair was added soon after. Together, they "*did this big survey asking all department heads what policy-related courses were covering policy.*"[159] This work produced a large report detailing a variety of different types of courses comprising policy education. From this research, the chairs "*came up with two*

---

[159] Interview, Faculty Member, Transdisciplinary Cluster, Curriculum Committee Co-chair, Co-instructor, Fall 2019

major activities" and split up leadership among themselves. The first activity was to "*design a gateway course*" and the *"second activity was to design a degree or certificate.*"

According to the lead on this course's design, "*one question was what type of policy I want to address.*" From early conception, the faculty member notes that they "*had this idea that this course would be flexible, so at least some part of the material can be used in another course with a different policy domain. So if you have education policy as an example, we can offer the same thing for health policy and offer the same thing for security and so on.*" The structure of the course was to follow a "*modular design idea, that will have different modules of the course where* [they] *could take out some of the modules and then plug in the content area and make a course.*"[160] The intention was to maintain a flexible structure that could bring in a variety of disciplinary content, while also introducing students to a new field through a course that in part is intended to act as a recruitment into the larger certificate or degree program.

After the course idea was formed, the co-chair noted that the next step was to "*think about actually offering one complete course… to learn from* [the] *experience.*" The negotiation for selecting the subject for the course was done in accordance with a different transdisciplinary cluster. The topic of security was provided by the other cluster, which posed an issue for the co-chair:

> "*I wasn't interested in the problem of* [security]. *But, you know, I was interested in policy. So that was an issue. So I started making this team, and around the same*

---

[160] Ibid.

time, we had [faculty member] *join our* [transdisciplinary cluster]. *And I know that she teaches policy courses and has this policy background. So that was a very good resource. I looked for somebody who is an expert in* [security]. *I think I came up with a list of three or four people. One of them,* [faculty member 2] *is very knowledgeable in the domain and kind of an expert and has a very good link with industries. So I contacted him…and we made a team.*"[161]

The faculty member with a background in policy research and instruction notes that she was sent to the [transdisciplinary cluster] while she worked for the center for teaching and learning to see "*what the* [cluster] *was doing.*" From there, she notes that she "*must have accidentally made a comment, showed interest in curriculum…and they asked* [her] *to work on that point.*"[162] In these meetings, she notes that "*there was kind of a back and forth between what the curriculum development should entail, should it be a certificate… a class… a new program?*" According to this faculty member, the initial consensus among the committee was to "*do a class first.*" At this point, a different transdisciplinary cluster had offered the topic of [security] for the first offering of the course, but the curriculum committee was lacking a subject-matter expert for this topic.

The faculty member they invited to teach the course notes that he "*kind of fell into the class backwards.*" When interviewed, he describes himself as being "an odd fit for a typical political science department" because his "*research and teaching interests lie elsewhere.*" At the meeting with the curriculum committee, the course was described to

---

[161] Interview, Faculty Member, Transdisciplinary Cluster, Curriculum Committee Co-chair, Co-instructor, Fall 2019

[162] Interview, Faculty Member, Course-Subject Expert, Course Instructor, Fall 2019

the faculty member with "*the aim to essentially design something that could straddle the fourth-year undergrad, first year master's level and to introduce STEM students in particular to policy processes*." According to this faculty member, the course idea "*congealed around* [security] *as a reasonable focus because it is inherently interesting in its own right, and then also had the benefit of having* [the other two faculty members*] and myself involved to check several boxes.*" The faculty member elaborated on "*checking boxes*" by noting that:

> "*departments are built around disciplines and are in siloes…and that's sort of the way that things have been done, and probably the way things will predominantly continue to be done. But the* [transdisciplinary clusters] *were all planned to work across those, and to meaningfully do so, you need representation across different constituent units. So you didn't necessarily need three of us from two different parts of the university, but it certainly helped in trying to pitch the courses as the pilot for the gateway. So when I say it checks the box, it was good that we had the three of us. If it had just been engineering or social science, the* [cluster] *probably would have kept working on it rather than giving us its blessing because it just wouldn't fit the bill for that because* [they] *wanted something that was leveraging strengths.*"[163]

With the three instructors from different colleges, the course fulfilled the intentions of the transdisciplinary cluster. However, the logistics of co-teaching a course among three faculty from three different colleges posed a different challenge. Additionally, the course

---

[163] Interview, Faculty member, Course-Subject Expert, Course Instructor, Fall 2019

was to be offered to both undergraduate and graduate students so there was a need to present the course with a graduate and undergraduate course number. In the liberal arts and engineering department, there is some curricular flexibility built in through the avenue of a special studies course. This reserved course number allows for departments to teach special topic courses up to for up to two semesters before it must either be discontinued or passed through the governance curriculum committees explained in previous sections. The course was taught:

> "*as a one-off… to demonstrate a proof of concept—to see how people from different disciplinary backgrounds working together actually work together. Manage if there's a giant mismatch of expectations or anything like that. Also, to see if the students enjoy the class--if they seem like they're taking stuff out of it, and to check out what the enrollments are like in cross-listed courses of this nature, and all those sorts of things.*"[164]

The development and implementation of this course as a pilot served many roles for those involved. From a learning experience for the curriculum committee to the eventual goal for it to bridge students to a new program. The administrative work of this course was largely carried out by the program manager of the transdisciplinary cluster. This faculty member had the role of translating and negotiating the course so it would fit within the structures of the university curriculum in a way that still fully compensated each of the co-instructors. She notes that "*the big challenge was that* [they] *had three instructors from three different colleges*." The transdisciplinary cluster "*really wanted to pilot this model,*

---

[164] Interview, Faculty Member, Course-Subject Expert, Course Instructor, Fall 2019

to put some real teeth behind the [transdisciplinary] *model, which is supposed to be interdisciplinary and about developing the courses." Perhaps most importantly, she notes that the course "will not be sustainable, if you can't give adequate credit to everyone.*"[165] To provide adequate credit would mean that the course would give 100% instructional credit to three full-time faculty, which is a negotiation with upper level administration about what the course entails for the transdisciplinary initiative. From a budgetary perspective, the practice with co-teaching has been to divide the 80% allotted to the faculty instructor by the number of instructors. If the course is cross-listed, the remaining 20% is distributed across the cross-listed departments based on how many students enroll in the course. Because of this budget model, faculty are incentivized to actually split up the teaching allotment and not attend sections together, which is counter to the interdisciplinary team-teaching.

The Acting Vice Provost for the Office of Transdisciplinary Initiatives notes the same challenge for faculty who want to co-teach:

"What is difficult is that from a departmental perspective, a faculty member teaching the course at 75% or 50% on a budget sheet is still not enough… In actuality, they need 100% that they need credit for from their home department." The challenge is "getting department heads to release faculty members' time to be able to do that when departments have their own load that they don't address at a 100% level. The easy part is the budget sheet. You say it's 25% here and 75% here,

---

[165] Interview, Program Manager, Transdisciplinary Cluster, Interview 2019

the money goes this way. It's a lot more challenging to make that value proposition to a department head."[166]

In this case, the transdisciplinary cluster's program manager advocated for the team-teaching model and argued that there is a "*value added through the synergy*" of the team. The first step, "*was to make sure that the department heads*" of each faculty member "*were on board with this. Luckily*, [they] *had three very agreeable department heads,*" which she remarked, "*will not always be the case.*" One of the department heads was involved in the transdisciplinary cluster at a higher level. In the early negotiations of the course, each of the instructors pushed for full teaching credit. For the invited professor with the expertise in [security], he notes that he "*was very firm from the beginning that* [he] *wouldn't do the class if it meant an overload teaching assignment.*" He notes that the involvement of his department head in the transdisciplinary cluster "*seemed to help, because she had a finger on the pulse of what was happening in the* [cluster*], so she knew what* [they were] *trying to do, and being included in all of that could benefit the department long term. So she approved it.*" The curriculum committee co-chair shared a similar argument:

> *"Logistically, to make these courses successful, when you have three teachers for a course, you can say that everybody is working one third. But you know that they are working more. For this course, I think all of use were doing the whole course because we were present in all of the planning and sessions. But administratively, the default is that when you're co-teaching you get just one third of the credit of the*

---

[166] Interview, Acting Vice Provost, Transdisciplinary Initiative Office, Fall 2019

whole course… So we had lots of negotiations at the university-level to make sure that all three departments are getting full credit."[167]

The development of this course required translation at the university level such that it could be beneficial for those involved in its design and instruction. The co-chair of the curriculum committee notes that the "processes were not in place." He carries on to reflects that,

"we made many people mad because we weren't following the guidelines, and [university administrators] couldn't understand why everybody should get full credit. But you can also imagine that a junior faculty, like [one of our co-instructors], *who has to also get tenure, and is already teaching some courses for* [social science]. *This third of the course will then be counted. You're supposed to teach, let's say two courses per semester. If you make it 2.33, it just is the same as two. It doesn't add. It doesn't make anything but you're spending like lots of time. So we made sure that this course is counted for him as one course, and for* [our other co-instructor] *as one course.*"[168]

The Registrar notes that the fact that these three instructors received full instructional credit was an exception across the university. According to the registrar's staff, the full credit for co-teaching would have had to be "*built into the* [new budget model]." Because it is not, "*the Provost offices have to get involved*" which happened for

---

[167] Interview, Faculty Member, Transdisciplinary Cluster, Curriculum Committee Co-chair, Co-instructor, Fall 2019
[168] Interview, Faculty Member, Transdisciplinary Cluster, Curriculum Committee Co-chair, Co-instructor, Fall 2019

the course in question. In this case, the Vice Provost for undergraduate affairs was involved. The Registrar's Office noted that in this negotiation they "*threw up all the cautions and flags, saying that this was totally outside of how* [they]'*d normally do it*." In the end, they agreed to *"run a pilot on it to assess* [the course] *after it was over. But it is not the way the* [new budget model] *is designed*." In the budget model, there are "*three credits that are contact hours to the student*." The question the registrar's staff asks is, "*what is the percentage of that hundred percent that each faculty is contributing?"* In this particular case, the Provost's Office was able to bypass this limitation of the budget model and the course accounting spreadsheet that follows its model. Overall, the Registrar's Office staff member notes that *"without something changing for the* [new budget model], *it's just not built… for this type of co-teaching.*"[169]

In total, there were five course reference numbers (CRN) for the one course. Because the course was offered to graduate and undergraduate students, the two colleges with graduate programs listed the course twice. The third college listed the course order an existing special topics course number. Each of the five CRNs were listed with their respective instructor in the same room and at the same meeting time as the rest. Overall, this course was created through a negotiation between a variety of stakeholders with different levels of power. For some, the course was perceived as a one-off that will likely not be repeated. For others, the development of this course shows the limitations of the university structures that bind curricula. All in all, the original purpose of the course, by

---

[169] Interview, Staff Member, Registrar's Office Governance, Fall 2019

those who conceived of the idea initially, is to use it as a gateway that brings students into a new transdisciplinary subject.

5.7 Summary

This chapter is an unfolding narrative that revolves around different actors navigating and negotiating different structures at the university pertaining to interdisciplinary curriculum development. Ultimately, the university structures are as major an actor as the individuals who work within them. The findings detail the evolving institutional structures as much as the actions of the faculty and staff actors who navigate these structures.

While the transdisciplinary initiative was first communicated as a way to address societal challenges, build on existing disciplinary strengths, and broaden student learning, many of its initial goals evolved as time passed. The budget model, originally intended to incentivize and reward transdisciplinary and interdisciplinary activity, ended up a separate university-wide initiative that stemmed from the university's uncertain financial future, not just at Virginia Tech but across all universities in the United States.

The faculty and staff navigating these new structures as well as existing policies regarding interdisciplinary curriculum development devised bypasses to the structures that posed as barriers. In the first course, the instructional development team adapted their course to the structures and new initiatives like the integrated general education program and later the transdisciplinary initiative. The team of second course brought in the institutional power that supported the transdisciplinary initiative to break through the existing structures that prevented co-teaching models. In the frame of trading zones, each of these actors used different currencies and power to make the trades with the different

levels of the university. In the next chapter, the five principles of trading zones will be used to further analyze the systems in which the university actors translate and negotiate interdisciplinary curricular trade.

Chapter 6 – Discussion

In Galison's frame of trading zones, actors from different disciplinary contexts communicate in a way that "by no means captures the full world of either, let alone both." This '*thinness*' that Galison references is what makes trade possible; it signifies the local coordination that emerges from consensus by the actors engaged in trade (Galison, 1997b, p. 36). In the context of an institution undergoing three university-level initiatives, the trading zones and actors seeking out trade are as numerous as they are interrelated. The trade that constitutes interdisciplinary collaboration in the academic sense has been expanded to include the trade between varying levels of academic units as well as the external entities that hold power over the university curriculum.

6.1 Trading Zones in Higher Education

In an institution made up of many smaller organizations, overarching initiatives have multiple layers of complexity that stem from the use of language and materiality, disruptions to existing stability, neoliberal reductivism, applicability within initiatives, and the power differences that underlie each layer. The university-level goals may present in one way as an initiative and then in practice, be differently interpreted, adapted, or resisted by various stakeholders. This study examines interdisciplinary course development at a large R1 university undergoing three university-level initiatives. Much of the complexity in this study is indicative of the different narratives that have existed across the university entities and actors.

The language and materiality used to communicate the three initiatives is presented and operationalized differently for the actors trying to design interdisciplinary curriculum. Across the study, the three initiatives have looked different in public-facing rhetoric and

their implementation by faculty and staff at the university across time. The resistance to particular initiatives becomes clearer through the lens of existing stability. The existing stability at a university at large is the notion of disciplines and departments that categorize knowledge. Transdisciplinarity attempts to rewrite the traditional university. In this case study, the university has a stable identity as a predominately technical R1 university. Attempts by the administration to disrupt this stability were met with faculty-driven resistance, which then resulted in different outcomes to the initiatives.

In situating the university amidst the larger economic trends in higher education, administrators focused their efforts on implementing the new modes of academic trade through specified currencies, e.g., unit, scorecard, and earmarked allocations outlined in the PIBB metrics. The different types of existing currency were organized by administrators, so departments and colleges to specify their own strategic goals under the university's strategic mission umbrella.

When we examine the two examples of interdisciplinary course design, before and after the tripartite push for transdisciplinarity at the university, there are clear similarities in the challenges that faculty faced in developing their courses. Even after three years of outward-facing support of transdisciplinary curriculum development, the three university-wide initiatives did not eradicate the structural challenges that the first interdisciplinary faculty faced in developing and sustaining their course. The applicability of these three initiatives is still a work in progress as they are used, adapted, and rebuilt in practice by faculty and staff.

It is important to see the university in its societal, economic, and political environment. The goals of these large-scale initiatives reflect not just the aspiration of

administrators but also reflect efforts to fiscally sustain the university in its changing economy. The way these initiatives diffuse through the multiple levels of the university suggests the varied power structures at the university. University stakeholders internal and external to the institution have been influenced by the changing political economy that increasingly values technological innovation and workforce development. We can see these institutional structures more clearly when actors engage in academic trade—the public-facing policies and initiatives become more malleable as more actors engage with them.

6.1a The Role of Language and Materiality

When we look back to make sense of the chronology of events, there is a tendency to smooth over the discrepancies that were felt by actors involved. The institutional documentation provides a curated record of the initiatives that were imposed upon the institution. But the voices across actors involved in the initiatives were the ones to expose the inconsistencies and impracticalities that shifted the terrain. Focusing on the 'multiple vocabularies' led to a better understanding of the complexity within the university (Latour, 2005). The conflicting narratives are especially clear in tracing the paths of the two courses from conception to implementation. In many ways, this negotiation of language is a natural phenomenon as language itself is neither a transparent nor a neutral carrier of information (Austin, 1975). The intentional and accidental mediation that language carries is a prominent theme across this study.

Faculty-Driven

Language varies in its meaning according to use and user for a variety of actors involved in academic trade. One example is that of the term, 'faculty-driven.' In

conversations regarding curriculum development, faculty and administrators used this term for multiple reasons. In governance committees, 'faculty-driven' was used as a point of pride and ownership. In the faculty senate, between higher-level administrators and the senators, this term was used as a form of defense by administrators in that university-level changes may be coming, but the university is still faculty-driven. Staff in the Registrar's Office also used this term to explain that their role in curriculum governance was that of aid, rather than in driving decisions that alter curricula. However, many of these decisions made in a governance setting are checked and rechecked by the registrar's staff. The use of 'faculty-driven' in this sense is a tool of deflection for the Registrar's Office.

In many ways, the term 'faculty-driven' is a shield that implies that faculty are, in fact, in control of university-level and curricular change at the university, but in use, it reveals ways in which faculty are losing ownership over the university. However, in the instance of the transdisciplinary initiative and new budget model, the unrest expressed by the faculty at the advent of these initiatives resulted in faculty-driven change that led to the resignation of the provost who spearheaded them. As participatory and inclusive upper administrators purported the university-level initiatives to be, the faculty-driven outcome was to require new leadership. The upper administrator's use of the term 'faculty-driven' may have been used initially as a shield, but ultimately, it was the weapon that brought on a change of leadership.

The term, faculty, has come to take on several new meanings as new teaching ranks become prevalent. These new ranks fragment the faculty body amid positions, such as collegiate faculty, professor of practice, instructor, clinical faculty, each with different responsibilities and promotion guidelines. Faculty in these new positions rarely serve on

university governance committees or in the faculty senate, more often due to high teaching loads than to policy stipulations. The increase in student enrollment—a university-level strategic goal—has justified the creation of teaching faculty ranks gives administrators more control over the faculty body by establishing fewer permanent ranks. Ironically, this expansion dilutes the impact of tenure-track faculty, while increasing equity for teaching ranks.

The faculty senate brings up the issue of student enrollment in multiple faculty constituency reports to the Board of Visitors. The 2019 report focuses on the issue of tenure by first defining it to the board and then providing data that shows the lack of new tenure-track hires in relation to the increase in student credit hours (12% over four years).[170] The Senate urges the university to "*restore the role of tenured faculty.*" Notably,

> *"Faculty and staff are being asked to support an ever-growing number of students, in an ever-growing number of locations, comply with ever-increasing regulation, and implement an array of new initiatives and programs. This request is only that the tenured faculty ranks be proportionate to our growth".*[171]

The faculty senate appeals to the identity of the university, in which they note that tenure is a unique aspect of university organizations that should be preserved. However, the student enrollment argument may be falling on deaf ears as the expansion of different faculty ranks is on the rise. Seemingly, administrators have bypassed former practices of growing tenure-track faculty by developing different faculty ranks that can take on more

---

[170] University Document, Faculty Constituency Report, 2019
[171] Ibid.

teaching loads than the tenure-track faculty. With the decrease in revenue from research from Cold War-era federal funding (McClure et al., 2019), as well as the increased competition from corporate labs seeking out federal funds (Williams, 2003), student tuition and fees are the next forms of reliable and sustainable revenue.

Decentralization

At the same time, the new budget model is described as a mechanism to equitably distribute decision-making power across constituents at the university—from upper administration to deans, department heads, and faculty. Decentralization is a theme that runs through the PIBB model, as a way to give colleges autonomy in deciding how to focus their academic and research productivity on fostering faster rates of growth at the university overall. Administrators' use of the term 'decentralization' implies that they are relinquishing control over collegiate activity and performance. According to the parameters of the budget model, this implication falls short of true autonomy.

In setting performance targets, each college must consult with relevant vice presidents (VP) (some example VPs are research and student affairs, buildings and grounds, and finance and resource management). The reasons for this consultation are stated as ways to ensure that performance targets are in accordance with the university's core mission and do not conflict with logistics at the university. For instance, if a college is targeting a significant increase in enrollment, they must consult with the VP of Buildings and Grounds to ensure that there is enough classroom space. In turn, this required alignment provides an opportunity for upper administrators to influence the goals set by colleges in a way that counters decentralization. If a college does not meet its targeted

performance goals, administrators once again have the power to "*tweak the knobs*" on the offending college.

Many of these vice president positions and their subsidiaries are relatively new compared to traditional university roles such as tenure-track, and tenured faculty. In 2012, the Wall Street Journal noted a significant trend in the United States to hire more administrative personnel to manage people, programs, and policies. The number of administrator hires had increased 50% faster than the number of hired instructors (Wall Street Journal, 2012).

Gary Rhoades, one of the authors of Academic Capitalism (1997), comments on this trend as it relates to broader trends in academia:

> *"There is an irony here. We are in the midst of what could be called an austerity agenda that claims that we are in a 'new normal' of no new public resources for higher education and heightened concern about escalating tuition and student debt. Yet colleges and universities are investing in growing numbers of noninstructional employees, expanding costs in units and activities that lie outside the academy's core functions. To what extent is the periphery becoming the core?"* (2014, p. 106).

The language of decentralization as a goal of the PIBB takes on a new meaning as it implies accountability to upper administration. Hannan and Freeman discuss that since the 1970s, market logic has become prevalent in higher education and, in turn, has brought about the demand for accountability (1977). The university's 'product' is education, in which "faculty are long-term employees and alumni, long-term clients" (Hannan & Freeman, 1989, p. 74). Increasingly, research universities are involved in workforce

development,[172] which implies a political entanglement. In the landscape of trade, external entities such as state governments are becoming more involved in engaging the university in trade. Hannan and Freeman state that accountability is becoming an expected practice in higher education is due to resource scarcity, which has been the trend nationwide since federal funding continues to decrease since the time of the Cold War Era.

The new budget model provides a platform for upper administrators to set metric values at different levels. Already, the incentive for enrollment growth exists, particularly with out-of-state students, in which the SCH for these student unit allocations are much higher than other metric allocations. Additionally, there are smaller but significant metrics for courses that fall into the IGE program, honors college, and transdisciplinary initiatives. Over time, these premium amounts can be "*tweaked*" to provide incentives to colleges that fulfill the university's goals. The use of the term 'decentralization' throughout the PIBB implementation plan, as well as administrator interviews, is jarring as the intricacies of the budget model show clear instances of administrator control and surveillance. Through the lens of trade, the inclusion of surveillance or accountability may be conceptualized as regulation, in which the upper administrators have the power to ensure trade (i.e. targeted metrics) falls within the university's core mission.

6.1b Disrupting Existing Stability: The Cost of a High-Stakes Identity

The transdisciplinary initiative and new budget model are mechanisms, administrators tout, that unify and align productivity with the university's core mission. However, the traditional structures of the university curriculum committees already

---

[172] News source, Inside Higher Ed, 11/8/2019

provide unity and alignment under topics regarding the curriculum. The established entities like department, college, undergraduate, and graduate curriculum committees, and the faculty senate, constitute much of the cross-disciplinary curricular and policy trades negotiate within the university's overarching goals. As a note, the Integrated General Education plan passed through governance in 2015, but the transdisciplinary initiative and new budget model did not undergo the same vetting process within shared governance. As the social, political, and economic context of higher education changes, external entities have become directly and indirectly involved in the curriculum—regional and discipline-specific accreditation,[173] industry funding,[174] and market-logic (Slaughter and Rhoades, 1997). These different entities can justify different avenues by which to implement university-level initiatives that bypass the existing stable structures of the traditional university.

As resources become scarcer, universities are turning to different programs and initiatives to set themselves apart as competition looms. The idea of a traditional university that produces fundamental knowledge has since past (Slaughter & Rhoades, 2004b). External research funding privileges the applied sciences (Rosinger, Taylor, Coco, & Slaughter, 2016)[175] and students are promised better job prospects if they choose STEM majors. Universities are promised more state resources if they produce more STEM

---

[173] Regional - SCHEV, SACSCOC; Discipline-Specific – ABET in Engineering Education
[174] News source, University News, 2018-2019
[175] According Rosinger et al., science and engineering fields receive roughly 97% of federal R&D funding (calculations based on information provided by the National Science Board in 2014, pp. 5–9).

majors.[176] To draw in these students and faculty, universities, driven by upper administration, take measures to attract these actors.

Research productivity in science and engineering is also a point of distinction in academia. In science and engineering, there is the notion that research can be commercialized and thus are heavily compensated through large grants and Federal legislation to incentivize patenting through the Bayh-Dole Act in 1980 (Brint, 2005). In addition to the larger grants available in these fields, the publications are also produced at a faster rate. Science and engineering disciplines prioritize journal articles or even conference papers in some fields over longer formats. In the humanities, books are the gold standard of which to publish. As one can imagine, the rates of publication in these fields are vastly different. Where articles are published more frequently, books take more time.

The tension between faculty and administrators has existed perhaps since the introduction of higher education administration as a separate profession. Burton Clark described them in 1983. "Instead of being arms of the state, or representatives of the professors, [administrators] are, in pure form, the leaders—'captains'—of autonomous enterprises" (1983, p. 209). The job of administrators is to position their autonomous enterprises to draw in different revenue streams—from students, from faculty who are likely to bring in lucrative research grants. Consequently, the trend for administrators has been to implement novel initiatives that reorient a university's identity as one that attracts

---

[176] News source, Inside Higher Ed, 11/8/2019

'talent.' As we have seen, these large-scale initiatives that disrupt the fabric of stable structures can be met with hostility by those who make up these stable structures.

In the example of the transdisciplinary initiative and the new budget model, the former Provost sought out a way to make Virginia Tech known for its transdisciplinary research, curriculum, and outreach. The goals were to turn VT into a destination for talent in these thematic clusters identified with the transdisciplinary initiative. The new budget model was to create the reward structure for the transdisciplinary efforts, but the details of both structural shifts are due to faculty-driven negotiation and navigation within initiatives.

In some ways, the lack of specifics was a way for the administration to provide flexibility in facilitating participation from deans, department heads, and faculty. Without strict details, upper administration implied that academic units would have room to devise their own strategic plans based on their local context. Yet, the communication from upper administration regarding this potential form of participatory design was stifled as different faculty and staff across the university have interpreted the PIBB and transdisciplinary initiative through jaded lenses. Gaye Tuchman expresses a familiar sentiment toward the provost at Wannabe University as it relates to power.

> *"Keeping the specifics to himself, the provost acted as though he had read the work of Michel Foucault: maintaining a monopoly on some kinds of knowledge helped him to solidify his power"* (Tuchman, 2009, p. 102).

Whether the process was intended to be more than participatory at face-value is difficult to discern. The combination of limited communication and existing tension

between faculty and administration led to a variety of interpretations by those involved in trade at the university.

For the faculty senate, the participatory element repeatedly fell short. The Senate noted that they were "giving feedback on a model which [they] only know in parts and which [had] already been altered significantly!" In addition to the comments about feeling in "whiplash" and trying to hit a "moving target," the senate also pointed to "the divide between the Humanities, and other disciplines with no sponsored research, and heavily-funded units."[177] The transdisciplinary initiative, albeit relatively unstable, and contributing to the whiplash, was a way to include disciplines that had fewer resources than those who were involved in the research institutes that operated with closed bounds. In 2016, the faculty senate conducted a survey that stated, "most institutes more or less abuse their power. Most put barriers that prevent faculty from accessing important resources." The transdisciplinary initiative was seemingly a way to increase inclusion and openness. However, there was still a sentiment in the faculty senate notes that "the 'haves' will not support the 'have nots.'[178] At a university that identifies heavily as a technical and engineering research university, the 'haves' in this case refers to these larger and more resourced disciplines.

Without specifics and faced with a bull market, the faculty, department heads, and deans ultimately produced a final count of 298 metrics—an obviously unrealistic number to implement. The act of collecting these metrics may have been a way to engage and

---

[177] University Document, Faculty Senate Meeting Notes, 10/04/2016
[178] University Document, Faculty Senate Meeting Notes, 4/11/2017

educate colleges in the PIBB before it was to be implemented, but it is difficult to conclude whether this was ever intended to be more than participatory at face-value.

In trade, there is the presupposition that power differences do not exist. However, this assumption fails to account for the impact of time. The transdisciplinary initiative sought to create problem-focused, transdisciplinary clusters that were not driven by any specific discipline. This seemingly egalitarian approach of building transdisciplinary spaces at the university presented an equal playing field for the disciplinary actors involved in each cluster. However, this top-down trade initiative did not take into account the historical, resource-dependent, or cultural inequality already extant at the university. Historically, Virginia Polytechnic Institute and State University may have expanded its focus from engineering from its days as Virginia Agricultural and Mechanical College (1872) to Virginia Polytechnic Institute (1944), but even in its new status as a state university, the dominance of the engineering college remains prevalent in the culture and in the engineering student and faculty composition (35% and 27% respectively).[179]

In building egalitarian transdisciplinary spaces, upper administrators do acknowledge the persistent inequalities among disciplines but fail to materialize and sustain equity among them. In institutions where single departments drive inter- and transdisciplinarity, there is the trend that departments that are able (the 'haves') absorb the departments that are not (the 'have nots').

Engineering-driven transdisciplinarity

---

[179] University Document, Office of Institutional Research, Accessed 2019. These estimates are based on Fall 2018 enrollment and employment data.

In the case of Virginia Tech, part of the focus with the transdisciplinarity initiative was to emphasize inclusivity and openness across the university. These points of distinction seem in response to the growth and expansion of departments that are able to bring in vast quantities of external resources, engineering. But even with such growth, engineering departments remain imbalanced with regards to diversity and inclusion of social identity variables such as race and gender (Riley, Slaton, & Pawley, 2014) as well diversity of thought that could yield more holistic skillsets (Downey, 2012). At MIT, Rosalind Williams, former Dean of Students and Undergraduate Education and Professor in History of STS, uses the term "expansive disintegration" to frame the engineering-driven interdisciplinarity she witnessed in the departments (2003, p. 31).

Williams speaks of the engineering ideology as being built around finding and solving problems. "There is no 'end to engineering' in the sense that it is disappearing. If anything, engineering-like activities are expanding" (2003, p. 31). Williams argues that the boundaries of engineering have disappeared; no longer is "engineering a coherent and independent profession that is defined by well-understood relationships with industrial and other social organizations, with the material world, and with guiding principles such as functionality" (2003, p. 32). Instead, engineering has adapted to focus on problems that have become more complex and require interdisciplinary knowledge but ultimately fall under the category of potential commercialization (Slaughter & Rhoades, 2004a)or solving costly problems in society (Popowitz & Dorgelo, 2018). Engineering departments are continuing to diversify and specialize in their foci. Biomedical engineering and human factors engineering are two examples of engineering departments that have integrated

different disciplinary domains (biology and psychology, respectively) into their selectively porous boundaries.

At MIT, Williams describes the list of engineering departments as evidence of this expansive disintegration.

"To see the expansive disintegrating of eng, one need only look at the list of eng depts at MIT. Their traditional boundaries are crumbling as departments stretch and reshape themselves to confront a host of problems, varying wildly in scope and character. The departmental structure developed during the 19th century and the early 20th century […] During most of the twentieth century, engineering at MIT was organized in these departmental "nuclear families." Now the School of Engineering has become a collection of extended families, with stepchildren, in-laws, and hyphenated last names" (Williams, 2003, p. 32).

The historical evolution of engineering departments is not confined to MIT. At Virginia Tech, engineering departments have also taken on more sub-specialties as well as external funding sources demand it. This emergent form of problem-focused department evolution lets engineering drive the cart of transdisciplinarity, picking up other disciplinary expertise as the market demands it. In this way, emergent, bottom-up transdisciplinarity is at the behest of the discipline with more power in which it pulls in other disciplines in supplemental, support, or service roles (Vanasupa, et al., 2012).

In 1999 during MIT's Technology and Culture Forum, a former Provost of MIT, John Deutch, started his keynote with a sentiment on the division between science and

technology. According to Deutch, the "distinction between science and engineering was no longer very useful." He states,

> "The world is now dominated by application, not by technology generation. In any project, there is 'parallel processing' of thinking about the science, thinking about engineering issues like quality control, thinking about budget and marketing issues, and thinking about legal and political constraints. From the start, people work in groups that mix the range of disciplines necessary to get the project done. We are faced […] not with disciplines but with situations" (Deutch quoted in Williams, 2003, p. 41).

Engineering ways of thinking and doing lend itself to adapting to the changing societal, economic, and political dilemmas. This emphasis on application-driven technology that is purported to solve relevant societal problems is a strength of the field and wholly explains the expansive disintegration Williams illustrates. At Virginia Tech, the transdisciplinary initiative presented an alternative to this model of the 'haves' driving transdisciplinarity, in which the transdisciplinary clusters drew from a more representative sample of university disciplines. However, without acknowledging or disrupting existing power inequalities, the initial egalitarian setup was short-lived.

A tenured professor in the humanities speaks of his experience in a cluster, in which he attended the meetings at the beginning but then discontinued his involvement after he saw it apparent that his voice was not valued. Similarly, social science and humanities faculty who were hired through the transdisciplinary initiative into familiar "home" departments have noted that as they have become more settled in their departments, they

no longer see the benefit of attending the meetings or continuing involvement in the nexus spaces of the transdisciplinary clusters.

Back in 2016, the former provost's original intention to bring in a wave of 300-400 new faculty through the transdisciplinary initiative was an attempt to disrupt the extant power structures between departments. The inability of the university to enact this type of structural and resultant cultural sea change gave way to a trading zone where faculty had to make smaller yet still high-risk trades over short periods of time to continue their work in transdisciplinary spaces. These trades may have been justified in the short-term, as they benefited students or were intrinsically motivating for faculty to pursue, but over time they could not be sustained amid the larger stable structures that maintained a value system with the same currencies still dominating the trading zone. Increasingly, the endeavors that do prove lucrative and thus sustainable are those aligned with market forces. Market forces that comprise "not just revenue generation efforts that commodify and commercialize higher education, but also political-economic efforts that restructure and rationalize professional work" (Rhoades, 2014, p. 114).

Markets to provide stability

The university does not exist siloed from the political and economic environment. Research and instruction are arguably a product of what is valued in society. The actions taken by university administrators are largely to increase the productivity of the university, which also follows the goals of a neoliberal economy. These goals, in large part, undermine the disciplines that do not draw large sums of sponsored research or produce employable graduates.

In Gumport's examination of academic structures, education has shifted from the "dominant legitimating idea of public higher education as a social institution… toward the idea of higher education as an industry" (2000, p. 70). In qualifying the university as an industry, "public colleges and universities" become viewed "as quasi-corporate entities producing a wide range of goods and services in a competitive marketplace" (Gumport, 2000, p. 71). Engineering and other STEM graduates are highly desirable by state and national initiatives (National Academies Press, 2016) and thus have privileged positions through increased external resources. As an example, a recent agreement between Virginia state politicians and Virginia Tech is about the need to increase the number of Computer Science and Computer Engineering graduates.[180] The emphasis on engineering education (since the Cold War era) has had major effects on the nature of higher education and continues to have permeable effects on the other disciplines (Altbach, Gumport, Johnstone, & Johnstone, 2001; Terman, 1976).

Market forces have influenced the trajectory of the university since before World War I when students chose more 'practical' disciplines to major in times of economic turmoil. When large sums of federal funding poured into universities after World War II, universities developed graduate programs and increased their focus on science and engineering research. The current trend of transdisciplinarity follows a societal evolution as well. In many European countries, sustainability is the form of transdisciplinarity that is being implemented in large-scale initiatives. The field of automation and artificial intelligence is another transdisciplinary theme growing rapidly with the aid of federal and

---

[180] News source, Inside Higher Ed, 11/8/2019

industry support. These external actors influence the type of research that is attractive to fund for it can serve a purpose in the nation's economic production. New degree programs can be created if they show evidence that their graduates are highly employable (SCHEV, 2019).[181] Over time, these incremental decisions that actors partake in to better their careers, based on the metrics provided to them, become large-scale reflections of what is valued by society and what is not.

In some ways, the tradition and stable identity that is attributed to the university's inability to adapt quickly is what preserves the institution from fully operating in a neoliberal, privatized paradigm in which management decisions are rooted in economic decisions that draw in revenue and cut expenditures. In a neoliberal paradigm, universities are pushed to operate like corporate industries to survive. In past decades, universities had fewer concerns regarding resources because of the high volume of federal research funding and state government investments. Increasingly, as governments divest from university sponsorship, higher education is faced with management decisions that require new sources of revenue. In recent years, these developments are seen through increases in enrollment, market-driven adaptations of applied research with the potential to commercialize, and fewer tenure-track hires across the university. Yet, there are still aspects of the university's structure that are protected. The curriculum may change because of a variety of technical issues, but by and large, faculty are the ones who develop course curricula (Tuchman,

---

[181] The State Council of Higher Education in Virginia (SCHEV) requires that for new degree programs to be approved, they must show evidence that graduates will obtain employment through a variety of existing job postings as well as projected starting salaries and the projected change to gauge employment demand for the proposed degree program (SCHEV policy documentation)

2009).[182] Degree programs are also becoming more difficult to develop without direct evidence that the degrees will grant graduate employment.

Yet not all faculty have the privilege and freedom of developing course curricula. At Virginia Tech, the director of the IGE program notes that his office "*had to be careful when giving* [course development] *grants* […] *Many young professors have lots of great ideas, but no support, or a little support or actually anti-support*" from their departments. The message is that they "*shouldn't be working on course proposals...* [they] *should be doing these other things*" like research and departmental teaching. The director notes that they "*learned quickly to be more careful and more upfront with letters of departmental support on folks that are pre-tenure or folks in more vulnerable positions, like instructors that are re-upped every year.*"[183] The new integrated general education program has learned to make decisions based on the stable culture of the university that values faculty activities dictated by promotion values, which indirectly devalues the curriculum.

6.1c Neoliberal Reductivism: Accountable Growth

The complexity of enacting large-scale initiatives at a university is heavily rooted in the many currencies that exist across the different organizational layers. According to Galison, all trade is rooted in the presupposition of currency (1997). Academic currencies vary across disciplines, organizational levels, and the actors involved. In this study, the metrics outlined by the PIBB are clear examples of different types of currency set forth by

---

[182] Professional degree programs may soon throw a wrench in this statement though. These programs do not require SCHEV approval. Additionally, the revenue from these programs go largely to the department rather than to the university through indirect overhead costs as in the traditional SCH equations.

[183] Director, Office of General Education, Interview

upper administrators. However, each discipline has a currency that is a product of different disciplinary standards—some disciplines value books over journal articles, others value exhibits. In curricular trades, student credit hours and enrollment numbers are the currencies that some traders—administrators—have come to prioritize in the university.

From the frame of trade, currencies have taken on new significant wit the changing social, political, and economic landscape. Resource scarcity in the form of state funding divestment has raised the importance of finding alternative revenue sources. According to the State Higher Education Executive Officers Association, "*years of state budget cuts during lean economic times have not only contributed to increased tuition and heavier student debt burdens, but have also led to larger class sizes, fewer academic programs, and diminished institutional resources to help students succeed in college.*"[184] These developments have changed the significance of the currencies to various actors conducting trade in the university.

With the PIBB, we see that the incentives provided by the upper administration for colleges are a contrived way to bring about growth under the guise of decentralization and college autonomy. In the analogy of the church and car dealership put forth by the Vice Provost for Budget Management, there lies the message that the initiatives are necessary for the university's survival. According to Weisbrod's two good framework, "higher education institutions pursue two types of goods, mission goods and revenue goods" (Weisbrod et al., cited in McClure et al., 2019, p. 14). Mission goods are those that reinforce the mission of the university, but do not make money directly—the church—and

---

[184] Public Document, SHEEO Letter to Congress, 4/7/2020

revenue goods are those that make the university enough money to sustain the mission goods—the car dealership. Notably, the mission of the university is what constitutes a university's identity or 'brand' as it is a tool that is used to attract students. The authors of the framework note that a university must engage in both pursuits to be sustainable (Weisbrod, Ballou, & Asch, 2008).

However, increasingly, there are concerns that the shifts in state subsidies give rise to an imbalance between goods, which could lead to pursuits that counteract the mission— e.g., increasing class sizes to the degree that the quality of learning suffers. As societal, economic, and political influences shift, the university may prioritize goods differently. Gary Rhoades, a co-author of academic capitalism, asks *"what extent and in what ways academic capitalism is driving priorities focused less on the production process (instruction and research) and more on marketing, assessment, and efforts to entrepreneurially engage and play in private sector markets"* (2014, p. 104). These priorities are largely understood through the development of university strategic plans, which are increasingly becoming prevalent in higher education management.

At Virginia Tech, *"The university develops the annual budget as a one year quantification of the university's strategic plan. The strategic plan is the framework for enacting the university's mission."*[185] The strategic planning committee is a recent development. The initial discussion and collection of metrics took place from 2016-2017 with a group of deans, department heads, and faculty who were asked to have discussions

---

[185] University Document, Finance and Audit Committee, Proposed 2017-19 Operating and Capital Budgets approved by BoV, 5/2/2017

about metrics that they would deem appropriate for their units. This group was the basis for the work of the strategic planning committee, which published the university's 2019-2025 strategic plan in the summer of 2019.[186] In 2020, academic units across the university were tasked with devising their own strategic plans to submit to administrators who oversee them. For instance, academic units, like the research institutes, must submit their plans to the provost and academic departments submit theirs to their college deans. This process can be understood as a collection of proposed trades occurring at different levels of the university with overlapping stakeholders.

The transdisciplinary initiative is one example of problem-focused and applied knowledge research and instruction that follows in the paradigm of engineering. Similarly, this quantitative, outcomes-based paradigm is the basis for the new budget model as it seeks to find data-driven ways to increase productivity and reduce inefficiencies. As resources become scarcer, the university has prioritized efficiency. Some universities, Virginia Tech included, pay "$*25,000 to $75,000 (depending on size)...*[to] *join the Academic Benchmarking Consortium*," in which universities provide spending data to its researchers, and find out how their administrative costs line up with their peers."[187] This emphasis on organizational efficiency is rooted in Taylor's Principles of Scientific Management discussed previously in 5.4e. Morris Cooke, an engineer by training and one of Taylor's followers, published a report in 1910 on "Academic and Industrial Efficiency" to raise the issue that the increasing university costs were unsustainable (Cooke, 1910). These issues on university inefficiency have resurfaced in this age of state funding

---

[186] University Document, Strategic Planning Committee Member Correspondence, 2020
[187] News Source, Tugend, Chronicle, 2019

divestment and decreased federal grants. In response, universities are replacing traditional metrics in education with "economic ones that emphasized return on investment or 'best value'" (Brown, 2015 cited in McClure et al., 2019, p. 23). At Virginia Tech, the design and use of metrics map out inefficiencies and are purported to lead to predictive analytics that further reduces economic inefficiencies.

From the frame of trade, the emphasis on efficient growth is indicative of the way that local coordination has changed in past decades. Because of resource scarcity, reducing university costs relative to productivity has increased in importance. Resultingly, the trade between actors—faculty, students, administrators—has shifted more toward a neoliberal paradigm, which "seeks to economize social spheres governed by other values (i.e., liberty, justice, fairness, rule of law, public good, citizenship, etc.) and replace them with market values" (McClure et al., 2019, p 23). A couple of examples of this shift in practice are increases in enrollment and out-of-state student enrollment.[188]

Many of the metric allocations designated in the PIBB embody the changes toward a neoliberal paradigm. In the design of metrics, the former provost had noted that the high number initially collected demonstrated the plurality of Virginia Tech. However, of the 298 first collected, only eight have been implemented in the 2019-2020 fiscal year. While communication from the Office of Budget Management state that more metrics will be included in future fiscal years, the reduced quantity may have a conforming effect across

---

[188] The total enrollment revenue totaled 73% of the total university division revenue sources educational and general program in 2018-19. The general fund made up most of the remainder at 21%, which is tied to state investments. University Document: 2018-2019 University Authorized Budget Document.

academic units. These fewer points of measurement reflect former Total Quality Management (TQM) philosophies, which is a predecessor of the incentive-based budget model. In TQM, management emphasized 'sameness' and sought to reduce variation as a way to improve quality. Arguments against this management philosophy highlighted its "ideology of quality that is conservative as exclusionary and reinforces established forms of power and authority" (Bensimon, 1995, p. 605). With the PIBB communication, upper administration emphasizes the autonomy given to academic units as they set their own performance targets. However, if only a few metrics are used across the university, the underlying philosophy directing colleges will be that of TQM, in which the incentive will be to reduce variation regarding what is rewarded rather than to value plurality as the former provost had intended.

Enrollment growth is one of the most highly rewarded metrics put forth by the PIBB. The PIBB, transdisciplinary initiative, and strategic planning documents all state growth as a central theme. However, the resulting increase in class sizes as incentivized by the SCH unit allocations in the PIBB can affect student learning in good and bad ways. According to Tuchman's case-study of increasing class sizes, the faculty instructors had to adapt their assessment practices to keep up with the higher volume of students. Problems that included writing or in-depth problem solving "were too labor-intensive to assure that grades would be ready in time for graduation." Without funding "for more teaching assistants to grade papers, the kind of final exam questions" had to change (Tuchman, 2009, p. 124). Additionally, in larger class sizes, students realize their anonymity and are "more likely to cut classes" (2009, p. 224). In an organizational environment that values a high SCH to FTE ratio, interdisciplinary co-teaching models also become increasingly

challenging to sustain, which can make it more difficult for students to "achieve a sense of the critical limitations of a given disciplinary approach" (Skorton & Bear, 2018, p. 100).

For administrators, university growth does not come without increased efficiency. To this end, the curriculum development goals of the transdisciplinary initiative become constrained to single instructor courses or co-taught courses that enroll enough students to buy another instructor's teaching load. From a technical standpoint, co-taught courses are split up by percentage FTE for each faculty instructor.

> *"It's there in the system. They are on an accounting spreadsheet. I could say, split it this way. What's difficult is, what if, from a departmental perspective, when a faculty member is teaching the course, whether it's 75% on a budget sheet or 50% on a budget sheet. In actuality, it's 100% that they need credit from their home department. And so that's where there are challenges in getting department heads to release faculty members' time to be able to do that when departments have their own load that they don't address at 100% level. The easy part is all the budget sheet. To say it's 25% here, and 75% here, the money goes this way. It's a lot more challenging to make that value proposition to a department head."[189]*

The challenge for faculty who want to design and co-teach interdisciplinary courses seems to be in asking department heads to release instructional time, but in actuality, the department head is responding to the financial system imposed by upper administration. In many instances, faculty and institute actors bypass these overarching university

---

[189] Interview, Acting Vice Provost, Office of Transdisciplinary Initiatives, Fall 2019

structures with small grants that buy out faculty teaching time. But these minor fixes are symptomatic solutions to systemic structures that value efficiency. As C. Wright Mills put it, "*Caught in the everyday milieux of their ordinary lives, ordinary men often cannot reason about the great social structures—rational and irrational—of which their milieux are subordinate parts. Accordingly, they often carry out series of apparently rational actions without any idea of the ends they serve*" (quoted in Morrill, 1995, p. 217). The continued grant-finding efforts only serve to perpetuate the structural incongruities that value teaching efficiency over teaching models that are more costly according to the metrics designed and imposed by upper administration.

6.1d Applicability: So where are we with interdisciplinary course design?

The two examples of interdisciplinary course development detail the paths each faculty team took to overcome institutional hurdles. The faculty team to develop the first interdisciplinary course navigated and adapted to institutional structures before any of the three initiatives. They used the institute to connect with faculty and guest lecturers, a physical classroom space, as well as the time of several former instructors working at the institute. In addition, the faculty team used connections with the Honors College to provide a course registration number.

The faculty team at the helm of the second interdisciplinary course also faced challenges. Even though they developed the course explicitly because of the transdisciplinary initiative, the faculty team still had to overcome institutional hurdles to teach and receive credit for the course. Again, this process required the support of various faculty, staff, and administrators to ensure that this course became a reality. From acquiring department head buy-in for each instructor to bringing in a vice provost help restructure

the CRNs to allot full teaching credit, the faculty team overcame multiple challenges that preceded any student interaction. Amid the new transdisciplinary initiative and incentive-based budget structure that rewards transdisciplinarity, the faculty team had to seek out additional supports in the form of internal grants from the IGE program and external state grants targeting 'innovative curricula' to design and teach the course. Notably, the faculty developing the second interdisciplinary course sought out these financial supports through the aid of staff from the Office of Transdisciplinary Initiatives and the IGE Office.

The barrage of top-down university initiatives still fell short of the practical, institutional challenges that faculty from different disciplines face in developing interdisciplinary curricula. The stability of structures that govern curriculum development remains, with Registrar's Office staff referring to the second course as "an exception" that would likely not be repeated. In this university system, there is a clear disconnect between the overarching initiatives and goals at the higher levels of administration and the practical feasibility of designing and sustaining an interdisciplinary course.

6.1e Power and Diffusion: Internal and External Exchanges at the University

When we think about the organizational structure of a university, the organizational charts presented on university websites tell only a small story. This story leaves out the complexity of the university's power dynamics internal and external to the organization by presenting a simplified hierarchical ranking according to formal ranks (Hammond, 2002). The societal, economic, and political context in which the university resides pressures the internal exchanges. The internal exchanges are increasingly external exchanges. In the second example of interdisciplinary course development, the faculty involved discuss the challenge of creating a new degree program because of regional accreditation. On the one

hand, university rhetoric states that many of the jobs students will have, have not been developed yet, but on the other hand, future-focused degree programs are unable to pass through the state council because they lack current job prospects.[190]

Accreditation

If the university seeks to develop curricula that is market-oriented to attract students, it must contend with hurdles like state accreditation. The curriculum is subject to an increasing number of influences pushed by various stakeholders who can enact change—or trade—with different academic currencies. Depending on the discipline(s) the curriculum spans, the stakeholders may differ slightly, but overall, trades on the curriculum happen in a complex political web that is seemingly governed by everyone and no one at the same time. In effect, the curriculum is under the influence of the same laissez-faire form of governance that Adam Smith's Wealth of Nations put forth. In which, the "invisible hand of the market" dictates who rises and falls within academia as it does within classical liberal economics, also discussed as neoliberalism.

However, even as state subsidies decrease each year, the Department of Education still maintains "power over how institutions of higher education teach students" (Tuchman, 2009, p. 143). This power is imposed through accreditation agencies. In the US, there are six large regional accreditation agencies, as well as several smaller ones. Each college and university is a member of the agencies that accredit them. The Department of Education gives these accreditation agencies the power of "determining whether a particular

---

[190] Interview, Staff, Office of Transdisciplinary Initiatives, Fall 2019

institution meets standards that qualify its students to receive federal loans and grants" (Tuchman, 2009, p. 143). Consequently, if a university did not meet the standards by its accreditation agency, then the students of this institution "would not be permitted to receive federal loans and grants to attend" (Tuchman, 2009, p. 143). Through these ties, the university curriculum is still under the control of government accreditation as financial support wanes.

Engineering accreditation

Accreditation also extends to disciplines. In engineering, ABET, the Accreditation Board for Engineering and Technology, serves as the mechanism to shape what students learn. Similar to regional accreditation agencies, ABET also carries the weight of the government in permitting federal loans to students. In the late 1990s, ABET officially relinquished its control of the classroom when it moved from the input to outcomes model of engineering degree accreditation. ABET shifted this responsibility to engineering departments by asking them to develop an "outcome-based" approach in curriculum development (ABET, 2014; Prados, Peterson, & Lattuca, 2005).

This development in accreditation marked the most recent development in the engineering curriculum at large. The long-held tradition of a four-year engineering degree was not as stringent as the engineering curriculum became subject to curricular additions.

> "*All the forces that are pulling engineering in different directions—toward science, toward the market, toward design, toward systems, toward socialization—add logs to the curricular jam. The most obvious symptom of the identity crisis of engineering is the crisis in engineering education*" (Williams, 2003, p. 70).

Williams describes several difficulties within MIT's engineering degree requirements that are common at Virginia Tech. In what she refers to as "the great compromise," the engineering degree is a contentious negotiation among an increasing number of stakeholders:

> *"Already, with the increasing pressure from science on one side and from humanities, arts, social sciences, and management of the other, engineering departments find their share of the curriculum in a vise at a time when they have more and more that they want to teach. It is, roughly speaking, the curricular equivalent of Moore's Law: every 18 months the amount of information one would like to cram into the head of a student doubles*" (Williams, 2003, p. 72).

In addition to the disciplinary pressures, industry presents another stakeholder of the engineering curriculum. Especially, given the fact that engineering is one of the few remaining higher education degrees that can employ graduates with high salaries. Most other degrees would require an advanced degree or additional certification to reach similar salaries.

As industry adapts to a changing social, political, and economic environment, its needs for employees change as well. Some companies have voiced the need for more interdisciplinary education for engineers directly as they have identified the need in their own industry.[191] However, the case of adding interdisciplinary education to an engineering

---

[191] University News, Boeing Professional cited in Calhoun Program News, 2019

student's degree sheet can pose just as many challenges as other critical skills that have been deemed vital by different stakeholders.

In the case of the second interdisciplinary course, one of the faculty members commented on the difference between degree requirements and how that may pose challenges in drawing in students from engineering.

"It turns out that engineers do not have as much curricular flexibility as political science students.[192] *The political science students have massively free compared lists of courses that they can draw and a large pool of electives and turns out,* [Business Information Technology] *in the business school and engineering both have way fewer options for extra credit that you can take that contribute to degree. They're all basically mandated elective classes, or you have to take a core competency degree. And so that's still something we're trying to figure out how it plays out in practice, because the realities of that at the program major level, basically, political science students might take [our] minor track, but it's unlikely that the [engineering] students will have enough time to realistically take these tracks, so you're going to have a bit of a mismatch."*

Students are a stakeholder of their curriculum, but for some degree programs, the lack of flexibility diminishes their power with curricular choice. Engineering, with its stricter and higher number of course requirements maintains a sense of curricular autonomy in the larger university curricular environment. Curricular trade in engineering comes at a

---

[192] Also note that in referring to engineering students, the social science professor calls them engineers, but in referencing political science students, he calls them as such. This is common across many universities but is especially relevant at an institution with a heavy polytechnic identity.

higher cost for students—in terms of time and money—and for faculty—in terms of time and other promotion and tenure currencies.

Students as stakeholders in academic trade

En masse, students hold power through their choice of degree programs. In this sense, the student-as-consumer model holds where students will pay to enroll in specific degree programs. The proverbial ivory tower as the university is always entered by the outside world "in the form of new students, who turn over much more rapidly than do faculty members" (Williams, 2002, p. 58). The university can respond to student choices by increasing the capacity of these programs to hold more students. However, student choices are influenced by external forces as well. Market forces that dictate the employability of a major will affect the types of majors that are more popular than others. Agreements with state politicians or industries can also affect the growth of specific majors. Finally, the most high-achieving students—the ones who as alumni will promote the university's brand and bankroll—will enroll in a degree program and select a university that places students in desirable jobs. In this frame, students are the commodity who obtain degrees pushed by state or industry funds. These students then work in the discipline and contribute to the regional economy or find employment in the industry that funded their major.[193] In these examples, the interdisciplinary initiatives translate into market-driven behaviors that universities engage in to graduate students as well as market-driven

---

[193] News source, Inside Higher Ed, 11/8/2019

behaviors by students in choosing which major will give them access to upward social mobility.

Ultimately, time plays a vital role across the study of initiatives at the university level and in the experience of actors. As events unfold, different actors and organizations negotiate and translate university-imposed types of trade into related but distinct practices. The consequent diversity of disciplines and their forms of translation makes the work of administrators more difficult as there is more negotiation required in trade. In some ways, the intentions of transdisciplinarity might be another form of imposed uniformity that seeks to bring departments together in ways that are easier for administration to surveil and control.

6.2 Summary

The five principles of trading zones shed light on the complexity inherent in engaging in trade at a university of varying institutional hierarchy. Through the focus on the two interdisciplinary course design, the malleability of university policies and initiatives come to light. However, this malleability is a form of trade that requires local coordination by the actors at the boundaries of the academic units. In the case of the two courses, their sustainability depends on whether the actors developing the course can systematically restructure the institution's mode of trade or if they will have to continuously devise bypasses that keep funding the course.

The sustainability of interdisciplinary activity from the view of administrators and institutional actors is denoted by different currencies and power structures than that for the faculty. The evolution of the budget model provides these structures. When taking the university as its own actor engaging in trade with its external socio, political, and economic

entities, the types of trades at these levels are shown to conflict with the types of trades sought after by the faculty and staff who design interdisciplinary courses. In a space of multiple and overlapping trading zones, there can be a tendency to focus on one trading zone from the perspective of single actors who operate with currencies that only apply to in that zone. With the inclusion of multiple overlapping trading zones in the analysis, this study provides an encompassing view of the different systems that exist for different actors and how they all fit together. The use of the trading zones framework brings to light the layered translation and negotiation to make sense of the structures that last over time.

Chapter 7 – Implications, Future Work, and Final Conclusions

7.1 Implications for Interdisciplinary Coordination

The context in which interdisciplinarity is conducted is important for the longevity and sustainability of an egalitarian collaboration. Science and Engineering have become heavily resourced fields in large part due to the Cold War era federal funding boom and their potential to produce technological innovation (Leahey & Barringer, 2020). But as different sources of funding become more prevalent, there is an opportunity to bring other disciplines into a more equitable role in the curriculum and in collaborative research.

University-level initiatives are translated differently through the multiple layers of the institution. In addition, they take on the cultural characteristics of the university they are enacted within. In the case of Virginia Tech, its existing engineering identity coupled with external resources that reinforce its power carried into each of the three initiatives, more visibly with the transdisciplinary initiative and PIBB. The power dynamics across disciplinary cultures is a necessary feature of university contexts that needs to be acknowledged if the university-level initiatives seek to create egalitarian spaces for interdisciplinary collaboration. In this case, the "vast global differences" of traders in Galison's trading zone framework, carried into the "local coordination" of the transdisciplinary initiative (1997, p. 138).

7.2 Implications for Engineering Education

The field of engineering education first emerged as a practitioner field. In the first few decades of the Journal of Engineering Education articles, engineering professors published descriptive and evaluative articles of engineering curricula (Beddoes, 2012). Today, the journal publishes more systematically research-oriented articles to produce

"rigorous research" (Jamieson & Lohmann, 2009). However, as engineering education grew as a distinct body of research, the implementation of its scholarly research to practice faced challenges (Finelli, Daly, & Richardson, 2014). Henderson and Dancy pointed out that engineering faculty are even aware of research-based evidence but are slow to implement practices because of structural constraints (2007, 2011). At the challenge of scholars outside of the discipline, scholars in engineering education have been pushed to "expand the analytical lens from primarily viewing students and curricula to include organizations, vested interests, and the accretion of decades of competing initiatives that structure current reform efforts" (Wisnioski, 2015).

This dissertation takes a broad view of interdisciplinary curriculum design to understand the interrelated and competing initiatives that exist for faculty and staff as they negotiate and translate university initiatives to pursue course development. In so doing, the findings contextualize the pedagogies studied in Scholarship of Teaching and Learning and Engineering Education literature amid the university context. For instance, as universities continue to incentivize large class sizes because of revenue instability, the research that shows the benefit of small class sizes in student learning will be more difficult to bring to practice. Similarly, the research that shows merit for co-teaching models composed of multidisciplinary faculty members will also require a more comprehensive understanding if it is to impact practice. In the efforts to bring research to practice, this dissertation supplements literature on pedagogical reform by shedding light on the institutional structures that these pedagogies must sustainably disrupt or incorporate into the reform. Without the situational awareness of pedagogical reforms, we risk alienating scholarship from practice altogether.

7.3 Future Research

Much of this research has omitted the perspectives of a key stakeholder of the curriculum, students. Future research will build on understanding of the university-level initiatives by bringing in the student perspective to supplement the practices of other university actors. Students play a vital role in the design of interdisciplinary curriculum, for instructors will make changes based on student response during the semester as well as in future iterations of the course. Additionally, understanding student choice is another key element to bring into this study as it affects the longevity of courses as well as whether to expand enrollment. Many of the choices the second faculty team made were based on projections of student choice and need, speaking of the course as a 'gateway' to draw students to the next sequence of courses. The next steps for this research will be to investigate the behaviors of students as they make decisions on whether to enroll in courses as well as the impact of the interdisciplinary co-teaching model on their perceptions of their learning.

However, the main driver for this research project has been to understand the context in which faculty negotiate and translate university-level goals to their curriculum design pursuits. In some cases, these pursuits have led to sustained curriculum development and in others have been fleeting as faculty have found more rewarding endeavors. In this study, the faculty have shown a great interest in translating their versions of interdisciplinarity into a curricular space and have bypassed barriers to do so. Notably, the two courses that were examined are both electives classes that do not adhere to in-major or accreditation requirements. Thus, what is the process for interdisciplinary courses that are pursued in a single department? Do they become relegated to a special topics course at the

graduate school only to be taught twice or are there cases in which these courses become permanent fixtures of the curriculum to then lead to minors or second majors?

The next steps of this study will be to focus on courses or sequences of courses that exist within a department but bring in outside disciplinary expertise. There are cases in which curricular tracks have become institutionalized like in human factors engineering or human computer interaction, but what were the interrelated factors that sustained them? Additionally, future research will examine the societal, political, and economic differences across contexts to understand how some geographic locations have developed permanent curricular tracks and others have not. This example is especially relevant in thecase of sustainability in which many western European universities have begun integrating sustainability learning objectives into their curricula.

7.4 Final Conclusions

Overall, the structure of a university is consistent with overlapping trading zones, each with different motives but seemingly unified through the process of curriculum development. Curriculum development is an inherently cross-disciplinary endeavor that involves faculty representatives from across the university at least in the layered approval process. Still, processes of institutionalizing interdisciplinary courses fall outside established department and college zones, where boundaries that are reinforced by history, revenue streams, and reward structures must be navigated.

In the two examples of interdisciplinary course development presented in this study, the processes depended on the individual faculty and the academic organizations they worked across. The process was inherently faculty-driven. Yet, the overarching institutional structures were malleable in the short term for one case and in another case

dictated the adaptations that a course underwent to maintain survival. The analysis of these two processes sheds light on how faculty and staff engage with the policies and initiatives at the institution and the ways they use interdisciplinary course development to negotiate and adapt abstract initiatives into practice.

Many high-level initiatives that purport transdisciplinarity and integrative education are misaligned with the structures at the department level and the faculty rank level. The findings show the importance of institutional buy-in and support at the practical levels of course development rather than letting faculty and staff figure out the details through service work that does not benefit their own careers. Seemingly, this experiential learning that faculty undergo time and time again would make them well-positioned to inform high-level initiatives and structural developments. Instead, mid-level administrative entities like the Registrar's Office, Office of Integrated General Education, and Transdisciplinary Initiative Office have created systems to connect faculty who engage in the initiatives. These middle entities have used networking, community building, and mentorship models in their curriculum trade to help faculty learn from each other's experience in navigating the misaligned institutional structures. Notably, many of the staff who work in these offices do not hold the institutional power that comes with a tenured faculty role nor that of upper-level administration. They are the emergent scaffold built to carry the weight of top-down initiatives. This practice is more of an adaptation to the system at large rather than a proactive measure that facilitates large-scale initiatives.

At the upper levels, administrators acknowledge that the underlying platform they developed provides incentives for entities engaged in curricular trade. With the ability to adjust the environment on which trade takes place, these administrators can control and

surveil the platform in which entities engage in trade. For small adjustments, this type of large-scale strategy is possible, but when manipulations of the platform become more conspicuous, they can lead to a pervasive lack of trust among the entities engaging in trade.

The initiatives in the study were adapted into different change efforts at the local level or they cease to exist altogether. The national shift in revenue streams (student tuition) has pushed many public state universities toward a vision of growth. However, with growth the implementation of large-scale initiatives becomes more complex as additional initiatives increase the likelihood of competition between them. The focus on increasing revenue through enrollment growth has become a staple of the neoliberal university— initially touted as a way to improve efficiency and provide transparency in the public sector, increased dependence on tuition has since devolved to metrics like semester credit hours and faculty full-time equivalence. These incongruent targets shift university motives away from difficult to measure values like student learning and faculty motivation.

In any policy decision there are winners and losers. At the university, this environment defines the types of currencies that are permitted—e.g. sponsored research, enrollment metrics—and the policies that reward specific actions—e.g. growth, attracting out-of-state students. In the context of rewarding increased enrollment and more student credit hours per faculty teaching equivalent, the intention for growth is made explicit by upper administrators. But these intentions are not as corporate as one might initially conclude. The external market forces and state divestment of funds require the university to rely on different types of revenue. Competition for students has increased while state investments in the university have decreased. The university, as an establishment, has undergone several reformations since its early inception in the 1600s. Now both "church

and car dealer," the university expands its roles to maintain its relevance and use in society. As society has gone through different political and economic reformations, the university has followed.

Each policy affects how trade at the university will be conducted. We have seen that in the short term, faculty can adapt to policies through external and internal grants, but faculty who have used these to bypass policy note the difficulty of sustaining this work alongside commitments to teaching. Navigating institutional structures also depends on who the faculty team comprises. Depending on the level and discipline, actors engaging in curricular trade will have different options available to them. These efforts often do not offer much in the way of currency toward promotion and tenure, thus vulnerable faculty populations may have a harder time sustaining these practices. In the case of the second interdisciplinary course development, we saw that the faculty team had assistance from the vice provost from student affairs as well as a research faculty member whose partial position was to help the team navigate the institutional processes. Even still, one of the co-teachers noted that he would step down in the following year.

The answer lies in faculty autonomy. Autonomy is a cultural expectation of faculty identity. The popular metaphor of herding cats that has been used to describe faculty may be a parody but is rooted in the notion of faculty autonomy. When we reflect on the term 'faculty-driven' that remained prevalent through the findings and took on many uses, there is still a truth to this phrase, even though it was largely used to convey the opposite. The challenges the high-level administrators faced in implementing the transdisciplinary initiative and the new budget model as quickly and comprehensively as had been initially proposed were due to major faculty resistance, as documented heavily in the faculty senate

meeting notes. Even though faculty operate in an individualized manner to further their academic careers, together they hold power in driving or preventing many initiatives that leaders attempt to impose on the university.

To this I note the need to be critical of the metrics that accompany new initiatives. From an individual standpoint, it can be difficult to see their long-term implications on the university. Additionally, there is a need to interrogate the proposed intentions of initiatives as they become practice, for there are often discrepancies between the two. Lastly, when faculty are able to see university initiatives through its multiple modes of operation in different institutional layers that extends beyond their individual dossier and departmental politics, they can bring an interrelated understanding of long-term implications into their own practice. This understanding is crucial to keep the faculty perspective and voice present in the large-scale university initiatives that have become prevalent across the nation.

REFERENCES

Abbott, A. (2001). Chaos of disciplines. University of Chicago Press.

ABET. (2014). Criteria for accrediting engineering programs: Effective for reviews during the 2015-2016 accreditation cycle. Accreditation Board for Engineering and Technology - Engineering Accreditation Commission. Retrieved from http://www.abet.org/accreditation/

Akera, A. (2017). Setting the Standards for Engineering Education: A History. Proceedings of the IEEE - Scanning Our Past, 105(9), 1834–1843.

Akera, A., & Seely, B. E. (2015). A historical survey of the structural changes in the American system of engineering education. In International Perspectives on Engineering Education (pp. 7–32). Springer.

Altbach, P. G., Gumport, P. J., Johnstone, D. B., & Johnstone, D. B. J. (2001). In defense of American higher education. Baltimore, MD: Johns Hopkins University Press.

Altheide, D., Coyle, M., DeVriese, K., & Schneider, C. (2008). Emergent qualitative document analysis. Handbook of Emergent Methods, 127–151.

Austin, J. L. (1975). How to do things with words. In How to do things with words (Vol. 88). Oxford University Press.

Barisonzi, J., & Thorn, M. (2003). Teaching Revolution: Issues in Interdisciplinary Education. College Teaching, 51(1), 5–8. https://doi.org/10.1080/87567550309596402

Beddoes, K. D. (2012). Feminist Scholarship in Engineering Education: Challenges and Tensions. Engineering Studies, 4(3), 205–232. https://doi.org/10.1080/19378629.2012.693932

Bensimon, E. M. (1995). Total quality management in the academy: A rebellious reading. Harvard Educational Review, 65(4), 593–612.

Blewett, P. (1993). Introducing Breadth and Depth in the Humanities and Social Sciences

into an Engineering Student's General Education Curriculum. Journal of Engineering Education, 82(3), 175–180. https://doi.org/10.1002/j.2168-9830.1993.tb00098.x

Boix Mansilla, V., Miller, W. C., & Gardner, H. (2000). On disciplinary lenses and interdisciplinary work. Interdisciplinary Curriculum: Challenges to Implementation, 17–38.

Borgmann, C. W. (1964). The Ford Foundations's Role in Engineering Education. Ford Foundation.

Brainard, J. (2002). US Agencies Look to Interdisciplinary Science. Chronicle of Higher Education, 48(40), A20–A20.

Brint, S. G. (2005). Creating the future: "New directions" in American research universities. Minerva, 43(1), 23–50. https://doi.org/10.1007/s11024-004-6620-4

Brint, S. G., Turk-Bicakci, L., Proctor, K., & Murphy, S. P. (2008). Expanding the social frame of knowledge: Interdisciplinary, degree-granting fields in american colleges and universities, 1975-2000. Review of Higher Education, 32(2), 155–183. https://doi.org/10.1353/rhe.0.0042

Brown, W. (2015). Undoing the demos: Neoliberalism's stealth revolution. Mit Press.

Bucciarelli, L. L., & Drew, D. E. (2015). Liberal studies in engineering – a design plan. Engineering Studies, 7(2–3), 103–122. https://doi.org/10.1080/19378629.2015.1077253

Casey, B. A. (2010). Administering interdisciplinary programs. The Oxford Handbook of Interdisciplinarity, 345–359.

Chi, M., VanLehn, K., Litman, D., & Jordan, P. (2011). Empirically evaluating the application of reinforcement learning to the induction of effective and adaptive pedagogical strategies. User Modeling and User-Adapted Interaction, 21(1–2), 137–180.

Chrisman, N. (1999). Trading zones or boundary objects: Understanding incomplete

translations of technical expertise. 4S Meetings, San Diego.

Claris, L., & Riley, D. (2012). Situation critical: Critical theory and critical thinking in engineering education. Engineering Studies, 4(2), 101–120. https://doi.org/10.1080/19378629.2011.649920

Clark, B. R. (1998). Creating entrepreneurial universities: Organizational pathways of transformation. Issues in higher education. ERIC.

Cohen-Cole, J. (2014). *The Open Mind: Cold War Politics and the Sciences of Human Nature*. University of Chicago Press.

Cooke, M. L. (1910). Academic and industrial efficiency: A report to the Carnegie Foundation for the Advancement of Teaching. Merrymount Press.

Csikszentmihalyi, M. (1996). Creativity: flow and the psychology of discovery and invention (1st ed.). New York: HarperCollinsPublishers.

DiMaggio, P. J., & Powell, W. W. (1983). The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields. American Sociological Review, 48(2), 147–160. Retrieved from http://www.jstor.org/stable/2095101

Donald, J. G. (2002). Learning To Think: Disciplinary Perspectives. The Jossey-Bass Higher and Adult Education Series. ERIC.

Douglass Klein, J., Traver, C., Raucci, S., & Jones, S. A. (2009). Special session - Inventive courses: Blending engineering and the liberal arts. Proceedings - Frontiers in Education Conference, FIE, (March 2015), 3–5. https://doi.org/10.1109/FIE.2009.5350505

Downey, G. L. (2012). The local engineer: Normative holism in engineering formation. In Engineering, development and philosophy (pp. 233–251). Springer.

Drezek, K. M., Doolittle, P. E., Brandt, C. B., Fowler, S. B., & Wildman, T. M. (2008). The Intellectual Impact of Interdisciplinarity: A Series of Studies of Graduate Students and Faculty Engaged in Interdisciplinary Scholarship.

Eckel, P. D., & Kezar, A. J. (2003). Taking the reins: Institutional transformation in higher education. Greenwood Publishing Group.

Faulkner, W. (2007). "Nuts and Bolts and People": Gender-troubled engineering identities. Social Studies of Science, 37(3), 331–356. https://doi.org/10.1177/0306312706072175

Finelli, C. J., Daly, S. R., & Richardson, K. M. (2014). Bridging the Research-to-Practice Gap : Designing an Institutional Change Plan Using Local Evidence. 103(2), 331–361. https://doi.org/10.1002/jee.20042

Flyvberg, B. (2001). Making Social Science Matter. https://doi.org/10.1017/CBO9781107415324.004

Foley, W. A. (1988). Language birth: the processes of pidginization and creolization. Linguistics: The Cambridge Survey, 4, 162–183.

Foucault, M. (1980). Power/knowledge: Selected interviews and other writings, 1972-1977. Pantheon.

Frost, S. H. (2005). Overcoming obstacles to interdisciplinary research. Academic Leader, 21(5), 1–8.

Funtowicz, S. O., & Ravetz, J. R. (1993). The emergence of post-normal science. In Science, politics and morality (pp. 85–123). Springer.

Galison, P. (1997a). Image and logic: A material culture of microphysics. University of Chicago Press.

Galison, P. (1997b). Trading with the Enemy. In M. E. Gorman (Ed.), Trading Zones and Interactional Expertise: Creating New Kinds of Collaboratoin. Cambridge, MA: The MIT Press.

Galison, P. (1999). Trading Zone: Coordinating Action and Belief. In M. Biagioli (Ed.), The Science Studies Reader (Vol. 16, pp. 137–160). Routledge.

Geiger, R. L. (2006). The ten generations of American higher education. Peking University Education Review, 2.

Gillette, D. D., Lowham, E., & Haungs, M. (2014). When the Hurly-Burly's Done, of Battles Lost and Won: How a Hybrid Program of Study Emerged from the Toil and Trouble of Stirring Liberal Arts into an Engineering Cauldron at a Public Polytechnic. Engineering Studies, 6(2), 108–129. https://doi.org/10.1080/19378629.2014.944186

Golafshani, N. (2003). Understanding reliability and validity in qualitative research. The Qualitative Report, 8(4), 597–607. https://doi.org/10.3367/UFNr.0180.201012c.1305

Gorman, M. E. (2010). Trading Zones and Interactional Expertise: Creating New Kinds of Collaboration. https://doi.org/10.1103/PhysRevLett.79.2332

Graham, R. (2018). The Global State of the Art in Engineering Education. Cambridge, MA.

Gumport, P. J. (2000). Academic restructuring: Organizational change and institutional imperatives. Higher Education, 39(1), 67–91.

Hammond, T. H. (2002). Herding Cats in University Hierarchies: The Impact of Formal Structure on Decision-Making in American Research Universities*. Governance in Higher Education.

Hannan, M. T., & Freeman, J. (1977). The population ecology of organizations. American Journal of Sociology, 82(5), 929–964.

Hannan, M. T., & Freeman, J. (1989). Organizational ecology. Harvard university press.

Hearn, J. C., Lewis, D. R., Kallsen, L., Holdsworth, J. M., & Jones, L. M. (2006). "Incentives for Managed Growth": A Case Study of Incentives-Based Planning and Budgeting in a Large Public Research University. The Journal of Higher Education, 77(2), 286–316. https://doi.org/10.1080/00221546.2006.11778927

Henderson, C., & Dancy, M. H. (2007). Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics. Physical Review Special Topics - Physics Education Research, 3(2), 1–14. https://doi.org/10.1103/PhysRevSTPER.3.020102

Henderson, C., & Dancy, M. H. (2011). Increasing the impact and diffusion of STEM education innovations. Invited Paper for the National Academy of Engineering, Center for the Advancement of Engineering Education Forum, Impact and Diffusion of Transformative Engineering Education Innovations, Available at: Http://Www. Nae. Edu/File. Aspx.

Holley, K. A. (2009). Interdisciplinary strategies as transformative change in higher education. Innovative Higher Education, 34(5), 331–344. https://doi.org/10.1007/s10755-009-9121-4

Interdisciplinary training for undergraduates in biological and mathematical sciences: Program solicitation. (2004). Retrieved from National Science Foundation website: http://www.nsf.gov/pubs/2004/nsf04546/nsf04546.htm

Jacobs, J. A. (2014). In defense of disciplines: Interdisciplinarity and Specialization in the Research. In The University of Chicago Press. Chicago and London.

Jamieson, L. H., & Lohmann, J. R. (2009). Creating a culture for scholarly and systematic innovation in engineering education: Ensuring US engineering has the right people with the right talent for a global society. Washington, DC: American Society for Engineering Education.

Jesiek, B. K., & Jamieson, L. H. (2017). The Expansive (Dis)Integration of Electrical Engineering Education. IEEE Access, 5, 4561–4573. https://doi.org/10.1109/ACCESS.2017.2677200

Kezar, A. (2012). Embracing non-tenure track faculty: Changing campuses for the new faculty majority. New York: Routledge.

Kezar, A., Eckel, P. D., The, S., Education, H., Aug, N. J., Taylor, P., & Kezar, A. (2019). Meeting Today ’ s Governance Challenges : A Synthesis of the Literature and Examination of a Future Agenda for Scholarship Meeting Today ’ s Governance Challenges. 75(4), 371–399.

Klein, J. T. (1990). Interdisciplinarity: History, theory, and practice. Wayne state university press.

Klein, J. T. (2006). A platform for a shared discourse of interdisciplinary education.

Klein, J. T. (2010). A taxonomy of interdisciplinarity. The Oxford Handbook of Interdisciplinarity, 15, 15–30.

Klein, Klein, J., & Julie. (2005). Humanities, Culture, and Interdisciplinarity. 1–279.

Knepler, H. (1973). Engineering education and the humanities in america. Leonardo, 305–309.

Kuhn, T. S. (1962). The structure of scientific revolutions. University of Chicago press.

Lang, D. (1999). A primer on responsibility centre budgeting and responsibility centre management [RCB, RCM]. CSSHE Professional File, (17), 1.

Latour, B. (2005). Reassembling the social—An introduction to actor network theory. In Management Learning. Oxford University Press.

Lattuca, L. R. (2001). Considering Interdisciplinarity. In Creating Interdisciplinarity (pp. 1–22). Vanderbuilt University Press.

Leahey, E., & Barringer, S. N. (2020). Universities' commitment to interdisciplinary research: To what end? Research Policy, 49(2). https://doi.org/10.1016/j.respol.2019.103910

Leslie, S. W. (1987). Playing the Education Game to Win: The Military and Interdisciplinary Research at Stanford. Historical Studies in the Physical and Biological Sciences, 18(1), 55–88. Retrieved from https://www.jstor.org/stable/27757596

Loui, M. C. (2005). Ethics and the Development of Professional. Journal of Engineering Education, (October).

Martin, J. L. (2017). Thinking Through Methods: A Social Science Primer. University of Chicago Press.

Martin, T., Coupey, E., McNair, L. D., Dorsa, E., Forsyth, J., Kim, S., & Kemnitzer, R. (2012). An Interdisciplinary Design Course for Pervasive Computing. IEEE Pervasive Computing, 11(1), 80–83. https://doi.org/10.1109/MPRV.2012.2

Massy, W. (1996). Resource allocation in higher education. University of Michigan Press.

Mathison, S. (1988). Why triangulate? Educational Researcher, 17(2), 13–17.

McNair, L D, Baum, L., & Mouchrek, N. (2016). Collaborative teaching: Exploring reflective practice to address uncertainty avoidance. 2016 IEEE Frontiers in Education Conference (FIE), 1–4. https://doi.org/10.1109/FIE.2016.7757616

McNair, Lisa D., Davitt, M., & Batten, G. P. (2015). Outside the 'comfort zone': impacts of interdisciplinary research collaboration on research, pedagogy, and disciplinary knowledge production. Engineering Studies, 7(1), 47–79. https://doi.org/10.1080/19378629.2015.1014817

McNair, Lisa D., Newsander, C., Boden, D., & Borrego, M. (2011). Student and faculty interdiscipinary identities in self-managed teams. Journal of Engineering Education, 100(2), 374–396.

McNair, Lisa D., Newswander, C., Boden, D., & Borrego, M. (2011). Student and Faculty Interdisciplinary Identities in Self-Managed Teams. Journal of Engineering Education, 100(2), 374–396. https://doi.org/10.1002/j.2168-9830.2011.tb00018.x

Miles, M., & Huberman, M. (1994). Qualitative data analysis: An expanded sourcebook. sage.

Miles, M., Huberman, M., & Saldana, J. (2014). Fundamentals of Qualitative Data Analysis. In Qualitative Data Analysis - A Methods Sourcebook (3rd ed., pp. 69–103).

Miller, C. A. (2010). Policy challenges and university reform. The Oxford Handbook of Interdisciplinarity, 333, 334.

National Academies Press. (2016). Developing a national STEM workforce strategy: A workshop summary.

National Academy of Engineering. (2005). Educating the Engineer of 2020. https://doi.org/10.17226/11338

National Institutes of Health. (2006). Summary of the President's FY 2006 budget. In National Institutes of Health. Washington, DC.

National Science Board. (2014). Science and engineering indicators 2014. Arlington, VA.

Newell, W. H., Wentworth, J., & Sebberson, D. (2001). A theory of interdisciplinary studies. Issues in Interdisciplinary Studies.

Noble, D. F. (1979). America by design: Science, technology, and the rise of corporate capitalism. Oxford University Press, USA.

O'Dell, T. (1938). The evolution of the registrar. Peabody Journal of Education, 16(1), 12–20.

Ozkan, D. S., McNair, L. D., & Bairaktarova, D. (2019). Teacher Learner, Learner Teacher: Parallels and Dissonance in an Interdisciplinary Design Education Minor. IEEE Transactions on Education. https://doi.org/10.1109/TE.2019.2901781

Patton, M. Q. (1990). Qualitative evaluation and research methods. SAGE Publications, inc.

Pawley, A. L. (2007). Where do you draw the line: A Study of Academic Engineers Negotiating the Boundaries of Engineering. 229.

Pawley, A. L. (2012). Engineering faculty drawing the line: A taxonomy of boundary work in academic engineering. Engineering Studies, 4(2), 145–169. https://doi.org/10.1080/19378629.2012.687000

Peterson, M. W. (2007). The study of colleges and universities as organizations. Sociology of Higher Education: Contributions and Their Contexts, 147–186.

Popowitz, M., & Dorgelo, C. (2018). University-Led Grand Challenges (UCLA).

Prados, J. W., Peterson, G. D., & Lattuca, L. R. (2005). Quality assurance of engineering education through accreditation: The impact of Engineering Criteria 2000 and its global influence. Journal of Engineering Education, 94(1), 165–184. https://doi.org/10.1002/j.2168-9830.2005.tb00836.x

Priest, D. M., Becker, W., Hossler, D., & John, E. P. S. (2002). Incentive-based

budgeting systems in public universities. Edward Elgar Publishing.

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

Rhoten, D., & Parker, A. (2004). Risks and rewards of an interdisciplinary research path. American Association for the Advancement of Science.

Ricci, D. M. (1984). The tragedy of political science: Politics, scholarship, and democracy. Yale University Press.

Riley, D. M. (2012). Aiding and ABETing: The Bankruptcy of Outcomes-Based Education as a Change Strategy. ASEE Annual Conference & Exposition.

Riley, D. M. (2013). Power. Systems. Engineering. Traveling Lines of Resistance in Academic Institutions BT - Engineering Education for Social Justice: Critical Explorations and Opportunities (J. Lucena, Ed.). https://doi.org/10.1007/978-94-007-6350-0_3

Riley, D. M. (2015). Facepalms and cringes: liberal education misapprehended. Engineering Studies, 7(2–3, SI), 138–141. https://doi.org/10.1080/19378629.2015.1062499

Riley, D. M. (2017). Rigor/Us: Building Boundaries and Disciplining Diversity with Standards of Merit. Engineering Studies, 9(3), 249–265. https://doi.org/10.1080/19378629.2017.1408631

Riley, D. M., Slaton, A. E., & Pawley, A. L. (2014). Social justice and inclusion: Women and minorities in engineering. Handbook of Engineering Education Research, 335–356.

Rosinger, K. O., Taylor, B. J., Coco, L., & Slaughter, S. (2016). Organizational segmentation and the prestige economy: Deprofessionalization in highand low-resource departments. Journal of Higher Education, 87(1), 27–54. https://doi.org/10.1353/jhe.2016.0000

Rudolph, F. (1977). Curriculum. A History of the American Undergraduate Course of Study Since 1636.

Sayer, A. (1992). Method in Social Science: A Realist Approach (2nd ed.). Routledge.

Seely, B. E. (1999). The other re-engineering of engineering education, 1900–1965. Journal of Engineering Education, (July), 285–294. https://doi.org/10.1002/j.2168-9830.1999.tb00449.x

Skorton, D., & Bear, A. (2018). The National Academies Press. https://doi.org/10.17226/24988

Slaton, A. E. (2010). Race, rigor, and selectivity in US engineering: The history of an occupational color line. Harvard University Press.

Slaughter, S., & Rhoades, G. (2004a). Academic Capitalism and the New Economy: Markets, States, and Higher Education. Baltimore, MD: The Johns Hopkins University Press.

Slaughter, S., & Rhoades, G. (2004b). The Academic Capitalist Knowledge/Learning Regime. In Academic Capitalism and the New Economy: Markets, State, and Higher Education (pp. 305–338). Baltimore and London: The Johns Hopkins University Press.

Smith, B. L., & McCann, J. (2001). Reinventing ourselves: Interdisciplinary education, collaborative learning, and experimentation in higher education. ERIC.

Smith, E. D. (1945). Can humanistic-social study be made engineering education. Journal of Engineering Education, 36, 134–138.

Smith, K., Sheppard, S., Johnson, D., & Johnson, R. (2005). Pedagogies of Engagement: Classroom-Based Practices. Journal of Engineering Education, 94(January), 87–101. https://doi.org/10.1002/bmb.20204

Snyder, S. A., Ozkan, D. S., Bairaktarova, D., Staley, T. W., & & Biscotte, S. (2019). Teaching Across Boundaries: Examining the Institutional Process of Establishing Multidisciplinary Courses. ASEE Conference Proceedings.

Sochacka, N. W., Guyotte, K. W., & Walther, J. (2016). Learning Together: A
    Collaborative Autoethnographic Exploration of STEAM (STEM + the Arts)
    Education. Journal of Engineering Education, 105(1), 15–42.
    https://doi.org/10.1002/jee.20112

Stake, R. E. (1995). The art of case study research. Sage.

Star, S. L., & Griesemer, J. R. (1989). Institutional Ecology, "Translations" and
    Boundary Objects: Amateurs and Professionals in Berkeley's Museum of
    Vertebrate Zoology, 1907-39. Social Studies of Science, 19, 387–420.

Stark, J. S., & Lattuca, L. R. (1997). Shaping the college curriculum: Academic plans in
    action.

Stewart, I. R., & Dickason, D. G. (1979). Hard times ahead. American Demographics,
    1(6), 12–17.

Stone, T., Bollard, K., & Harbor, J. M. (2009). Launching Interdisciplinary Programs as
    College Signature Areas: An Example. Innovative Higher Education, 34(5), 321–
    329. https://doi.org/10.1007/s10755-009-9119-y

Suskie, L. (1995). Opportunties to Demonstrate Learning Seven Steps to Fair
    Assessment. Aahe Bulletin, 52(9), 7–9.

Suskie, L. (2008). Understanding the nature and purpose of assessment. In Designing
    better engineering education through assessment (pp. 3–19).

Swoboda, W. W. (1979). Disciplines and interdisciplinarity: A historical perspective.
    Interdisciplinarity and Higher Education, 49–92.

Terman, F. E. (1976). A brief history of electrical engineering education. Proceedings
    IEEE, 4(8), 1399–1406.

Thelin, J. R. (2011). A history of American higher education. JHU Press.

Trompette, P., & Vinck, D. (2009). Revisiting the notion of boundary object. Revenue
    d'anthropoligie Des Connaissances, 3(1), 3–25.

Tuchman, G. (2009). Wannabe U: Inside the corporate university. University of Chicago

Press.

Vanasupa, L., McCormick, K. E., Stefanco, C. J., Herter, R. J., & McDonald, M. (2012). Challenges in Transdisciplinary, Integrated Projects: Reflections on the Case of Faculty Members' Failure to Collaborate. Innovative Higher Education, 37(3), 171–184. https://doi.org/10.1007/s10755-011-9199-3

Wall Street Journal. (2012, December 28). Dean's List: Hiring Spree Fattens College Bureaucracy-and Tuition. Wall Street Journal. Retrieved from http://online.wsj.com/news/articles/SB100014241278873233168045781614907160 42814

Weingart, P. (2010). A short history of knowledge formations. The Oxford Handbook of Interdisciplinarity, 3–14.

Weisbrod, B. A., Ballou, J. P., & Asch, E. D. (2008). Mission and money: Understanding the university. Cambridge University Press.

Williams, R. (2003). Retooling: A historian confronts technological change. MIT Press.

Wisnioski, M. H. (2009). "Liberal Education Has Failed": Reading Like an Engineer in 1960s America. Technology and Culture, 50(4), 753–782. https://doi.org/10.1353/tech.0.0346

Wisnioski, M. H. (2015). What's the Use? History and Engineering Education Research. Journal of Engineering Education, 104(3). https://doi.org/10.1002/jee.20075

APPENDIX A: Interview Protocol

A.1 Faculty Interview Questions:

- Can you tell me a little about your co-taught course?
- How did you come to be involved in it?
  - Follow-up questions that pertain to the previous answer:
    - Who else is involved and what departments are they from?
    - Where did the idea for the course originate?
    - How did you come together as a team?
- Can you talk to me about the students?
  - Which majors do they come from?
  - What years are they in?
- Can you describe some of the activities that you might do with the class?
  - What do you think students are most challenged by?
  - What do you think is the biggest challenge for you?
    - For your faculty team?
- What are some things that you wish you could change for future iterations?
  - How has this course been received by your department?
    - Follow up – in terms of promotion and tenure, institutional support structures
  - Are there support structures for you and your team with this course?
  - What do you see for this course in the future? 2 years, 5 years, 10 years?
- Are there other faculty or administration individuals that you would recommend for me to speak with?

A.2 Administrative Staff Interview Questions:

I'm interested in the course approval process for undergraduate courses. I've outlined based on the course approval package document on how the process works but was hoping to ask you a few questions to better understand how the process works on the ground.

- At what stage do you usually become involved in someone's course approval package?
  - Is this late or early for you? What would be your preference for when people request help?
- I'm specifically interested in cross-listed or co-taught courses from faculty in different departments.
  - Can you talk to me about how this differs from courses with a single instructor with it listed in one department?
  - Are there any example courses like this that you can point to?
    - What were the most challenging parts in getting these courses approved?

- What elements of the process helped faculty get these courses approved? Like any resources that they could tap into?
- How common is it for faculty to go about this route?
  - Are there any commonality among the co-taught or cross listed courses that stand out to you? Can you elaborate on why this may be?
- If you could tweak the system, what are some things you would add or remove in the course approval process?
  - Why or why not?
- Are there other faculty or administration individuals that you would recommend for me to speak with?
  -