Political Context

The political context of our project plays a significant role in assessing the feasibility and effectiveness of a re-imagined engineering curriculum at Lafayette College. This research mainly focuses on analyzing studies from academic articles, policies, and regulations. It is divided into two overarching scopes: the national perspective and Lafayette's perspective. The national scope focuses on the analysis of literature and case studies from renowned institutions, think tanks, and universities across the United States. Lafayette's scope highlights initiatives and policy within the College's Engineering division. In addition to the literature review, stakeholder analysis holds a considerable amount of weight in re-thinking Lafayette's engineering divison's curriculum and objectives. Survey results from the engineering faculty, found in the technical context of this report, are used as a strong point of insight into the engineering culture. The insight from students, faculty and the administration contribute to the development and definition of the current Lafayette engineer's identity. After all, engineering with people is focused on working together as a community to create lasting change. (Fila, Hess, Hira,Tolbert, and Hynes, 2014).

National Scope

Outside of the Lafayette engineering program, literature from institutions that specialize in engineering education or otherwise defined in this report as, engineering education institutions show a national interest in challenging the "traditional engineering model." Renowned institutions such as: the American Society of Engineering Education (ASEE), the National

Academies of Sciences, the American Society of Civil Engineers, the National Science Foundation (NSF) and US National Academy of Engineering (NAE) have contributed to this conversation. *The engineer of 2020 (2004)* called the attention of many academic and professional circles as it defined the "engineer of the century." It emphasized that "in 2020 and beyond, the engineering profession will need to develop solutions that are acceptable to an increasingly diverse population and will need to draw more students from sectors that traditionally have not been well represented in the engineering workforce" (Phase, 2005, 28). Since then, national conversation has devoted efforts to tackle the definition and role of today's engineer in accordance with the needs of society. Although the integration of entrepreneurship and innovation in engineering dominates this conversation, our course proposal on community-centric engineering highlights an equally important theme within the national conversation.

Over a decade ago, the American Society for Engineering Education and the National Science Foundation partnered in a two-part project on shifting engineering culture through research on engineer's perspectives on engineering education and the current state of engineering culture. This initiative resulted in a published report titled, "Innovation with Impact: Creating a Culture for Scholarly and Systematic Innovation in Engineering Education" focuses on answering the who, what, and how of scholarly and systematic educational innovation in phase one and using that framework in phase two to build understanding on the current "state of [engineering] culture" (American Society for Engineering Education, 2012). This report encourages administrators "to merge the long-standing entrepreneurial spirit of engineering faculty to introduce educational innovations into their engineering programs with the confirmed

theories and practices on how people learn" (American Society for Engineering Education, 2012). The final report emphasizes the application of research into political and educational systems. It highlights the large gap in United States perspective on engineering stating that, "while the engineering profession has become an important component of the national capacity for innovation, the same cannot be said for engineering education" (American Society for Engineering Education, 2012).

National academic institutions recognized the correlation between economic prosperity and progressive high technology (Kayumova, Savva, Soldatechenko, Sirazetdinov & Akhmetov, 2016**)**. This nationalist perspective has driven the popularity of research and applications of entrepreneurial approaches to engineering education. This change in engineering standards " [is] driven by the emergence of a connected, competitive, and entrepreneurial global economy, in which successful engineers increasingly need technical competency and professional skills that differ from what worked in the past. The stage is set for a Renaissance period for engineering education." (Apelian, 2013, 5)

Student demand for entrepreneurial education has grown with the rise in the reputation of the entrepreneurial process as "the country's future success and global leadership" (Byers, Seelig, Sheppard, & Weilerstein, 2013). Engineering colleges and universities have responded to this demand. Olin College states that their program, "deliberately want[s] to mix the DNA of engineering students and entrepreneurial business students" (Olson, 2013, 4). This call for change is not only beneficial to students, but to the engineering companies that recruit engineering students. For example, Boeing, an aircraft manufacturing company, emphasizes that they employ well-rounded engineers. It highlights desired characteristics such as creativity,

teamwork, effective communication, flexibility, critical-thinking skills and curiosity. Although these skills can be achieved through a variety of approaches, entrepreneurial models achieve both educational and American capitalistic standards (Olson, 2013, 14-15).

Despite the growing entrepreneurial approach to reforming engineering education, there are other strategies that equally satisfy the demands of reforming engineering to fulfill the standards of today's engineer. The integration of community-centric values within engineering education not only provides engineers the professional and technical tools necessary in the workforce, but challenges them to understand the contextual purpose and influence of their work on society.

Community-centric engineering education fulfills the aspirations and attributes of engineers as described in the book, *The Engineer of 2020* (2004). The modern engineer is expected to have developed and strengthened skills in analysis, practical ingenuity, communication, leadership, professionalism, high ethical standards, curiosity and flexibility. (National Academic Press, 2004, 53-57) In addressing the aspirations and demands of engineers, the standards of education, as stated by the NAE report, *Innovation with Impact*, must adapt to the rigor of this generation's necessities.

One of the strategies of community-centric learning addresses the modern societal challenge through contextual engineering methods. This strategy is manifested through the US National Academy of Engineering's Grand Challenges. This initiative was developed to perpetuate the idea of the engineer as an influence for a better future. Accounting for the greatest problems of today, a large panel of subject-matter experts worked to identify fourteen grand challenges that satisfy the engineering mind while challenging them to achieve sustainable and

community focused solutions. The NAE emphasized the "people part of engineering" in their work (NAE Grand Challenges for Engineering, 2008). Grand challenges breaks down into four themes that are pertinent to the future of humanity: sustainability, health, reducing vulnerability, and joy of living. The committee honed in on "placing the people's and planet's needs before personal fulfillment." The NAE committee reiteratively emphasized that "engineering was about helping people" (Fila, Hess, et al., 2014).

Since the user-centered design objective is strategically similar to that of community-centric design, implementing a more user-oriented design process in engineering courses would achieve the goal, "to deliver highly usable systems that satisfy users experience while reducing the waste and cost of delivery" (Guerra, and Shealy, 2018, 1) This design process has five steps: empathizing, defining, ideating, prototyping, and testing. In the article, this method produced more diverse solutions with a "focus predominantly on user experience in an effort to change behavior and shift demand". (Guerra, and Shealy, 2018, 2-3) Therefore, the design method is one of many strategies aimed at focusing engineering education and projects on the user or community.

In order to get a better understanding of how community-centric development based courses are organized, we researched programs that have incorporated this type of curriculum into their engineering programs. We did this in order to gain a sense of what other institutions such as Harvey Mudd, Olin, Purdue, MIT, Carnegie Mellon and Colorado School of Mines are doing in order to produce more "well-rounded" engineers.

One of the most successful programs that integrates engineers with their community is the Engineering Projects In Community Service (EPICS) program at Purdue University. EPICS

aims to bridge the gap between engineering education and community service. The program was designed so that engineering students receive class credit while working on long-term and large scale real world design projects that benefit the community. The program's goal is to have the community benefit from low-cost technical expertise to address problems that they face. EPICS organizes student teams, each focusing on certain projects in the community surrounding Purdue University. The teams consist of ten to twenty students each ranging from each of the four class years. When seniors graduate, first-year students in the incoming class take their spots on the team. EPICS allows for students to understand context of the community and for the project to develop at a pace beyond the limits of a fifteen week semester. The academic goal of the EPICS program is to develop students' technical and professional skills that they need to be successful in the professional world. It teaches students to see engineering not just as equations but rather as a way to help mankind. This program allows students to see the importance of the community's needs by working in partnership with the community to define and solve a problem (Coyle, 2006).

The Colorado School of Mines (CSM) has another effective community-centric engineering program. Juan Lucena, author of *Engineering and Sustainable Community Development* and a professor at the Colorado Schools of Mines is in charge of CSM's Engineering and Community Development minor. This program offers a mix of many social science and engineering courses paired with a student's main major while also offering many courses that teach students about community-centric design. These courses helped guide the construction of the 200-level course that our team designed. Beyond the Engineering and Community Development minor, CSM seeks to prepare all of their graduates to further their

understanding of the contexts in which technological and engineering development occur. The goal of the common curriculum at CSM is to help students "develop interdisciplinary perspectives on the ethical, social, and cultural contexts within which engineering takes place" (Colorado School of Mines, 2018). CSM and Purdue are just two schools that have made the step to educate engineers with a more community-centric approach. In order for Lafayette to stay competitive with these types of engineering programs, we must adapt our curriculum to encompass a more holistic approach to engineering.

Shuman argues via ABET accreditation criteria that "the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and social context" as well as "an ability to communicate effectively" (Shuman, 2005). We expand upon the technicalities of ABET in our curriculum proposal context, but it is important to note here that ABET still influences the perception of the course within engineering education and its standards. ABET's professional skills criteria further validates the impact of community-centric engineering education in the development of the Lafayette engineer.

Lafayette Scope

The co-habitation of engineering and liberal arts education at Lafayette is often amplified to prospective students and partner institutions. The Engineering division's site explicitly states that "the programs are grounded in Lafayette's traditional strength in discipline-specific engineering and complemented by the College's excellence in the liberal arts" ("Program...",

n.d.). Academic and pedagogical initiatives led by faculty indicate that there is an overall interest in furthering the esteemed motto of Lafayette engineering.

Although each professor has their own definition of community, their research and teaching interest in community work guides their influence on students inside and outside of the classroom. As Prados mentions, "engineering faculty view themselves as mentors dedicated to nurturing and developing students; develop and use advanced educational materials that promote student based learning" (Prados, 1998, 5). Faculty's commitment to students and their research influence their role in identifying the Engineering division's gap in utilizing the liberal arts opportunities available.

Select engineering professors stand out in their initiative to embody in practice the motto of a "well-rounded" education. They lead initiatives such as the Bachelor of Science in Engineering (BSE) proposal and the integration of Community Based Learning and Research (CBLR) initiative in their engineering courses. Professor Lauren Anderson and Professor David Brandes led the BSE proposal. The B.S. Engineering degree is a response to the "growing demand from many students and faculty for increased opportunities for study in interdisciplinary engineering fields such as bioengineering, environmental engineering, energy, materials, and robotics" ("BSE CEP...," n.d.) Aside from her leadership in this proposal, Professor Anderson shows her commitment to creating supportive communities for female engineers and work-life balance through her mentor role in the Clare Boothe Luce Research Scholars Program. Professor Brandes actively participates in and leads local projects on campus through the school farm, LaFarm, and the bird collisions project, amongst other community-centric initiatives.

The Landis Center for Community Engagement created the CBLR Initiative in efforts to "provide the infrastructure to support academic service-learning and community-based research at the College" ("Community-Based...", 2018, n.p.). This initiative directly responds to the ongoing challenge of developing sustainable and mutually beneficial partnerships between the campus and the surrounding community. In targeting faculty to commit to service learning, CBLR is slowly growing in recognition and impact. Dr. Kney, the director of the Landis Center, shares his aspirations model for this initiative. Kney notes that "[Landis Center leaders] plan on using one time visits as an introduction [to community engagement] in hopes that there is a growing partnership and eventually show students and faculty benefits of working with communities" (A. Kney, personal communication, November 28, 2018). Professor Kney embodies Lafayette's community-centric, liberal arts mindset, and our proposed course aims to further this concrete manifestation of Lafayette's values.

In practice, engineering courses that support CBLR include Engineering 101, select engineering senior design projects, the Engineering Studies capstone, Introduction to Environmental Engineering and more. Professors Rachel Koh in the Mechanical Engineering department and Benjamin Cohen in the Engineering Studies department are strong advocates for community-centric work. Professor Koh has shown, " commitment and service to diversity on campus to promote awareness and a positive learning environment for all students" through their leadership in the Community-Engaged Mechanical Engineering Senior Design Project class and an ES 101 course that draws connections between current events and engineering ("College Honors…", n.d., n.p.). Professor Cohen's Engineering Studies capstone course directly discusses engineering and Sustainable Community Development using local projects as case-studies and as

an exposure to these community engaging work strategies. Other engineering professors are also strong advocates and members of communities near the College.

The Technology Clinic at Lafayette provides students with similar initiatives as those described above. It was founded to solve problems through the work of a multidisciplinary team. Students who are a part of the team engage in real-world challenges and address the needs of the community in focus. The Tech Clinic currently works with the Borough of Weatherly, Pennsylvania to develop a technical system to connect trails as well as a project on improving the communications system at Lafayette. As the Tech Clinic Director, Dr. Lawrence Malinconico has insight into working with clients and supporting students throughout their design and implementation process ("About...," n.d.).

Two additional faculty initiatives on campus that play an influential role in the development and realization of our engineering course on campus are the Meta Mindset and the Center for the Integration of Teaching, Learning, and Scholarship (CITLS). Faculty aim to foster creative and bold entrepreneurial design thinking for their students through The Meta Mindset. This initiative is supported by the Kern Entrepreneurial Engineering Network (KEEN), the entrepreneurial program at Lafayette. KEEN develops the Entrepreneurial-Minded Learning as a method to prepare Lafayette students for the demands of contemporary society. Therefore, the "Meta Mindset invites faculty to deliberately create opportunities for students to practice this journey, building skills for recognizing opportunities, managing risks, seeking effective collaborators, and understanding the intrinsic and extrinsic value of thinking like an entrepreneur" ("Meta Mindset," n.d., n.p.). As this initiative works towards addressing the

demands of the modern engineer, it is important to note its focus on entrepreneurship as a strategy to accomplish this goal.

Through a pedagogical perspective, the Center for the Integration of Teaching, Learning, and Scholarship (CITLS) supports the development of new and experienced professors' pedagogical skills. This center serves as a strong reference in the development of curricula and a large contributor in the potential implementation of a community-centric course proposal ("About...," n.d.).

Since the College's administrative staff and policies are crucial when developing and approving a proposed course, we considered the role they play in the design and prospective future of our course. We discovered that a few key players' goals for the College align with our pursuit of integrating community-centric design within the engineering curriculum. They include but are not limited to: the Board of Trustees, the Provost's Office, the Presidential Cabinet, the director of the Engineering division and the Registrar's Office. The Board of Trustees has the final say on all large decisions pertaining to campus life, including academic programs. The Provost's Office and the Presidential Cabinet have the power to make administrative decisions about the future of academics at Lafayette. Our proposal focuses on a strategic shift in Lafayette's culture similar to the mission of the President's campaign, " Live Connected, Lead Change." The director of the Engineering division, Scott Hummel, is on several course proposal committees and guides the division in the direction he sees for engineering at Lafayette. After speaking with him, he expressed interest in our course proposal and advised us on the process of course approval and his vision of Lafayette's Engineering division. Lastly, the Registrar's office

manages the course proposal process and provides information on the development and submission of proposals.

Looking Ahead

Our project challenges the norms of the traditional engineering identity by placing community at the center of engineering education's values. Our political context identifies the stakeholders who are both in agreement with our objectives and who are decision-makers in Lafayette's academic course evaluation and approval process. From studies and reports conducted by engineering education institutions to faculty initiatives, there are many stakeholders with varying perspectives regarding our project. This section emphasizes the role that policies and academic conversation have on the definition of the "urban engineer." Our report's historical scope highlights the leadership of intellectuals in the shift in rethinking the definition of the "engineer of the century". As this report continues to develop the necessary research and analysis to design a thorough community-centric course, the roles of students and professors' voices are crucial in understanding and developing community-focused engineering design. In the curriculum design context, we will analyze students' survey results and observations as direct recipients of the engineering curriculum to gain a better insight into the Lafayette engineering culture and demand for our proposed course.