Engineering Studies ES 101 Module

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Introduction

The Engineering Studies major here at Lafayette College can be best compared to a hidden gem within the prestigious engineering department. For the past 50 years, our mission as a major is to foster an understanding of engineering that goes beyond the technical groundwork and redefine engineering as a liberal art. The technical skills students learn within the major are supplemented with substantial humanities and social science coursework that can be commonly applied in careers in and beyond the technical profession engineers are typically found within. Students within the major commonly cite it as an interdisciplinary spin on the traditional engineering track, and upperclassmen in the major praise the skills and methodology championed by this branch of the engineering department that is not taught by any other major on campus. The unique blend of technical training engineers receive, combined with the liberal arts components that focus on communication, context, policy, and social aspects is something unique and incredibly useful for engineers to know about in the 21st Century and beyond. The curriculum taught to EGRS students encourages 'going beyond the blueprints', and challenges students to reflect upon contextual solutions based upon the various communities that they serve.

A first-year Engineering major regardless of the branch, they are required to take an introductory course to learn about engineering through the lens of two different branches of engineering. Each lens, or module, would take place through the course of seven weeks where students would learn about the type of work engineers of that branch typically do. A chemical engineering module, for example, would have students work on creating biofuel and teach them about chemical bonds, energy, molecules, and how to calculate the amount of energy burned by a certain type of catalyst compared to another. At the end of seven weeks, the module would conclude, and the second module would begin, with the students being taught engineering

through a different branch of study, (Civil, Mechanical, Electrical, etc.) The main purpose of these modules is to be able to introduce the core concepts of engineering to students of course, but also be able to get students excited about what they are learning and doing.

Engineering Studies major in the past has been a major with less representation and notoriety within the engineering department compared to their traditional counterparts. Our team conducted a small survey amongst our nineteen Engineering Studies peers in the 2022 graduation class through GroupMe's polling function, asking about how everyone found out about and decided to pursue the major. A whopping 64% of seniors within the major transferred into it from another major after learning about it during their time at Lafayette, while only 21% of seniors started their Lafayette College education as an Engineering Studies major. 15% of EGRS Majors had paired this major with a different field of studies, such as economics or psychology. One of the largest takeaways from this small survey was that the majority of the seniors within the Engineering Studies Major, the people who have learned about and now champion the ideals of engineering as more than just a technical discipline, had no idea about this major's existence when starting at Lafayette College.

With that being said, it is necessary for incoming engineering students to at the very least have the opportunity to learn about what the Engineering Studies major has to offer through an EGRS focused ES 101 module. Through this module, students would receive an earlier glimpse into the major and how it differs from the other majors that are typical of the Engineering Division, in addition to getting freshmen students excited about the opportunity they have available to them. To grab the attention of the student's interest, we would have to raise and answer the following questions: "What is Engineering Studies? What are the core values that make Engineering Studies unique from the other engineering disciplines offered at Lafayette?

How can we introduce this major to students in a way that gets them interested and excited about Engineering Studies?"

In efforts to answer these questions thoroughly and effectively, we propose creating an ES 101 module educating the students on what the Engineering Studies major at Lafayette fully entails and then training them to look for solutions through an EGRS lens. This course would take the form of a seven-week module explaining the ins and outs of the Engineering Studies Major. Consisting of three different integral parts, the course would aim to answer any questions the student had about the major and hopefully would cause more students to want to study Engineering Studies at Lafayette. The first part of the course would be a thorough introduction to the history of the Engineering Studies major at Lafayette and how it has evolved to stay relevant to the field of engineering. We feel this is a great way to set the groundwork for the rest of the course while explicitly showing students the tradition they are a part of. The second part would consist of introducing the three main and required courses students would have to take if they decided to enroll in the Engineering Studies major. Therefore, there would be brief introductions regarding the EGRS 251- Engineering and Public Policy, an introductory course to the governance of science and engineering, EGRS 261- Engineering Economics and Management, a course that addresses the concepts and analytical techniques of engineering economics and management, and EGRS- 451 Engineering and Society, our capstone seminar that focuses on how engineering impacts society as well as how society impacts the practice of engineering. We intend to spend a week on each of the listed courses. In the given week, the goal is to introduce the students to the concepts, themes, and points of emphasis from the higher-level class, at a simpler level that first-year students in their first month of college will be able to grasp. Dispersed throughout these weeks are class discussions and group work, giving them practice at

communication and teamwork. This will give students the skills they need to prepare for the final project. The last part of the course would be a final project. These projects would require students to work amongst their peers to prove their understanding of what was taught throughout the seven weeks that the course took place.

Our enticing course description "Humanitarian Engineering" should encourage students down the EGRS path. Also, because the Engineering Studies major is a foreign concept to many incoming and current students, it will be hard to fully explain what the major is in the short period of seven weeks. In addition, though we intend for the course to be thorough despite the limited time, there is still a chance that a student does not understand what the Engineering Studies major truly is after completing the course.

To thoroughly understand and outline the need for our proposed course, we must examine the social and political aspects of engineering and its relation to engineering education. Engineering education is constantly being revised and improved to meet the social influence of the time, and we intend to mimic this in the module. For instance, in our course, we will be examining what social issues come into play regarding the issue and what existing conditions are in place that helps contribute to the problem.

In our report, we will break down the social contexts on a national and community level, as well as the political contexts in which this module proposal exists. Once this has been established, we will then introduce the syllabus, and explain in detail what the potential plans for a seven-week course period would entail.

Social Context

In this section, we delve into the history of engineering on a national scale as well as the history of engineering specifically at Lafayette College. Along with this history, we also delve into the culture of engineering and other problems that are associated with it in the workplace and even at colleges and universities. This analysis of culture is especially important at Lafayette as that is the focus of our study and where we will be implementing our engineering module. We believe that by adding an Engineering Studies module many more engineering students will gain a new understanding of engineering and the way it can connect to other paths of study leading to more well-rounded engineers which in turn will help improve the engineering culture at Lafayette which will hopefully spread and transition to a national scope as these students move into the world.

National History of Engineering

The period after World War two was an important time for the United States as the economy was booming and life was on the up and up. Engineers were feeling the effects of this as well as it seemed almost anything was possible through technology. Wisnioski, the author of Engineers for Change, emphasizes this with this quote which states, "the period from 1945 to 1964 was one of near-utopian belief in technology beneficence"(Wisnioski 3). Unfortunately, this did not last long as the country soon after transitioned into the Cold War era. This blind acceptance of following the wills of governments agendas as evidenced by this quote from (Fred something) which states, "the engineers…the people who made the hardware, who used existing knowledge to make something go, were in nine out of ten, conservative in politics, acceptance of any regime in which they found themselves, interested in making their machine work, indifferent to long term social effects" (Friedel 2). This quote perfectly illustrates how Engineers began to

lose the trust of the American people. They were disconnected from the communities they served, were not involved in social change, and were just seen as machines aiming to accomplish the will of various regimes. Engineers working more and more on government projects as well as a rapid increase in technology that was not beneficial to society made people question technology's value to society and whether or not a man could even control it. Engineers had lost how to "restore progressive meaning to technology"(Wisnioski 10). The military applications of technology at this time made it feel like technology had become heartless and was no longer a thing that could improve society and the quality of life. Engineers became the scapegoat for not being able to control technology and how it was now used to harm humanity rather than advance it. Many engineers and other activities sought to find a way to restore humanity to engineering. During this time of engineering education was mainly focused on the technical aspects and there was little to no emphasis on the social factors involved. This further compounded the issues that were starting to arise with engineers as their academic background was ignoring the community creating a cycle of new engineers that when creating technology never thought about community continuing to drive the lack of trust of engineers at the time. With lots of activities voicing their concern with the current trajectory of engineering, many universities were inspired to make changes to their engineering curriculum to reflect more modern and humanistic approaches to engineering. Edwin Layton author of Revolt of the Engineers: Social Responsibility and the American Engineering Profession stated that the goal engineers were trying to solve to find were ways "to lead their profession in a certain direction cultivate a special role for (some) engineers in solving the social and economic problems of modern America (Friedel 4). They believed that this change would need to start at the university level. One institution which led the way in this was MIT. Many students voiced their displeasure with the fact that the current engineering

curriculum was too focused on technical aspects of engineering and wanted a new interdisciplinary curriculum. This allowed for engineers to be educated differently and allowed them to be more holistically minded and be overall better engineers that could approach problems from new angles. Other universities such as Harvey Mudd, CalTech, and UCLA also pioneered a new interdisciplinary engineering curriculum with UCLA stating that engineers should be "managers of the public good"(Wisnioski 184). These 4 universities helped pave the way for a new engineering reform that continued into the 1990s.

History of Engineering Studies

Lafayette College has a storied engineering program dating 155 years with the first civil engineering degrees being offered in 1866. Over the years the program grew as did the college with more majors such as electrical being added in 1889, followed by mechanical in 1899. During World War II Lafayette helped train cadets in engineering. However, much like many schools, Lafayette's engineering department also went through changes after the war. Students at Lafayette, much like at schools like MIT, called for a change in the engineering department. This is evidenced by a "The Lafayette" article wherein laying out improvements for the college stated that "the entire engineering curriculum should undergo intensive investigation"(Wilmer & Rehrig, 1969, 6). These students believed that to compete with other larger universities and offer competitive engineering the school needed to restructure the curriculum to reflect current changes in society. They further argued in another point that the school needed to restructure BA and BS requirements to allow students to explore more interdisciplinary interests. The school soon after introduced the Bachelor of Arts in Engineering as well, becoming a co-ed college in 1970. This major at the time focused on flexibility within the engineering department

incorporating liberal arts courses with the technical side of the engineering program. Over time the major eventually garnered the name of Engineering Studies.

Lafayette's engineering continued to experience reform in its engineering department in the 1980s and 90s. But even so, it still did not make Lafayette special in being able to overcome the pervasive engineering culture that exists today. In our project, we will help show how more work needs to be done to help educate engineering students into looking at problems in a different way. Far too many engineers look at problems through the lens of "how can fix this problem?" instead of asking "why is this problem happening?". This is part of what makes the Engineering Studies program special and the skills that are developed need to be shared with other engineers. In the 1990's the engineering study major began to develop as more courses focused on engineering economic and engineering public policy were added. Later in 2007 Engineering Studies became its separate Bachelor of Arts department. Today the major is a key player in helping with engineering reform at Lafayette as taking key components from the major and adding them into others will help continue to make Lafayette engineering unique and stay competitive with other universities.

National Culture

While the history of engineering shows that there has been a change in engineering for the better there are still many cultural problems that plague engineering on a national scale. There is still a disconnect between engineers and the communities they design for. Many engineers design for the community as passive receivers often not taking into account how this technology will be used by the people they will provide it for. This is highlighted in multiple cases by the book Engineering and Sustainable Community Development (Lucena). Problems arise because the community is not involved in the process of developing these technologies.

After all, the engineers are making assumptions about how they will use the technology. One great example of this from the book is given when discussing new water technologies given to Africa in the late 1980s. The water systems were designed to be solar-powered and the engineers believed that they would help give these people an easy and sustainable way to get water. While a good idea in theory the project ended up failing. When researchers returned to examine the progress, they found that only "five years later in 1995 … only 30% were still in operation and by 2000 10 years after the initial implementation, they found that only 12 percent were still in operation"(Lucena 4). These systems did not fail because they were designed poorly. They did exactly what they were meant to do and were engineered well from a technical standpoint. They failed because they were not designed with the community in mind. This example is crucial for engineers to understand. The engineers that designed these technologies assumed that the people who received them would know how to use and operate them as well as assuming that these systems would fit into the way their community operates. They did not fit in with the community and were neglected.

This case perfectly illustrates a huge problem in modern engineering which is not listening to the community when designing technologies for them. Engineers often believe that they are the smartest ones in the room at all times, but just being smart is not going to help when it comes to being involved in the communities that you are designing. Community needs to be at the center of the design and to learn about the community you need to be able to listen and understand that you do not know everything about them and what they need. According to Dr. Pathote who is an engineering professor at Chameli Devi in India, "in addition to having the ability to explain technical problems they (engineers) must be politically aware so that technical decisions can be

made, understood and communicated across cultural boundaries"(Pothote) This quote emphasizes the need for better communication skills to be developed among engineers. Engineering Sustainable Community Design hammers this point home as it discusses even more cases such as the Honduras dam. Local engineers and policymakers believed that the dam was too risky and that the benefit was not worth the immense cost. The World Bank believed that while costly the benefits were worth the cost and would help the Honduran economy. They went ahead with the project ignoring the pushback. The dam ended up having multiple expensive failures and repairs and ended up costing Honduras millions putting them into massive debt and even leading to their currency losing value. It is not often taught in engineering programs to listen, which is why the engineers ignored the community and went ahead with the project despite them saying that they thought it would fail. Far too often engineers get caught up in how much good the project will do for the people rather than listening to what the people want. This issue has been looming large over the engineering community and new ways need to be developed to combat it.

These current issues with engineers and their disconnect from the communities that they design for highlight the need for engineer curriculum reform on a national level. According to a study done by the Colorado School of the Mines, "Most engineering curricula continue to privilege the technical over the social dimensions of problems and deprive students of the opportunity to develop crucial problem framing skills"(Mines). This issue is highlighted by the fact that "the first introduction to engineering is always through sciences i.e., physics, chemistry and mathematics"(Pothote). If engineers' first courses for engineering are all technical then they will always approach problems through that lens. Engineering curricula could benefit from having a larger emphasis on socio-technical engineering at the beginning of undergraduate

studies. Colorado School of the Mines defines sociotechnical thinking as "the interplay between relevant social and technical factors in the problem to be solved"(Mines). This definition shows that engineers need to have an educational background where they can easily evaluate social factors from a variety of disciplines. Just learning to solve classroom problems does not effectively prepare students to solve real-world problems. While ABET, which guides engineering curriculum, does highlight the need for both technical and non-technical aspects for engineering curriculum, engineering culture puts a much larger emphasis on the value of technical skills. They admit that while they have added more "professional" skills which include communication, teamwork, understanding ethics, and social context, they still believe that "there is considerable research that remains to be done there"(Shuman). These thoughts are also echoed by NAE which says that while "technical excellence is the essential attribute of engineering graduates" that those graduates should also possess "communication, ethical reasoning, and societal and global contextual analysis skills"(Mines). Often important skills such as ethics, sustainability, policy, and the ability to work well in teams are given a back seat. A curriculum that focuses on many of these non-technical skills would go a long way in helping to produce more well-rounded and better-prepared engineers. This sentiment is echoed by Professor Amadei from Rice University who says that current traditional engineering education no longer produces "global citizen engineers who have the skills to address complex geopolitical economic problems and the complex problems of our society"(Amadei). This leaves a gap in what engineers learn and what their actual function is in society.

These skills are essential for engineers to have. Non-technical skills need to be hit upon at a much earlier point in their academic careers. It is too late to add many of the skills later. New engineers need to start developing these skills as soon as they step foot on campus so they can

begin to develop and apply them to the problems they will come across in their daily lives. Once they graduate and enter the workforce, having these non-technical skills will help them redefine what it means for an engineer to be a social agent. Adding many of these ideas to the current engineering curriculum as well as education and encouraging engineers to pursue more non-technical engineering disciplines would do a lot to help close this gap.

Lafayette Culture

Many of the problems that plague engineering on a national level also plague engineering at Lafayette as well. Just from our experience at Lafayette during our first three years as Engineering Studies majors, our team has witnessed firsthand many of the problems with the engineering culture at Lafayette. Most engineers do not see themselves as part of the greater academic community and feel like they are a step above the other majors. This is evidenced by statements like, "well she has a fake major" or "well if I was an econ major I would easily have a 4.0" and even "why are you complaining about your major try to do engineering". A large number of engineering students show little respect for the other majors on campus, especially those that focus more on the arts and social sciences. This superiority is even seen in the engineering department itself as other majors see themselves better than others and even belittling the Engineering Studies major with terms such as "pretendgineer" or "pretendgineering". This shows that much like on the national scale Lafayette engineers value technical prowess overall believing that non-technical disciplines are below them and not worth their time. Some engineers may feel differently and if given the opportunity would enjoy engaging in more classes outside their major that reflect their interests. A further cultural problem that exists among the engineering department is the stigma around even switching their major to Engineering Studies. Most students who switch from a high technical major such as

civil engineering or mechanical and go to Engineering Studies are seen as failures. From a poll of the senior Engineering Studies majors, 64% of them transferred in from other majors. Students will say, "yeah he is an idiot he was a mechanical engineer and had to switch to Engineering Studies". Many of these students do not even consider if this switch was because they realized that they wanted to pursue something different. A lot of these issues revolve around the fact that most engineers do not even know what Engineering Studies is. They do not understand its purpose or goals for its students and because it is a Bachelor of Arts believe that is useless in the real world. Rather than being mocked, the idea of interdisciplinary studies should be celebrated in the engineering department. If more students were introduced to what the major is through our proposed ES 101 module that would help change many of the engineers' perspectives on the major. More would understand the purpose of why it exists at Lafayette and why it helps make Lafayette's engineering department unique. Furthermore, it could even help many engineers who are not Engineering Studies majors better understand the value of non-technical skills in engineering by giving them an introduction to engineering through the lens of socio-technical engineering solutions.

Current Issues

Engineering education has been an ongoing conversation in terms of how it must reinvent itself to meet the constantly changing social and political landscape that the world operates in; now more than ever, engineers serve as the agents of society that are tasked with tackling monumental issues such as climate change, and yet in the same era we are also facing the consequences of learned biases in technology, and how these biases perpetuate the subpar conditions that vulnerable populations live on a day to day basis. On an even larger scale, engineers must be able to explain and defend the decisions they make in a decisive political

climate. The purely techno-centric background is not good enough anymore to tackle these issues. Understanding that the problems Climate Change creates and the solutions that are synthesized to help people in North America are region-specific, and not a blanket solution to apply to villages in India or Africa, is now a requirement for engineers, not a luxury.

These issues lie at the crux of the argument as to why engineering education has changed in the past, and why it will continue to be an ongoing process that warrants constant revision and reevaluation of the skills engineers must be equipped with. (Should probably put this in with the socio-political)

Expanding Socio-Political Context

The nature of our project lends itself to a large degree of overlap between the social and political contexts behind the creation of an introductory module for Engineering Studies due to the similarity between the issues plaguing engineering for the last century and the attitude current engineering students take when met with the concept that Engineering Studies are as valid a branch of engineering as any other. On a national level, institutions that specialize in engineering education 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 the US National Academy of Engineering (NAE), have all recognized and defined institutions with programs like the EGRS Division at Lafayette College, as 'engineering education institutions that show a national interest in challenging the traditional engineering model'. At a national level, these institutions have all acknowledged that the engineers of 2020 and beyond must be able to develop solutions suitable for people of diverse backgrounds and draw upon the knowledge and talents of people who were not traditionally represented within the engineering profession. To that end, engineering education institutions

across America have taken up the challenge of redefining what the '2020 engineer'; institutions such as Harvey Mudd, Olin, Purdue, MIT, Carnegie Mellon, and Colorado School of Mines have all incorporated community-centric development-based courses into their engineering curriculum.

All of this is not to discredit what Lafayette College engineering has done in the past or discredit the path it is going now. Now more than ever, Lafayette College has taken steps towards expanding the engineering education division beyond the traditional disciplines by introducing environmental engineering and integrative engineering programs. The Engineering Studies program would not exist if the institution itself did not understand and champion the importance of an engineering education that pays attention to the skills learned outside of the traditional engineering education curriculum. While we (students) praise Harvey Mudd and Olin for their approach to engineering education, however, we also write off the very engineering program that seeks to best incorporate the '2020 engineer' vision as a major for those who were not bright enough to continue with a more traditional engineering approach. While it is unlikely that the vast majority of engineering students take this stance regarding the Engineering Studies program, and towards other 'non-technical majors', there is a large enough minority that holds this view that it is worth addressing.

When addressing the issue on a smaller, 'Lafayette'-specific scale, it is important to establish the current population of the major right now. The Engineering Studies major is made up partially of people who have declared as an EGRS Major from the start, and more importantly, it is made up of people who have switched majors from one of the more traditional engineering disciplines to EGRS for one reason or another. As it stands right now, the lack of a solid introduction of the major could be a contributor to the 'stigma' Engineering Studies has

among its engineering peers. Having a substantial population of the major be made up of students who have transferred out of traditional engineering disciplines contributes to the impression that the new major is 'easier' than the old one.

One of the steps that the college could take towards combating the current divide between traditional engineering divisions and EGRS Majors would be to introduce the concept of Engineering Studies earlier on during a 4-year education at Lafayette College. When a freshman signs up for the Introduction to Engineering course, they are given the opportunity to take part in a small survey that allows them to take part in small-scale projects and learn about certain opportunities within certain divisions of engineering. The Chemical Engineering module, for example, had us create our own renewable fuel source using biofuel, and taught us about how chemistry all plays a part in that process. In the preliminary survey, the option associated with that interest painted the Chemical Engineering module as 'an opportunity to discover alternative fuel sources. If we are to create an EGRS Module for the ES 101 course, advertising the major for what it is in *very* broad strokes, a more liberal and 'people-focused' approach to traditional engineering, focused on critical thinking outside of the traditional Engineering Problem-Solving method, could serve to entice students that may have interest in the major that they did not even realize was there.

While the addition of the EGRS module alone would not necessarily solve the stigma of traditional engineering vs. the '2020' Engineer, it would help solidify the identity of the major in the minds of students earlier on and give an additional point of entry for those interested in the major aside from those who knew about Engineering Studies before coming to Lafayette, or those who happen to transfer into it. Lafayette College as an institution is following the notion that the engineer of tomorrow must be able to tackle new challenges that traditional engineering

education alone would not prepare them for, however, the Engineering Division could do more to promote just how important that notion is. Engineering Studies is a solid step in the right direction for the college, though the addition of an Engineering Studies Module would be taking the next step in terms of preparing more students for what engineering requires of them in the future. More exposure for Engineering Studies as a 'legitimate' form of engineering would serve the engineering community at Lafayette well, and the ES 101 Module would be a strong candidate for creating that exposure.

Curriculum Proposal

Introduction

When discussing the need for an Engineering Studies module for ES 101, it is imperative to address the current state of the major at Lafayette College from a social context. As it stands now, Engineering Studies is treated as a lesser form of engineering by our peers that are studying more technical engineering branches. In addition, after conducting a survey among the senior year students in the Engineering Studies major, 64% of the students did not start as Engineering Studies majors and ended up transferring into this branch of engineering from another traditional branch. The common consensus among the seniors that took part in this survey, however, was that the skills exclusively learned within the Engineering Studies department have prepared them for the plethora of situations that 21st-century engineer faces in the world.

To that end, incoming engineering students must learn about what the Engineering Studies major has to offer and how it differs from the other majors that are typically considered first. In that same survey, only 21% of seniors started as Engineering Studies majors and stayed that way from the start. The current absence of an Engineering Studies module for ES 101 leaves new engineering students in a situation where they may not know about a potential branch of

engineering that they may be interested in and could be a large contributor to why so many students end up transferring into this major from another one. Creating an Engineering Studies module in this sense would help introduce students to this branch of study much earlier on in their college experience.

To properly create an Engineering Studies ES 101 module, we first need to understand what the core of the Engineering Studies major is. For this project, the core classes that we take as Engineering Studies majors are Engineering Public Policy, Engineering Economics, and the capstone: Engineering and Society. These three classes serve as the basic principles that differentiate EGRS from the other technical-based majors. We are fundamentally trained to think about engineering-based problems from angles that are outside of the typical 'Engineering Problem Solving' methodology. When discussing energy alternatives like solar panels, for example, Engineering Studies majors do not just think about how much energy a solar panel can create, we are trained to think about how many panels it would take to create an equivalent amount of energy to the sources we use now. We think about where these solar panels would go, how much they would cost, and who is affected by these decisions. It is through this exhaustive analysis that Engineering Studies majors can confidently advise and guide the course of technical projects that will provide the best possible outcome for the communities that they serve. To that end, an ES 101 module should provide students with a surface-level understanding of the skills needed to make these types of analyses, and more importantly, get students excited about the major.

Part of our preparation for this proposal deals with understanding the fundamental formatting of the ES 101, and we sought guidance from engineering professors who have taught the course in the past. We discussed the contents of a potential ES 101 module with Professor

Sanford and Professor Senra, who had defined the goals that the EGRS ES 101 module should aim to achieve. To that end, we believe that we have created a syllabus for a prospective EGRS ES 101 module that properly encapsulates the fundamentals of the major, as well as provide students with a fun, engaging introduction to not only the Engineering Studies major but Lafayette engineering as a whole.

The syllabus for our course outlines the seven-week period in which the module will take place, as well as states the expectations of the class, learning outcomes, the catalog description, class meeting times and location, office hours, abstract, required texts, grading scheme, disability statement, privacy statement, federal credit hour compliance and academic integrity statements. As is the case with all ES 101 modules, the main goal of the course is to get new students excited about engineering. From a more specific perspective, however, the specific outcomes we are aiming to achieve from an EGRS angle are for students to understand what Engineering Studies are and the importance of interdisciplinary engineering education, while also gaining an understanding of the engineering design process. We would like for students to recognize that engineering at Lafayette and beyond is innovative and exciting, and that being able to identify social, ethical, and economic issues surrounding the information for projects play just as large a role in ensuring a project's success as the technical aspects of it. We aim for this module to help students develop their organization, management, and teamwork skills, and also gain experience conveying engineering information in a written report.

Proposed Syllabus

ES101

Socio-technical engineering

Professor TBD, AEC 315, Fall 2022

Catalog Description

This course teaches the fundamentals of socio-technical engineering. Students will use engineering design processes to aid them in: recognizing the need for a socio-technical engineering solution, defining the effects of economic, political, ethical, and community contexts, among other aspects of engineering design. Instructors will integrate societal contexts of engineering practice and use that to help students gain the understanding to do the same and examine the implications of socio-technical engineering solutions.

Class Meeting Time and Location

Section 10: MWF 8:00 AM to 9:15 AM, AEC 315 Section 11: MWF 11:00 AM to 12:15 AM, AEC 315

Office Hours

All sections: MW 10:00 AM to 10:50 AM, AEC 244 (or by appointment)

Abstract

Socio-technical engineering is essential in today's modern world to meet the needs of individuals and societies. Having engineers engage in non-technical skills that will allow them to approach problems is crucial. Our focus in this ES 101 model is on introducing students to the Engineering Studies major and socio-technical problem-solving.

Expectations

Our classroom is a place for discussion, not a lecture hall. You are expected to actively participate in these discussions and to work on particular projects – generally in teams – that allow you and your fellow students to learn by doing, learn by observing the results of others, and learn from one another while trying out new ideas. What you learn will depend directly on your willingness to participate and be involved. So, do not be afraid to participate and get involved with the discussion. Not everyone has the right answers and by listening and engaging you will be able to expand your knowledge on these topics.

Required texts

There is no required textbook for this module. The few readings for this class will be given in PDF form for students to print or access on their devices.

Student Learning Outcomes

Upon completion of this course, students will be able to:

- Understand what Engineering Studies is and the importance of interdisciplinary engineering education
- Understand the engineering design process
- Apply a socio-technical analysis of open-ended engineering challenge
- Be able to recognize that engineering at Lafayette and beyond is innovative and exciting
- Have experience using engineering equipment, tools, software, and hardware appropriate to the topic of the course
- Be able to identify social, ethical, and economic issues surrounding the information for projects
- Develop organization, management, and teamwork skills
- Gain experience conveying engineering information in a written report

Grading Scheme

Note: Students must complete both modules and graphics to pass the course. This module: The grading breakdown within the Socio-technical engineering module is shown below.

Homework: All homework assignments will be due at the beginning of class unless otherwise specified. If you arrive late to class, your homework is also late. Late homework assignments will be penalized by 25% for each day the assignment is late. All homework assignments must be earnestly completed by the end of the seven-week module to pass.

Final Presentation and Final report group energy project will be introduced in the third week of the module with details concerning these assignments.

Attendance: The success of this course is highly dependent on your active participation with your design team and with the class. As such, only three unexcused absences will be allowed. You will be considered absent if you arrive at class more than thirty minutes late or not at all. The first unexcused absence will not be penalized. The second unexcused absence will reduce your module grade by 5%, and your third unexcused absence will reduce your module grade by an

additional 10%. Disciplinary action for students with greater than three absences will be handled on a case-by-case basis.

Participation: How do you get a perfect participation grade? Come to each class prepared and on time, con- a tribute to class discussions at least once a week (hopefully much more!), allow other students to contribute, and maintain a high level of respect and professionalism with your peers.

Graphics: Prof. Rosenbauer will inform you.

Co-curricular activities:

Students are required to attend a minimum of five co-curricular events during the semester. These events must include the Resnik lecture on November 28th and at least four other ES101 co-curricular events. Students are welcome to attend more than five events. If a student cannot attend the Resnik lecture, then the student may attend an additional two ES101 co-curricular events to substitute for the Resnik lecture missed to receive full credit for the co-curricular component of the course.

Grading for the co-curricular component:

• Attendance at 5 or more events = 100%• Attendance at 4 or more events = 80%• Attendance at 3 or more events = 60%• Attendance at fewer than 3 events = 0%

Module A	40%
Module B	40%
Graphics	15%
Co-curricular	5%

Homework	25%

Final Presentation*	25%
Final Report*	20%
Attendance	15%
Participation	15%

Students will need to reserve a slot for all noontime co-curricular events. A link to a video describing the reservation process will be sent to students at the beginning of the semester. Lunch will be served at these events and in most cases, the students' meal plan will be charged for the lunch. IMPORTANT: Students are expected to act professionally during all of the co-curricular events. Use of cell phones, reading non-related materials, talking, or other rude behaviors will not be tolerated. This is a college course and students are expected to behave accordingly.

Disability Statement

In compliance with Lafayette College policy and equal access laws, I am available to discuss appropriate academic accommodations that you may require as a student with a disability. Requests for academic accommodations need to be made during the first two weeks of the module, except for unusual circumstances, so arrangements can be made. Students must register with the Office of Advising and Co-Curricular Programs for disability verification and the determination of reasonable academic accommodations.

Privacy Statement

This course uses Moodle course management system. Moodle contains student information that is protected by the Family Educational Right to Privacy Act (FERPA). Disclosure to unauthorized parties violates federal privacy laws. Courses using Moodle will make student information visible to other students in this class. Please remember that this information is protected by these federal privacy laws and must not be shared with anyone outside the class. Questions can be referred to the Registrar's Office.

Federal Credit Hour Compliance

The student work in this course is in full compliance with the federal definition of a four-credit hour course. Please see the Registrar's Office website (http://registrar.lafayette.edu/files/2013/04/Federal-Credit-Hour- Policy-Web-Statement.doc) for the full policy and practice statement.

Academic Integrity

To maintain the scholarly standards of the College and, equally important, the personal ethical standards of our students, written assignments must be a student's own work, just as is expected in examinations and class participation. A student who commits academic dishonesty is subject to a range of penalties, including suspension or expulsion. Finally, the underlying principle is one of intellectual honesty. If a person is to have self-respect and the respect of others, all work must be his/her own.

Course Schedule

Course Schedule	Monday	Wednesday	Friday	Homework
Week 1	• Syllabus day and discussion about what is engineering	• History of Engineers/ Intro to Engineering studies • Design process	• Career paths for engineering studies and class discussion about engineering ethics	Read Ch.1 of Engineering and Sustainable community Development with focus on cases for next Monday
Week 2	• Discussion of reading from homework	• Lecture of socio-technical factors in engineering	• Discussion of Honduras Dam case • Think about policy implications of case	Read Honduras Dam case from Engineering and Sustainable community development by this Friday
Week 3	• Lecture of government structure and policy process	• Lectures continued on role of policy in engineering and how engineering affects policy	• Small group discussion of hypothetical case in class • Small presentation at the end	Find an engineering policy article in the news and write a one page reflection due Monday.
Week 4	• Lecture on basic economic principles • Time value of money and equivalence factors	• Introduction to excel • Will work on learning how to use excel to solve engineering economics problems	• Problem Set day • Students will split into groups and work on engineering economics problems due Monday	Work on Problem Set

Course Schedule	Monday	Wednesday	Friday	Homework
Week 5	• Introduction of project • Lecture about renewable energy	• Group meeting day • Work on choosing energy source and work on proposal outline	• Meet with professor to discuss outline and continue to do work and research about source	Turn in outline due Friday
Week 6	• Lecture going over things to consider in policy as well as replacement analysis	• Work Day to work on rough draft due Friday	• Meeting with prof to go over rough draft.	Turn in rough draft due Friday.
Week 7	• Work Day for final draft and presentation	• Work Day for final draft and presentation	• Final Presentation Day • Turn in final draft	Turn in final draft and presentation

Description of Course Schedule

Week 1

In the first week of this course, the primary focus is to explain what the course is and the purpose it has. For instance, at the first meeting, students will go over the syllabus with the instructor and peers. This gives students a greater understanding of what will take place and what is expected of them. Also, it allows for students to ask any questions they may have about the format or contents of the course. After the students feel comfortable about the syllabus, we would then transition into a discussion about what exactly engineering is and its history. We feel the history topics that would be best discussed would be Global, United States, Lafayette, and then the EGRS major. This will give the students a wide scope to begin, and then narrow down to them specifically. This is also helpful in leveling the playing field and establishing a common understanding of engineering despite the students' common knowledge.

At the next meeting, students will be lectured and watch a slide presentation on the Intro to Engineering Studies which would outline the core classes and values of the program. Included in this lecture would be the outcomes of the major and the possible and common career paths post-graduation. Lastly, there will be information on what makes the program different from the others. This meeting would display to students what the major truly embodies and they can begin to help persuade them to join the EGRS major. We will make sure to accurately portray the technical aspects of the major, as well as the socio-technical aspects. Overall, this meeting would help educate the students on what the program offers to them and their future.

At the meeting at the end of the week, there will be a class discussion about the ethics of engineering following a Crash Course video on the subject. The Crash Course video will provide a foundation for the discussion as it introduces and defines engineering ethics. We can move into

the impact engineering ethics has as well as a plethora of examples. The Professor could also start getting into ethical issues within engineering such as redlining. This will be helpful in the sense that the students will get some information about a very important topic in the engineering field.

In terms of homework for week one, students will be responsible for reading an excerpt from "Lessons from Ghana: Why Some Technological Fixes Work and Others Don't" by Nalani Chhetri, which is referenced in *Engineering and Sustainable Community Development by Juan Lucana, Jen Schneider and John A. Leydens*. This short article provides a great example of how to approach and how not to approach an engineering problem as there are non-technical factors at play. The examples in this are simple enough for first-year students to comprehend, while also highlighting the clear positives and negatives.

This week, it is best to lay the groundwork for the rest of the semester. Explaining Engineering Studies, in its current state and the previous, will allow students to formulate their thoughts on becoming an EGRS is right for them. We intend to make the rest of the course enjoyable, but also developmental. Moving into Friday, where we begin the first day of building the engineering study skills we are looking into each semester, the professor needs to cover the big ideas so they can be referenced and thought about throughout the semester. We feel watching the Crash Course YouTube Video on Engineering Ethics would be a good starting point. The video provides good examples and information, while also being entertaining. Following it will be a lecture about ethics and engineering ethics. There will be some opportunities for student discussion, but given the sensitive nature of the topic, it will be limited. The topic of redlining, among other inequalities, is going to be introduced. These topics will simply be introduced as the purpose is to make the students aware of the issues.

Week 2

For the second week of the course, students will learn about socio-technical factors and some of the issues that can arise through the use of "Lessons from Ghana: Why Some Technological Fixes Work and Others Don't" by Nalani Chhetri, and other real-world examples.

At the first meeting of the week, students will participate in a discussion based on the excerpt about gelled ethanol and Twig Light they were assigned. In this discussion, students should demonstrate what they have learned and share their thoughts with their peers. To ensure that the students cover the material, the discussion will be graded on both discussion and participation. The case study that was assigned last week, on gelled ethanol and twig light technology, from the *Engineering and Sustainable Community Development,* will be the topic of the discussion. The ideas that will be best suited for the classes to follow will be centered around the question, why did these technologies not work? To summarize the short reading is about students from Arizona State University that designed solutions to perceived problems in Ghana. The students created a gelled ethanol stove that did not produce smoke as they viewed the smoke from cooking with firewood as an issue. The students did not account for the cultural aspects of the families they were creating this technology for as their food required large pots that were not compatible with the tiny stove. The stove was designed for five family members, but the average home in Ghana has anywhere from ten to twenty-one family members. The students also overlooked the fact that their solution was more expensive, as families used free firewood as their fuel source. The Ghana families did not even view the smoke while cooking as an issue. The excerpt then moves into a more successful example, with the Twig Light story. The designers worked with poor villages to create a solution to their specific needs. The Twig Light

technology was originally for lighting up a small room by burning twigs. When this was shown to the villagers, they suggested using charcoal instead of twigs, the lights shined brighter than ever before. After more discussion with the villagers, the design team realized that electricity in the area was unreliable and expensive. This made charging cell phones extremely difficult. After a few modifications, the villagers had a new way to charge their phones. This demonstrates the potential when you ask the right questions and account for socio-technical factors. It is certainly important for students to do the reading before the next class as it will be extremely helpful for discussion purposes. These two topics can provide an interesting way to introduce the students to socio-technical factors without them even realizing it. To reinforce the technical aspects of the major, we can hammer home tangible engineering factors and set aside a few minutes to discuss potential ideas for other uses of the technologies or ways to improve the gelled ethanol.

The next class meeting will be a lecture focusing on the importance of socio-technical factors affecting the field of engineering. When the lecture is over, students will be encouraged to participate in a discussion about the lecture. At the end of class, the students will be reminded to complete the assigned reading 'The Stranger's Eyes' from the book *Engineering and Sustainable Community Development by Juan Lucana, Jen Schneider, and John A. Leydens* (Lucena). The lecture and assigned homework will be extremely important and helpful for the discussion that will take place at the next class session as the reading embodies many socio-technical aspects.

At the end of the week, students will participate in a discussion about the excerpt 'The Stranger's Eyes'. This story is about a young man named Pierre from North America who is tasked with installing mills for grinding grain in Mali in West Africa. Pierre runs into a plethora of socio-technical problems. The ones we feel would be best suited for the class discussion about

how the women feel about the men not being involved in this project, the existing mill across the street, and the religious positions that must be elected. The women were initially concerned about the fact that men were not to be involved. The culture in Mali is not the same as the Western world and the purpose of his mill was to prevent women from being overworked. They had questions "if the mill breaks down, who will fix it? Who will make sure that it has diesel to run? Who will really take care of the money?" (Lucena et al. 89) Pierre overlooked the fact that there was an existing and struggling mill across the street from the location of the new mill. This could have created problems with competition, loyal customers and could potentially divide the tight-knit community. Lastly, a Christian woman was to be elected president and treasurer, while non-Christian could only be vice-president and secretary. This created hatred and jealousy, leading to a split in the community. The professor can segway the discussion into next week's topics of policy off of what the effects could be when having required religions for powerful positions as the people can control the policies. The discussion is intended to get the students thinking about all of the factors involved in engineering. The technical failure of the mill can also be discussed to help hammer home the technical aspect of the Engineering Studies major while still highlighting socio-technical issues overlooked by Pierre. Again, to hold students accountable for doing the assigned reading and meaningfully contributing to the discussion, the discussion will be graded.

Week 3

Week three starts with a lecture about government structure along with the policy process. During this lecture, students will learn the basics of the subject while also hinting at the relevance to engineering. Today is crucial for setting the groundwork for the students, giving them all similar knowledge levels. The overall theme throughout this week should parallel EGRS

251 to help further their understanding of the major. According to the Lafayette College Course Catalog, EGRS 251 "introduces students to the governance of science and engineering. Course topics include the overall context for science and engineering policy, the public policy process and institutions involved in that process, and several current sciences and engineering public policy issues. The course includes a combination of role-playing exercises, debates, field trips, as well as traditional lectures." We intend to cover similar topics at a level designed for first-year students.

At the next meeting, students will be educated on the role of policy in engineering and also how engineering affects policies. Oftentimes, engineers and engineering students have a very limited understanding of how public policies affect their careers. Engineering is constantly influenced by laws and regulations, and failure to comply with them, whether it be safety, environmental, etc., can ruin entire projects. They will learn about stakeholders, how to identify a stakeholder, and their importance within a project.

In the final meeting of the week, the students will be introduced to the socio-technical topics about COVID-19. This is a topic where all students already have a substantial knowledge base as it has impacted all of their lives. The main topic of today's class will be Zoom and we will look into the societal impact it had. This great quote from Enid Mumford "The most important thing that socio-technical design can contribute is its value system. This tells us that although technology and organizational structures may change, the rights and needs of the employee must be given as high a priority as those of the non-human parts of the system (p. 338)" could be an avenue to force the students to view Zoom and other online meeting sites differently. After the brief overall class discussion, students will be split into groups to talk and

have them consider the social, political, and engineering aspects of the issue. At the end of the class, students will have to share with the class what they talked about amongst their groups.

This week's homework assignment will be to find an article on an engineering policy and to write a one-page reflection. This assignment will be graded. This assignment will help make sure if the students are understanding what is being taught and discussed in the class.

Week 4

Week four begins with a lecture about supply and demand, markets, the invisible hand. The goal of today is to give the students a working knowledge of how the economy works. To get the most out of lecture two of this week, we need to provide the students with a foundation of the economy and its markets. This week should discuss topics from EGRS 261, at a lighter level. This is to help show students what their course load through the engineering students major will look like. This lecture will cover the basic yet important economic concepts. Supply is the amount of good that is being sold on the market by a producer. At high prices, it is more profitable for the producers to increase the supply. The demand is the quantity of the goods that the customers wish to buy at various prices. At higher prices, the consumers will have a lower demand. This is easily shown through a supply and demand graph. The invisible hand is a concept that describes unseen forces that can move an economy. This is mainly done through production, consumption, and finding an equilibrium point.

The next lecture will be about the time value of money and how interest rates work. These two topics will allow students to grasp the economic side of a project very well. We want students to understand economics as it is a factor throughout all stages of an engineering project. The time value of money is the concept that money available in the present is worth more than the same amount of money in the future. This can be attributed to interest and inflation. Interest

rate is the rate at which a lender charges the borrower for money loaned. This is why people put money in a bank, and how people can get loans from a bank. During this meeting, the professor could have a great opportunity to discuss the engineering design process that they feel is best suited for this course.

On the last meeting of week four, students will be split into groups. In these groups, students will be responsible for working on a problem set. These problems will help introduce students to basic Excel skills. These basic Excel skills are not only useful to learn for organization and efficiency, but they also will meet the ES 101 module goal of introducing an engineering technology. What was learned in the week's lecture will also be emphasized in the problems. The professor will be there for questions and guidance, but the group work aspect is important. We feel the best way to conduct this is to strongly discourage the divide and conquer method, forcing the students to interact as much as possible.

In terms of homework for this week, students have to turn in the problem set they worked on with their groups. Turning in the problem set will help make sure the students are completing work with their groups and are understanding what is being taught.

Final Project

For all ES 101 modules, an important part of the curriculum is a final project which helps to culminate the material that they have learned over the course of the module. For our final project, students will be put/choose groups of four or five and be given a prompt. The prompt for the final project will be "The small town of Lafayetteville's current energy infrastructure is not outputting enough energy for the town. You and your team are brought in to help solve this problem. Choose an energy source from one of the four options, Solar Energy, Nuclear fusion reactors, Wind Energy, and Coal. You will construct a report which will consider the

sustainability, effectiveness, community needs, ethics, policy and economic factors surrounding your energy and construct an argument for why that source will best serve the town of Layetteville". Other information about the town will be given such as geographical location, the main source of income in the community, and other pertinent information that will help the student be able to conduct sound analysis on the community. We believe that is a great project as it will force the students to use the knowledge they have learned over the four previous weeks of the course. On top of that, the debate between non-renewable energy and renewable energy is crucial for all engineering students to have background knowledge of as many of these new solutions will be at the forefront of energy in the future. They will have to grapple with choosing a renewable energy source such as solar or wind or going with a non-renewable energy source. Educating new engineering students on the topic will help them learn more about a topic that will be a focus of their engineering education and will most likely be involved in their careers in the future.

In considering the ethics, sustainability, and community needs they will need to go back to week two of the module and look at the material covered there. This will include thinking about how the energy system will fit into a community which will draw on the case studies from *Engineering and Sustainable Community Development*. Along this path, they will also need to consider how this technology could go awry and potentially harm the community. This will also include how to make the energy source feel like a part of the community and something that they own, not just something that was built for them. The sustainability of the energy source also needs to be considered as you want to make sure you give the town something that will help them reduce their carbon footprint, last for a while, and still give them clean energy.

For considering the policy surrounding their energy source students will need to revisit material from week three. Here they will need to outline the process they would need to follow to get the energy source approved by the local government. Here they would also need to consider the stakeholders for the source. Who is going to fund this? How will you keep them engaged throughout the project? Here they will also need to think about the success of other energy sources like this and how they have fared in the past. This will be important as they start to construct their proposal and develop their solution. Including this in the final project is a great way for the students to start applying the topics they have learned in week three. It is one thing to discuss political factors in class but in this, they will have to brainstorm and think about how their proposed technology will affect the people of Lafayetteville and the various policies and processes for how they will implement their energy source for the town.

An economic analysis will also be done on the potential energy source solution. Here students will use information from week four to conduct a cost-benefit analysis of their solutions. They will be given data on each of the energy sources such as lifetime, initial cost, and how often replacements are needed. Using this data, they will conduct present, future, and annuity analysis to understand how much their source will cost now, 10 years from now, and how much annually it will cost the town of Layetteville to maintain and upkeep. This will allow them to conduct some technical analysis in this project and will help them understand the long-term effects of projects in a monetary context. On top of that students will also need to potentially consider how this new energy source will help improve the town of Lafayette's economy utilizing more employment opportunities as well as helping to increase the economic output of the town. All of these different factors will help put a more technical emphasis on this project which is for the

most part focused on non-technical aspects. This section of the project will allow the students to apply their knowledge of the material that they learned in week four in a real-world context.

Since the project will cover the last three weeks, set deliverables and checkpoints will be set for the students to achieve at the end of each week. As part of the first week, there will be an introductory lecture about renewable energy. This lecture will include a discussion of the 4 main energy sources Wind, Solar, Nuclear, and Coal. They will learn about the pros and cons of each energy source as well as learning about implementation costs, maintenance costs, energy output, and sustainability of each energy source. After the lecture is over, they will then be split into their groups and will be tasked with choosing the energy source that their proposal will focus on. This will involve them meeting as a group to discuss different ideas and potential options. As a part of this process, they will start conducting some research and analysis. Once they have chosen their source, they will put together an outline for their proposal. On Friday of that week, they will meet with the professor and they will give them feedback on it and how they can improve what they have done for their rough draft. The rough draft of the proposal will be due the Friday of week six. For this, the students will need to have done the majority of their research and calculations done and put them into a report which should be about fifteen pages which is seventy-five percent of what the final report will be. After turning this in and going over it with the professor they will receive a final round of feedback which they will use to construct their final presentation and report. They will have all of week seven to work and at the end of the week on Friday each group will present their presentation which will be fifteen minutes to the class. This presentation will be an oral form of their report to give the students experience in communicating an engineering report verbally which is an important skill to develop over their time in college. The students will need to submit their final report as well that day which should

total in the length of about twenty pages. Through this project and over the course of these three weeks we hope these students will learn a lot about teamwork, communication, conducting engineering research, economic analysis as well as gaining skills in delivering written and verbal engineering reports.

As part of the project, students will be given information diagrams that detail the pros and cons of the sources as well as the costs.

Diagrams on the next page.

Energy Sources

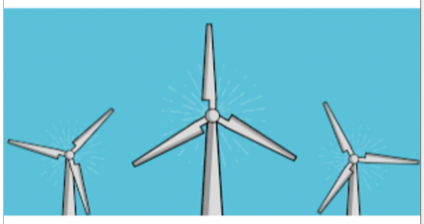
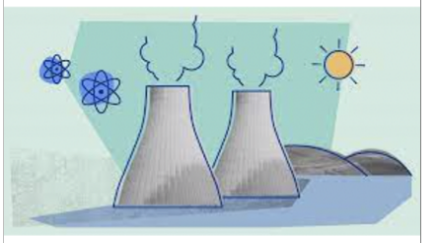
1. Solar Energy 	Pros: • Solar energy systems do not produce air pollutants or carbon dioxide. • Solar energy systems on buildings have minimal effects on the environment.	Cons: • The amount of sunlight that arrives at the earth's surface is not constant. Efficacy depends on location, time of day, season of the year, and weather conditions. • Need a lot of space in order to capture sunlight effectively.
2. Wind Power 	Pros: • Renewable Clean Energy • Low Operating Costs • Efficient use of land space	Cons: • Wind is not always consistent • Loud and visual pollution • Some adverse environmental impacts as birds often fly into them and can sometime disrupt animals habitats
3. Nuclear Energy 	Pros: • Carbon Free Electricity • Small land footprint compared to other energy sources • High energy output • Reliable energy source	Cons: • Uranium is technically non renewable • Very high upfront cost • Nuclear waste • Malfunctions can be catastrophic
4. Coal 	Pros: • Abundant supply • Currently cheap to extract • Reliable and capable of generating large amounts of power	Cons: • Emits major greenhouse gases/acid rain • High environmental impact from mining and burning • Mining can be dangerous • Finite engird source

Figure 1 as created by authors.

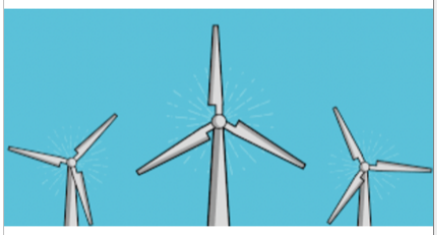
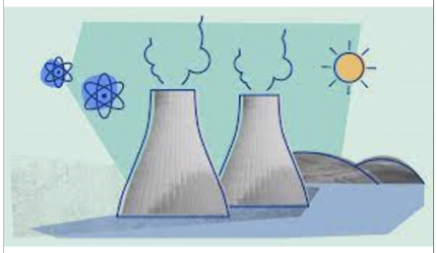
Energy Sources	
1. Solar Energy 	Cost: Installation - $600,000 Annual Cost: 66,000 Replacement 25 years
2. Wind Power 	Cost: Installation - 2.4 million Annual Cost : 135,000 Replacement 20 years
3. Nuclear Energy 	Cost: Installation - 6 billion Annual Cost: 20 million Replacement 60 years
4. Coal 	Cost: Installation - 2 billion Annual Cost: 10 million Replacement 35 years

Figure 2 as created by authors.

ABET Accreditation

The main purpose of this course was to focus on the development of non-technical skills among engineering students, especially first years. While there is some technical analysis involved, we hope the students will gain a better understanding of how to look at problems from a socio-technical perspective. This will have been accomplished through seminar-based discussions, reading, and writing to understand the cross-section of engineering and historical, political, economic and social, and community contexts. Through their final project, these skills will be hammered home and will hopefully help shape students to apply these ways of thinking into solving other engineering problems even if they choose not to become Engineering Studies majors.

Making this course ABET-accredited would be a little bit of a challenge, but according to ABET.org under the general criterion for student outcomes, the following list shows many of the criteria that we believe our course accomplished.

- An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability. ability to function on multidisciplinary teams; an ability to identify, formulate, and solve engineering problems;
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively
- An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice. (Amadei, 2010, 87)

These ABET outcomes directly relate to our final project as well as correlate to our course outcomes. The first listed criterion about designing systems with a realistic constraint

aligns with our final project where students are asked to consider different social contexts. The second criterion focuses on teamwork which is a major component of the course not only on the final project but also throughout the duration of the course as students will be asked to work in small groups to discuss questions and work on problems. This is a vital skill to learn in engineering which this course will hammer home and will further help them gain the ability to appreciate different approaches to problems.

ABET's third criterion delves into the understanding of the ethics of engineering. This is also touched on in our course in the second week as we delve into community-centered engineering as well as discussing case studies which we help will give students a background to continue to view problems from this lens in their future endeavors. The next criterion focuses on effective communication. This will be accomplished in our course through multiple writing assignments as well as the final presentation and final paper. The final criterion that will be met is learning techniques skills and modern engineering tools. While this is not as much of a technical course as others, students will still be getting exposure to technical skills. These will be covered mostly during week four where we delve into engineering economics where students will learn how to use equivalence factors as well as get some experience in excel. By achieving these outcomes students will have gotten a well-rounded introduction to engineering which will give them vital skills as they begin their engineering careers.

Conclusion

Having an engineering education that is focused on community is important in helping to prepare engineers today for the societal needs that they will encounter today. Over the course of this report, we have used social, political, and ethical context to discuss and explore why there needs to be greater emphasis on this type of curriculum not only at Lafayette but on a national

level as well. We believed that this could be accomplished at Lafayette through more exposure for incoming engineering students by introducing a new ES 101 module that exemplifies the value of Engineering Studies and places extra emphasis on looking at technical problems through a socio-technical perspective.

Our initial research into the issues within engineering culture and discussion from earlier in the semester helped us be able to identify many of the current issues and culture problems that we aimed to address. Many of these large issues revolved around engineers losing their way and the loss of trust from the communities they attempted to serve during the 1960s and 1970s. This shifted the way engineers were viewed in society and played a large role in inspiring many groups at the time to come up with solutions to remedy these problems. This was seen on a national level as many universities began to reform their engineering curricula. This historical shift was even seen on a much smaller scale at Lafayette with the introduction of the Engineering Studies program in 1970.

Lafayette's engineering division followed many of the current trends and paths as other engineering programs reformed across the country. The goal of introducing a Bachelor of Arts degree for engineers was to put great emphasis on non-technical skills and push for interdisciplinary studies across campus. This was intended to create engineers who saw problems through a different lens that allowed them to put greater focus on the community. And through being able to address socio-technical issues through engineering better serve their communities. Engineering education has had a shift towards ethical development. This has been evidenced by new ABET guidelines which have placed a growing emphasis on non-technical skills. This allows students to better understand the community. As noted by Professor Sanford in discussions with her, she said: "many important problems in the world are socio-technical

problems that cannot be solved just by technical solutions". It is clear that in the new world engineers will need a greater variety of skills to continue to tackle problems that they are entrusted to fix.

Unfortunately, in the current engineering culture, specialty in non-technical skills is looked down upon. Many engineers believe that being the person with the most technical knowledge and skills is the person best fit to solve the problem. This is a national problem and can also be seen at Lafayette as the Engineering Studies program is looked down upon and even referred to as "pretendgineering". We believe one way that this problem at Lafayette can be remedied is by creating an Engineering Studies focused module to help better educate students about the importance of non-technical humanitarian engineering.

Through this course, students will engage in activities in lectures that will help them achieve a certain set out outcomes. These outcomes will not only aid them in giving them skills that will be building blocks for the rest of their engineering career but also help them better understand the importance of socio-technical engineering solutions. These outcomes which have been outlined in our curriculum proposal include understanding the engineering design process, identifying social, ethical, and economic issues, as well gaining experience in teamwork, and learning better communication skills through the mediums of presentation and a written report. This course will hopefully inspire more students to potentially join the Engineering Studies program but more importantly serve as a backbone for the other engineers to always try and consider the non-technical side of things that they will experience throughout their engineering careers.

The research and design of this course proposal would greatly benefit from further research into the engineering student body. Understanding more of what students feel like they

need in their engineering education would be a great way to help improve this course and other curricula. On another note, for such a short course as an ES 101 module, the constraint of a seven-week schedule also puts restrictions on the amount of material that can be taught to the students. Double the time could be spent on different topics if the course was longer but the brevity of ES 101 is a part of what also helps make the course special. A more in-depth version of this project would be to deep dive into all the engineering curriculum at Lafayette and attempt to try and embed interdisciplinary topics throughout all the engineering majors and courses taught. Would also have been beneficial to discuss with all the various engineering departments heads many of the issues we discussed and what their thoughts on them were and how they see the future of engineering progressing in the years to come. We hope that this proposal is taken into consideration and that it will hopefully be added to the list of ES 101 modules as we believe that this course would greatly benefit the Lafayette engineering community.

This project helps show the growing demand for more holistic engineering education with a community at its center. Implementing a course like this at Lafayette is just the beginning. Much more needs to be done to continue to grow these ideals in the engineering department at Lafayette; if engineering students had an infinite amount of time available to them, adding courses that promote the 'holistic' engineer's education would be a step forward in the right direction. As it stands though, the current required several classes for traditional engineers would make fitting extra humanitarian courses a time crunch on majors that already require that their students overload on classes should they come in without existing college credits or elect to not take classes over the summer and winter. Sweeping education reform at Lafayette would have to take place for the 'holistic' engineer to become the standard at Lafayette College instead of just a few proud EGRS majors, however, we believe that introducing engineering through the EGRS

lens is a strong step in the right direction if we are to begin sparking a change on Lafayette's campus. Getting students excited about engineering, and about Engineering Studies specifically would have nothing but positive impacts within the engineering community at Lafayette College.

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