Adding Art to the Acopian Stairwell

Groundwork for a Proposal

Josh Blake

Merinda Hansen-Kemp

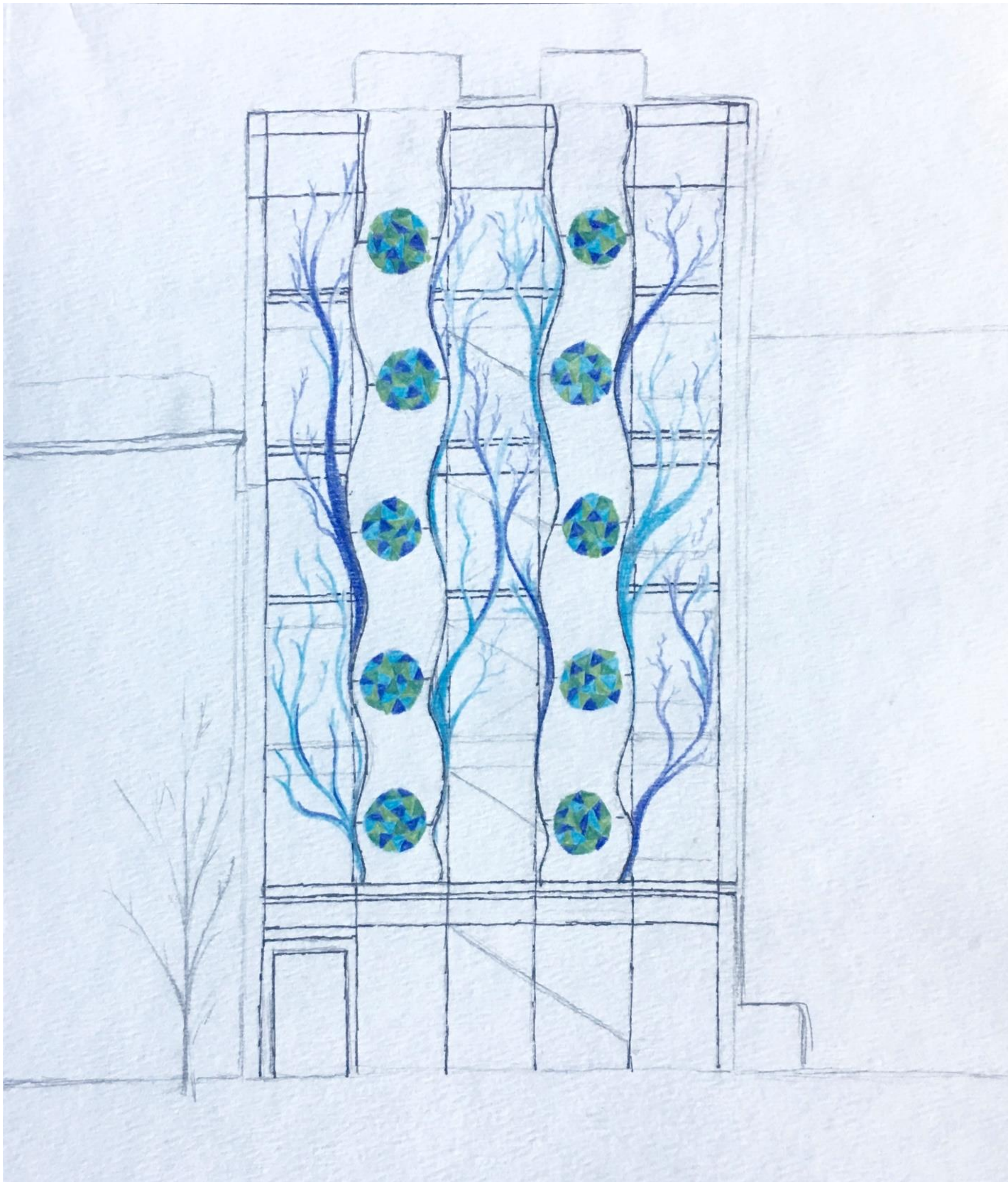
Katie Millar

EGRS 451: Engineering Studies Capstone

Dr. Benjamin Cohen

Fall 2017

Table of Contents:



Design by group member Katie Millar '18

Introduction

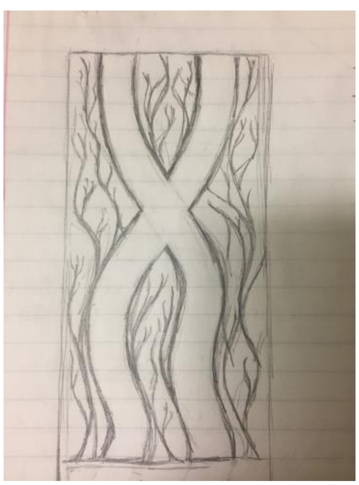
Acopian Engineering Center is home to any student pursuing an engineering education. Students will spend a vast majority of their four years walking the halls and stairs of Acopian. Currently, this building doesn't foster a creative or positive learning environment. Acopian is not an architecturally pleasing building, and its lack of enticing aesthetics perpetuates the negative connotations of engineering as a discipline that focuses solely on technological performance. Acopian is a no-frills, cut and dry building designed to provide a space for academics but does nothing more to foster learning.

Acopian Engineering Center was built for functionality, not to be the most aesthetically pleasing building on this campus (S. Hummel, personal communication, November 10, 2017). This explanation perfectly highlights what our project hopes to accomplish; adding an art sculpture to the central stairwell that will transform this dull, dreary building into a happier, brighter learning environment. "It's not about adding on arts education. It's about fundamentally changing education to incorporate the experimentation and exploration that is at the heart of effective education" (Lahey, 2014, p.3). Lafayette has the privilege of having an art department on campus, therefore why wouldn't they use it to help diversify the curriculums of all disciplines?

Current Acopian Staircase

Lafayette engineering is an intense, intellectual, and powerful community that strives to create and produce only the best engineers. Due to this competitive nature, the engineering culture has difficulty understanding the benefit of collaborating with other community members. Our goal is to change this culture by adding an art installation that highlights the interdisciplinary nature of engineering by showcasing the power of combining multiple groups of the Lafayette community to *spice up* Acopian. By adding an artistic element, the building will be brighter and more welcoming not only for the engineering students, but for prospective students and visitors as well. We want this project to start a conversation about engineering, art, sustainability, community, and what we believe should be the future of engineering.

The future of engineering will not be brought about without issue. We must overcome numerous obstacles before implementing our art display. These problems include the constraints of the canvas, the view of art within engineering, and the expert culture within engineering. A limiting factor for our design process is the constraints that the canvas puts on our design. Our canvas, the glass wall behind Acopian, is limited in that its structural strength is uncertain at best. We are also limited in where we can attach our installation to the glass wall. However, this challenge has opportunities within. Adding to a glass structure present the unique opportunity to affect the natural light which enters the building. It also creates a dynamic where any art installation will be seen close up from inside the building and far away from outside Acopian. This creates the possibility to vary the art's message of the art based on the viewer's physical perspective. Overall, the Acopian stairwell presents numerous challenges and opportunities when considered as a canvas for our art installation.



Original design sketch by Katie

The inspiration for our design flows from the Lehigh and Delaware Rivers in the city of Easton. The two rivers have played an integral part in the shaping of the Easton community, and by extension the Lafayette community. Our design will consist of two plastic halfpipes, formed in the rough likeness of a river path, which will be affixed to the outside of the glass window panes in the Acopian stairway. Within these plastic halfpipes, technicolor glass orbs will be strung across the piping by steel rods. Surrounding the halfpipes will be a series of decals on the windows designed to resemble tributaries. Once again playing on the theme of the rivers running through Easton. The decals will add to the artistic element of the installment by leaving interesting shadow patterns within the interior stairway. Additionally, the glass orbs will reflect light into the stairwell, creating an interface of colorful lights and contrasting shadows.

The two plastic half-pipe “rivers” serve as a metaphor of the merging between engineering and liberal arts. To highlight this as a key principle of our Lafayette experience, the installation will also contain a pumping mechanism to supply a flow of water through the plastic halfpipes. The water will not only increase the aesthetic appeal of the installation, but it incorporates fundamental aspects of creative engineering design and more calming environment. Understanding the concepts of fluid mechanics is an integral aspect of an engineering education, and including a pump that utilizes these ideas in the art installation successfully blends the two disciplines.

The pump will be powered by solar panels located on the roof of Acopian, adding to the engineering aspects of the art installation. The solar panels allow for a higher degree of sustainability within the project. The panels will provide energy to power the water pumping mechanisms without requiring more substantial power requirements from Acopian. The installation is also sustainable in that the water that runs through the halfpipes will be collected from rainwater, and recycled through the system.

This project will include social, political, economic, and technical analyses that discuss the design details in more depth. At present, we have three possible project stages of varying economic and feasible difficulties to present to key community members with the goal of gaining support and funding for the installation. The hope is that our research will convince key community members that this project is worth investing time and money into because it will benefit student life and the Lafayette community

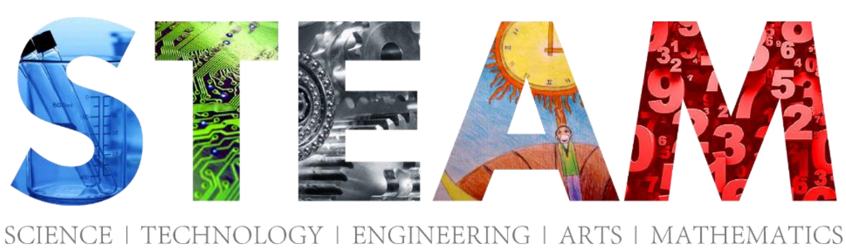
Social Context

Introduction

Our social analysis highlights the three main contexts driving this project. The main focus surrounding the contexts are the need to take an interdisciplinary approach to transform engineering culture and education. We break the social context down into the cultural, educational and psychological contexts, each expanding on the underlying social elements defining our problem.

Educational Context

When someone says "engineering", the first thing that comes to mind is often a focus on functionality, with form and effects as byproducts of the simplest and easiest technical solution to a problem. This somewhat negative view persists not because it is the inherent nature of engineering, but how engineering is taught in colleges and universities across the nation. Engineering education in recent history has maintained the wide berth of disconnect with other disciplines. This is largely due to the strictly technical focus of traditional accredited programs. Within these strictly regulated programs, it has been found that "creativity is not appropriately taught or rewarded" (Atwood, 2016). One study found that of engineering students with self-described highly creative dispositions, only half would graduate in the engineering discipline (Atwood, 2016).



Creative students are being discouraged from pursuing an engineering degree because their creative inclinations are not acknowledged or developed. Perpetuating the stereotypes, emphasis is placed on solving problems solely through the most efficient object, with no room for creativity. This focus on engineering and technology as a highly technical and functional object, stems from the anti-humanist view of technology, and technological determinism. Anti-humanism is a school of thought that places technology as a physical object and ignores the circumstances surrounding the product which shape its use (Matthewman, 2011, p. 8-26). Anti-humanism regards technology in terms of technological determinism, which is the idea that technology has the ability to shape social and cultural constructs. This viewpoint has been reflected in engineering education. Thinking in terms of technological determinism, the contexts in which engineering technologies are placed are ignored, because the assumption is that these technologies are ingrained with inevitable and predetermined influences. In other words the object's effects are fixed within its technology, and there is no way to design it to have a certain desired outcome.

With this mindset ingrained, engineers have been taught to design the technology, and let it run its "natural" course within society. The worry is that continuation of this type of mindset will create engineering students that are "not fully comfortable thinking creatively and considering their designs for real world contexts" (Constantino, 2010, p.50). There has been much controversy surrounding the curriculum and ABET accreditation, and whether or not these programs will continue to "foster improvement and innovation" (Deans and ABET Review Accreditation Criteria, 1990, p. 3). Engineering education has prepared its students to create things, but it has not taught them how to consider how their designs will fit into the larger contexts that shape the socio technical systems they are ultimately placed within. Continuing to educate in this way will only produce engineers that are ill equipped to produce creative solutions, and will not be able to keep up in a world that is rapidly changing (Constantino, 2010, p.50).

It isn't just that engineering has tunnel vision for the final technical product, but it places itself on a tier above other disciplines. There is an "expert versus novice" mentality, that engineers are the experts with highly coveted technical skills, and other skillsets are somehow less than or inferior to their technical know-how. Technical skills are of course, essential in the engineering profession. However, there is a need to broaden the knowledge of the typical engineer, such as incorporating creativity to engineering curricula. This will ultimately attract more creative engineers, and move engineering in a positive and productive direction, stimulating innovation (Atwood, 2016). With the incorporation of creativity into design, engineers "are able to innovate in ways that improve our quality of life and the state of the world" (Daly, Mosyjowski, Seifert, 2014). An artwork in the Acopian stairway will help to demonstrate this positivity, and the importance of finding solutions outside of a technical context. In the piece, engineering is a supplement to provide a more conceptual functionality to an artwork. Merging art and engineering allows for greater creativity and innovation, rather than simply completing a task. Opening engineering to other disciplines such as art will help in "fundamentally changing education to incorporate the experimentation and exploration that is at the heart of effective education" (Lahey, 2014). Artwork in an engineering building will exhibit the interdisciplinary development of the engineering department, pushing Lafayette's curriculum to a better future of engineering education. It will also show students the possibilities for application of their technical skills. Beyond the calculations and measurements, there is opportunity to incorporate these skills into other areas of academia.

Psychological Context

The psychological context surrounding engineering largely has to do with the perception of engineering and the emotions of the students within engineering. In terms of perception, there are two relevant subsets within the Lafayette community. There is the perception of those within engineering and those outside of engineering. We are also interested in the emotions of engineering insiders and how those emotions affect learning outcomes. Specifically, our project aims to improve both the general perception of engineering and the learning outcomes of engineers through the use of art.

Engineering has a perception issue both from outside and within. From an outsider's perspective, engineering seems not only boring, but almost hostile. The subject matter combined with learning environment makes outsiders perceive engineering as a foreign concept, which stands alone in its own academic realm. This negative outward perception is reflected by the proportion of students in higher education that enroll in and graduate from engineering programs. Around 10% of first-year college students in the United States plan to major in engineering, and only 5% of college majors finish an engineering bachelor's degree (National Science Board, 2014, p. 116). Clearly, engineering as a whole needs to shift not only its perception, but its retention.

On a school specific level, Acopian and its physical atmosphere has a negative impact on Lafayette engineering student learning outcomes. It has been shown that negative emotions are positively correlated with poor learning outcomes (Pekrun, Goetz, & Titz, 2002, p. 102). This is important because Acopian, as a building, is a sterile, functional construction that only serves as a space for engineering education. Because Acopian is harshly lit and lacking of any kind of aesthetic consideration, it's apparent that the physical environment has a negative impact on the emotional state of Lafayette engineering students (Kuller, Ballal, Laike, Mikellides & Tonello, 2007, p. 10). These negative emotions can lead to decreased performance within the classroom (Pekrun, Goetz, & Titz, 2002, p. 102). This is not to say that Acopian's physical design is causing students to fail their courses, but as a space it is doing little if anything to improve the learning environment.

Our project aims to correct the psychological woes of the Acopian engineering center by challenging the general perception of engineering and improving the environment where engineering education takes place. This combination of outcomes will simultaneously intellectually stimulate and comfort Acopian's inhabitants. The result of this effect will be an overall more welcoming environment that fosters a sense of interdisciplinary culture.

In this proposal we attempt to address the issue of negative perception by integrating art and engineering. By showcasing an integration of art and engineering we intend to communicate the fact that engineering is not something that exists by itself. The art display intends to show that engineering, when integrated with other disciplines, enhances both itself and the discipline it's being integrated with. In this case, the art on the Acopian stairwell will show the community that the possibilities of engineering are limitless. It will also challenge what they perceive as being engineering. Our art display, at first glance, may not seem like engineering. However, if the viewer analyses the design, they will realize that engineering plays an integral role in the artwork. This realization is what will change the psychology of the Lafayette community. Realizing the interdisciplinary potential of engineering could have a profound impact on those who view our art display.

In addition, our art display aims to improve Acopian by making the building psychologically more comfortable. The aesthetically unpleasant building lacks any amount of diverse color and comfortable lighting. By improving the levels of natural light flooding the building our project could improve the mood of those working in Acopian. Also, by introducing different shades of light our project aims to create a more comfortable atmosphere within Acopian (Kuller et al., 2007, p. 10). Furthering this narrative, enhancing the color palette of the building's light will create a friendlier, welcoming environment. In general, by improving both the lighting and aesthetic of Acopian our project will improve the emotional status of engineering students, thus improving learning outcomes of students.

Cultural Context

Lafayette markets itself as a strong community with an accepting and open culture for anyone. Yet there is a sense that Acopian is only for engineers and that engineers are the best and brightest on this campus. However, we are hoping to shift the cultural identity of engineering by showcasing its true interdisciplinary nature by combining art and engineering. The cultural context of this proposal will discuss challenging perception to enable change, including Easton, recognizing engineering as interdisciplinary, the importance of public art on college campuses, and student interaction.

Studies have shown the value of public art on college campuses for student life as well as for the campus' aesthetic. In *The Administration of Public Art on State University Campuses*, Lawrence Mankin states that, "Public art can serve multiple purposes for a university campus, including (*a*) embodying and reflecting the intellectual and creative mission of the institution, (*b*) enhancing the aesthetics of a campus, (*c*) fostering campus community spirit, and (*d*) memorializing individuals or events significant to the institution's history." (Mankin, 2002, p. 57). Our design will encompass all of these purposes and showcase the value of public art for a community. Our project will exemplify the benefits of receiving an engineering degree from a liberal arts college; that engineering and liberal arts are deeply intertwined. Engineering Studies is a distinct major offered by Lafayette College and our project would memorialize its importance for the college and its students. This project hopes to show students that they can receive a technical education that also fosters creativity and inclusion, part of Lafayette's mission. The addition will also enhance the interior and exterior of Acopian, which will benefit the overall campus aesthetic. Lafayette is culturally rich and a public art installation designed by engineering studies students and the Lafayette community could perfectly highlight its ability to be academically diverse.

As defined in the problem, we believe engineering culture focuses too much on the technical rather than recognizing the benefits of a diverse understanding. Engineers struggle to understand the importance of varying opinions therefor creating a hierarchy between themselves and other disciplines. This project hopes to challenge these beliefs and change the current engineering culture. *Engineering and Sustainable Community Development,* written by Juan Lucena, works through community development case studies, highlighting the various problems engineers encountered when solely focusing on the technical aspects of engineering. Lucena reminds us that, "the engineer might have learned new techniques, approaches, or solutions to problems had he decided to engage the community and listen" (Lucena, 2010, p. 91). Most engineering curriculums don't provide learning environments where engineering students work with students from other disciplines and therefore typically aren't taught how to empathize and communicate effectively.

Engineers can learn a lot from other groups if they choose to listen, therefore for our project we have chosen to work with community members from different areas of expertise; Stacy Levy, Jim Toia, Mary Wilford-Hunt, Scott Hummel, Daniel Sabatino and Benjamin Cohen. Stacy Levy is an artist located in Spring Hills, Pennsylvania who has designed other art installations in the Easton area and throughout Pennsylvania. The rest of these advisors are members of Lafayette College faculty and staff. Jim Toia is an artist and professor. Mary Wilford-Hunt is the college's architect and a professor. Scott Hummel is the Director of Engineering. Daniel Sabatino is a mechanical engineering professor at Lafayette College. Finally, Benjamin Cohen is the Engineering Studies capstone professor. Their input has provided us with varying opinions to create a sustainable, enticing, interdisciplinary project that includes an involved and engaged community.

This project hopes to change the current culture to one where engineers and artists want to work together and recognize the importance of varying opinions and backgrounds. The book, *New Creative Community: The Art of Cultural Development*, mentions that “the objective of Cultural Development is culture--as a sociological dynamic in which society grows and changes; as a powerful sector of the economy; as a professional environment inhabited by skilled creators, artists and craftspeople; as a transmitter of aesthetic expression, ideas and values” (Goldbard, 2006, p. 121). This definition of cultural development showcases the value culture provides for a community. For Lafayette, the addition of art in the Acopian stairwell will bring together art, mechanical engineering, civil engineering, chemical engineering, and engineering studies in the hopes of changing the cultural dynamic of the engineering community to demonstrate how interdisciplinary engineering should be.

Lafayette College works to maintain a close relationship with Easton, therefore incorporating Easton's history and culture is a valuable asset to the design. Easton's two rivers, the Lehigh and the Delaware have contributed to Easton's history, therefore we want the design to start as two rivers and expand into tributaries as they travel down the building. The staircase is visible from both the football field as well as Detrich Road that circles around Fisher Field.

"Bushkill Curtain".

Image from stacylevy.com

These viewpoints are important for students and visitors so installing artwork on the staircase will invite people to come to Acopian to get a closer look. The two rivers will also symbolize the bridging of engineering and liberal arts because as stated on the Lafayette website, "[i]nterdisciplinary academic programs encourage students to integrate knowledge and develop critical-thinking skills that transcend fields of study" (Lafayette, 2017).

Local artist, Stacy Levy, has designed multiple projects in the Easton community, one of which is the "Bushkill Curtain" which is installed on Bushkill Creek near Lafayette's Film and Media Studies building. Part of our inspiration came from her project. We contacted her to include an artist's opinion on the scope, materials, and overall idea and message of the project. As someone who has already worked closely with the Lafayette and Easton community as well as created many other public art installations, her input was incredibly valuable. She helped us with the feasibility of our design as well as useful materials, structural components, and stressed the importance of prototyping. (S. Levy, personal communication, November, 10, 2017).

Gaining support and information from members inside and outside of Lafayette has helped remind the community the value of integrating disciplines.

Conclusion

We believe these three social contexts really define and expand upon what our project is hoping to solve. Each context explores a fundamental aspect of how we hope to change engineering culture and education and how the Lafayette community views engineering on this campus.

Political Context

Introduction

There are several factors that make up the political context of our project, and have shaped our solution to the problem at hand. The political context is evaluated through three separate focal points. Insider and outsider sources are assessed to gauge community attitudes and perceptions of the problem. The feasibility of the project within the current political climate, the effects that it has on our design, and the possibility of its funding are taking into consideration. Lastly, the artwork considers the overall sustainability, and how its promotion can increase the feasibility and effectiveness of the final project by promoting the future of engineering.

Insider and Outsider Perspectives

Part of our political analysis covers the need to gather perspectives from inside and outside the Lafayette community. Within the political context, it is important to think of who thinks there is a problem, who can help us resolve it, and who are going to be the decision makers? Having different community members involved in our project has helped transform our concepts and ideas because varying input solved unseen problems as we progressed. As stated in *New Creative Community, a* "direct, hands-on participation moves people more than anything else, enlarging their vision of possibility much more immediately than might be achieved through mere observation" (Goldbard 2006, 54). We believe that the more interaction we have with community members, the more excited they will become about the success and implementation of this project.

Words used to describe the building of Acopian and how it makes students feel. Words provided by Lafayette engineering students from various engineering disciplines.

Although we believe that Acopian is in need of public art to improve the overall aesthetic, we reached out to community members to see if they agreed, to avoid solving a problem that didn't actually exist. When talking to students inside and outside of the engineering division, it was unanimous that Acopian is "like a dungeon" and in desperate need of a makeover (A. Barton, personal communication, October 4, 2017). We polled various engineering students to provide words and adjectives describing how they would describe the building of Acopian and how it makes them feel. We then put these words together on a word cloud to showcase the dissatisfaction that these students have with their current learning environment. As our group researched and interviewed community members, we found that they are interested and excited about our project and want to help and get involved. Jim Toia, Scott Hummel, Daniel Sabatino and Mary Wilford Hunt have all offered us input from their distinctive backgrounds and provided us with direction to help shape our project. Jim Toia, a Lafayette art professor, provided us with names of artists such as Olafur Eliasson to look to for inspiration as well as helped expand on how to best use light in the space. Olafur Eliasson is an Icelandic artist, now based in Berlin, who "strives to make the concerns of art relevant to society at large" (Eliasson, 2017).

Scott Hummel, Director of Engineering for Lafayette College, gave us insight into where he hopes to see the future of engineering and a possible source of funding for our project. He believes that the future of engineering will have a lot of influence from Olin College, where the curriculum is project based instead of lecture based. He informed us that he has funding for interdisciplinary projects similar to ours and if we came to him with a detailed proposal then we could talk about the logistics of starting implementation (S. Hummel, personal communication, November 10, 2017). Daniel Sabatino, professor of mechanical engineering, took us to his lab to prototype different flow patterns to see how we can manipulate our design to get the best shadowing through the windows. We worked with multiple sources of light and materials to find the most appealing shadow pattern. We came across difficulties keeping the water spread across the plastic since the casts would be completely vertical. We prototyped adding half globe bumps to the plastic and shined a light through the plastic which created a much nicer shadow pattern. We decided that was the best design option for the plastic half casts. Mary Wilford-Hunt, campus architect, provided us with drawings of Acopian and contact information for Stacy Levy. There are many community members that should be involved in the decision-making process, therefore we chose to include both members of the Lafayette community as well as artist Stacy Levy from outside of the community. In this way we included the voice of the college as well as a more removed and unbiased member in the development of our project.

The political context needs to consider who are the key decision makers and their importance to the implementation of the final project. For Lafayette's campus, these key decision makers include Benjamin Cohen, Scott Hummel, Jim Toia, and Allison Byerly. These are members of the engineering and art community as well as Lafayette’s president, each having an important voice in the final decision-making process. The above-mentioned members each have varying degrees of weight to their voices, but it is essential that they see that our project is solving a problem that needs to be fixed. We have discussed our project with Cohen, Hummel, and Toia and they have said that they think an art installation would be an excellent addition to Acopian. The more people and areas of Lafayette that agree that Acopian needs to improve its aesthetic and culture, a greater sense of community will be developed. However it was never made clear what the decision making process entails. The author of *New Creative Community* also states the “more striking, effective or beautiful works of art can arise from the process of deep engagement with other community members. What is learned in process deepens our collective understanding of quality as well as community” (Goldbard, 2006, 55). Overall, including more people throughout the process has allowed for a well thought out design that enfolds community values within the final product and works towards the desired solution.

Political Feasibility

A major political deciding factor in the future of the art in the Acopian stairway project is the feasibility of the proposed project. The expenses associated with the project must be deemed justifiable by decision makers. The feasibility of convincing the college to fund the project largely rests in the design, and its economic strains. The most technical of our designs, including a solar thermal powered pump to constantly disperse collected rainwater through the installment, provides the greatest integration of engineering and art, which is one of the main selling points of the project. However, this design is by far associated with the greatest costs to the college. So while it best consolidates the two disciplines and reinforces the interdisciplinary nature the college prides itself on, it loses feasibility in its large price tag. In order to be the most feasible, the final design must find a balanced solution that both unifies the arts and engineering at a cost the college feels it can afford.

Lafayette is currently focused on expansion, increasing the size of the college enrollment, accordingly adjusting the size of the campus. Because of this, much of the available funds are being allocated to projects that push the college in this direction. There is a large queue of projects that the college hopes to complete, aligned in a hierarchical timeline based on what the college deems to be the most essential in working towards their expansion end goals. With this current political climate, additional projects to be undertaken would likely be need to be considered a necessity to receive funding. A project in an already existing building that does not provide additional perceived functionality to the structure would normally not seem to be a necessary expense at first glance. However, as discussed briefly above, Lafayette prides itself on educating engineers with a broadened interdisciplinary curriculum. As stated on the Lafayette College website, the engineering program at Lafayette "provides an outstanding technical education, but also prepares students with the ability to think creatively, imagine broadly, communicate effectively and influence change" (Lafayette, 2017). Funding an artwork in the Acopian stairway that embodies the very principles that the college touts on their website is indeed a necessity if the college hopes to continue to present this view. If the project is thus viewed as essential to uphold the reputation of the Lafayette engineering department, the feasibility of its inception into Acopian is reinforced.

Something to keep in mind in the face of Lafayette expansion as well is the new science center currently under construction next-door. The current political climate this new center creates will be affecting our project. Acopian will be fighting to keep up with the new, selfsustaining Rockwell Integrated Science center. This new building will be the center of all talk on campus and students will be flocking to use the new, exciting amenities. This will require Acopian to find new ways to utilize its current building and stay up to speed. The engineering building and therefore the engineering department might be overshadowed by it shiny new LEED accredited neighbor. The state of the art science center will entice students and highlight the merits of the sciences. In this context, there is a need for Acopian to align itself with the advanced new building that asserts the collaboration across disciplines that is sold as a core principle of the Lafayette community. An installation that combines engineering and art is a perfect addition to highlight the interdisciplinary nature of learning engineering on a liberal arts campus. As Alison Byerly states in an article about the new science center, "[w]e believe that learning and discovery happen best at the intersection of disciplines" (Lafayette, 2017). Once again, an art installation will embody these words, and bolster the image that Lafayette strives to maintain, as being the intersection of engineering and the liberal arts experience. For Acopian to receive a piece of public art that is sustainable, aesthetically pleasing, and an engineering feat, students and visitors will be excited to come into Acopian to see and learn more about how interdisciplinary the engineering community can be. These benefits derived from this current political context of the project add to its feasibility, as they increase the need for the artwork's instatement within Acopian.

Sustainability

A major political context that has shaped our design is sustainability, in every sense of the word. Primarily, we are concerned with the environmental impact of our project on the micro and meta scale. The micro scale consists of how our project affects its immediate surroundings and environment. The meta scale considers the implications that our project has for the sustainability of engineering as a profession.

In a world where climate change is a central issue, it's impossible not to consider environmental sustainability as it affects our project politically. With the construction of the new Integrated Science Center, a LEED certified building, it's clear that sustainability is one of Lafayette's objectives. That said, if we intend for our project to be accepted by the community, it must be designed in a way that abides by the values of sustainable technology and social engineering. In this respect, the best possible outcome is to have our project require no outside energy, avoid disrupting the natural processes that occur in its vicinity, and inspire engineering students to do the same.

Historically engineering education is a discipline that focuses on functionality above all else (Wisnioski, 2012, p. 163). Engineers are taught that problems can be solved if the correct equations are used to tackle the problem. However, in the larger context of the world, more than functionality needs to be considered when solving an issue. There are unquantifiable contexts that need to be considered when solving a problem using engineering. In this respect, engineering should be viewed as a social practice as well as a technical one. If these contexts are not taken into consideration, the technological "solutions" that engineers create can do more harm than good. For this reason, engineering education has aimed to become socially conscious as a discipline (Guyotte, Sochacka, Costantino, Walther & Kellam, 2014, p. 13).

The Acopian Art Stairs Project aims to be as sustainable and socially conscious as possible in the hopes of making it politically more attractive. The more economically heavy alternatives for this project include a water pump, solar thermal, and photoelectric system (costs are further described in the Economic Analysis). These systems are designed to be sustainable and self-sufficient in that they would not draw on the energy or resources of the existing infrastructure in Acopian. This is politically advantageous in multiple ways. Primarily, in trying to get the project approved, a major selling point is that the art employs green technology. The added benefit of these self-sufficient systems is that they have little recurring costs to the school (Parajuli, Pokharel, & Østergaard, 2014, p. 545). Politically speaking, this makes the project much more attractive since the school will not have to continually allocate large sums of capital to keep the artwork functioning properly. The hydraulic and electrical systems would cost only a couple thousand (see Economic Analysis), especially if the system does not need to store energy. Since the pumping system is above ground and removed from plant and soil interference, O & M costs will be considerably lower (Parajuli, Pokharel, & Østergaard, 2014, p. 545).

Another important political aspect of the Art Stair Project is its improvement to the sustainability of engineering as a profession. The best way to ensure that engineering can be effective in the future is to train students to analyze issues from multiple perspectives (Borrego & Cutler, 2010, p. 355). Lafayette College knows the way to encourage multi perspective thinking is through interdisciplinary education. This is exactly what the art stairwell project encourages and inspires. The proposed display aims to make engineers question how they view engineering and how engineering can be integrated with other disciplines. In this way, the project will help to create engineers who do not think of engineering in a purely functional manner. Rather, by inspiring interdisciplinary thoughts, the Acopian Art Stairs project aims to affect engineers in a way that will make them better prepared for the future. In doing so, this project is helping to create an engineering climate which produces engineers who will think of technology in a sustainable way.

Conclusion

The larger political context in which our project is placed is extremely important to take into consideration because it has a great effect on whether or not the project is eventually undertaken. Ignoring the political context would likely result in a design that is not feasible, sustainable, not accepted by the community, and therefore rejected by the key decision makers providing approval and more importantly, funding for our project.

Technical Analysis

The Acopian Art Stair Project is centered upon the integration of art and engineering. Our design combines the use of energy and structural technology to create an artistic design that fully utilizes the available natural resources. The defining feature of our project is the use of water as an inspiration for both the artistic and engineering systems. Our project intends to collect rain water and drizzle that water down a large plastic halfpipe on the side of Acopian. While the water is falling, light will be shined through colored glass, refracting off the passing water stream. This system will be powered by sunlight and be self-sufficient.

The one constant throughout our project is the flow of water. This water is gathered by rain basins that we will place on top of Acopian. However, the water caught in the basins is not intended to remain on the roof. Before the water makes its way down Acopian it will circulate through a solar thermal heating system on top of the building. This solar thermal system will be relatively simple. It will consist of multiple dark colored plastic tubes. These tubes will be heated by solar radiation. This heating system will prevent the water running through our project from freezing during potential snap freezes during the months of October, November, February, and March. This avoids the potential for system clogs as a result of ice formation within the tubing or other structures.

The water will make its way down to the side of Acopian to the wall face, the most aesthetically important part of the installation. The water will transfer from the rain barrels,

"Rain Meander". Pittsburgh Children's Museum. Stacylevy.com

where the water supply is stored, stationed on the roof and through a pipe outward towards the staircase windows. It will then pour the water out along the two clear plastic casts that will take the form of rivers. There will be two of them, the Delaware and the Lehigh or engineering and liberal arts, each 5" wide and will curve as they make their way down the 65' wall. The turns will be smooth to allow the water to flow down gently. These casts will appear as if a clear pipe was cut in half vertically and will be made of acrylic or Lexan, as suggested by Stacy Levy. The idea came from one of her projects titled, Rain Meander that uses a clear plastic cast for an installation in the Pittsburgh Children's Museum. The casts will have half spherical bumps, approximately 4" in diameter. After testing different flow patterns with Sabatino, we found that shining light through clear plastic that had sizeable dents, the shadow of water flow was most appealing.

Acrylic and Lexan are clear plastics that are flexible, durable, lightweight, and shatter resistant. The differences are that acrylic is clearer, cheaper, and won't turn yellow however is more likely to crack or chip. Lexan, or polycarbonate, scratches more easily, is more expensive, and could yellow over time but has higher impact resistance and is less likely to chip or crack (A&C Plastics, Inc., 2017). We would need to prototype and test each one to see which would be better for this project, however ran out of time to proceed with testing. These tubes would be made by purchasing the material and molding it into the desired shape or working with the manufacturer to create a design. These would have to be made into smaller sections and then glued together. Both potential materials work well with glue (Emco Industrial Plastics, 2017).

Each cast will be supported by vertical stainless-steel rods to hold them up parallel to the staircase wall and connected to footers in the ground. These stainless-steel rods will be attached perpendicularly to the side of Acopian to add support in the case of intense winds or other natural disasters to prevent from crashing into the window. The perpendicular rods will be connected at various levels along the wall to provide the most support without distracting from the overall installation.

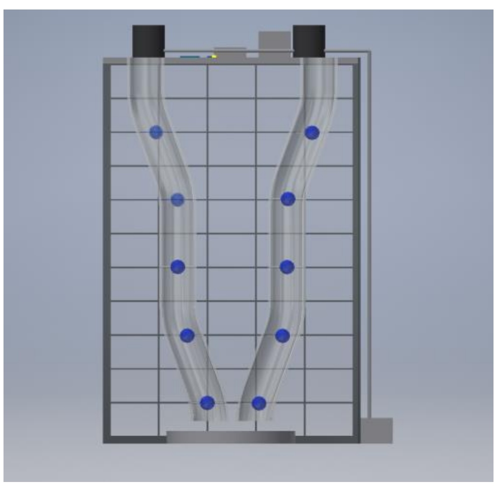
As the water travels down the rivers it will pass glass technicolor orbs. These orbs will hopefully be created by Lafayette art students and will be different shades of blue and green to add to the river design. They will be approximately 2' in diameter and will take on the idea of the inside of a kaleidoscope. The inspiration for these orbs came from artist Olafur Eliasson, an Icelandic artist who's "practice engages the broader public sphere through architectural projects and interventions in civic space" (Studio Olafur Eliasson).

"Infinite color double polyhedron lamp" – Olafur Eliasson

These orbs would be created using stainless steel, color-effect filter glass, and possibly mirrors to reflect some of the light in different directions. Olafur's design used smaller polyhedrons to create one large polyhedron. Another option for a reflective material could be Dichroic glass which "refers to color-effect types of glass that break up light to varying extents and make the different colors of the light spectrum visible depending on the angle and the type of light source" (Peters, 2014, p. 159). This type of glass is discussed in the book *Material Revolution 2: New Sustainable and Multi-Purpose*

Materials for Design and Architecture, in which it also mentions the resiliency and durability of Dichroic glass. The art students designing these orbs could follow his design or come up with their own creations. These orbs could be heavy, based on the quantity of glass used, but will be supported by the plastic casts and footers. During the day, sunlight will shine through these orbs and then through the translucent casts and create light patterns along the inside of the Acopian staircase. At night, LED lights will be located on the ground and shine on the installation so the installation will be visible in the dark both from the outside as well as the inside. The orbs will be hung on the installation by stringing stainless steel rods through the casts and through the orbs. The rods will be stainless steel because that will hold up with the varying weather conditions of Easton.

The casts will only take up part of the wall, since the wall is about 20' wide, so for the empty space on the wall decals will be installed. These decals will be similar to what is seen on the side of public buses. They will be on the windows and will be a continuation of the river pattern by appearing as tributaries down the side of the wall. They will be a mix of translucent and frosted and be varying shades of blue. These decals will be bright enough to see them when looking at the side of Acopian from the football field but will also create shadowing on the inside. Each tributary stem will be various shapes and sizes to create a realistic image of tributaries. These shadows will create different blue shadows and patterns inside the Acopian stairwell as the sun shifts throughout the day. Each window not covered by the cast will have its own decal. When walking



CAD drawing. Front view of design

up the stairs, students will be able to see the overall river and tributary system flowing down the staircase windows and will be greeted with blue shadows and light, watching the rain water run down to the ground.

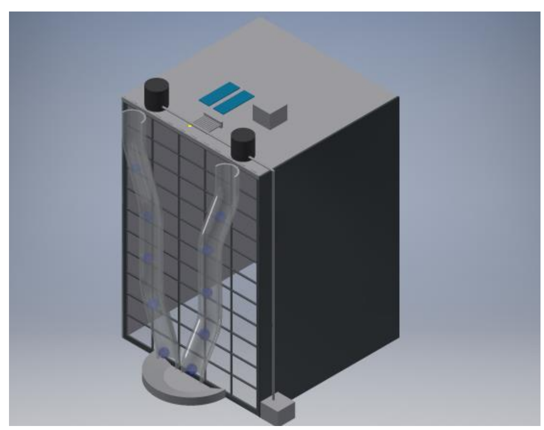
Decal inspiration

The plastic half tubes containing the colored orbs will need to be secured to the wall to prevent swaying in the wind. A frame that uses the existing structure of the glass will need to be installed to keep the tubes in place, as well as support them. A structural analysis will need to be conducted to ensure that the tubes and orbs to not put excessive strains on the building. Since the windows have panes, the wall could be drilled into to attach supports, otherwise it would be very difficult to make the structure free standing.

To support the frame providing stability to the installation along the window, footers would need to be placed in the ground. Typically made of concrete with a rebar reinforcement, footers are an essential part of a support system. In order to install the footers, excavated trenches would need to be dug at the base of the installment, and the concrete poured in. The support structure would then be placed on top of the footers. Footers are especially important in areas that have particularly soft or troublesome soils, since settling could more easily occur.

The length, width, and placement of the footers are all very important and depend on several factors. First and foremost, the size and weight of the structure must be taken into consideration. Acopian spans six stories, and so the footers will need to be able to support a structure that reaches to this height. However, the art installment will weigh much less than a typical building, so the footers will not need to be the equivalent size as those for a six story building. The soil quality is another factor that affects the footers size and placement. Footings spread out the weight of the structure so the soil can carry the load (Concrete Network, 2017). According to Concrete Network, “The load spreads out within the footing itself at about a 45-degree angle, and then spreads out in the soil at a steeper angle, more like 60-degrees from the horizontal.” (Concrete Network, 2017). Spreading the load out puts less pressure on the soil, except for the soil directly under the footer, which needs to be tightly compacted after excavation to avoid extra settling. The type and density of the soil are important when designing the footer because different soils will respond differently to the load. Therefore, in order to properly install a footer to support the art installment, the soil under the pavement surrounding Acopian needs to be analyzed to ensure that the structure remains standing.

As the water flows down the plastic half tubes, supported by the frame relying on the correctly placed footers, it will eventually reach the bottom of the installment. Here, it will be collected in a retention tank. The tank will hold the water, and allow it to be pumped up and back through the installment. The tank will need to be sufficiently large to hold the volume of rainfall typically expected in Easton. It will need a spigot to drain in case of maintenance purposes, and should be designed to keep out any insects or animals. The tank will also need to have an overflow system, in case of unexpected rainfall. To divert overflow water, a drainage swale will be installed to carry water away from the building and surrounding parking lot. A drainage swale is typically shallow rock filled basin with gently sloping sides (This Old House, 2017). The swale can be surrounding by plants, or have



CAD drawing of design

plants down the center (This Old House, 2017). The plants help to absorb the excess water, while the rocks divert the water away from the building.

The water moved up the side of Acopian using a hydraulic pump. This pump is required to move the water at a flow rate of 2 m^3/h. Using the ideal flow equation $Ph(kW) = q \rho g h / ((3.6)106)$, we found that pumping the water 21.6 m up Acopian's stairwell wall would require .138*h(kW)*, assuming a pump efficiency of 85% (Lysen & Hulle, 1982, p. 56). Using the Waterway Iron Might Pump as an example, our theoretical pump would have a voltage of 115 V ("Spa Guts," 2017).

In an effort to make the water pumping system clean and self-sustained we plan to power the system using solar panels to be placed on the roof of Acopian. With a solar resource of 4.2 KWh/m^2/day Easton has a slightly high level of solar energy than the average US town. In order to intercept the most possible solar energy, the solar panels would be placed at the optimal angle for their latitude, which would allow them to intercept approximately 4.57 kWh/m^2/day. With energy efficiency of about 15%, polycrystalline panels would be the most likely type of solar panel to be used in the limited available area on the roof. Using the equation "(4.57kWh/m^2/day)(.15)(1/24days/hr) = installed capacity", we know the system would have an energy capacity of about .02856 kWh/m^2/hour (Lysen & Hulle, 1982, p. 56). This capacity indicated that we would need to install at least 3.15 m^2 of polycrystalline panels in order to power the pumping system.

If we want the system to operate in times of low sunlight, the solar panels would have to store the energy that they gathered before it could be used to power the pumping system. Because we are using solar energy, the panels would only be gathering energy for less than half of the day. Assuming this battery or solar storage module would need to store approximately a day's worth of energy, we would need a battery with approximately a 1.0 kWh storage capacity. However, if the water was only set to run for a portion of the day, a smaller, more reasonably priced battery or no battery could be used instead (Lysen & Hulle, 1982, p. 55).

Since our system is self-sufficient, water will repeat the cycle of pouring down the display as long as there is enough of a solar resource. In this way the water levels of the system will gradually build up to the point where drainage will occur every time it rains. This is when the installed swale will become particularly necessary. Ideally, the result would be a design that needs little maintenance and positively impacts the surrounding environment.

Economic Analysis

When considering a project it is important to have a full understanding of both its costs and benefits. What utility is the project providing its financier and over what time horizon? In the case of the Acopian art stairs project, the benefits mostly exist as positive externalities and the costs as both upfront and recurring expenses.

There have been found to be many positive externalities that will benefit the college, incentivizing the initial investment. First and foremost, public art has many positive psychological effects on viewers. It can build community, enhance and enrich man-made environments, help cope with anxiety, and even provide a greater level of consciousness, not to mention, happiness and joy (Bach, 2006, p. 27-28). Students that are in a higher state of psychological well-being will overall perform better on schoolwork. If there is an artwork in Acopian that provides, joy and could potentially relieve anxiety, it is likely that students will have greater mental functioning, and therefore a greater capacity to excel in their studies. Better performance from students would increase the college's statistics, and therefore their rankings within the colleges of the country. With better rankings comes an increased ability to entice future students to enroll in the college, bringing in more revenue for the school.

The college also hopes to increase its size, in order to receive the increased revenue that is associated with a greater enrollment of students (Tatu, 2016). However, there is a large push back from local residents against the college's expansion (Tatu, 2016). One of the many benefits of public art on college campuses is that it has been shown to "positively affect the local economies" (Landi 2012, 24). If the college could help to improve the local economy through a public art installation, town-gown relations would likely be less tense. If it could be shown that the college is actually benefiting the local residents, they might be less resistant to the desired expansion. The college would then be able to increase its size and bring in the desired extra revenue to complete other needed projects.

Public art can also be used to “embody and reflect the intellectual and creative missions of the institution” (Landi, 2012, 23). An artwork that showcases the principles and values of the Lafayette educational experience would be intriguing to potential students. Such an artwork could be a big selling point to prospective students, and would effectively advertise the interdisciplinary nature that Lafayette prides itself on. The artwork would be a physical, concrete example of the college’s blending of liberal arts and education, as opposed to simply parroting it on tours. It would be a testament to future students that Lafayette is the sort of school that promotes innovation, and would help to bring in more applicants, driving the acceptance rate to new levels. The college would receive greater prestige, and a greater desire for students to attend, which in turn would bring in more tuition payments. Greater prestige for the college would also mean better futures for graduates. Employers would be more likely to higher Lafayette graduates if the acceptance rate was lowered, and the college subsequently received higher rankings. As alumni further progress within their careers and have a higher likeliness of being hired, and making larger salaries. With more expendable income, alumni would be more likely to donate to the school in the future, once again providing the college with more economic gains.

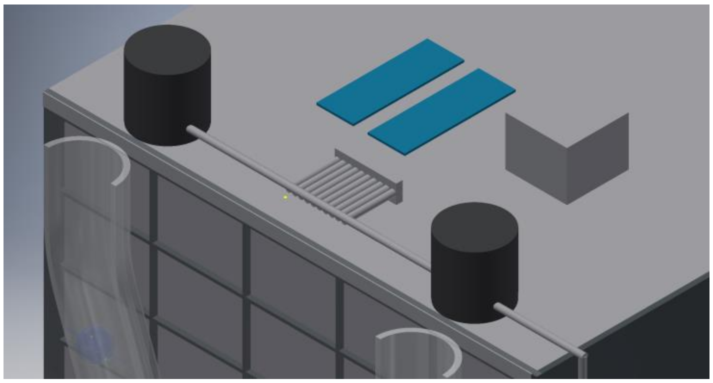
To acquire the benefits of a public art installation, the school will need to fund mostly upfront costs. These costs will generally fall under the category of materials, parts, construction, or labor. For the purposes of this proposal, the main focus will be on materials and parts. Construction and labor costs would be a reasonable next step for future iterations of this project.

The nature of this art installation means that a majority of its costs will be upfront. These costs will generally fall under the category of materials, parts, construction, or labor. For the purposes of this proposal, the main focus will be on materials and parts. Construction and labor costs would be a reasonable next step for future iterations of this project.

The main cost of this installation will stem from the large half cylinder that will run down the length of Acopian and support the glass orbs. At this time the cost of the half pipe and its casting are yet to be determined. We suggest the next phase of this project investigate the costs of associated with casting the half pipe, building its structural supports, and maintaining the structure itself.

Another significant source of cost will be the glass orbs suspended within the large half pipe. These orbs are intended to be approximately 2 feet across. They are expected to be made using colored/stained glass, which is $10.50 per square ft ("Home Depot," 2017). The costs of covering the surface area of one orb would be 4*π*10.5= $131.95. That should be the extent of the cost since the labor is intended to be done by students and the binding material is considered to be a negligible cost in this context. In this estimation, 10 orbs are being utilized, which would leave the cost at $1,319.50. The rods pinning these orbs to the plastic casting would be 4' long, 1.5'' diameter. At a cost of $52.25 per rod, these metal parts would have a total cost of $522.50 ("Metals Depot." 2017)

An important source of expense is the water and electricity system. The heart of the water system, a ⅛ hp hydraulic pump with a voltage of 110V or 220V and a cost of $160 ("Spaguts," 2017). The pump will be charged by two 265 watt solar panel with a combined cost of $730 ("Delphi Glass," 2017). The energy generated by the solar panel will be stored in a 1.2 kWh solar energy storage module. The storage module has a cost slightly greater than $1227.79 ("MG Solar-Shop," 2017). Another major cost of the water system is the storage container for the accumulated water. A 500 gallon plastic water storage tank costs about $359 ("Plastic-Mart," 2017). A similar cost will be affixed to the water basin that will be catching rainwater.



CAD drawing. Solar panels, rain barrels, solar thermal, storage module.

Also, we intend to modify the windows of Acopian with a decal or etching. The intention is to create an imprint that will cast a shadow representing a tributary system. There are a number of ways to achieve this effect, however most of them are fairly expensive. One of the cheaper options is to use window decals in order to create the desired effect. One decal can cover a singular Acopian window (43''x68") at a cost of $136.50. This alternative would cost a significant amount if any large area were to be covered. For example, to alter the windows on either side of the half pipe would require about 30 decals. This would cost $2,490 and may not have the desired effect since the decals would have to be identical ("Signazon," 2017). If the decals are individually designed the cost would be $4,095. Future groups should consider if it is worth the increased costs to have a better, more aesthetic design.

These upfront costs give a reasonable picture of what the materials and parts for Acopian Art Stairwell project will cost. All together these estimated costs add up to $7366.79. It should be noted that these are purely the costs of materials for only a portion of the most expensive alternative. This estimate does not include labor, support structures, half pipe castings, and smaller hardware items.

Item	Number	Individual Cost	Total Cost
Solar panels	2.00	$365	$730.00
Rain barrels	3.00	$359	$1,077.00
Storage module	1.00	$1,228	$1,227.79
Half pipe casting	TBD		
Technicolor orbs	10.00	$132	$1,319.50
Rods	10.00	$52	$522.50
Support structure	TBD		
Decals	30	$83	$2,490.00
Total			$7,366.79

The majority of the expense of this project will be the upfront costs, however there will also be reoccurring costs. These reoccurring costs will take the form of cleaning, replacement of parts and other general maintenance. Not all parts will require cleaning but certain parts will at different time intervals once the project has been installed.

Elements installed along the wall that will need certain maintenance include the casts, technicolor orbs, and the decals. The plastic casts will need to be cleaned once a semester from bird poop and other things sticking to it over time. They can be cleaned with simply soap and water. The plastic casts should last as long as they don’t crack and scratches can be fixed with either drilling a hole or injecting methylene chloride into the crack. After ten years, it is possible that the plastic will start to yellow in which case they would need to be replaced (Emco Industrial Plastics, 2017). The technicolor orbs will also need to be cleaned once a semester due to bird droppings, leaves, sticks or other things that could get caught in them or between the orbs and the cast. It is possible that the glass could break and shatter due to birds running into them and then they would need to get the glass replaced. If part of the orb shatters it would need to be unhinged from the caste and brought down to be fully evaluated and then replaced depending on how much of it breaks. Yet if they remain intact, which they should, then they would just need to be washed with soap and water to allow for clear exposure. The decals will be attached to the outside of the window and will need to be cleaned and properly maintained by washing them. The decals typically last around 3 years so they will need to be replaced more frequently if they start to un-stick. They are not re-positionable once placed on the window so they will need to be placed on carefully to avoid misplacement. The decals are also easy to remove and would only need window cleaner and a sharp edge to scrape off (Signs.com, 2017).

Maintenance for the drainage swale would mostly come in the form of making sure that is clear from debris that would restrict the flow of water (Popular Mechanics, 2017). This would mean upkeep of any plants that are installed to absorb water, and could easily be carried out by Lafayette Facilities crews.

The required cleaning and maintenance will require the company hired by Lafayette to come when they would normally clean the windows and then clean installation. This will add to the overall recurring costs of the project.

A key factor of the economic analysis and developmental success of this project is the source of funding for this project. Since this project will be in Acopian and will also include the art department, we will be looking for funding from these disciplines. Scott Hummel, director of engineering, told us that he has funds for projects similar to ours that are interdisciplinary. He told us that if we come to him with a strong proposal then he would be willing to fund this project. He didn’t specify the amount of funds he would be able to allocate; therefore, we also would consider proposing this project to alumni and also President Bylery. We would propose the project in terms of three stages. The first being our cheapest option that would only include the glass decals. This would give the possible donors insight into what the final product would look like and wouldn’t require too much funding. We would then discuss with financiers the second and third installation over a five-year period. This way the funds wouldn’t have to come all at once, especially if Scott Hummel is given more funding annually then we could use grant funds for different years. The five-year plan would also allow for a more in-depth analysis of the second and third stages and would allow the project to reach its full potential by the end of the five years.

Conclusion

Implementing an artwork in the Acopian stairwell is a multifaceted project that requires careful thought and planning that spans many disciplines and departments. Our project, at its inception, sought to create a finalized design for the installment to be implemented within the stairwell. Our group went through extensive brainstorming processes, creating and shaping a design we felt would best combine engineering and the Lafayette liberal arts experience. In order to create the best design, the concepts surrounding the installation were also addressed. Extensive research was conducted on the Political, Social, Technical, and Economic contexts that encompass Lafayette, the Easton community, and the broader topic of engineering education as a whole.

With further research, our design, as well as our conception of our product's end goal, began to shift to align with our findings. Our group has indeed come up with an interdisciplinary design idea for the stairwell, however, this design is not an end all be all. Instead of proposing a specific design, our group intends that this paper be a proposal for an artwork, with our design and research as background information to carry the project into the future. The design may change as others continue to work on the project, as it has changed many times over the course of the semester. With this in mind, our group's main goal has become creating a well outlined proposal to initiate funding and begin the first stages of installing an artwork that will highlight the core values that the Lafayette Engineering department claims to embody, and instill a greater degree of creative thinking within its students.

Throughout the course of our project, we encountered numerous challenges. One of the most prominent challenges we faced was creating a technically feasible idea that aligned with our creative, artistic vision. Initially, our ideas were highly conceptual and idealistic. The first stages of the design paid little regard to the actual feasibility of implementation, and focused solely on the artistic appearance. Our many ideas then evolved over time in relation to our increased understanding of the technical concepts behind our intended creation. As we conducted more research and looked into the contexts surrounding the work, we had to alter our idealized dreams of a potential artwork to fit into the technical constraints. These ideas also transformed with each additional community member we reached out to involve in our project.

Certain aspects of our designs had to shift because we realized that would no longer have the desired effect on the atmosphere of the Acopian stairwell. Our conference with artist Stacy Levy increased our knowledge of materials and their function, and we realized that our original design would be very difficult to carry out. For example, we amended our original idea of stringing multiple smaller plastic orbs through the half pipes because her suggestions and expertise steered us in a different direction.

Another challenge we encountered was working against the clock. We had large ambitions at the start of our project which helped jumpstart our engagement and research. However as time wore on, we realized that our end goal needed to shift. We went from hoping to present a proposal to Allison Byerly to laying the groundwork for the next stage of the project. Another constraint in regards to time was the difficulty in scheduling with community members. For example, we were unable to meet with Daniel Sabatino until our project was more than halfway complete. When meeting with him we ran into certain obstacles with the water aspect of our design and it became apparent that it wasn’t as feasible as imagined. Had we been able to meet with Professor Sabatino earlier, it is likely that our design would have evolved into something different and possible more attainable. However these challenges are much easier to see looking back now and will be learning tools to be used by students in the stages that follow.

Considering the progress we have made, further efforts should be devoted towards creating a deeper technical analysis, speaking with key community figures, and finalizing the artistic direction. Of all the sections that require further research, finalizing the artistic design is the most important. Having a clear picture of the aesthetic is imperative to building focus within the project's scope. Once an artistic design is near being finalized, the technical analysis can be better investigated. Further research within the technical analysis will likely include more research into the pumping and structural systems that operate within the project. These systems are central to the current design and will likely be relevant in the future. Without a thorough investigation of these systems, a serious proposal cannot be realized.

While finalizing the artistic design and later developing the technical analysis, it's imperative that future groups actively utilize and expand the established community contacts. In terms of art, local artists like Stacy Levy and Jim Toia are invaluable resources that can give feedback on the design and prevent future groups from running into avoidable errors. It would be advantageous to establish more of these types of contacts within the artistic community of Lafayette and Easton as a whole. The more artists who are involved in this project, the more likely it is to succeed in achieving its aesthetic and societal goals.

Future students working on the Acopian arts stairwell should make full use of the technical experts that exist within the engineering community of Lafayette. Maintaining a consistent relationship with professors like Scott Hummel and David Sabatino will achieve two goals. Those relationships will make the technical analysis far more efficient by reducing the technical roadblocks the students are likely to encounter. Also, by involving these key figure, support for the project will undoubtedly grow. This will make acquiring funding and future relationship building substantially easier.

Bibliography

A&C Plastics Inc., (2017). *Lexan vs acrylic*. Retrieved from http://www.acplasticsinc.com/informationcenter/r/lexan-vs-acrylic

Atwood, S. A. and Pretz, J. E. (2016), Creativity as a Factor in Persistence and Academic Achievement of Engineering Undergraduates. J. Eng. Educ., 105: 540–559. doi:10.1002/jee.20130

Borrego, M., & Cutler, S. (2010). Constructive Alignment of Interdisciplinary Graduate Curriculum in Engineering and Science: An Analysis of Successful IGERT Proposals. *Journal Of Engineering Education*, *99*(4), 355-369.

Costantino, T., Kellam, N., Cramond, B., & Crowder, I. (2010). An interdisciplinary design studio: How can art and engineering collaborate to increase students' creativity? *Art Education*, *63*(2). Retrieved from http://www.jstor.org/stable/20694825

Daly, S. R., Mosyjowski, E. A. and Seifert, C. M. (2014), Teaching Creativity in Engineering Courses. J. Eng. Educ., 103: 417–449. doi:10.1002/jee.20048

Deans and ABET Review Accreditation Criteria. (1990). *Engineering Education News*, *17*(4), 3-3. Retrieved from http://www.jstor.org/stable/43902622

Delphi Glass. (2017). "*Stained Glass Sheets*." Retrieved from https://www.delphiglass.com/stained-glass/

Eliasson, O., (2017). *Olafur Eliasson*. Retrieved from http://olafureliasson.net

Emco Industrial Plastics. (2017). *FAQs for acrylic*. Retrieved from http://www.emcoplastics.com/acrylic-faqs/

Goldbard, A., & Adams, D. (2006). *New creative community: The art of cultural development*. Oakland, CA: New Village Press.

Guyotte, K. W., Sochacka, N. W., Costantino, T. E., Walther, J., & Kellam, N. N. (2014). Steam as Social Practice: Cultivating Creativity in Transdisciplinary Spaces. *Art Education*, *67*(6), 12-19.

Home Depot. (2017). "*265-Watt Polycrystalline Solar Panel*." Retrieved from https://www.homedepot.com/p/Grape-Solar-265-Watt-Polycrystalline-Solar-Panel2Pack-GS-P60-265x2/206365797

Küller, R., Ballal, S., Laike, T., Mikellides, B., & Tonello, G. (2006). The impact of light and colour on psychological mood: a cross-cultural study of indoor work environments. *Ergonomics*, *49*(14), 1496-1507. doi:10.1080/00140130600858142

Lahey, J. (2014) *Stem Needs a New Letter: Science, technology, engineering, math--and arts and design.* The Atlantic. Retrieved from https://www.theatlantic.com/education/archive/2014/01/stem-needs-a-newletter/282973/

Levy, S. (2017). *Stacy Levy*. Retrieved from https://www.stacylevy.com/

Lucena, J., J. Schneider, and J. Leydens, eds. (2010) *Engineering and Sustainable Community Development* (Morgan Claypool)

Lysen, E., & van Huelle, F. (1982). Pumping Water with Solar Cells. *Renewable Energy Review Journal*, 4(1), 54-59.

Mankin, L. D. (2002). The administration of public art on state university campuses. *Journal Of Arts Management, Law & Society*, *32(1).*

Metals Depot. (2017). "*6061 Aluminum Round*." Retrieved from https://www.metalsdepot.com/aluminum-products/aluminum-round-bar

Mg Solar Shop. (2017). "*Sony Fortelion Life-PO4 Energy Storage Module.*" Retrieved from https://www.mg-solar-shop.de/pv-battery-offgrid-systems/Sony-fORTELION-LiFE-PO4Energy-Storage-Module-1-2-kW.html

National Science Foundation. (2014). Science & Engineering Indicators. National Science Board. *NSB* 14-01.

Parajuli, R., Pokharel, R., & Østergaard, A. (2014). A comparison of diesel, biodiesel and solar PV-based water pumping systems in the context of rural Nepal. *International Journal Of Sustainable Energy*, *33*(3), 536-553. doi:10.1080/14786451.2012.761221

Pekrun, R., Goetz, T., Titz, W., & Perry, R. P. (2002). Academic Emotions in Students' Self Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research. *Educational Psychologist*, *37*(2), 91-105.

Peters, S. (2014). *Material revolution 2: New sustainable and multi-purpose materials for design and architecture*. Basel, Switzerland: Birkhäuser.

Plastic Mart. (2017). "*500 Gallon Norwesco Plastic Potable Water Storage Tank*." Retrieved from http://www.plastic-mart.com/product/3538/500-gallon-plastic-water-storage-tank43101?gclid=EAIaIQobChMIwoi4rdaH2AIVxp8bCh3Fbgg7EAQYASABEgJnP_D_BwE

Signazon. (2017). "*Large Decals*." Retrieved from https://www.signazon.com/large-decals/

Signs.com. (2017). *Signs.com*. https://www.signs.com

Spa Guts. (2017). "Iron Might Circulation Pump." Retrieved from https://www.spaguts.com/products/iron-might-circulation-pump-118.aspx?keyword=&gclid=EAIaIQobChMIjobmqemH2AIVy1YNCh2SswaXEAQYAiABEgKakfD_BwE

Tatu, C. (2016, July 22). Lafayette College plans major expansion, project involves razing homes. Retrieved December 12, 2017, from http://www.mcall.com/news/local/easton/mc-lafayette-college-expansion-20160722-story.html

Wisnioski, M. (2012) *Engineers for Change: Competing Visions of Technology in 1960s America* (MIT)