Feasibility Study for an Artistic Footbridge on the Karl Stirner Arts Trail

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Landing Page

This report is intended to inform the reader on the feasability of a pedestrian footbridge connecting the Karl Stirner Arts Trail (KSAT) to Lafayette's Bushkill campus. In this report you will find four major contexts (Social, Political, Economic and Technical) that resolve to answer the question: "how can a footbridge address the disconnect between the Lafayette College and Easton communities, as well as facilitate the identity of the KSAT?"

The team conducting this research consisted of three engineering studies seniors at Lafayette College: Jake Levy, Emma Fortier, and Rachel Harrington. Each student has unique background knowledge in the engineering and liberal arts fields that embodies the interdisciplinary nature of the engineering studies major.

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The primary focus of this project tackles the disconnect between the Lafayette College and Easton communities. This problem is inherently expansive; its roots trace back far into the town and college's relationship, a situation further analyzed in the Social Context section. Due to the problem's extensive nature, solutions reach far and wide. As this disconnect spawns from a multifaceted relationship, one project will likely not be able to address all of the nuances and angles of such a problem. Nevertheless, this report aims to explore a possible solution to *bridge* the disconnect between the Lafayette and Easton communities.

In light of our identified problem, our group deliberately resisted adhering to the confines of an explicitly technical or non-technical approach. Instead, we determined key elements on which to focus our solution. First, the scope of our work is limited by the fact that our proposed solution would incorporate the Karl Stirner Arts Trail (KSAT). However, this physical restriction is more clear cut than the ideological criteria. First, the solution needs to connect the Easton community to Lafayette; this element directly addresses the problem of a disconnect between the Lafayette and Easton communities. Second, our approach needs to provide an artistic contribution to the trail; our group aims to cohesively weave our solution into the ethos of the KSAT. To this end, an artistic contribution would be integral to this coherence of identity. Last, our solution aims to allow Lafayette students to feel like they are a part of the trail. This final point will be parsed out in full in the Social Context and Political Context as details are specified.

As our group outlined what our solution needed to address, we turned to a proposed project on the horizons of the KSAT Board's agenda: a pedestrian footbridge. Subsequently, this report revolves around the feasibility of building a footbridge over the Bushkill Creek on the KSAT.

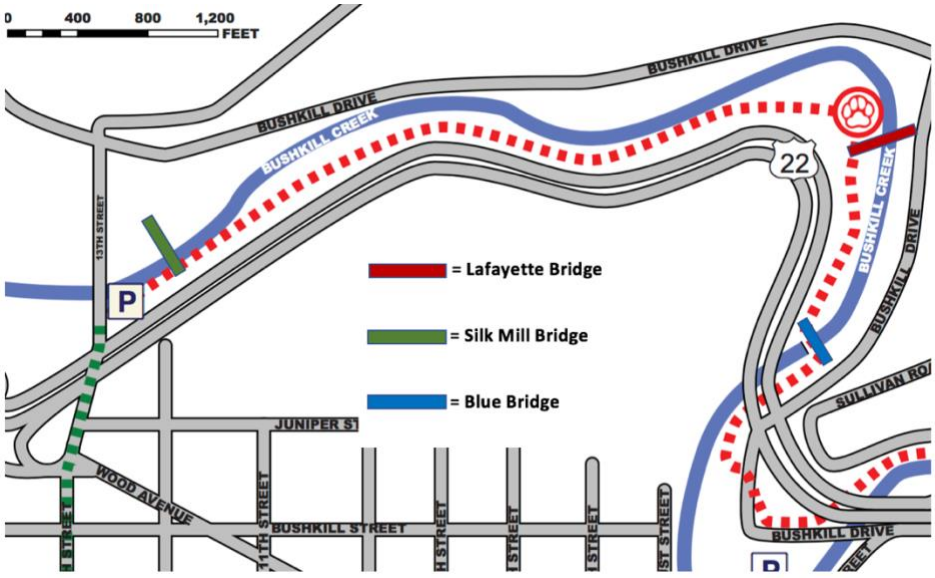

Figure 1: Map of the Karl Stirner Arts Trail

As shown in the above in *Figure 1*, this footbridge would be placed beside the existing dog park, with the bridge connecting one side of the trail to the area where an auto-dealership currently

resides. This location was taken from recommendations from Jim Toia, Chairman of the KSAT Board, and lends itself to a greater development and expansion of the area.

In order to drive this work, our group began with a question: how could a footbridge address the disconnect between Lafayette and Easton and facilitate the identity of the KSAT? We deliberately chose this open-ended question in order to let our research drive our results and to allow our group to fully explore the pros and cons of a footbridge on the KSAT. With this approach, our group equally considers a no-bridge option, implicit in the question. In other words, our group is not making the assumption that a footbridge will necessarily address the given problem or is the best solution to the given problem. Instead, by parsing out the social context, political context, technical analysis and economic analysis, our group hopes to demonstrate the merits and drawbacks of building a bridge on the KSAT. We hope that the next group to inherit this capstone project will be able to look at our report and understand whether or not to continue exploring a footbridge as a feasible option for the city. Furthermore, our group will be providing recommendations throughout our report, in an effort to optimize the positive impact of a footbridge.

In order to properly address our question, both the disconnect between the Lafayette and Easton communities and the identity of the KSAT need to be fully understood. While the former will be parsed out within the Social Context section, the latter will be outlined here, as the KSAT is fundamental to most, if not all, of the following analysis. Physically, the trail runs 2.5 miles beside the Bushkill Creek and contains various and rotating art installations, ranging from sculptures, murals, and light installations. Metaphorically, the trail runs as an artery through the heart of Easton, providing a shared space for the Lafayette and Easton communities. According to the KSAT's website, "the KSAT aspires to define and commemorate the City of Easton's commitment to the arts and become a national destination for art and nature lovers alike" (Karl Stirner Arts Trail, 2017). Similarly, the website comments that "environmental sustainability and public stewardship of an urban 'green infrastructure' are defining factors in the philosophy of the Arts Trail" (Karl Stirner Arts Trail, 2017). With these statements, the KSAT clearly defines two of its defining values: the arts and sustainability. Subsequently, our group prioritized these elements when considering the feasibility of a footbridge and then how these components could be incorporated into a solution.

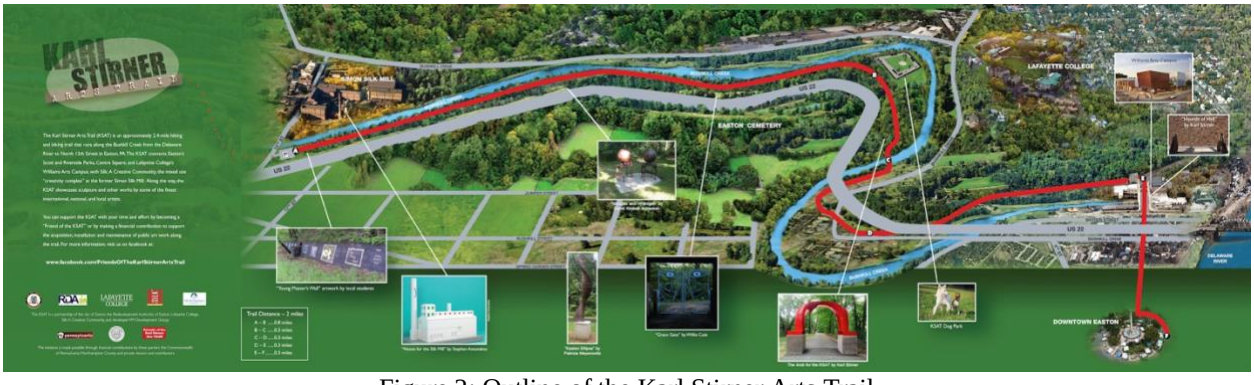

Figure 2: Outline of the Karl Stirner Arts Trail

Apart from the physical description of the trail, the placement of the trail equally plays a role in this project. Here, placement refers both the geographical context and the temporal context of the

trail. In terms of geography, the KSAT is bookended by the Silk Mill and the new Bushkill campus. Temporally, both of these projects are looking to the future with their development plans. The Silk Mill Revitalization project is aiming to rebuild an area of Easton and will continue to become more prominent in the upcoming years. Likewise, the new Bushkill Campus at Lafayette is part of the college's new expansion plan for the next few years. Geographically, the KSAT is placed between these forward-looking projects, thereby granting it the opportunity to connect these developing areas. Uniquely placed, the KSAT provides a *bridge* that would potentially bring these two developments closer in multiple ways. Looking towards the future, this project could represent a foundation for these two new developing areas of the community.

Though the KSAT provides an opportune space, conducting a feasibility study of a footbridge did not present without challenges. First, a footbridge is a fundamentally vague solution. Our group deliberately used an ambiguous definition to allow for the most flexibility in our analysis and to leave as many options open for the future of the footbridge. However, this same ambiguity that allows us flexibility simultaneously poses a significant challenge; the lack of specificity makes a detailed economic and technical proposal difficult. To this end, our group uses the Economic and Technical Analysis sections to outline the possibilities and options available. Then, in order to ease this trial of ambiguity, our group made several concrete decisions to minimize complexity. For example, the KSAT Board has expressed their desire to place a footbridge at the corner of the trail, across from the dog park. Our group was originally wary of this position due to its proximity to an existing bridge, but ultimately conceded this location, as this location lends itself to a larger redesign of the area, which will be discussed in the Conclusion. As a result, our group could focus more on the design of the bridge and simultaneously eliminate a variable: location.

Another challenge our group faced was balancing the physical elements of a footbridge. As a result, our group chose three main physical criteria to consider while working on our project: sustainability, functionality, and aesthetic appeal. Sustainability can be achieved in a multiplicity of ways: through sustainable materials, through the implementation of photovoltaic cells to power a light installation, or through a consideration of the community's future needs. Furthermore, this element of sustainability reflects the environmental ethos of the KSAT. In terms of functionality, a footbridge needs to be physically reliant, otherwise it will be a danger to the surrounding communities. In terms of aesthetics, the artistic aspect of the footbridge will need to fit into the mission of the trail: "advancing civic dialogue and infusing the community with creative capital, so as to bolster economic revitalization and foster civic and cultural pride" (Karl Stirner Arts Trail, 2011). The synthesis of these three elements, sustainability, functionality and aesthetic appeal, will be integral to a successful footbridge design. To this end, our group is recommending that the footbridge, regardless of the specifics of its design, is not merely a footbridge, but instead provides educational, sustainable and aesthetic components. Subsequently, our group suggests a footbridge similar to the one shown below.

Figure 3: Mock-Up of a Bridge

The following analysis, divided into four sections, provides our group's research and subsequent recommendations. First, our Social Context addresses three central contexts that together, craft a holistic understanding of the footbridge; these three contexts are public space, public art, and town-gown relationships. Second, our Political Context delves into understanding the preexisting discourse surrounding the footbridge. Specifically, the three stakeholders of the project are explored: Lafayette College, Easton, and the KSAT Board. Third, our Economic Analysis, provides the reader with preliminary research into the direct and recurring costs a footbridge would incur. Furthermore, the footbridge's return on investment is explored. Last, our Technical Analysis explores the materials, sustainability and space that the footbridge would include. Holistically, these four sections aim to satisfy our goal of providing our audience with cohesive and coordinated material to make an informed next step. Subsequently, our Conclusion provides a synthesis of our recommendations.

Social Context

Our group framed our social context by focusing on three specific contexts that relate to our project. To this end, Public Space, Public Art, and Town-Gown Relationships holistically represent how a footbridge could both address the disconnect between Lafayette and Easton and facilitate the identity of the KSAT. As a result, these social contexts coalesce to form a coherent understanding of the social context of a footbridge on the KSAT.

Public Space

The first component of the footbridge feasibility project involves the element of public space. Historically, public space in an urban environment has been "[related] to the social, political, and physical health of urban residents and communities" (Stanley, 2012 1090). Public space can manifest itself in a city in a multitude of ways: food production areas, parks and gardens,

recreational space, plazas, streets, transport facilities, and incidental space. As a whole, any of these spaces can function as a public space, and in turn can benefit social interactions, strengthen a democracy, and encourage a healthier mindset (Stanley, 2012 1090).

Figure 4: Signage on the Karl Stirner Arts Trail

In particular, the KSAT represents a unique intersection of parks and recreational spaces. Parks became popular in 19th century North America "due to reformist movements aimed at improving the cultural refinement or physical health of city residents" (Stanley, 2012 1098). With the KSAT's inclusion of a dog park and its function to passively improve the physical health of city residents, the KSAT can be categorized as a park. Conversely, due to the same passive space for exercise, the KSAT can equally be counted as a recreational space, especially as the trail primarily functions as a running and walking path for its users. Through this lens, the KSAT fits into a larger history of public space in urban environments. Specifically, a footbridge could continue this holistic history of parks and recreational spaces by extending the trail itself, both in its functionality and its expansion of a recreational space.

To this end, the KSAT represents public space in the urban environment of downtown Easton. In looking at urban public spaces in particular, a comparative study of community gardens in NYC concluded that "in order [for public spaces] to develop and flourish, such spaces necessitate a social group that shares high levels of participation, control and sense of ownership (psychological ownership) over its local-material space" (Eizenberg, 2012 107). Subsequently, our analysis of the footbridge will interact with these three aspects: participation, control and psychological ownership.

In terms of participation, Eizenberg defines the term as "the direct involvement of residents in designing, constructing or managing their living environment" (2012, 107). Within the scope of the footbridge, the residents refers to Eastonians and the Lafayette community. As a result, in

order to have a successful urban public space, a footbridge would combine the efforts of both communities. To this end, the designing of the footbridge should involve both art professors and students, civil engineering professors and students, as well as Eastonian artists and engineers. This combination of efforts will equally serve to reinforce the metaphorical meaning of a bridge, so as to connect the two communities.

The second point, control, gestures to the ability of community members to "[develop] attachment to, identification with, and meaning of place" (Eizenberg, 2012 107). From our perspective, the KSAT Board epitomizes the control that Eizenberg references. This board, comprised of both Easton and Lafayette community members, makes decisions about the KSAT with both entities in mind. As a result, the KSAT Board provides a opportune platform for decision making. In other words, in the hands of the KSAT Board, this footbridge will have a higher chance of being successful as it allows both groups to wield equal control over this shared public space.

The last element of public space that Eizenberg discusses revolves around psychological ownership. While the previous two components are relatively quantifiable metrics, this final factor is more subjective and enigmatic. Furthermore, due to its gravity, this last element stands as the crux of a successful public space. As Eizenberg elaborates, psychological ownership leads "to the effect that [the object] is perceived to be part of the extended self" (2012 107). This concept implies a level of responsibility towards this object, a metric much more difficult to gauge. Though psychological ownership does not necessarily involve the physical ownership of an item, if students (or the Lafayette community) plays a role in the creation or design of the footbridge, this could be a unique way to leverage psychological control. Eizenberg equally recommends that the regulation and imagination of a public space is handled democratically in order for communities to feel psychological ownership for a space. Conveniently, the KSAT Board provides a limited democratic format for decision making over the trail. Subsequently, utilizing as much of the Easton and Lafayette community would promote a democratic process, which would in turn provide a platform for psychological ownership for the different groups.

However, the KSAT has already had to address many of the issues of public space, as the KSAT has been in existence for several years. As a result, the trail already provides opportunity for participation, with a musical playground and a dog park. Similarly, the KSAT Board provides opportunity for control over the future of the trail in a distinctly democratic and inclusive format. Last, the trail has increasingly been working on augmenting Eastonian's and Lafayette Students' feelings of psychological ownership through collaborative projects between the city and the school. These factors reinforce the KSAT Board's unique ability to proctor and manage a public space that involves multiple stakeholders.

Public Art

The role public art plays in the construction of civic spaces has a long history in the United States. At the height of the Great Depression, President Franklin Delano Roosevelt (FDR) worked tirelessly on efforts to mitigate the crippling unemployment rates of pre-World War II America. As the turmoil of the U.S worker continued to fester, FDR established hundreds of social programs in order to help fill the empty pockets of unemployed Americans. While this

may have effectively put a Band-Aid on the struggles of the mainstream laborer, non-traditional workers, such as artists, continued to suffer from the economic conditions of the times. In late 1933, FDR's secretary of commerce, Harry Hopkins, sought to put an end to the literal starving artist and established the Public Works of Art Project (PWAP) (Adler, 2009). From the ashes of the Great Depression, public art was born.

For this project, the historical context of public art acts as both an anecdote and an integral component of a potential footbridge. The big picture of the PWAP was to "give work to artists by arranging to have competent representatives of the profession embellish public buildings" (Adler, 2009). In other words, the PWAP's purpose was not just to help struggling artists in a time of peak unemployment, but also to grow the connection between the two inherently different professions, art and government. Just as the PWAP created a bond between two previously separated fields, public art in the KSAT has the same potential to bridge the gap between the Lafayette College and Easton Communities.

Figure 5: "Tilted Arc" Sculpture in Manhattan

Despite the conceivable ability for public art to bring communities together, public perception of that art can be complicated. Subsequently, a footbridge must convey meaning and significance to the public, which is far from a simple feat. Specifically, traditional art is created with a focus on the individual artist's expression, but public art must be created with a focus on the viewer's perception. For this reason, public art is notoriously controversial. In 1981, an art installation entitled "Tilted Arc" was erected by artist Richard Serra at Federal Plaza in downtown Manhattan. The art piece was viewed as ugly and a nuisance to the public due to the location and was eventually voted to be removed (Bryzgel, 2016). Our group chooses to deliberately emphasize the potential for public art to be publicly condemned due to the fraught history between Lafayette and Easton, which will be explored more both in the following context and in

the Political Context. Essentially, this footbridge provides a unique opportunity to metaphorically bridge the two communities through a successful and shared project. As a publicly condemned installation of public art could lead to an unsuccessful project, thereby serving to further divide the two entities, our group emphasizes the careful curation of the aesthetic component of a footbridge.

Subsequently, as our group explored how to avoid public controversy, we endeavored to understand what goes into public opinion on public art. In the book, *Public Artopia: Art in Public Space in Question*, Martin Zebracki cites five important attributes in public art perception: educational background of the community, the community's familiarity with public artwork, appropriateness, sociableness, and meaningfulness (Zebracki, 2011). Ideally, if these attributes are taken into consideration with the prospective KSAT footbridge, potential for failure can be minimized. However, while many of Zebracki's five characteristics of successful public art are easily satisfied within the communities of Easton and Lafayette, some provide distinct challenges, such as the consideration of educational background.

Easton, PA is a widely mixed community when it comes to education. According to the United States Census Bureau, 81.3% of Easton residents 25 years and older have a high school degree or higher, and 17.1% of the same age demographic has a bachelor degree or higher (United States Census Bureau, 2015). While this may seem like an overwhelming majority, this statistic excludes virtually the entire Lafayette College student body. Although the Lafayette student community technically falls under the "high school degree or higher" category (i.e with the majority), the fact that Lafayette students are all pursuing bachelor's degrees brands the Lafayette Community's educational background as fundamentally different from the majority of the Easton Community's. According to Zebracki's findings, this division in educational experience implies that finding a middle ground of acceptable public art for both communities may come as a challenge. Despite this educational separation, our group sees this component as merely a consideration for the KSAT Board, instead of a firm blockade to the future of such a footbridge project.

Furthermore, the KSAT Board has experience tackling the challenge of public art. In fact, the KSAT has continuously installed art pieces into the trail. Negative opinion pieces about these installations are difficult to find, which would suggest a lack of backlash. Clearly, the KSAT Board has historically implemented publicly appreciated, and therefore successful, art installations. However, the installation of public art in the form of a footbridge slightly complicates the challenge. Though the KSAT has not faced criticism over its art pieces, if they had, the installation could be removed with relative ease. Conversely, the removal of a footbridge is significantly more complicated. To this end, the KSAT Board's careful curation and design of a footbridge is integral, given the complex history of public art, the relative permanence of a footbridge, and the potential power of a successful shared project between Lafayette and Easton.

Town-Gown Relationship

The role of town-gown relationships have a long history in the United States. Specifically, a town-gown relationship refers to the relationship between a college town and the college or university it houses. Unfortunately, many town-gown relationships have devolved into a parasitic relationship, giving the term a negative connotation. Specifically, due to studies conducted by Stephen Bruning, Shea McGrew, and Mark Cooper, each party is often under the impression that the other is placing themselves before the other; the town feels like the college is prioritizing its own needs over the town's, and vice versa. As a result, discussions between the college and its town can bristle with uncomfortable or aggressive static (Bruning, McGrew & Cooper, 2006). As a consequence of this discomfort, "many universities have reacted to the difficulties by isolating the university from the surrounding community, in effect eliminating the need to manage the town-gown relationship" (Bruning, McGrew, & Cooper, 2006). Unfortunately, this instinct to isolate only serves to further widen the gap between the two communities.

Despite this pessimistic historical context, the affective distance between Lafayette and Easton is not as divisive as in other cases. For example, though interactions between Lafayette and Easton have not been easy, the college has not self-isolated, as demonstrated by continued faculty and student engagement in the city. Furthermore, back in the 1800s, Eastonian residents founded Lafayette College (The Lafayette Story, 2017). In this way, the relationship between Easton and Lafayette is unique to other colleges, as the school originated from the burgeoning town and each have grown together over the past 200 years.

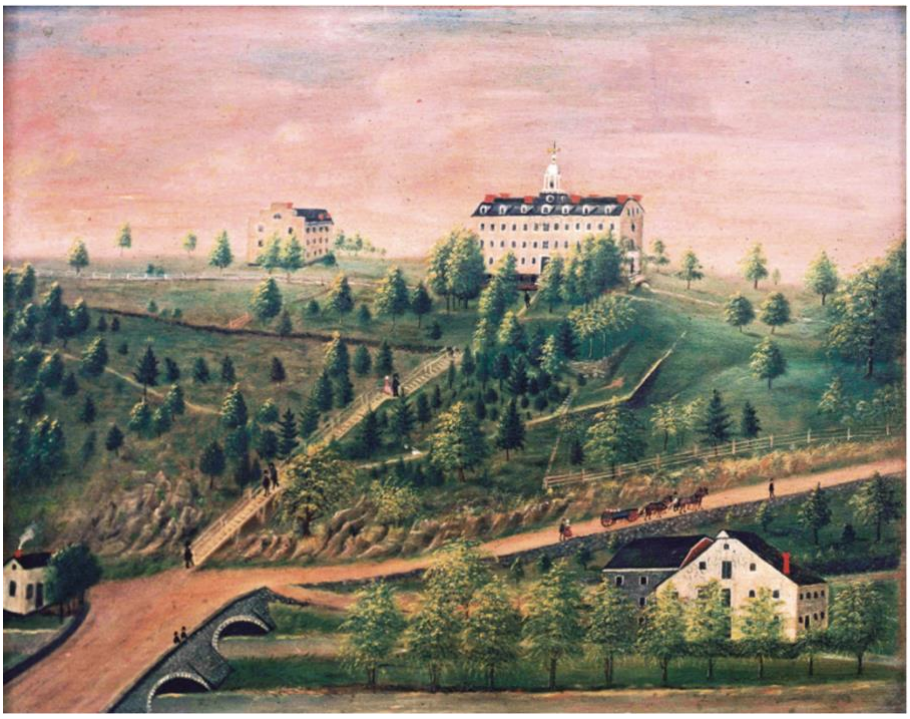

Figure 6: Rendering of College Hill

Though this particular town-gown relationship is not as disparate as other colleges and their communities, the solutions that Bruning, McGrew and Cooper posit are still valid. For example, their research discusses several strategies used by colleges to improve their town-gown relationships. First, their work explores colleges that primarily seek to bring college students into

the city. Unfortunately, the research demonstrates a lack of success with this approach (Bruning, McGrew & Cooper, 2006). Instead, Bruning, McGrew and Cooper advise that colleges endeavor to bring the town onto the college's campus. Through this strategy, residents of the community begin to feel more connected to and involved with the college. As their work posits, "this relationship-building strategy is mutually beneficial" (Bruning, McGrew, & Cooper, 2006), as the residents are gaining a new community and the college is gaining the validation of its community. Thus, our research found that bringing the community to campus creates a more successful town-gown relationship than bringing the campus to the community

After finding these results, we applied this logic to the proposed footbridge. As Jim Toia, chair of the KSAT Board, reflected, the footbridge would primarily serve as an entryway for college students to explore the city by means of the KSAT. In this way, the footbridge would serve mainly as a means to bring the college to the community. However, by framing the footbridge as a conduit between communities, instead of primarily from the college to the community, the footbridge transforms into a permeable membrane between the two entities, allowing for a fusing of the two communities.

To amplify this permeability, our group suggests that this footbridge should endeavor to bring both Lafayette and Easton residents together to this unique shared public space. In order to achieve this goal, we propose that the footbridge includes artistic and educational components in order to engage and unite both communities. To this end, an artistic element would make the bridge a visual landmark, thereby attracting both Lafayette and Easton residents to this shared space. Then, the educational component would ideally feature both the Lafayette and Eastonian communities working in tandem, perhaps through programming between Lafayette students and Easton schools.

Furthermore, the KSAT itself represents a unique space. While Bruning, McGrew and Cooper focus on bringing the community to the campus or the campus to the community, the KSAT brings a new space into contention. Physically, the KSAT is located between two developing areas: between the Bushkill Campus (Lafayette's project) and the Silk Mill Revitalization Project (Easton's project). Evidently, the KSAT physically holds a unique position within both communities. Metaphorically, the KSAT equally represents a unique position in both communities, as the KSAT Board involves leaders of both the Lafayette and Easton community. Subsequently, within the history of parasitic town-gown relationships, the KSAT provides an unprecedented opportunity to forge a symbiotic town-gown relationship. As a result, a footbridge represents an opportunity to literally and metaphorically bridge these two communities, as well as build a new foundation for the Lafayette-Easton town-gown relationship.

Political Context

The stakeholders of a proposed footbridge are the Lafayette community, the Easton community and the Board for the Karl Stirner Arts Trail. By analyzing these three players, our group endeavors to present a cohesive picture of the political context of a footbridge on the KSAT. Though these three key components are analyzed separately, each entity impacts the rest. In other words, these stakeholders do not exist in a vacuum, so a true analysis necessitates their overlap and intersection. Furthermore, each entity will benefit differently from a prospective

footbridge. In turn, each group will also shoulder a cost of the footbridge, whether a literal economic cost or an opportunity cost.

This context analysis outlines a comprehensive political understanding of this footbridge. In other words, what policies and politics are involved with such a project. Furthermore, this political context will place the footbridge within a holistic redesign for the area surrounding the footbridge, or the Bushkill Campus. According to Jim Toia, director of the KSAT Board, the footbridge project is merely a piece of a larger development of the area. This development would also include the construction of a visitor's center and parking lot where, currently, a car dealership stands (Toia, 2017). Then, the footbridge would serve to connect these pieces to the KSAT. Similarly, in order to be an attractive investment for the city, Toia encouraged that the footbridge include educational, sustainable and artistic components. With this brief physical outline, the political context for the footbridge can be discussed.

In order to frame this political analysis, our group is utilizing the analysis of one prominent park, Seattle's Olympic Structure Park. Holistically, partnerships between cities and their colleges can be fraught with challenges. This analysis of Seattle's Olympic Structure Park outlines how a partnership between a private company and a non-profit or a partnership between two non-profits can be difficult due to different visions and priorities, especially when working with a public space. Here, although Lafayette College is technically a non-profit, the school often operates as a private enterprise. Subsequently, though Ashley argues that dual-non-profit (DNP) projects find greater success, with their collective proficiency in fundraising and planning (Ashley, 2015), the pitfalls of private-public partnerships (PPPs) may more aptly apply to this footbridge. Here, Ashley points to a difference in institutional vision that consequently "favor private rather than public interests" (Ashley, 2015), especially as funding often comes from the private counterpart. As Lafayette College would likely fund this footbridge project (Toia, 2017), these pitfalls must be considered. In particular, the vision of the college and the city must be parsed out.

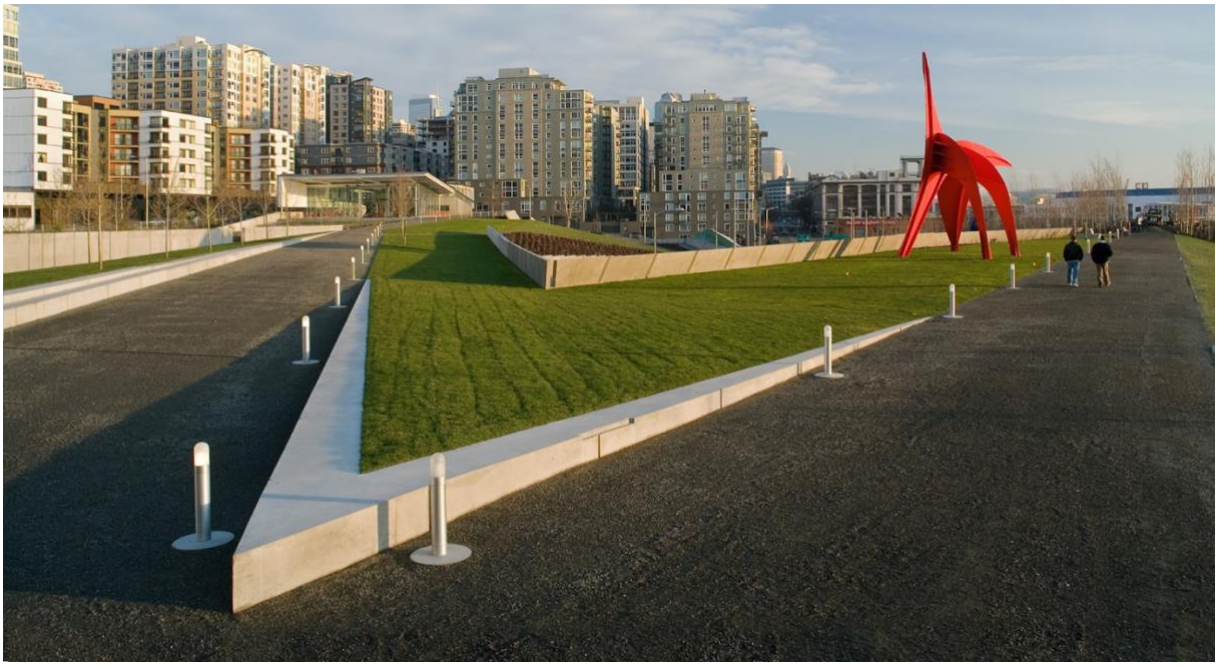

Figure 7: Seattle's Olympic Structure Park

Lafayette College

Before a discussion of their priorities, however, Lafayette College's role in the development and proposition of a footbridge on the KSAT must be understood. Broadly speaking, colleges often play a role in the civic development of the communities that surround them (Bruning, McGrew, & Cooper, 2006). However, as demonstrated in the Social Context section, the relationship between a college and its town is often complex and fraught with conflict. To this end, Lafayette's geographical placement exacerbates the potential for division. A daunting, steep staircase overhanging a cliff is the only physical connection between the college and the town itself. Though the physical seclusion of the campus lends itself to a student body isolated from its town, the hill cannot fully account for the apathy exhibited by the town and the college for one another. For this reason, over the past few years, Lafayette has worked to engage themselves within the community. Through volunteer efforts, LaFarm, and festivals, Lafayette students have engaged with the community. However, despite its efforts to meld the two communities together, Lafayette still appears relatively detached from its city. Subsequently, it is imperative to understand how Lafayette is situated socially and politically within Easton in order to look forward to the potential implementation of a footbridge on the KSAT.

In order to understand this positioning, our group looked to the college's master plan, developed in 2009. This master plan was created to be a guide for the college to achieve certain goals, including the aim to enhance the connection between the Lafayette and Easton communities. This master plan prides itself on being a "collaboration between members of the Lafayette College community, including students, faculty, staff, City of Easton officials and community representatives," but the plan is written largely from the college's perspective and for the college's benefit. Specifically, the authors of the plan employ distinctly egocentric language throughout the plan. For example, the master plan outlines eight master principles that theoretically shape and guide the plan's contents. Of these principles, only two mention the community outside of Lafayette. Based on this small metric, the college does not see their role within Easton as an even split between the college and Easton; instead, the aims of the college revolve primarily around itself. Furthermore, the two purposes that do include Easton ("Enhance College-community gateways" and "Improve off-campus properties to reflect Lafayette's commitment to improve city-campus transitions" (Master Plan, 2009)) emphasize the improvement of physical connections to college hill, rather than the enhancement of physical and psychological connections to Easton.

Additionally, this master plan is nearly nine-years-old and has not been updated, so it is difficult to gauge how Lafayette's attitudes and aims have evolved over this time. As a whole, the inclusion and consideration of Easton in Lafayette's vision for its future suggests a collaborative and bright future for the two entities. However, written word does not necessarily guarantee action. As a result, this nine-year gap allows our group to analyze the progress that Lafayette has made, especially regarding its principles surrounding the college's connections to Easton. The initiatives that this plan specifies is summarized with the following statement: "Physical connections to College Hill were strengthened by tying into potential streetscape improvements, reinforcing business and campus connections, and opening up campus edges to pedestrian activity along the Cattell Street corridor" (Master Plan, 2009). Clearly, the footbridge, or anything like it, is never directly mentioned in the report. Despite the lack of a direct mention,

the intent and spirit of the footbridge does coincide with the master plan's aims to bridge the two communities.

However, this nine year gap has also involved less successful initiatives between the college and the town. First, as Lafayette intends to expand their campus, they sought to build a new dormitory. Despite their efforts, the city did not approve this project. This failed effort certainly does not improve relations between Lafayette and Easton. Next, Lafayette sought to construct an elevator by the stairway behind Ruef Hall. However ,"while the college makes on choice on what to do concerning its construction plans for dorms, its plan for an elevator to downtown Easton have been put on hold" (Kelly, 2017). Together, both the dormitory and the elevator represent failed projects attempted by the college. As a result, the footbridge has the potential to join this list of failed projects, only serving to exacerbate the tense relationship between Lafayette and Easton. Conversely, the footbridge could represent a successful project between the two entities.

However, the success of the footbridge swells beyond its physical implementation. Here, 'success' can be defined by the footbridge's ability bridge the disconnect between the Lafayette and Easton communities. Unfortunately, this metric is difficult to quantify. As referenced in the Social Context, the psychological ownership of a public space often results in higher levels of participation. This psychological ownership could begin with a distinct change in language in Lafayette's next iteration of a master plan, so that the interests of the community are more equitably represented.

Easton

The second piece of the political context revolves around the Easton community, the missing voice in Lafayette's master plan. Alluding to the private-public partnership previously mentioned, Easton's position and vision must equally be considered. In light of this analysis, Easton's Community and Economic Development Board states, "the vision of Easton's future growth and prosperity is built upon its proud history as cultural, commercial, and transportation hub" (ECED). Following from this vision, the city of Easton has begun their Silk Mill Revitalization project. This project is "a $100 million redevelopment project with apartments, warehouse space and arts-related businesses" (Miller, 2017) that builds on the history of the silk industry that once employed much of Easton. Similarly, the proposed footbridge could connect to the history of the rope factory that the KSAT is built on (Toia, 2017). Subsequently, a footbridge could build on Easton's mission to become a cultural and historical hub.

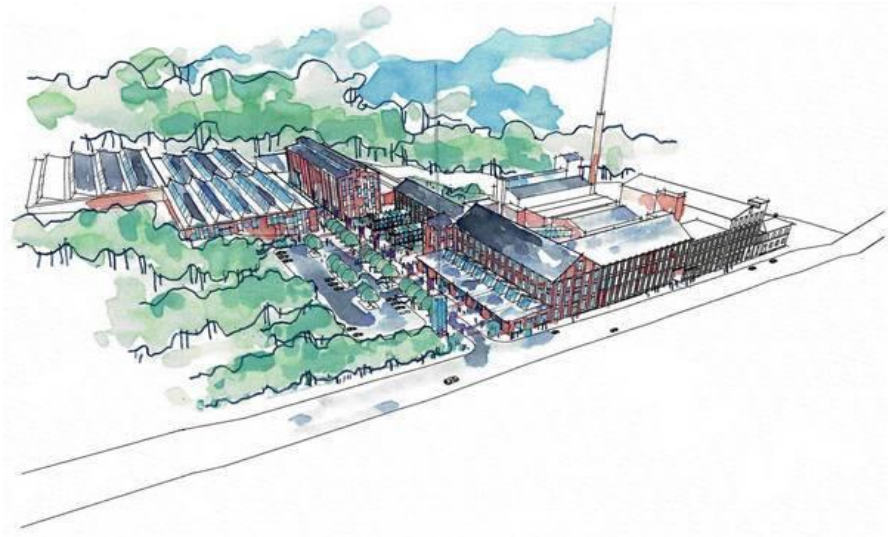

Figure 8: Rendering of the Silk Mill Revitalization Project

However, Easton's political positioning reaches past the tight lines espoused by Easton's Community and Economic Development Board. To this end, public opinion must be considered. Unfortunately, public opinion may be a difficult hurdle to overcome. Regardless of average public sentiment, those who oppose Lafayette's expansion into College Hill are far louder than their sympathetic counterparts. As a result, based on the opinions and voices of our group and capstone cohort, the college perceives that Easton is notably against Lafayette and its expansion. This perception is solidified through opinion pieces that express how "Lafayette must execute its plans in a way that is either consistent with the vision that Easton's residents have chosen for themselves or offers alternative value to compensate for the project's risks. To date, Lafayette has not met this obligation" (Gaffney, 2017). Clearly, Eastonians' potentially negative opinion of Lafayette's initiatives should be considered in the construction of a footbridge. With a history of failed projects, such as the elevator and proposed dormitories, the footbridge has the potential to further divide these two communities and to highlight their differing views on and visions for the city. Conversely, the footbridge could act as a unifying agent between the Easton and Lafayette communities, as a peace offering between the two communities that represents their collaborative power.

With these varying opinions in mind, the footbridge has the potential to unify Lafayette and Easton's often disparate visions. As discussed in Ashley's research, when two organizations with differing goals work together, a project can swiftly fall apart. In order to mitigate this potential failure, the trail itself can act as a physical manifestation of the two communities' ability to collaborate. For both Lafayette and Easton, "it has taken awhile for the community to realize the trail is there and what it offers" (Tatu, 2017). Subsequently, this trail could represent an opportunity for successful collaboration. To this end, the footbridge equally has the potential to be a shared successful project between the two entities and subsequently represent cohesion between Easton and Lafayette. With the trail as a foundation and an example of the potential for collaboration between the two communities, the footbridge can follow in its footsteps and subsequently serve to bridge Easton and Lafayette.

KSAT Board

In particular, the KSAT Board represents the pinnacle of collaboration between these two entities. The KSAT Board makes decisions regarding the artistic contributions to the trail, expansions of the trail, and maintenance of the trail (Karl Stirner Arts Trail, 2017). The KSAT Board itself involves three main groups: the Arts Advisory Council, the Board, and the Lafayette College Advisory Group. The first element is comprised of Lafayette administrators, Easton artists, Easton curators, and Easton administrators. Similarly, the Board itself includes Eastonians and Lafayette faculty alike. Furthermore, this board seems to represent a synthesis of many of Easton's initiatives, as it pulls together Lafayette College, the Nurture Nature Center, Eastonian administrators, and outside development groups. Last, the Lafayette College Advisory Group exclusively consists of Lafayette professors and faculty, with representation from all ends of campus: economics, English, engineering, art, geology, etc (Karl Stirner Arts Trail, 2017). These groups work in unison to make decisions for the whole of the KSAT.

While these three groups work together, primarily, the Board drives the direction and vision of the trail (Karl Stirner Arts Trail, 2017). In an interesting way, this Board represents a microcosm of an ideal version of the Lafayette and Easton relationship. Through this council, members of both the Lafayette and Easton community work together to make decisions for a shared public space. As both communities are represented on this board, theoretically, the interests of both groups would be advocated for. Furthermore, combination groups such as this work to collapse the strict lines drawn around each community.

In addition, precedent exists within the Board to further collaborate and fuse the two communities. For example, in June 2017, Phillipsburg, Belvidere and Easton high school students worked with Lafayette students to add several sculptures to the trail (Sturm, 2017). Jim Toia, Chairman of the Board and professor at Lafayette College, has spoken openly about his desire to continue to fuel work between high-school and collegiate students (Sturm, 2017).

In terms of the footbridge itself, politically, the KSAT Board already has authority and credibility within the town. According to a recent news article, "the KSAT Board has complete autonomy over the trail and The City of Easton Department of Parks and Recreation completely backs the KSAT Board" (Bart-Addison, Geraghty, Kyler, & Rack, 2015). This credibility eases the political tension, as the KSAT Board should be able to maneuver the Easton politics with relative ease. Furthermore, as the board represents the interests of both communities, ideally the general public should support the initiatives brought forward by the Board.

Specifically, Toia has openly and adamantly supported the footbridge initiative. In this way, the Board, as represented through Toia's work, is already looking into the possibility of a footbridge. Subsequently, a footbridge project has the potential to clinch the agenda-setting moment within the Board, especially as the KSAT Board has just hired a part-time curator for the Arts Trail (Tatu, 2017). Conversely, the KSAT is currently expanding and exploring the rehabilitation of a trestle by the Silk Mill into a pedestrian footbridge. This pre-existing project should be taken into consideration with the design of the footbridge. The pedestrian bridge by the Silk Mill is planned to be fundamentally utilitarian bridge (Miller, 2017), so this footbridge should endeavor to

separate itself from potential redundancy by being a visual landmark, an educational opportunity, or a beacon of sustainability.

In terms of how these decisions about the footbridge should be made, consultative, deliberative and collaborative leadership has been shown to be a much more successful and productive way to govern and make changes (Lees-Marshment, 2016). Clearly, the three groups within the KSAT represent this type of leadership. Speaking more broadly, these same practices can be taken and applied to the footbridge project as a whole. In other words, all three stakeholders (Lafayette College, Easton and the KSAT) should have a voice in the project. Conveniently, the KSAT Board makes this easier. A missing voice, however, would be the student population of Lafayette College, an integral part of the disconnect between the communities but of a difficult one to incorporate in long-term organizations like the KSAT Board due to the relative brevity of a student's residence in Easton. Through this lens, our group proposes the necessity of student voices in this project--through a collaboration of Easton artists and Lafayette art majors, or Easton civil engineers and Lafayette civil engineering majors. As a result, the student voice could be incorporated into the KSAT Board and a subsequent conversation about the footbridge.

In the end, the KSAT Board will likely be the organization to propose and execute this potential footbridge, with funding from Lafayette College. Within Easton's political scene, the KSAT Board, as shown, has a desire to further unite the Easton and Lafayette communities. Furthermore, the KSAT Board has the credibility within the context of Easton to successfully tackle this project. Through these measures and through the collaborative nature of the KSAT Board, the pitfalls outlined by Ashley in her research should be avoided, resulting in the successful execution of a footbridge.

Economic Context

An economic analysis of a bridge requires an analysis and judgement of its value. However, much of the value of a footbridge is derived from the purpose it serves a community, rather than its monetary returns. Subsequently, return on investment will be judged based on the intangible results of such a footbridge. As our Social and Political Contexts have outlined, a bridge could serve to unite the Lafayette and Easton communities through its physical manifestation of their ability to collaborate. Though a dollar sign is difficult to put on this asset, one might say this benefit is priceless. Furthermore, any educational programming or environmental benefits would be equally difficult to fiscally quantify. Last, as the footbridge represents a piece of a larger redesign of the area, the footbridge can be understood as an investment towards a larger, cohesive, and future project. Despite the benefits of a footbridge being largely intangible, the direct and recurring costs of a footbridge are explicit. In this sense, as a design is chosen for such a bridge, its economic impact will become increasingly integral to the success and validity of the project.

In an effort to understand what these direct and recurring costs would be, our group looked to similar projects as a point of comparison. First, our group looked to the footbridge proposal by the Silk Mill Revitalization project. The goal of this bridge is to "connect the trail to the newly renovated Silk Mill project." At the beginning of the project, Toia expressed, "it's a pedestrian bridge, but it's also an arts piece" (Lewis, 2016). However, over the course of the project, the

bridge's functionally began to preempt its aesthetic; as a result, the eventual bridge design represents an fundamentally functional and utilitarian pedestrian footbridge. This functional bridge cost $250,000 and was funded by grant from the Commonwealth Financing Agency. As a result, our group can predict that this project's footbridge would meet and exceed the cost of a purely utilitarian bridge, as our bridge hopes to realize Toia's aims of an artistic bridge. To this end, we estimate that $250,000 will be a minimum cost for this bridge.

Furthermore, this Silk Mill footbridge provides this future bridge with opportunities for grants. In other words, it seems feasible that a future footbridge could receive similar economic support, as this proposed bridge would be providing a similar purpose to its Silk Mill counterpart. For example, the Silk Mill received its funding in part because it connected the trail to a developing area. Theoretically, this proposed bridge would connect the trail to the Bushkill Campus, in some future version of the area. However, as of now, the footbridge would connect the trail to an auto repair shop. Subsequently, our group recommends that this footbridge is delayed in its construction, so as to become a part of a larger redesign of the area. Thus, if the auto repair shop becomes a visitor's center, per Toia's vision, then this proposed footbridge could cohesively connect the two areas. As of now, however, spending $250,000 to merely connect the trail to a sidewalk does not seem as economically feasible.

Funding:

Most of the costs will be in the upfront construction of the bridge and its prolonged maintenance. However, the intangible value of educational programming and aesthetic components have the potential to offset the costs of the bridge. In this way, combining a physical footbridge with a holistic vision of educational and artistic components will make a footbridge significantly more appealing to a future benefactor. To this end, in our conversation with Toia, he expressed,"it's going to take the college, and maybe some academic programming, or an alumnus who sees the value of this, both as an educational moment and vehicle for the college as well as a reach out to the community" (2017) to receive funding. Subsequently, the intangible value of this footbridge will primarily serve to justify its construction and to counteract its costs.

In lieu of an independent donor or benefactor, the KSAT Board could equally be considered an option for funding. However, the economic context of the board would need to be considered. Toia expressed that a $3 million endowment would allow them to achieve a $160,000 working budget for every year. That working budget would then give them the freedom to make any improvements they see fit, like a footbridge. An argument against spending money on the footbridge right now would be for a better allocation of these desired funds. For example, a part-time curator is desired, and Toia estimates that would cost them $50,000 (Tatu, 2017). Thus, the funds of the footbridge, if accrued, would not necessarily be the most effective use of funds for the KSAT Board.

The third option for funding involves Lafayette College sponsoring the footbridge. This option provides the most conspicuous positive social implications. Alleviating the financial stress from the KSAT would allow them to move towards their other goals of the full time curator, $3 million endowment plans, and any other improvements they find fit to best benefit everyone. Not having the city of Easton pay for the footbridge would hopefully be repaid in political

cooperation for its construction. Despite these benefits, if Lafayette were to solely finance the project, this funding could be perceived as Lafayette attempting to expand their control over a developing Easton area; this source of funding has potential to feed into the "Lafayette takeover" sentiment rejected by many residents. However, this drawback assumes the most extreme version of negative public opinion surrounding Lafayette's potential sponsorship.

Long Term Considerations

Beyond the direct costs of the footbridge, recurring costs must also be considered. As the trail operates as a non-profit, its maintenance poses a potential challenge for the proper installation and upkeep of a footbridge. While the long-term costs of a footbridge would vary based on its design, they still must be taken into consideration.

Weatherproofing. Weathering of the bridge will occur as it outside, but the extent to the weathering will occur is directly linked to the materials chosen for the bridge. Flooding also needs to be taken into consideration when it comes to that material choice, as the Bushkill is prone to flooding. For example a fiber reinforced plastic would increase the initial cost of the project by about 10% when compared to concrete, although it would weather less (Nishizaki, Takeda, Ishizuka, & Shimomura, 2006).

Maintenance. Similar to weatherproofing, maintenance is also intertwined with the actual material of the bridge. Taking weathering into account, the FRP's are waterproof and would require less upkeep in the long run, compared to concrete. In a life cycle cost study of both FRP and prestressed concrete bridges in Japan, results concluded that "FRP bridges [have] a competitive edge over other types of construction in spite of its initial cost and that FRP footbridges are more efficient when longer life is required in severely corrosive environments" (Nishizaki, Takeda, Ishizuka, & Shimomura, 2006). In terms of bare minimal construction, FRPs seem to satisfy the Bushkill's need for a corrosion-free material and require less overall maintenance. However, FRPs may not fit the needs of artistic designs, so yet again a cost benefit analysis needs to be done by the decision makers to optimize their desired vision and budget.

Responsibility. A deciding part of the feasibility of the bridge will be its contingency plan, especially as the Arts Trail is run by volunteers. Volunteers pose a potential difficulty, as they hold no financial stake in the success or failure of the footbridge. Without funding for the bridge, finding consistent volunteers to provide care and maintenance for the bridge could be difficult. However, if the KSAT Board acquires a curator for the trail, the curator could provide a monthly inspection system for such a bridge.

Lighting

The economic impact of adding lights to the bridge depends upon their purpose: whether they exist to be functional, sustainable, or part of the art itself. After discussions with Toia, the cost of lights should be minimized, as the lighting would exist for the sake of lighting the trail (Toia 2017).

In light of this restriction, the simplest option would be basic electricity feed outdoor lighting. The average cost for electricity in Pennsylvania is 13.2 cents per kilowatt-hour. While this low cost does not seem like much, it would add to the recurring costs of a footbridge. This cost of energy also does not include the upfront cost of the lights themselves, as well as the required power lines. Without other incentives, the KSAT will not gain significantly from the addition of these lights.

Conversely, solar powered outdoor lighting would adhere to the KSAT's commitment to sustainability. Furthermore, solar lighting would provide visual and conspicuous confirmation of the KSAT's commitment to sustainability. Online, backyard solar lights greatly range in price, which gives the KSAT Board the flexibility to weigh the actual cost of solar lighting with their social benefit. However, portable lights can be stolen, forcing the KSAT board to replace them. Furthermore, there are several potential lighting options, each with their own merits and drawbacks. For example, LEDs are more expensive but environmentally friendly compared to a typical halogen light. However, the most sustainable option remains using the natural daylight hours, leaving the trail unlit the rest of the time.

The last point of consideration, which would be the most realistic way to incorporate light into the trail, would be using lighting as the art itself or in some element. Here, the light type itself and power source are the most problematic elements. Considering the pedestrian bridge is near the road, the lighting must not be too distracting. Guzzon's analysis of a bridge using "low-wattage LEDs" was that they "are response to ambient light levels," making them appropriate for use near cars and use for pedestrians (Guzzon, 2013). In terms of power, these low-wattage lights could use solar sources. This element would provide an incentive with its sustainability, while simultaneously removing a recurring cost by participating in the traditional electric grid.

Other Bridges

In order to estimate the cost of a footbridge, our group chose to use other bridge designs as points of comparison. To this end, looking at different per unit costs for different footbridge designs from commercial sources shows the range of expected costs, depending upon different options.

Using commercial bridge companies, estimates can be deduced using any measurements for a potential bridge design. Excel Bridge is a commercial custom bridge fabrication company that also builds prefabricated bridges. Their structures range anywhere between "$500 a linear foot to over $2,000 a linear foot" (Excel Bridge Manufacturing Co., 2017) but are dependent upon what the actual desires of the bridge are. Anderson Bridges is an expert in creating prefabricated bridges for easy assembly. On their website they state that their structures range from "$400 a linear foot to over $1,500 a linear foot, depending on the numbers options" they provide (Anderson Bridges, 2015). When comparing the per unit cost of the Silk Mill bridge, assuming all $250,000 went to the 120 ft long structure, the per unit price is roughly $2,000 a linear foot. So, although it is towards the high end of these ranges, based on Excel and Anderson, it can be assumed that the realistic per unit price is less, when it includes the other aspects require for the bridge. If the decision is made to move forward both these companies can be consulted for a more accurate estimate.

Compared to a much larger project in Australia, a pedestrian bridge was proposed for a crossing over the Onkaparinga River at a park in Verdun, Australia. The bridge cost $303,575, a price that includes everything from materials to implementation. A cost estimate report for the bridge accounted for excavating, bridge footings, abutment walls, structural steelwork, the bridge deck, metalwork, and the sitework. This bridge project is much larger than ours, with a length of 36,000 meters, and ends up including more parts than our footbridge project would entail, like having column supports. For unit cost comparisons part of their report can be found below.

PEDESTRIAN BRIDGE *Sandow Road, Verdun, S.A.*

ITEM DESCRIPTION		AMOUNT	UNITS	RATE	TOTAL	ITEM TOTAL
Excavator						
filling to river bed 3.0m deep	general fill material	144	m^3	$ 25	$ 3,600	
excavator hire & labour to fill	place & compact	144	m^3	$ 77	$ 11,088	
drain pipes to temporary dam	supply and install	1	item	$ 2,000	$ 2,000	
excavate 4 off pad footings	machine hire & labour	200	m^3	$ 63	$ 12,600	
backfill over pad excavation	machine hire & labour	90	m^3	$ 78	$ 7,020	
quarry rubble approach ramps	material	80	m^3	$ 40	$ 3,200	
quarry rubble approach ramps	machine, place & compact	80	m^3	$ 52	$ 4,160	
						$ 43,668
Footings						
N32 concrete to 4 off pads	material	40	m^3	$ 250	$ 10,000	
concrete pump x 2 set up	plant hire	1	item	$ 3,000	$ 3,000	
reinforcing to pads	supply & fix	1	item	$ 5,400	$ 5,400	
concrete to 4 off pads	place & compact	40	m^3	$ 38	$ 1,520	
hold down bolts & templates	supply & install	4	each	$ 375	$ 1,500	
surveying initial & bolt set up	supply	1	item	$ 1,000	$ 1,000	
						$ 22,420
Abutment walls						
N32 concrete to 2 off walls	supply	7	m^3	$ 250	$ 1,750	
concrete pump x 2 set up	plant hire	1	item	$ 2,500	$ 2,500	
formwork, propping	supply & erect	1	item	$ 5,700	$ 5,700	
reinforcing to walls	supply & fix	1	item	$ 3,000	$ 3,000	
concrete to 2 off walls	labour to place & vibrate	1	item	$ 1,000	$ 1,000	
						$ 13,950
Structural Steelworker						
4 / 355.6 x 9.5 CHS columns	fabricate	4	item	$ 4,400	$ 17,600	
4 / 355.6 x 9.5 CHS columns	treat & paint	4	item	$ 1,200	$ 4,800	
4 / 355.6 x 9.5 CHS columns	transport & erection	4	item	$ 3,700	$ 14,800	
non shrink grout	labour & materials	1	item	$ 600	$ 600	
densotape lagging	supply & install	1	item	$ 1,000	$ 1,000	
						$ 38,800
Bridge deck						
precast head beams	supply	2	item	$ 1,000	$ 2,000	
precast head beams	crane & erect	2	item	$ 1,000	$ 2,000	
prestressed concrete planks	supply	9	item	$ 3,000	$ 27,000	
prestressed concrete planks	crane & erect	9	item	$ 945	$ 8,505	
scaffolding & work platforms	supply & erect	1	item	$ 9,000	$ 9,000	
non shrink grout	labour & materials	1	item	$ 3,500	$ 3,500	
concrete topping	supply, place & finish	4.6	m^3	$ 1,200	$ 5,520	
						$ 57,525
Metalworker						
balustrade & handrail x 2.4m	fabricate and deliver	30	item	$ 800	$ 24,000	
scaffolding	supply & erect	1	item	$ 10,000	$ 10,000	
balustrade & handrail x 2.4m	install	30	item	$ 320	$ 9,600	
bollards	supply & install	6	item	$ 400	$ 2,400	
						$ 46,000
Siteworks						
concrete drainpipe	supply & install	4	m	$ 800	$ 3,200	
clean & contour to original	machine hire & labour	1	item	$ 1,100	$ 1,100	
						$ 4,300

Table 1: Information retrieved from http://www.walkingsa.org.au/

Another source is the Pedestrian and Bicycle Information Center, dedicated to creating "safe walking and bicycling as a viable means of transportation and physical activity" (Pedestrian and Bicycle Information Center, 2017). Their organization is much more interested in the movement of people and route management. In their estimates "wooden bridges are approximately $125,000 on average, and prefabricated steel bridges approximately $200,000" (Pedestrian and Bicycle Information Center, 2017). Using this resource, they have a database for costs for different options that could be used by their bicyclists and pedestrians. The PBIC created their own database for the cost options that can be used for pedestrian and bicycle safety based off of their own observed uses across the country. Below is a table of the different material bridge types; however, a link to the database is located below for any options that may be desired in the future.

Infrastructure	Description	Median Cost	Average Cost	Min Cost	Max Cost
Overpass	Wooden	$122,610	$124,670	$91,010	$165,710
Overpass	Prefabricated Steel	$191,400	$206,290	$41,850	$653,840

Table 2: Information retrieved from http://www.pedbikeinfo.org/cms/

Economic Conclusions

Funding is crucial for this project, and the strongest argument for a footbridge involves an emphasis of its intangible benefits to the surrounding communities. Furthermore, within a holistic redesign of the area surrounding the footbridge, the bridge itself becomes merely a piece of the entire revitalization project and serves to increase its benefits to the community. Our group recommends that the funding comes from Lafayette College, but the distribution of those funds revolves around the KSAT Board, so as to maintain neutrality and minimize the perception of Lafayette's invasion of Easton. Based on a comparison of various bridge projects, we predict that the bridge's estimated cost will be between $250,000-$300,000, not including the art. The long term considerations of recurring costs would hopefully be addressed by a separate responsible party, like the curator. Again, the specifics of the costs depend upon the bridge design itself, but any fiscal cost will be outweighed by the bridge's social and political benefits to both communities.

Technical Context

The purpose of this section is to provide the reader (i.e. the Board, the class, the city) with several options for the technical aspects of a footbridge. Specifically, our group identified three relevant considerations: environmental impact, physical dimensions, and materials. With these components, the group intends to equally address the additional criteria of sustainability, aesthetic appeal, and functionality in order to facilitate the end goal of this project: addressing the disconnect between the Lafayette and Easton Communities. However, while aesthetics is a consideration in all of our analysis, this technical section will primarily focus on sustainability and functionality, as our analysis confronts the physicality of a footbridge as it is integrated into its environment. For more information on aesthetics, reference the social context of this report.

In terms of sustainability, both the Lafayette community and the KSAT are dedicated to the conservation and preservation of natural resources in the city of Easton. In recognition of the inevitable environmental impact of a footbridge, our group felt it was important to highlight this sentiment towards sustainability in the technical design. In turn, this consideration raises several concerns about aquatic life and river current in the Bushkill Creek. As reflected by the KSAT website, the trail is often used by local fishermen for sport (Friends Of The Karl Stirner Arts Trail, 2017). Subsequently, the construction of a footbridge could disrupt both the aquatic environment and the ability to fish. Although properly built culverts used to support bridges and road crossings have no significant effect on fish populations, improperly built culverts have the potential to impede natural fish migration and damage aquatic ecosystems (Timm, Higgins, Stanovick, Kolka, & Eggert, 2017) (Wellman, Combs, & Bradford Cook, 2000). Based on this

research, culverts should be constructed with careful consideration to the fish population of the Bushkill Creek.

Another environmental concern surrounding this footbridge is the effect it may have on the natural current of the Bushkill Creek. In order to brace the bridge, supports would be required at either end, which may to interrupt the riverbank and negatively impact marine life downstream. For instance, the construction of the Ina Road Bridge in Arizona resulted in the death of a small percentage of non-native fish in the Santa Cruz River due to flow diversion (Casper, 2017). In order to combat this potential hazard, the group is recommending that the city or the Board conduct environmental impact and geotechnical reports if they proceed with the footbridge. These two reports will provide both the city and the Board with the necessary information for them to be fully informed about the impact this project may have on the trail and the surrounding environment.

The physical dimensions of the footbridge at this stage are fairly ambiguous. To simplify this uncertainty, we decided to create a simple example of a footbridge in Inventor (shown in *Figure 9*). The basis for this bridge's parameters revolve around the assumption that physical specs would likely mirror the currently under construction Silk Mill footbridge: approximately 120 ft. long (Tatu, 2017), with a 10-foot-wide deck to accommodate at least two people side-by-side, and a clearance of 8 ft. above the Bushkill Creek. Many of these variables were assumptions that would realistically need to be concisely measured by engineers and surveyors on site. To discuss the technical analysis in terms of contrasts of materials, this fictitious mock-up of a footbridge may be used for comparison purposes.

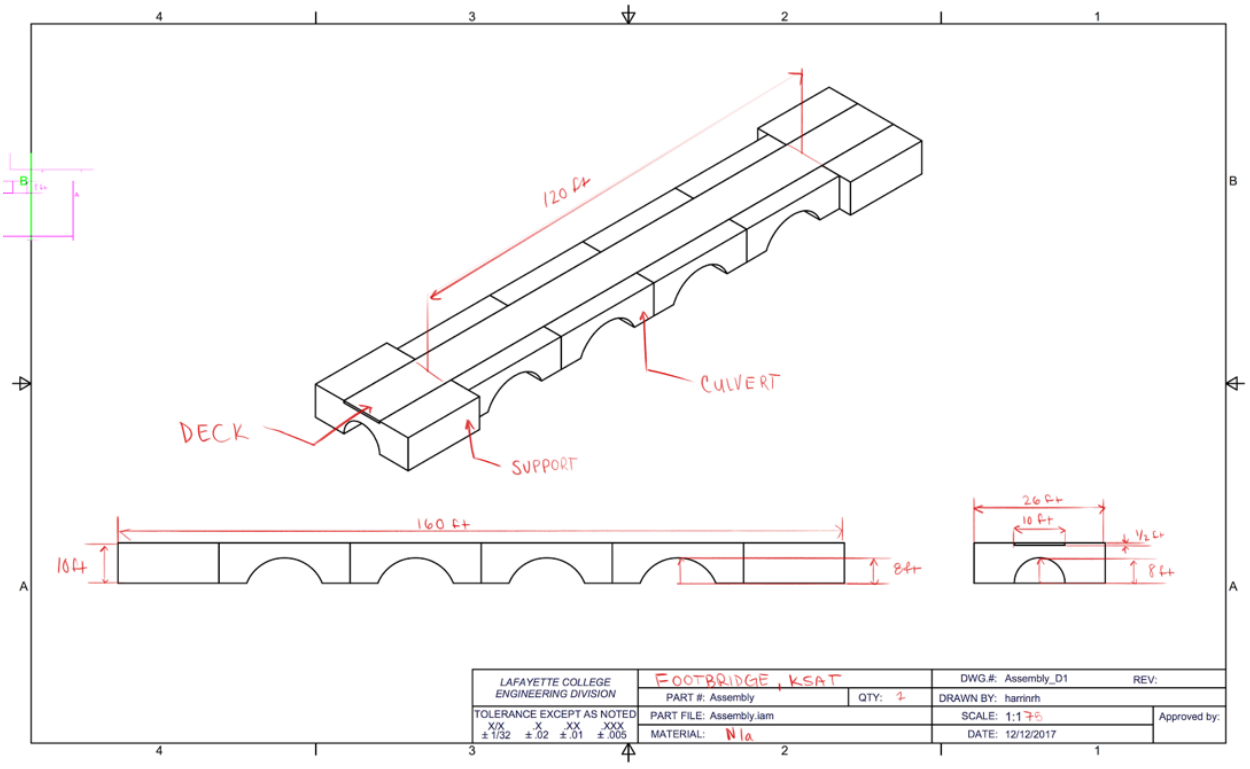

Figure 9: Inventor mock-up of KSAT bridge

The inventor model depicted in *Figure 9* is supported by two precast concrete supports. These supports would ideally recede into the river bank and be less visible to onlookers. The model also includes four culverts used to support the deck throughout its 120 ft. span. These culverts feature a cylindrical cutout with an 8 ft. radius of clearance at the highest point. This 8 ft. clearance radius is taking into account FHWA regulations for weathering steel above running water such as the Bushkill creek (Federal Highway Administration, 1989). The deck model features a 120 ft. length over the creek itself, with a clearance of 20 ft. on either side to account for the supports. In return, this makes the total length of the bridge 160 ft. As stated before, the modeled deck is 10 feet wide to accommodate at least two people and meet federal regulation minimums.

In reality, the dimensions of this bridge may not completely reflect that of the Silk Mill bridge or this Inventor model because the KSAT footbridge aims to be more artistic rather than purely functional (Toia, 2017). Likely, artistic elements would increase or decrease certain physical dimensions depending on the final product. Additionally, the width of the footbridge may change depending upon the amount of projected traffic or alternative uses such as bicycles. The clearance height for the bridge will need to be analyzed by an engineering firm, specifically dependent on the materials interactions with the water as the Bushkill Creek is known to frequently flood. Luckily, the mock-up inventor model allows future projects regarding this footbridge to experiment with different dimensions using the parameters function automatically. Additionally, it allows us to compare deflections and stress in different materials to better determine what works best for the KSAT bridge (*Figures 10,11,12*).
In terms of materials, our group researched three potential materials: steel, prestressed concrete, and fiber reinforced polymers (FRP). These materials were chosen because of their pervasive use in bridge building and their structural integrity associated with their material properties (*Table 3*). Each of these materials pose different benefits and disbenefits from a technical standpoint. In order to evaluate which materials are more suitable than others, we compared these materials on the basis of what best addresses the intention of this footbridge. Namely, sustainability, functionality, and durability.

Material	Yield Stress (MPa)	Tensile Stress (MPa)
Weathering Steel	355	630
Prestressed Concrete	84	8
Fiber Reinforced Polymers	N/a	480

Table 3: Information retrieved from http://www.build-on-prince.com/
https://doi.org/10.1016/j.jksues.2014.04.001/
http://www.totalmateria.com/

Two of the most common materials used in bridge design are weathering steel (also known as corten steel) and prestressed concrete. It is a common misconception that concrete has a longer service life than steel due to the corrosive nature of metals. In actuality, steel and concrete have highly comparable service lives, and the deterioration of either material is more dependent on daily traffic and age (American Iron and Steel Institute, 2007). With this in mind, it may appear difficult to choose between the two as materials for a footbridge. Sustainability for steel is one of the highest for any construction material, as it is one of the most recycled materials in the world (>90%) (American Iron and Steel Institute, 2007). However, weathering steel is subject to

several limitations by industry guidelines. The Federal Highway Administration (FHWA) urges caution when designing these bridges in certain environments and locations. Specifically, in environments with "Frequent High Rainfall, High Humidity or Persistent Fog" and locations "Eight feet or less over moving water (Federal Highway Administration, 1989)." Considering the fact that this footbridge is going to be located on the Bushkill Creek, and may be subject to high waters and flooding, weathering steel may not be a logical decision for the footbridge superstructure. An additional concern with weathering steel is the use of road salts to melt ice in the winter. Since the KSAT is open year round, it is likely that salts will be used to keep the trail ice-free. These salts can further corrode the steel superstructure in addition to the flood waters in the spring. Ultimately, a steel frame would be short lived and ill-advised (American Iron and Steel Institute, 2007).

Like weathering steel, Concrete superstructures may also be corroded by de-icing salts. Additionally, concrete bridges may be subject to freeze-thaw cracking damage that may compromise the structural integrity of the bridge itself. That being said, concrete is generally considered to be relatively a non-corrosive material and is often used as a primary resource in bridges located near or on bodies of water such as the Bushkill Creek. Concrete also has the added benefit of being able to take any mold or shape—an important consideration for the future artistic component in the KSAT. In terms of sustainability in comparison to steel, concrete requires significantly less energy than steel in production (Struble & Godfrey, 2004). However, concrete does not have the recyclability that steel possesses, putting the two more or less equal in terms of environmental impact.

FRPs are becoming an increasingly popular material in bridge construction. The lightweight nature of FRPs make them economically attractive in terms of transport costs in addition to being non-corrosive materials and extremely weather resistant. In comparison to prestressed concrete bridges, FRP's may also be molded into any desired shape using heat. However, FRP superstructures typically have longer life cycles than concrete. Additionally, FRPs require less overall maintenance than any other bridge material (Nishizaki, Takeda, Ishizuka, & Shimomura, 2006). From a purely technical position, FRPs stand out as uniquely suited for a small scale footbridge project such as the one proposed. Nevertheless, the FRP industry is notoriously problematic when dealing with waste. In other words, although they may be sustainable in practice, the contingency plan detracts from its environmental friendliness. Often, FRP waste is disposed of in landfills, actively contributing to the negative environmental impact the KSAT and the Lafayette community abhor (Halliwell, 2016).

In addition to these comparisons, the materials can also be compared in terms of relative Von Mises stress. Von Mises stress is commonly used in the industry to determine whether or not structures will fail because it demonstrates the relationship between external loads and subsequent deformation. In this model, both the supports and the culverts are assumed to be fixed joints on surfaces connected to the ground and the bridge deck; these supports are expected to restrict motion in all directions. Assuming a 200lb person stands directly in the center of this bridge, we can examine the subsequent reaction each of the three materials might display. It is important to acknowledge that this singular point load is not representative of real-world conditions as a bridge may be subject to higher or lower point loads and likely multiple loads at a

time. This model is simply a basis for different material reactions and may be altered when realistic foot traffic is determined.

Figure 10 shows how a steel deck may distribute a load across these supports, with a maximum Von Mises stress at about 0.00022 MPa. This number is minute and significantly under the critical stress for weathering steel shown in *Table 3*, indicating that this bridge would not fail under these conditions. Likewise, *Figure 11* shows a concrete deck under the same loading conditions, resulting in a maximum Von Mises stress of .00021 MPa. Although this maximum is highly comparable to steel, it is important to note that the scale for steel runs slightly higher than the scale for concrete. This indicates that a concrete deck may handle additional loads marginally better than a steel deck. Finally, the FRP bridge depicted in *Figure 12* shows the highest maximum Von Mises stress out of all three at .00082 MPa under similar loading conditions. Although of these potential stresses are well below the yield stresses of each material featured in *Table 3*, this analysis provides us with another material property consideration when designing this footbridge, or how loading conditions affect potential stresses within materials. Inventor is set up with several different materials outside of the ones examined in this report, as well as the ability to change the force on the load and the location. Future projects are encouraged to examine additional materials and loadings to best estimate what material would be suitable for the KSAT bridge and the traffic it may bring.

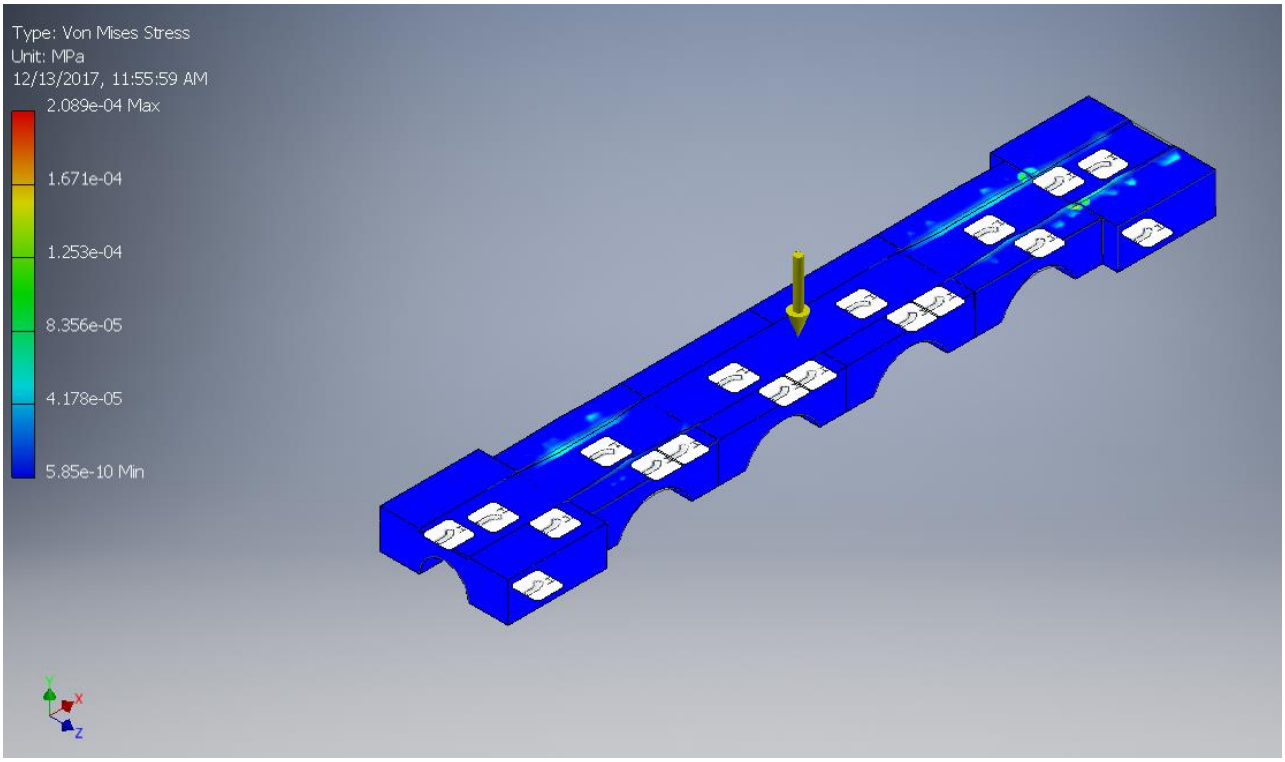

Figure 11: Von Mises stress over concrete deck

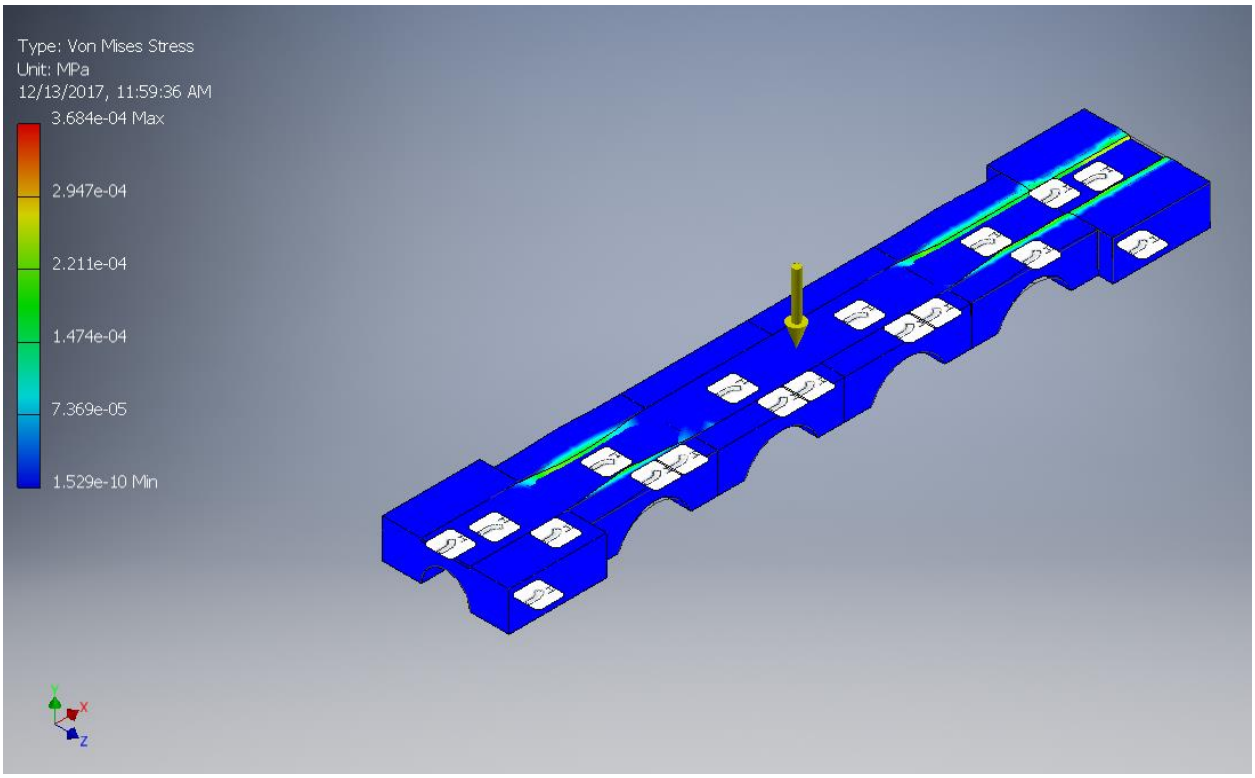

Figure 10: Von Mises stress over steel deck

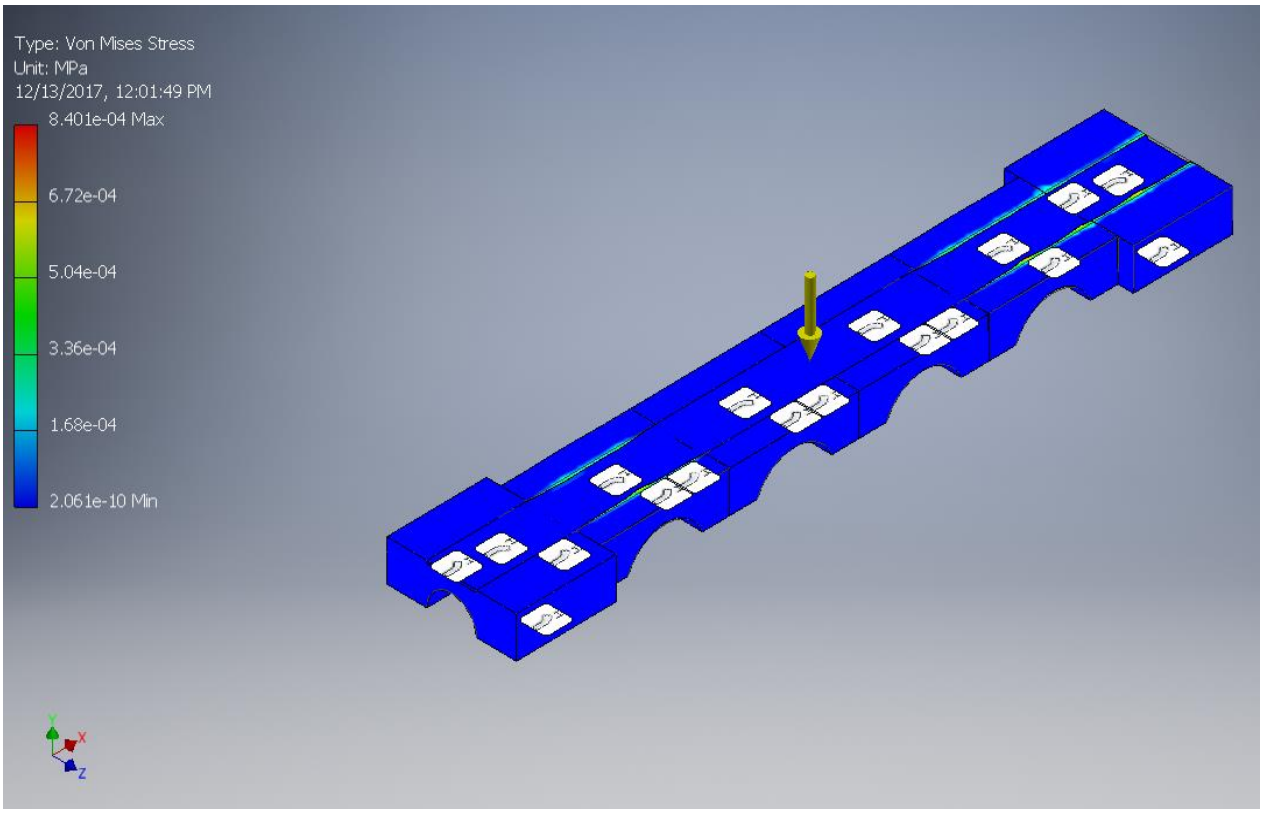

Figure #: Von Mises stress over FRP deck

Though our group cannot make any final decisions on materials, our report synthesizes information so that a future entity may be able to make an informed decision regarding the technical details of such a footbridge. Subsequently, our group, after preliminary research, recommends that concrete or FRPs would be the most suitable for the KSAT, instead Corten steel due to FHWA regulations. However, external factors such as cost may also play into recommendations featured in the economic section of this report. Future projects are encouraged to advance this research by applying professional opinions to this rough data to create a more precise outline of the actual footbridge.

Conclusion

In light of the social, political, economic, and technical analyses outlined in this report, our group has compiled several recommendations for the city, the college, and especially the KSAT Board as they each move forward with this footbridge feasibility study. These recommendations ultimately connect back to the research question stated in the Introduction. Therefore, these suggestions aim to forge the disconnect between Lafayette College and Easton and facilitate the identity of the KSAT.

Essentially, our group recommends that the next steps taken in this feasibility project involve a concentrated and collaborative coordination between the three entities involved, the college, the city and the KSAT Board. Based on our collective research, a shared vision for this footbridge and for any further rehabilitation of the area will be integral to the success of both the project and the relationship between the town and college. Furthermore, this coordination should involve a discussion of the various responsibilities involved in this project. For example, our project demonstrates that Lafayette College will likely fund such a project, either through an alumnus or through the administration. However, how will Lafayette funding the footbridge shape the vision of the footbridge? Will civil engineering students help in the design? Will art students work with Easton artists to design the aesthetics components of the bridge? These are all questions that will fundamentally impact the shape and success of the project.

Furthermore, zooming the lens out, each of these three components need to carefully coordinate and curate a collective vision for the surrounding area. For example, the vision depicted in the introduction involves a visitor’s center in place of the existing auto-dealership. This plan depends on Lafayette buying and attaining the land of the auto-dealership, a company owned by Easton residents, employing Easton residents and serving Easton residents. To this end, the assumption that Lafayette will eventually own this land perhaps reaffirms Easton’s perception that Lafayette is expanding its reach too far into the city. Again, the careful curation of a holistic vision for the Bushkill Campus between all three stakeholders will hopefully ensure a positive and successful project that will represent the college and the town’s ability to collaborate. Subsequently, in this revision, the footbridge will represent a piece of a larger reconstruction of the area. Eventually, the footbridge could act as a conduit between the two communities and cement the KSAT’s role in the unification of the college and town.

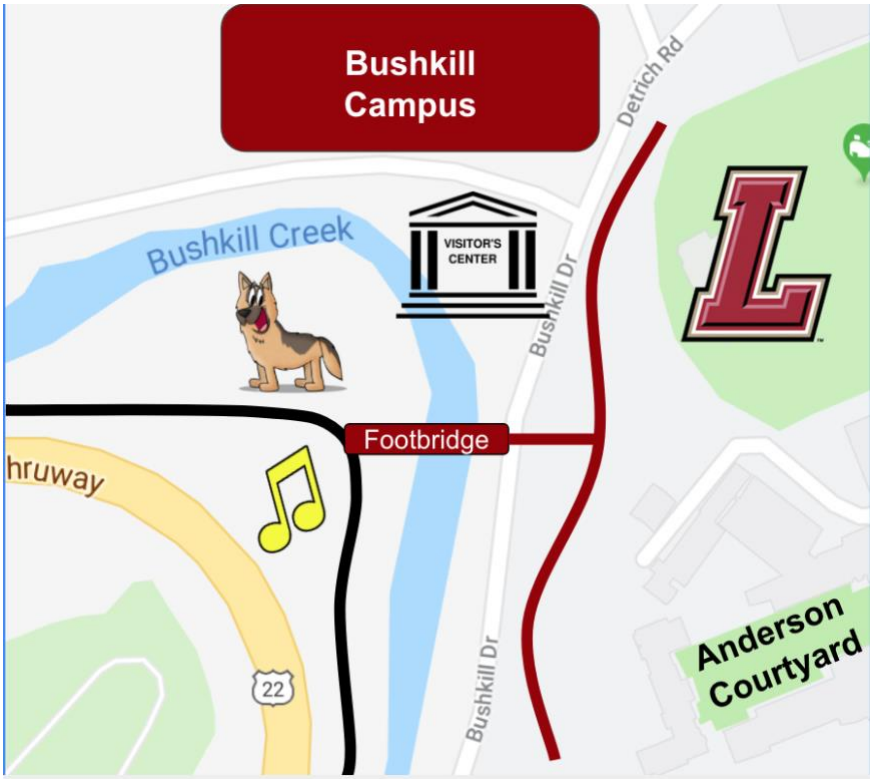

Figure 12: Loose Outline of the Vision for the Bushkill Campus

Our group also recommends that, whenever this bridge is implemented, the pedestrian footbridge is more than just a physical footbridge. To this end, our group recommends that the bridge involves educational, sustainable, and aesthetic components. In terms of education, this bridge provides a unique opportunity to act as an educational space for both Lafayette and Easton students. Through programming between the two curriculums, Lafayette students could educate students in Easton about the history of the trail and the rope factory it sits on. Not only would these elements forge a connection between the college and the city, but it would expand the footbridge into an educational landmark.

In terms of sustainability, the bridge could provide data about the Bushkill Creek. Through this plan, sensors adhered to the bridge could measure water depth, turbidity, flow rate, pH level, etc. This information could be fed back to the college in order to inform Lafayette's own environmental studies and sustainability education, especially as the Bushkill Creek periodically floods. Furthermore, this data could be seamlessly incorporated into educational efforts between Lafayette students and Easton students, with kits provided for third-graders to measure the pH of the water.

In terms of aesthetic appeal, we suggest that art is incorporated into the trail. First, this art will ideally fit into the ethos of the trail itself, thereby facilitating the trail's identity. Second, the art will transform the footbridge into a visual event. With the incorporation of art, the bridge transforms into a destination in of itself, instead of merely a means to get from one side of the river to the other.

Collectively, these educational, sustainable, and aesthetic components will increase both the direct and recurring costs of such a bridge. However, the return on investment equally increases. With each of these programs, the merits of the bridge expand, as both Lafayette and Easton derive more intangible value from the project.

Circling back to the Introduction, our group posited that our goal would be to implement a footbridge that successfully synthesized sustainability, functionality, and aesthetic appeal. To this end, we again propose the following bridge as a model for a potential vision of a footbridge.

Figure 13: Mock-Up of a Bridge

This mock-up collectively incorporates all three criteria. First, it promotes sustainability as the bridge assimilates into the nature it surrounds. Furthermore, this assimilation adheres to the atmosphere and ethos of the trail itself. Second, the bridge is functional; it provides a way for walkers and runners to successfully move from one side of the bridge to the other. Third, this bridge provides aesthetic appeal. Not only is the bridge itself aesthetically appealing, but the space it provides allows for rotating art installations, a staple of the KSAT. As these three criteria coalesce, the bridge itself becomes more than just a physical footbridge; it becomes a gathering place for both communities, a visual event, and a destination in of itself. Again, these elements only increase a return on investment and a justification for funding. Subsequently, though our group is not recommending that a direct next step involve the immediate construction and implementation of a footbridge, we still have provided ample research to support our recommendations.

In summation, our group recommends that the KSAT Board's next steps be a direct coordination between the three entities involved: the college, the city and themselves. This coordination will increase the likelihood that a footbridge will act, both in the process of its creation and in its actual existence, as a physical manifestation of the ability of the town and college to collaborate. Subsequently, the success of this project could serve to forge the disconnect between the two communities. Through this project, we have endeavored to demonstrate the intangible benefits of a footbridge and how these benefits could be best leveraged and optimized. In other words, how a pedestrian footbridge can both physically and metaphorically bridge the two communities.

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