GUAYABITOS SUSPENDED BRIDGE

BRIDGES BETWEEN WORLDS: TECHNOLOGY AND SOCIETY

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By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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More than one billion people around the world live with no or limited access to modern healthcare and markets. In some communities this isolation is caused by a geographic feature, such as a gorge or river, of which passage is dangerous. Access to education and opportunity is limited by fear that children will drown on their way to school, or the elderly will die in route to medical care. This problem is remedied by a pedestrian footbridge, which creates safe and reliable access to neighboring communities, allowing for expansion of population and economic opportunity, including a 75% increase in farm profits, 12% increase in children enrolled in school, and 18% increase in healthcare treatment (EIA conference, 2020). Fortunately for rural areas that are not able to receive sufficient education to design their own structures, a company exists that solely develops these projects with the purpose of social advancement in mind.

Bridges to Prosperity (BTP) is a program run by Engineers in Action (EIA), partnered with the Thornton Tomasetti Foundation, and exists as a non-profit organization dedicated to the construction of footbridges with the purpose of connecting rural and isolated communities. These companies have all worked on infrastructure improvement and water quality services in underserved communities, and now have operating field offices in Bolivia and Eswatini, and have hosted previous projects in Panama and Nicaragua. EIA has promoted and supports several university chapters across the United States, and the capstone project to be discussed here is the founding effort of the University of Virginia Chapter of Bridges to Prosperity.

TECHNICAL OVERVIEW

The fourth-year civil engineering student members of this newly founded team are myself, Marlene McGraw, Robert Peacock, John McClorey. The university advisor is Jose

Gomez, PhD, professor of structural engineering at the University of Virginia, who invited UVA alumni Leo Fernandez and Rupa Patel to advise the students in their development of the chapter, along with EIA staff Ethan Gingerich and Brenton Kreiger. Ethan Gingerich is Bridge Program Director, has traveled to Guatemala and Nicaragua to repair and construct pedestrian footbridges, and communicates with all chapters to ensure smooth cooperation for ongoing projects. Brenton Kreiger is Bridge Program Coordinator, and coordinates the online instruction of the various university chapters so that all designs and projects are equally well crafted so that future members of the program are able to sufficiently train the upcoming interested classes.

The task given to the University of Virginia Chapter is to design and implement a suspended footbridge over a river in the Carrasco province of Bolivia. The location name is Guayabitos, and was selected based on the needs of the surrounding community for increased agricultural and economic opportunity, along with statistics concerning the deaths and injuries caused by regular river crossings. In order to improve the safety of crossings and ensure that the goals of a benefitted community are met, a multi-tier suspended bridge is being designed by the team, with tower-raised cables to support the walkway and concrete based anchors to secure the varying load. The steel or wood walkway is supported on both ends by abutments of the previously listed features. The components of abutment design are more easily understood in a plan view of a previously designed footbridge similar to ours, pictured in Figure 1.

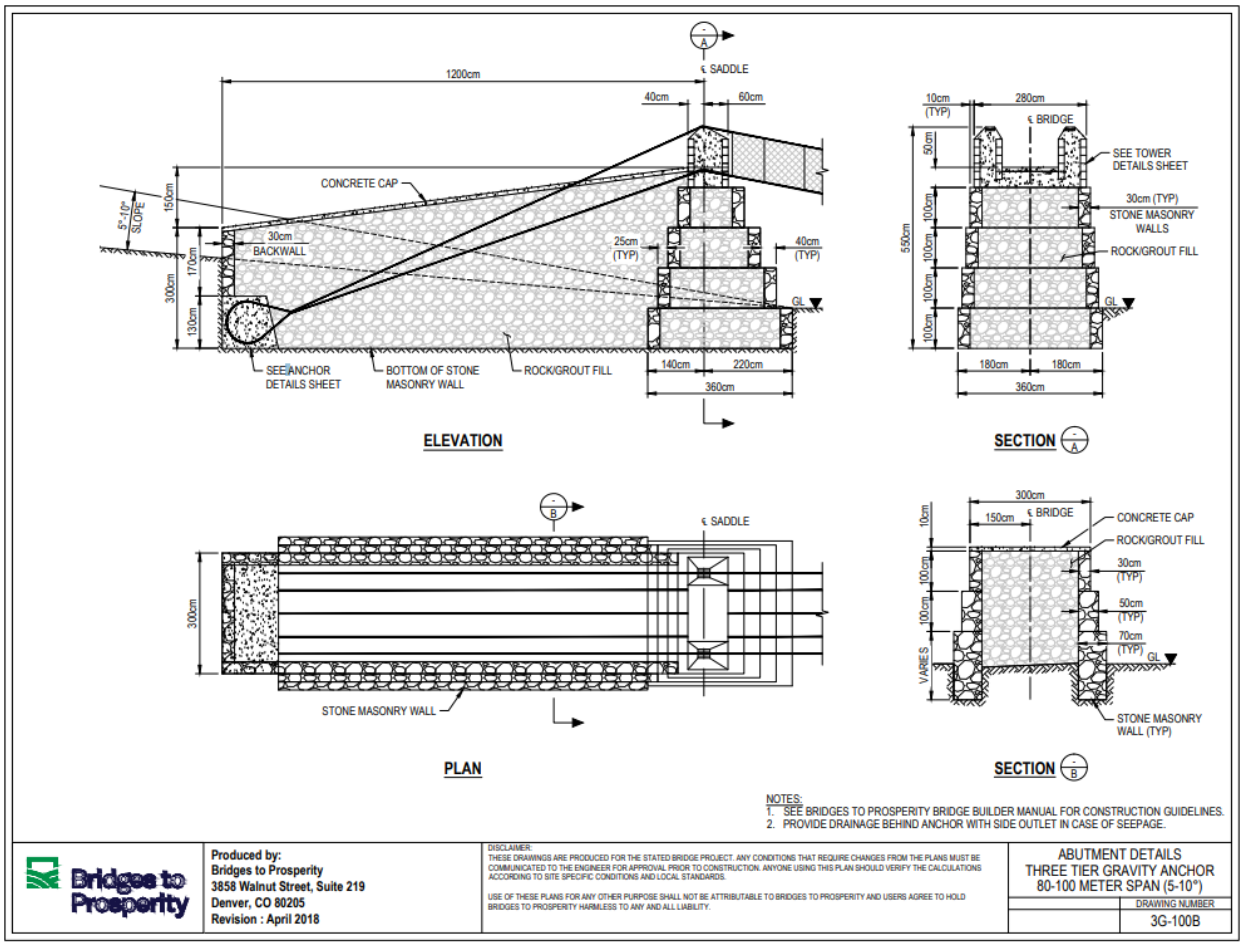

Figure 1: Three tier design for suspended bridge abutment, meant to span a river of 80-100 meters in width. This design could be mirrored on the opposite bank or designed with reduced tiers to compensate for a change in landscape. This is an example of the designs used to develop a bridge suitable for the site as surveyed (EIA Suspended Bridge Design, 2020).

The primary design objectives are safety, durability, and serviceability. The schedule designed by EIA spans two regular semesters, and consists of a weekly basis of completing learning modules, and 3 review calls with the Bridge Program Director, Review Call 1 in the fall semester of 2020 and Review Calls 2 and 3 in the spring semester of 2021 and directly before travel to the construction site, respectively. These tasks, along with a University required final capstone report and STS 4500/4600 thesis papers, make up the body of the research and technical projects. However, due to the continued influence of COVID-19, EIA has been in constant

communication with the UVA chapter, and keeps updating a fluid schedule as dates for modules and travel opportunities change.

Despite the continuous schedule fluctuations, the capstone team will have completed the online bridge learning modules by the end of their fourth year of education (2021). This will allow the team to travel to the Guayabitos site that summer, and supervise the construction of the designed bridge. The funding for the bridge and engineer residency will be provided by the local government of the Pojo Municipality, with the team members required to fundraise for their own travel expenses. Concrete materials, laborers, transportation, and heavy machinery will also be provided by the municipality. With the bridge constructed, the economic capability of the region will greatly expand. The footbridge provides safe access for neighboring regions to expand their business and agricultural operations to within reach of the city Cochabamba, a large city with modern communications and services (EIA Guayabitos Site, 2020). The previously witnessed and anticipated outcome of the project is a community with greater access to modern medical supplies, improved education, and general improvement to quality of life without the fear of losing one's life making what should be a routine route to work or school. The workings and outcomes of the project will be drafted in a technical paper created by all team members and their calculations, contributions, and experiences.

THE NEED FOR PROGRESS

The effects of a bridge built in the selected site are not byproducts of the construction: they are the purpose. The Guayabitos site in Bolivia was selected with careful examination of the surrounding economy and political situation. In November of 2019, President Evo Morales

stepped down from office, and his party Movement Towards Socialism (MAS) was replaced in the seat of power by the Democrat Social Movement, an unpopular and "Christian-fundamentalist" party, and its president Jeanine Áñez (Hylton, 2019). A period of violence followed, and became a regime of repression of ideas and traditions that resulted in bloody protests and street clashes for months on end. The unrest was only worsened by the COVID-19 pandemic, which Áñez used as a reason to postpone the regular May presidential election to September (Hylton, 2020). Public health services faltered, with infrastructure too weak to handle the influx of pandemic patients. Another postponement of the election to October sparked new protests, consisting of labor unions, farmers, and indigenous populations persecuted by the overzealous party. Leftist groups demanded Áñez resign, and called for the return of MAS once more, as they did over a decade previous when the last reign of a discriminatory government occurred (Faiola, 2020).

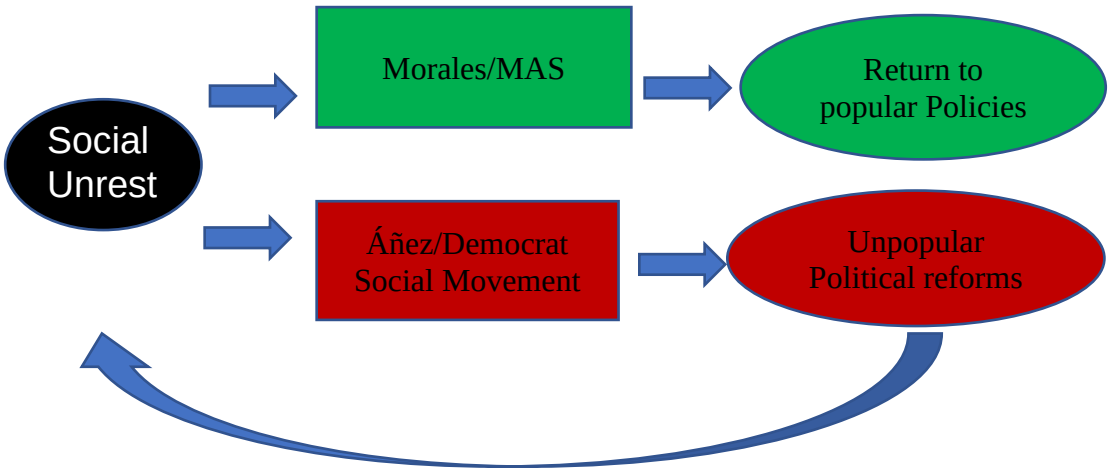

Figure 2: The looping nature of Bolivian politics in 2019 and 2020 show how inconducive to political stability the population is at this time. The same population that grew tired of the policies of MAS was the same as the voters that re-elected the party after being shown the alternative party's approach to governing the nation (Hetland, 2020).

Fortunately, in the October election MAS and its new representative Luis Arce won back the presidency, and were able to, with a population majority, oust Áñez and her now despised regime. During Áñez's presidency there was an uprising of extreme democratic values, which led the same agents that removed MAS to reinstate them, along with giving them a senate majority. For the previous 14 years of governance before Áñez, there was sustained economic development, and there is reason to believe that Arce will reinstate similar policies to try and restimulate Bolivian economics. However, the old policies did not have the challenge of COVID-19. The virus continues to hold the nation in a health crisis that drags down the economy significantly, and will make it difficult for the well-known policy-makers of MAS to adapt in ways all people will support (Hetland, 2020).

GUAYABITOS BRIDGE: MORE THAN JUST A PHYSICAL CONNECTION

As it stands, the nation of Bolivia is still very much divided. Hetland (2020) states, although current opinions are high and supportive of MAS after Áñez lost the election, that:

> "…voters are more committed to Morales's program than to Morales himself. Per official results, Morales won 47 percent of the vote in 2019, 5 percent less than Arce's apparent tally. The most likely reason for Morales's failure to score an outright majority last year was the widespread, though far from universal, rejection of his controversial decision to stand for reelection after losing a 2016 referendum to allow the president to run for a fourth term. It is also possible Arce benefited from the widespread disgust provoked by Áñez."

This indicates that the challenges to Arce as a new president during the COVID-19 era will not become gradually easier to solve; they will only become more difficult as time goes on. The population was indeed in majority for Áñez's removal, but was not near united in re-election of the deposed party. This leads to a nation politically and culturally divided, with indigenous populations and blue-collar workers recovering from harsh repression at the hands of their old government, and all peoples still gripped in a pandemic with only newly attended healthcare programs. That's not to forget the lack of sanitary services and running water to entire regions, and neglect of deceased body care and disposal (Hylton, 2020).

What is critical to Bolivia, now more than ever, is connection. As developed areas will adapt under a supportive government and begin to improve their infrastructure and utility, it is necessary for the isolated communities that have truly felt the hand of the pandemic to be connected to modern resources. In Cochabamba, the closest city to the site of the current EIA bridge project, medical workers have just ended a strike to protest the backlog of virus testing kits and funeral homes, both of which contribute to the steady spread of contagion. With new opportunities for improved handling of the virus, the city must become accessible to those who are accustomed to those conditions on a regular basis. Figure 3 shows the capabilities of isolated communities connected to an economic and technological modern city such as Cochabamba:

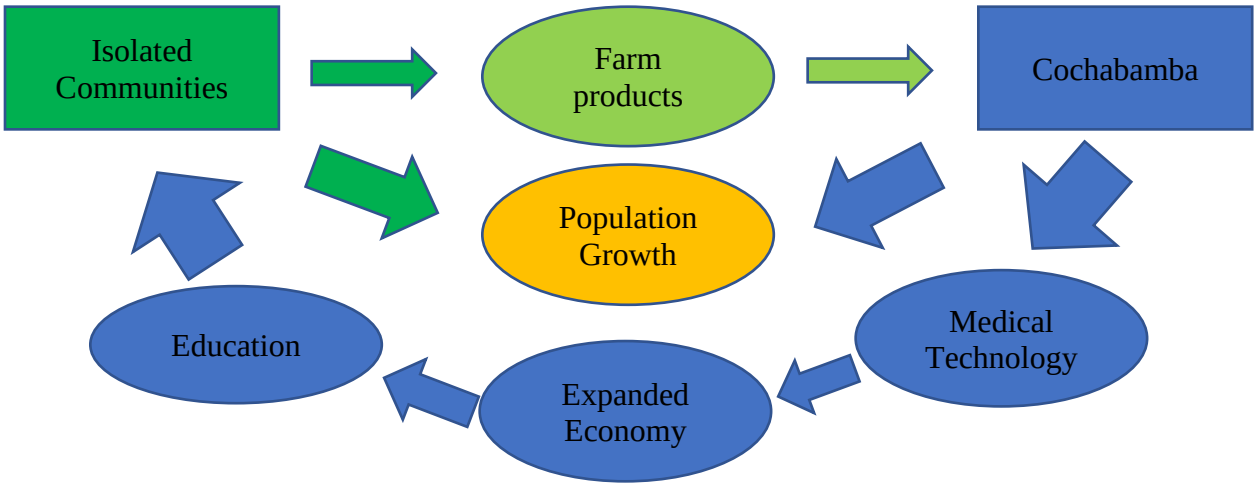

Figure 3: Isolated communities benefit greatly from increased access to the modern technologies offered by an industrialized city. However, access to rural farms and populations allow for gradual merging of communities, and growth of both populations culturally and economically (Narayan, 1999).

The objective of this work is to design the bridge, implement on site, and experience the merging of techniques, practices, and culture firsthand while constructing the footbridge. Future work is where the sociotechnical development of the local communities can be witnessed by researchers, so the approach used will center on Pacey's Triangle of Technology Practice (Pacey, 1983). This STS analysis procedure best fits the scenario of this capstone; utilizing three aspects of the project. First, there's the cultural aspect, with engineers from the United States arriving to a nation recovering from a government of social repression, there is potential for miscommunication of intentions and customs, along with a language barrier that could pose a real problem for technical work between designers and laborers. Secondly there is the organizational aspect, again being challenged by the language barrier, along with the thoroughness of the engineers designs and dependability of the project manager's scheduling skills. There is also the leniency and structure of the institution providing the funding, labor and equipment for the project, the Municipality of Pojo, and how its representatives wish to conduct the development on their land. Thirdly is the technical aspect, manipulating materials and machines efficiently and to design, and the overall implementation of a structure that will withstand the harsh seasons it will be built to relieve its users from worrying about.

The application of Pacey's triangle to an ongoing technical project may seem useless until the project is complete and the outcomes can be witnessed, but foresight is required if a project is going to withstand the test of time, both physically and culturally. Engineers cannot simply enter a rural area and drop a footbridge with the expectation of the community to fully

utilize it on its own. A bridge is only as good as the experience gained from creating it, so the community has to be as involved with the project as the municipality funding it, or the engineers designing it. The connection between peoples has to be presented in such a way that it will be used for decades to expand and improve economic potential and growth, along with education and culture. For a technical project to be worthwhile, especially one with the capability to improve the standard of living for the entire region of peoples involved, more than just the design drawings need to be analyzed. Understanding how a footbridge can help people connect and grow is the only way to justify the name Bridges to Prosperity.

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