Prospectus

Suspended Bridge Design for Guayabitos, Bolivia
(Technical Topic)

Stolen Land, Broken Treaties, Black Snakes: The Intersection of Pipelines and Energy Justice for Indigenous Peoples through a Social Constructivist Lens
(STS Topic)

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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I. Introduction

Roads are one of humanity's oldest technological tools; their usage extends back to around 10,000 BC, and the ways in which they have connected different civilizations (or different parts of the same civilization) have been a boon to human progress (Lay, 1992). Roads connect people, ideas, economies, and services. Bridges are a vital extension of roadways, forging paths that would otherwise be treacherous or impossible to navigate and creating opportunity and access for the people on the other side. This technical project seeks to create this connection by designing a suspended bridge for a rural community in Guayabitos, Bolivia, who are currently cut off from access to education, healthcare, and economic opportunity for half of the year when their local river floods.

While roads and bridges are an ancient infrastructure, newer infrastructure can also have profound impacts on the rights and well-being of the local stakeholders affected by its construction. However, historically marginalized communities often find themselves bearing a disproportionate amount of the burdens of construction and seeing fewer of the benefits. This is particularly true in the case of indigenous peoples and the construction of oil pipelines, which may seize their land but bring no benefit, economic or otherwise, to the disrupted community (Jonasson et al., 2019; Kerr et al., 2015; Whyte, 2017; Yakovleva, 2011). In recent years, many nations have begun to grapple with these issues and open dialogues with their indigenous peoples to find more equitable ways of bringing benefit to both parties (Hipwell et al., 2002; Jenkins et al., 2016). The United States, however, has made little, if any, progress on this front. This STS project will seek to explore why American pipelines have been so historically divested from the communities they build in, especially when those communities are indigenous, to hopefully reveal ways to improve the design process and outcomes for indigenous communities.

II. Technical Topic

Our world has become exponentially more connected than it once was, and especially in America most of us have enjoyed the privileges of having relatively easy access to food, healthcare, education, and amenities by car or bus. On a global scale, however, a lack of infrastructure, particularly bridges, has a profound impact on whether communities can access the services they need. Almost a billion people are prevented from accessing critical resources for some of the year because of an impassable river, which becomes a primary cause for poverty and can make treatable diseases fatal ("Why Bridges?," n.d.). Thus, designing and helping to construct these bridges can serve as a broad solution to several problems.

Our project site is in Guayabitos, Bolivia, a small town on the border of the Cochabamba and Santa Cruz departments (who oversee operations within their respective borders). During the rainy season, the river floods and is uncrossable by residents, who become cut off from medical, educational, and economic services, decreasing their quality of life significantly. Figures 1 and 2 display the site where the bridge is to be built. As can be seen from Figure 1, the area is a valley, not a gorge, and the site is very near to a fenced field which the team aims to disturb as minimally as possible. Figure 2 illustrates the elevation view of the site, as plotted in AutoCAD software by engineers who visited the site and provided this information to the team. While the left bank is fairly unproblematic, abnormal erosion activity on the right bank will make design more challenging than normal, as the team will need to ensure the stability of the structure for years to come, avoid significantly compromising the road that follows the river, and disturb the fenced field as little as possible. The team plans to consult with geotechnical experts from our alumni mentors, as well as geotechnical and stormwater management experts at the University, for guidance on this issue. However, preliminary design has begun with the approval of alumni and organizational mentors.

The design team is working with Engineers in Action (EIA) and Bridges to Prosperity (B2P) to complete this design; EIA has offered template bridge elements to be used in the design, following precedent of successful suspended bridge design, while B2P mentors are providing design review and suggestions. The team is following the design requirements laid out by EIA, which are shown in the Bridge Conditions Sheet in Figure 3. Following these requirements, the left side's base abutment has been selected and placed and is shown in Figure 4. The right design will need more consultation, but for the moment the initial assumptions the team used in tower placement are being accepted as preliminary design moves forward, to be adjusted as expertise is contributed to this problem. The expected deliverables for this project will be completed design sheets and calculations, construction schedules, and safety practices to be used on site. Depending on the state of COVID-19 by the summer, the team may also travel to Bolivia and aid in the construction itself.

III. STS Topic

While the technical topic focuses on the construction of bridge infrastructure, infrastructure of many kinds can help or hinder the communities they build in. Thus, the STS topic to investigate why American pipeline building is so divested from affected indigenous communities is a case study to begin to understand why infrastructure at large may successfully divest itself from the local community, and furthermore how this understanding can be used to change the processes around design, social or technical, to be more equitable and to create structural solutions to structural problems.

The relationship between pipelines and indigenous peoples is the latest offspring of a long history of theft and violence against native populations, beginning with European colonization of huge swaths of foreign countries. This theft has often masqueraded as friendship and trickery, creating and then repeatedly breaching partial treaties to take land and resources; this pattern has been formalized in the creation and then encroachment upon reservations, already hardly owned by native leaders, to support continued development and industry (Kerr et al., 2015; Whyte, 2017). The recent and frequent development of stealing indigenous land for pipeline construction has had distinctly negative effects on local populations; traditional food and water sources, for example, may accumulate pollutants and carcinogens or experience disrupted migration patterns that make it difficult or even dangerous to continue consumption, even though food plays a critical role in cultural transmission and mental health (Baker, 2016; Jonasson et al., 2019; Whyte, 2017; Yakovleva, 2011). The combination of generational trauma around land loss and continuing threats to indigenous ways of life understandably creates significant opposition to pipeline construction, but it hasn't been until recently that indigenous concerns have been considered in the design process. Literature in the field has begun to explore the concept of energy justice, the application of justice principles to energy production, as an avenue of engagement and protection for minority communities (Baker, 2016; Jenkins et al., 2016). However, this consideration has not been universal. In New Zealand, for example, the Maori people have found significantly higher success ensuring their rights are protected in design processes operating at the local level of government than at higher levels (Berke et al., 2002). Canada has long positioned itself as a strong advocate of indigenous rights, and there are many examples of ethical design processes that benefitted indigenous populations as much as the companies who operated in their territory, but this does not exempt it from its own flaws in creating complicated political environments where indigenous peoples are both wards and have rights to self-government (Belanger, 2011; Hipwell et al., 2002). In American history, however, there are very few examples of indigenous rights being protected even in the ways that Canada and New Zealand have, especially when related to the construction of pipelines or other energy systems (Bravo, 1996).

This STS project will seek to explore why American pipelines have historically been so divested from the communities they build for, especially when those communities are indigenous. Specifically, this project intends to consider the Social Construction of Technology theory of STS, which explores the way human action shapes technology, to more fully consider how social norms or attitudes may have shaped the design processes around energy infrastructure to categorically disregard local and minority communities (Sismondo, 2011). To research this question, this project will accumulate information about American pipelines that have operated on indigenous land, and investigate both the historical context of the pipeline and the processes that either included or excluded the affected peoples. Considering both attributes on several examples should provide interesting insights about what elements of the design process or American culture act as barriers to ethical design and could reveal leverage points to begin making the design process more inclusive and ensure that future development on native lands is done with trust, rather than exploitation.

IV. Timeline and Expected Outcomes

The technical topic has three formal review sessions; Review Call #1 will happen at the end of this semester and is intended to review the site data and preliminary design of the suspended bridge. The spring semester will begin work on the more complicated, full design plan, the delivery of which will form Review Call #2 and will occur in February. The development of the construction schedule and safety plans will form Review Call #3 and will occur in March. At the end of the process, the team will have at minimum full design plans for a suspended bridge, along with its construction schedule and safety plan; ideally, the finished deliverable would also include the actual construction of the structure itself, which would ensure continued access to education, healthcare, and economic amenities for the citizens of Guayabitos.

Research on the STS topic will be carried out through the remainder of the fall semester and the entirety of the spring semester, with a monthly check-in at minimum to ensure continued progress. The intended deliverable will be a paper analyzing several American pipelines running through indigenous territory through the lens of social constructivism to understand America's apathy to the continued theft of native people's lands and reveal ways to improve both the design process and land rights preservation for indigenous peoples in America.

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Figures

Figure 1: Google Earth Imagery of Site

Figure 2: Site Elevation Info (Created by EIA Engineers)

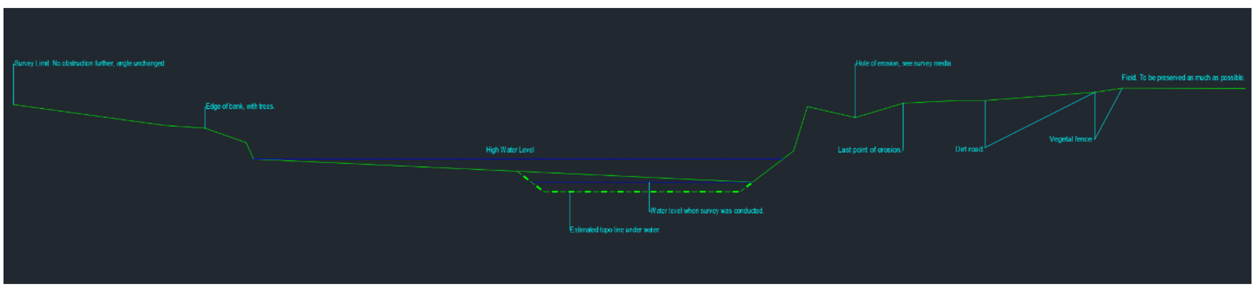

Figure 3: Suspended Bridge Condition Sheet (Created by Technical Team)

Variable	Value	Units	Limit		Units	Check	
			Rock	Soil		Rock	Soil
Left Foundation Setback	3	m	1.5	3	m	Acceptable	Acceptable
Right Foundation Setback	3	m	1.5	3	m	Acceptable	Acceptable
Left Foundation Behind Angle of Friction	20.81	degrees	60	35	degrees	Acceptable	Acceptable
Right Foundation Behind Angle of Friction	23.97	degrees	60	35	degrees	Acceptable	Acceptable
Span	60.7	m	120		m	Acceptable	
Delta(H)	1.77	m	2.428		m	Acceptable	
Left Side Ground Profile Slope		degrees	10		degrees	Acceptable	
Right Side Ground Profile Slope		degrees	10		degrees	Acceptable	
Left Number of Tiers		--	3		--	Acceptable	
Right Number of Tiers		--	3		--	Acceptable	
h_DL		m	3.035		m	Acceptable	
f	#DIV/0!	m			m		
h_hoist		m	2.7922		m	Acceptable	
h_LL		m	3.7027		m	Acceptable	
			Floodplain	Gorge		Floodplain	Gorge
Freeboard (as measured in AutoCAD)		m	2	3	m	Acceptable	Acceptable
Elevation of Low Side Walkway		m					
Highwater Elevation		m					
			Floodplain	Gorge		Floodplain	Gorge
Calculated Freeboard		m	2	3	m	Acceptable	Acceptable

Figure 4: Right Side Abutment Preliminary Design (Created by Technical Team using templates provided by EIA)