Cross-Cultural Co-Design to Encourage Community Independence

Ryan Candy, Hannah Murray, Maggie Ostwald, Kristophe Zephyrin

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Using Co-design and Construction of Bridges for Developing Community Independence

Many Westerners may define the town of Dwenase as impoverished. Compared to most Western cities, they might comment on the unpaved streets or rudimentary infrastructure. This claim could only be made without fully understanding the local culture. This is in part due to the relative notion of poverty that is defined by first-world countries to focus on what is lacking or deficient in a community.[i] In fact, the concept of poverty led to problematization, which identifies problems in underdeveloped countries that may not actually be an issue to the local residents.[ii] In turn, development projects are initiated from Western countries, both during and after the colonial era, which attempt to solve these problems, often unsuccessfully.[iii] However, the more important long-lasting effect is the increased dependence on outside resources. Following the independence of Ghana in 1957, the government was eager to show its worth and contributed to this effect by providing similar services and resources as the British had done before.[iv] This created a cycle of dependence in many small communities in Ghana.[v]

This project focused on the co-design and construction of two bridges alongside local workers in Dwenase, Ghana. We exchanged knowledge with our partners about these processes to advance their community and help them learn skills to further their careers. Not only did our partners learn technical skills, but this project demonstrated their ability to help themselves and their community. In the future, the community could construct its own high-quality roads, culverts, and bridges without assistance from the government. Ultimately, we used the design and construction of bridges as a vehicle to provide hope and show the community that they can create their own solutions to their problems. This allows them to become self-sufficient from outside agents, including Western influences and their own government, and leads to the creation of sustainable solutions.

Redesigning Development: Co-design, Communication, and Trust

Although our technical process began three months before arriving in Ghana, our co-design experience has been influenced by the history of Africa and the impact of the Western world on the continent as a whole. From road and highway projects to health services, development around the world has historically been from a top-down perspective where the lead developer determines the goals and objectives of a project. Top down development can sometimes cause communities to pin their hope on these entities to create change because the community does not have a voice in the goal-setting process. Because of these influences, we changed our idea of development away from the "Western savior" mentality that influenced similar efforts in the past.[vi] Every step of our planning process included reflection and comparisons of our plan to examples of development from our research.

For years, Africa has been viewed as prey for developed nations to exploit.[vii] Abundant natural resources and little to no regulation on development has led entities such as China, the United States, France and the United Kingdom to invest heavily in African affairs.[viii] These activities are often underwhelming as they tend to oversimplify the problem and fail to address the needs of the community. Oftentimes, this leads to developments that give investors great profits but provide only marginal benefits to the local communities themselves. This creates a cycle in which investors sustain the community through development but do not support them enough to become self-sufficient.

Problems with self-sufficiency do not solely affect the African continent. The United States' relationship with Puerto Rico in the late 1800's was complicated due to this outdated process of development. The main problems, the Spanish subjugation of the territory and economic instability, were solved due to Western intervention, but the people of Puerto Rico were left in a citizenship limbo where racial castes divided a once unified people. To develop effectively, entities must not only accurately identify the problem they are solving, but also implement aspects of social design to positively impact the community.[ix] This shift away from traditional means of development is difficult but is necessary to create effective solutions in these small communities, such as this project in Ghana. Co-design, when done thoroughly, can be a great tool to help change the development process.

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From our own personal experiences, co-design makes the entire design process more complicated due to all parties involved having a large share in the process. Everybody involved has a different set of skills and availability, so this greatly affected our project timeline. Organizing time for the carpenter, chainsaw operator, volunteers, and our daily partners allowed them all to be integrated into the process, but it also lengthened our 2-week build schedule to more than a month.

These complications are exaggerated when designing cross-culturally. For example, not only would you need a material and load analysis for building a bridge, but a foreign developer would also need to analyze the local culture and how it plays a role in affecting the design and construction of the bridge. Doing so helps everyone involved gain a deeper understanding of the proposed problem and thereby use their knowledge more effectively.

Co-design adds a few layers of challenges to the design process, but when done well allows for all parties to fully understand both the problem and the best solution. Defeating language barriers, creating cross cultural relationships, disregarding biases, and eliminating preconceived notions all add their own level of difficulty to design, but in doing so communication is increased, goals can be understood cross culturally, and knowledge is easily transferred between parties.

Our team's first hands-on experience with co-design involved meetings with some tradesmen and with the headmaster of the secondary school. Together we discussed project objectives and design considerations. The meetings were adjourned when moments of silence

replaced the barrage of questions from just a few minutes before. Then, since all questions were answered to the best of the group's ability, we regrouped and changed our focus to create a plan for the future. A final plan to execute construction of the bridges was created using a culmination of knowledge from the tradesmen and ourselves. After our meetings we all walked to the site with a different mindset and excitement about our work; perhaps this was an effect of constructive co-design.

Our meeting with the headmaster involved co-design in a slightly different light. We initially designed our learning objectives around bridge building specifically, but the headmaster and other teachers helped us understand that the design and trade students need experience applying the theories and concepts they have learned in the classroom. Together we created a list of objectives that we felt were beneficial for the students to learn during our time in Dwenase. Together we expect the students to receive hands on experiences working with tools, gain experience working in groups, and develop a new connection with the village. This completely changed our original plan, but it allowed us to create new interactive activities which were different than our original, lecture-like programming. During both of these meetings and throughout the entire co-design process, objectives were communicated effectively for the sole purpose of preparing our team to make well-informed development decisions.

"Many, many things on this trip have not gone according to plan; this will not, either."

Our initial plan was to construct a bridge entirely out of wood. We found that while on paper this design would work that we had insufficient knowledge about local conditions. Initially we rejected the idea of using concrete because of the research we preformed beforehand, but during our debate about using a new material it was necessary to take ourselves aside and think. We struggled to separate from our research because we felt invested in the information we learned. Also, the local community has the best insight in what can really improve their situation in their own way. During our time deliberating, we realized that this was a prime example of firsthand co-design and we had to change the way we think about our solution. After a long discussion and a lot of doubts we all agreed to use concrete to aid in

the construction of our bridge. The secret ingredient to success, however, is not concrete, but rather trust. Combining the knowledge of all the team members can help prevent unforeseen consequences and increase the likelihood for success, but the entire team must also trust the information given. Without it, the team is obsolete, and it becomes even more challenging to accomplish its goals.

Our co-design process was supported by our research on design methods, and case studies of development successes and failures. Not all aspects of traditional development utilize these types of research, but it can play a big part in successful co-design. Historically, development focused more on solving the problems, without working through the solutions in partnership with the community. From Puerto Rican to West African development, we have examples throughout history where community centered design could have mitigated the unforeseen consequences faced by these communities later in time. Co-design, in all its complexity, can allow for solutions to be developed while also benefitting the people who live and work in these communities.

Growth and Adaptation through Cross-Cultural Co-design

Co-design is an egalitarian process that integrates multiple ways of thinking to create a solution that satisfies a technical requirement. However, instead of focusing on the deliverable, the process of co-design holds the true value. In this regard, co-design does not reflect the traditional designer-client process. In our project, we work together with local tradespeople to co-create two different bridges. The process of creating the bridges is the reason for the project. The exercise of design and construction by combining local knowledge and relative engineering backgrounds is intended to encourage future local developmental success. The purpose of co-design is to learn from each other, so much that it develops a drive for long-term success in those who participated in the project. Together, we empower other people to have the confidence to become leaders, designers, and visionaries. All the while a physical deliverable is being brought to life that will benefit an entire community. Co-design is an invaluable process that gives everyone involved new interpersonal skills, and technical skills, to use throughout their careers to help make the world a better place.

The process of co-creating seeks to overcome pre-set barriers from those who came before us. One must understand the local history to understand how these barriers were set. In Africa, our local place of design, there is a preconceived belief that the continent is in poverty, compared to western countries. The rural Ghanaian villages are dependent on outside help, such as federal funding, to develop their communities.[x] This dependence is stalling desire for development on the local level. Africa is not poor in resources; Africa is one of the wealthiest continents when it comes to natural resources.[xi] Instead, Africa needs more people who have the vision to create something out of these natural resources. Africa's big picture is co-creating a self-sufficient cycle using local resources in an environmentally friendly way, all the while creating jobs and opportunities for people to have the best quality of life possible. One of the most critical ways to achieve that is not by waiting for the government to decide they want to put money into a rural community. The government will only put money and time into things in which they directly see fit, such as tourist destinations, major cities already rich with opportunities, global trade, or in mitigating major epidemics. Therefore, one of the most critical ways to achieve local self-sufficiency is by creating development from what is rich to one's local level. For example, working to design building materials out of what the earth

naturally provides accessible, like straw or coconut fibers in Ghana, has the potential to be an innovation that will guide the future of the global construction business.

By scaling the big picture down to the local level, co-design shines through. The process of exchanging ideas with those different from you will bring inspiration, new technical knowledge, and the opportunity to create a lasting impact on the community. Co-design strives to overcome the present-day tendency to rely on traditional western solutions to problems that are not relevant to rural African locations. In our experience, the process of co-design began as a submissive power struggle, as we did not truly understand the local social dynamics. Our project team arrived in Ghana with a design concept already in our head. We were open-minded as we knew the design would change, but we figured the underlying components of the draft would remain the same. We did not think that there would be many other bridge options that would be applicable in this setting. The key components of this mindset were being proactive and flexibly reactive.

"Originally we had one bridge with no concrete. Now we've got two bridges, both with concrete."

Our team of Ghanaian tradespeople and American college students sat down for a meeting and discussed together what our idea was, asking if there were any suggestions from the Ghanaian perspective. As much as we tried to explain the design through pictures, the language barrier proved to be an extreme comprehension roadblock.

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We cannot speak for the tradesmen' education levels or how long they've been out of school, but needless to say it is much different than brainstorming with other American engineering students. When we began physically working at the bridge site, the ideas started flowing much better than on paper. Unknowingly, we were all exercising ethnography in the field. The practices that we used, the flow of thoughts, and the physical deliverable continued to change for several weeks. By the end of these eight weeks, two worlds came together to create a long-lasting bridge. More importantly, two worlds came together to instill new visions, knowledge, dedication, and inspiration for creating smart future development.

Our co-designers for those eight weeks were underemployed tradesmen and women. When we first met, it took an adjustment to become acquainted with each other enough to confidently brainstorm design ideas. We had to first overcome the barrier set by past stereotypes. We were Americans, placing ourselves in their village, and already coming up with an idea for the next bridge. How do we equal out the power dynamic to allow for the free flow of ideas to create something better than we started with? We found the answer by listening. We asked dozens of questions to the tradesmen every day, always starting out simply, "ɛte sɛn?" meaning "How are you?" Our effort to learn the Twi language usually ended in jokes because we were so bad at it, but a bonding experience because we tried.

Just like getting better at Twi every day, the process of working together became smoother and smoother. Until suddenly, two of the tradesmen started striking because of issues with their compensation. These two men would rally the rest of the tradesmen to strike against the work for the community because they felt like they were not being paid enough. Further, they would harass our project team and one of our assistant advisors every day about it. When they did work, they did not work as a team, and they would not listen to other peoples' ideas. One day, one of our team members was explaining an idea for the framework for the third concrete pour. It was a complicated design and something most of us had probably never seen before. This innovation stemmed from the opportunity to reduce the amount of cement needed by one half. Tensions were high already, and one of the two men who initiated the strike yelled at us saying, "You cannot teach me!" That was the side of co-design that we feared the most and was exactly what we did not want to happen. However, what happened next was even more shocking: the chief of agriculture rolled his eyes. Everyone else ignored the man

arguing. He left and never returned. From here on, the team atmosphere shifted. We were able to overcome this obstacle by firing the two men who started causing problems. The decision to shift away from the problematic workers opened doors for people who truly cared to make a difference in the community through this project. The people that we worked with as co-designers for the remainder of the project were accountable, enthusiastic, optimistic, and resourceful. In other words, they truly embodied the characteristics of co-design.

All in all, the process of co-design had its challenges; without the challenge, there would be no reward. Together, we overcame obstacles to co-create two bridges that will ease the lives of dozens of people every day. The significance of those bridges is worth much more than the physical deliverable. Hearing that people around town have plans for development because of our work, is half of what we are striving for. The other half is us, Americans, not being the reason. We want the local people to realize that they are capable of innovation themselves. Africa is a blank slate for development. The resources are here. The people are here. The opportunity for self-progression is realistic. It is through co-design that we hope to connect the concept of local development to the abilities of local people.

One way we hoped to accomplish our project goals was by working with underemployed tradesmen to provide an opportunity to apply their skills in a real-world project from start to finish. Originally, we planned to work with Basic Design and Trade students through the design and build process. The Headmaster of the school, however, would only release them from school for an hour a week. This is hardly enough time to go through this process. Then, our advisor, Rob Krueger, suggested that we instead team with underemployed adults to best blend skill, knowledge, and experience. Still wanting to work with students, we hosted weekly activities at the school to educate young design and trade students about the fundamentals of project design and development.

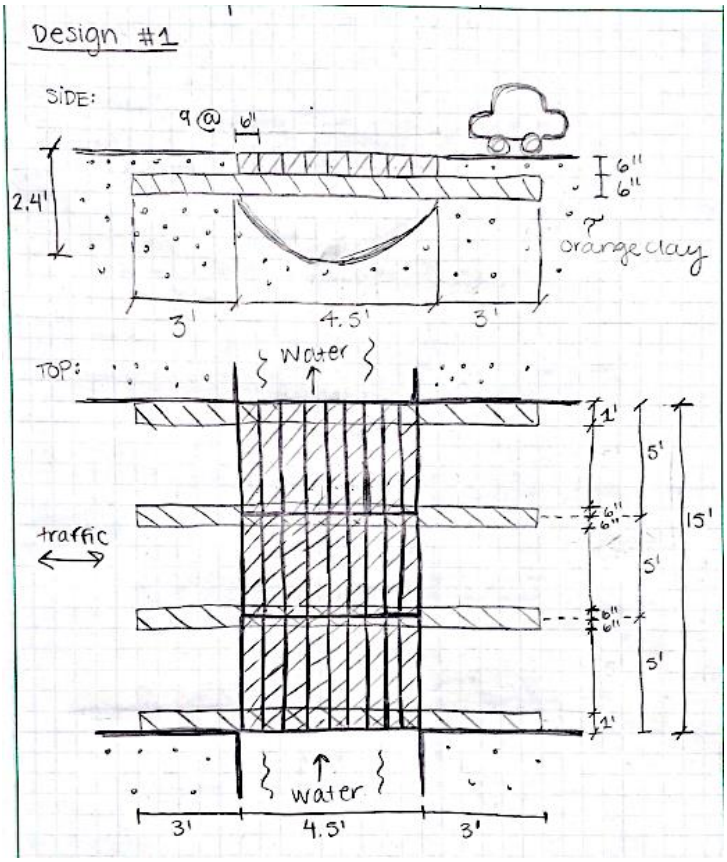
The need for a new bridge at the first site stems from an incident that occurred a few months ago, when a portion of the old bridge collapsed and caused a loaded cocoa truck to fall off the side. A new bridge was needed at the second site, in front of the health center, to maintain an entry point to the parking lot spanning over the culvert, which was recently excavated to drain water from the road during the rainy season. Together, we planned to build these two bridges to enhance the transportation network and mitigate flooding. Our most

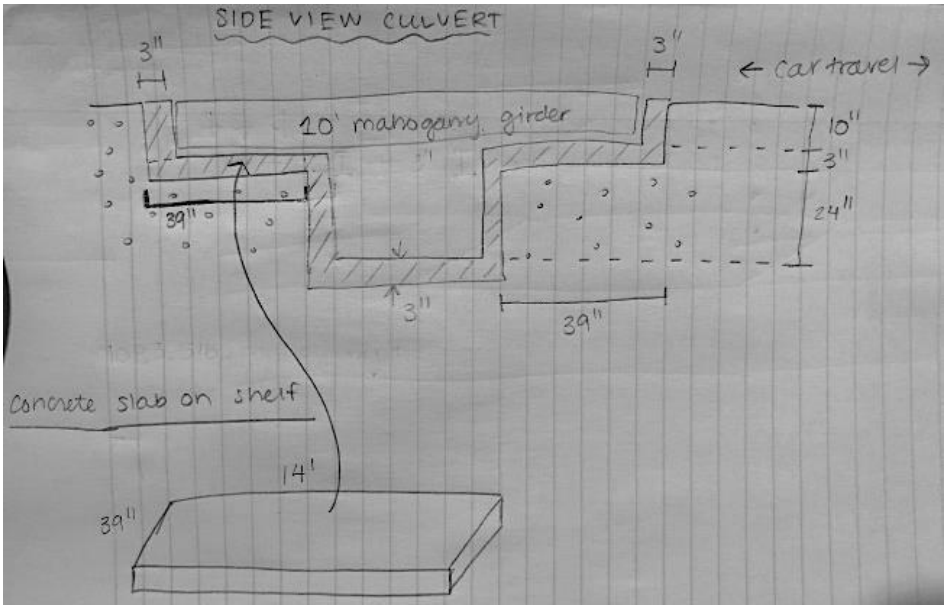
important objective is to leave behind the confidence to continue developing the community for the future. To accomplish our objectives, we organized general project tasks. First, we needed to finalize a bridge design. After agreeing on a design with our Ghanaian colleagues, the timber, concrete aggregate, cement, nails, and tools were obtained. Next, the culvert was excavated, leveled, and the concrete was poured. Once the concrete cured to full strength, the bridge was fully constructed as the beams were nailed together and the bridge was opened for travel.

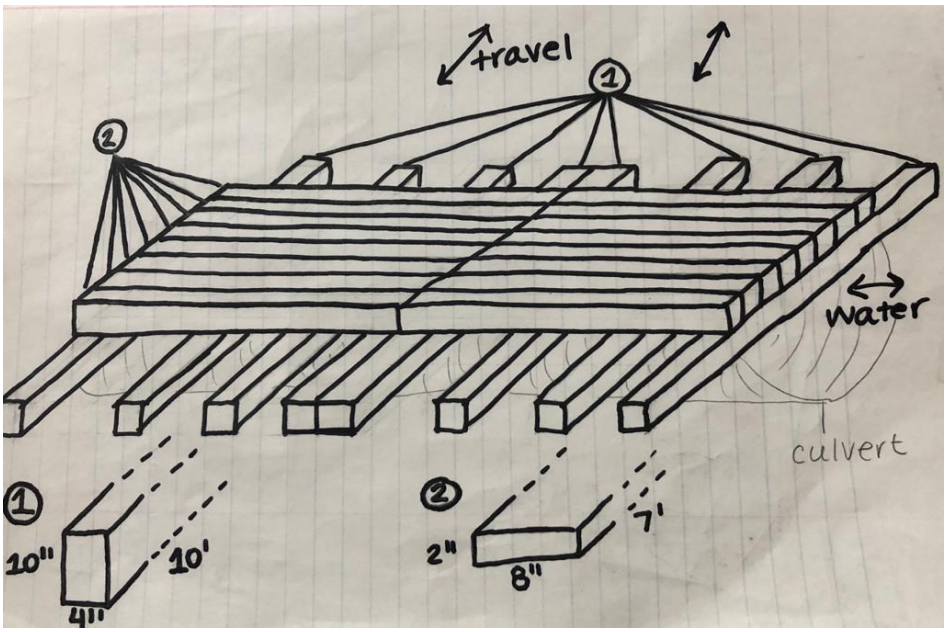
Arguably one of the most critical things we learned during this project was the importance of communication. Especially because of the significant language barrier, we often found ourselves reiterating our points and asking endless questions. The language barrier also led us to rethink our social interactions. For example, we used pictures of loaded trucks to gather information from the local residents about the loads we should design for at each bridge. We also analyzed other small timber bridges in the area to brainstorm design ideas because we were unable to discuss the designs with a local engineer.

The characteristics of the original designs were much simpler than the final designs and deliverables. The initial designs included only timber beams spanning into the dirt on either side with a truss on top or under the bridge, and perpendicular planks laid on top. The design process began with preliminary research of wooden bridges and material properties of teak and mahogany. Next, we proceeded with load calculations to determine the dimensions of the wood we could use and its actual stress value. By comparing the actual stress in the timber beam to the allowable stress for that species of wood, we confirmed that the bridge designs would support the desired load. The allowable stress of teak and mahogany were not listed in the National Design Specification Handbook (NDS), but we could assume teak and mahogany would still be strong enough through inductive reasoning because both species are stronger than Douglas fir and Southern pine, which are listed in the NDS. We confirmed the wood dimensions and required quantities based on finalized culvert dimensions. The mahogany tree we chose to cut down to supply the first bridge needed to be cut down regardless; its roots were growing into someone's home. After observing the project site and other nearby bridges, we were steered away from using a truss in the design as very few other bridges in Ghana utilize

trusses. It was also not necessary, and the culvert was too narrow and shallow to include this type of support.







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Our team brainstormed various methods of leveling a surface underground to lay the timber beams uniformly, like a shelf. Then, while excavating the shelf, our Ghanaian colleagues insisted on using concrete to encase the wood to prevent termites from accessing the wood. Further analysis of the concrete design and the expertise of a graduate student at WPI led us to also incorporate rebar. The rebar was placed laterally on the shelf to provide reinforcement as vehicles drive over. Another design feature we added was treatment of wood with pesticides based on an interaction with the Chief Engineer of the District, Wonder. The co-design process allowed us to adapt our design often based on new information from our colleagues. Overall, this led us to a more complicated project timeline, but with the help of everybody, we were able to accomplish each of our goals.

Our Ghanaian colleagues taught us how to use concrete in a setting so different from our home. Mixing and pouring concrete comprised a very significant portion of our timeline and took even longer than expected because all the mixing was done in a big pile by hand and shovel on the side of the road. The ratios and methods used for mixing are not precise and even changed periodically based on the availability of materials. After the first day, we were able to apply what we learned from the mason to mix the rest of the concrete following his methods. Other local tricks were observed along the way, such as how to use wet paper bags to fill gaps in the framework. Concrete curing times were adjusted from what we know as well based on the

properties of the concrete that was poured and whether it would be critical to the structural integrity of the bridge.

Many steps of completing these bridges took longer than expected, because it is more difficult to keep everyone on the same page when designing cross-culturally. Ultimately, it was worth it to take this time because it helped everyone learn more from the experience. Additionally, this helped us to encourage precision during construction. Most small-scale projects in Ghana involve little to no planning or structured methodology for completing tasks. In America we would measure twice before metaphorically cutting; in Ghana, it seems the cut will not be perfect no matter how many times you measure. A compromise resulted between our intended precision and a lack thereof, but fortunately, the designs were flexible enough that these imperfections did not dramatically impact the construction and completion of the bridges.

Finally, our cross-cultural partnerships brought inequitable gender roles to light. We first noticed this trend during our interactions with the students; typically, only boys are allowed to play soccer and only girls are allowed to play Ampe, a Ghanaian dancing game. We later saw this carry into our work on the bridges. At first, it seemed that every time the female members of our team picked up a tool, it was taken away by a male counterpart within seconds.

"Fetching water is traditionally done by females; that's why Kristophe and [Ryan] walked over."

We all grew very frustrated by this trend but managed to challenge these norms when appropriate. Letisha, the only female of our Ghanaian colleagues, proved to be the most innovative, resourceful, and ultimately the most valuable of any of our local partners. This is a notion that could only be identified and fully uncovered through participation in a community over a considerable amount of time.

Takeaways from the Cross-Cultural Co-design Process

Overall, we have internalized the art of active listening, participating in thoughtful conversation, remaining open-minded to project fluidity, and having an empathic presence. For example, the work week and work hours are extremely different from the United States. Work starts early, with a long lunch break to avoid the midday heat, before finishing in the late afternoon. Further, Thursdays are community days, used for community labor, funerals, or town meetings, and Sundays are for church. However, contrary to the United States, Saturday is a viable workday. When we adapted to these differences and embrace the local norms, both personally and in the co-design process, we were able to work more efficiently and successfully towards our goals.

"Measure twice, cut once"

The interaction and interdependence of our two cultures has allowed for growth and change for both parties. One challenge we identified through this experience is the intersection of very different ways of preparing and planning for a project such as building a bridge. Our education has trained us to follow a step-by-step design process while our Ghanaian partners seem to plan and execute simultaneously. Encouraging more preparation and embracing the "measure twice, cut once mentality" may help to save time, resources, and energy in future projects. To us, this "whatever works" methodology and other factors, such as the language barrier, made it difficult to communicate objectives and make decisions with our partners. We must resist the urge to fall back on our customary beliefs while maintaining our engineering background, all the while blending the expertise of our Ghanaian counterparts to create a viable, economical, and simple design. Because we were working in a different culture, we often did not employ our familiar design trends. Other cultures may not see eye to eye with our culture's typical way of designing, which can be beneficial. During this process of reconciliation, we made sure to take cultural differences into account to avoid the common mistake of solely pursing development.[xii] Understanding our cultural differences in these regards was the first step in effectively implementing co-design in our project. However

simple, this first step required listening, critical thinking, and cross-cultural communication, strategies that are often lost when working on projects in the United States.

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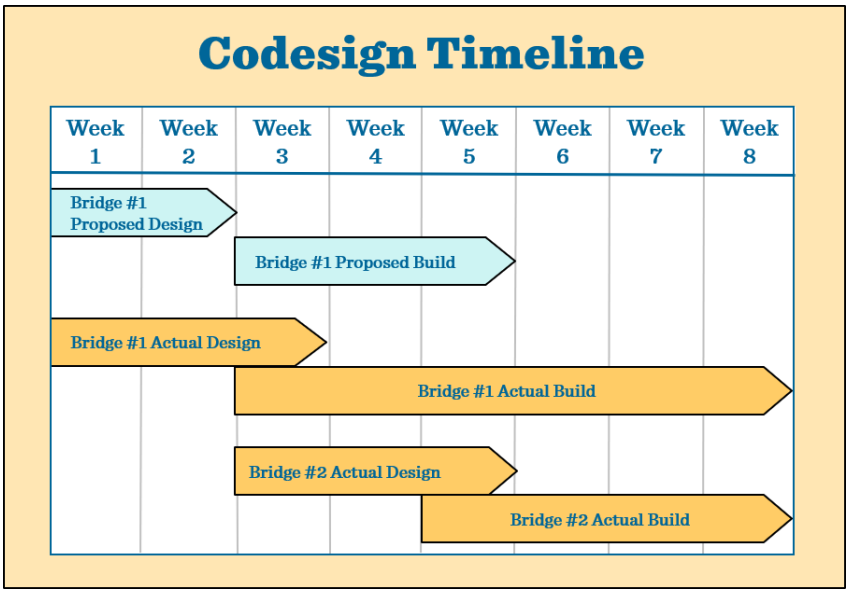
Ultimately, two decisions significantly altered the technical aspect of the co-design process. First, the use of concrete in the design required more time, labor, and material than we previously thought. Second, the unexpected addition of the second bridge to the project resulted in a condensed timeline and required a higher degree of coordination between our project group and our local partners. This is seen in the comparison between the initial timeline with one bridge without concrete and the actual timeline with two bridges that both are constructed with concrete. Before arriving in Ghana, we projected that the project would take five weeks to complete. However, after executing the co-design process to construct the bridges, it took close to eight weeks. Again, this would have resulted in more hardships without

the close assistance of our local partners, including communicating, problem-solving, and adapting alongside each other.

It is important to note that the decision to add concrete to the design occurred during the excavation process of the first bridge. This means that, unexpectedly, we would be embracing a design-build delivery method as the design fluctuated during the early stages of the construction process. While frustrating at times, this can be beneficial with the introduction of new information. However, it is necessary to include flexibility in the project timeline to allow enough room to adapt to these changes. As illustrated by the comparison between the proposed co-design process and the actual co-design process, the inclusion of concrete not only lengthened the schedule, but also added complexity to the plan. Overall, although concrete adds more variables and the need for coordination to the project, its inclusion in both bridge designs should increase the lifespan of the bridges and save time and resources in the future.



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After working in Dwenase for seven weeks, we understand that our local partners know how to build a bridge. Yet, just as we learn a lot when we are immersed in the local culture, we now realize how much our partners are able to learn from the culture that we bring with us. This results in an evolving co-design process that requires effective communication and decision-making optimization to reach our end goals in an effective manner. We now

prioritize listening, communicating, and maintaining an open mind during cross-cultural interactions. Every step of the way it was necessary to challenge our American-Ghanaian design team to continuously engage in participatory design.

Future Design Considerations

One goal that we maintained throughout this experience is to exchange knowledge between cultures. We could already see the fruits of this exchange during construction on the second bridge. Ideally, this knowledge could be transferred beyond those who were directly involved in this project. There are a plethora of bridges and other infrastructure that could be improved in terms of safety and ease of use. The Ghanaian partners we worked with have the ability to combine their resources and knowledge and spread it among others to complete these projects and ultimately enhance their community.

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Many African countries are impacted by the ramifications of colonial rule, particularly communities getting caught in a cycle of government dependence.[xiii] Thus, education, and specifically technical education, can help local communities break free from this cycle and work towards independence and becoming self-sufficient. When the townspeople grasp the role of process planning and design preparation, they are able to bring the necessary components together and complete infrastructure projects independent of the government. Eventually, businesses could be created and grown by those who work together and take advantage of the local supply of skills and resources.

"Working on the second bridge, the [local tradesmen] on site now know what to do, what not to do, and why they're doing it."

With future projects that utilize a co-design process, more knowledge and experience can be exchanged with our local partners to help contribute to their independence. These future co-design processes should include a large degree of flexibility due to the evolving circumstances surrounding the projects. This applies to both the project timelines and the final decisions for the project itself.

Further, the local partners for the given project should be identified prior to arrival in Ghana to help fully integrate them into the information gathering, brainstorming, and design phases of the process. Not only will this help avoid problems due to incorrect or a lack of information, but it also allows the partners to learn from the conception of the project all the way through execution and completion. The design and construction of the second bridge was significantly more seamless than the first, partially because we had already spent time working and getting to know our partners. During this time, we learned how to work together and communicate, and we established common ground rules. For example, it took several weeks to work out a compensation system for our colleagues that fostered good co-design and did not hinder our overall experience. The construction timeline of the first bridge was often put on hold by some of our partners refusing to work without increased pay. Ultimately, the purpose of our project was to benefit to local community, so some of our partners continued to volunteer their efforts in the name of that common goal, while others chose not to participate. These established rules shaped our interactions, improved the productivity of our project, and laid a foundation for future relationships.

Future projects will have the ability to make an incredible impact on the local community, both in tangible deliverables and education. Ultimately, this can improve the stature of and level of development in Dwenase and can encourage the people there to improve their town without the assistance of outside partners. This will contribute towards a higher standard of living within the town and can improve the life experiences of its community members.

Credits and Acknowledgements

We would like to thank the following people who made our project possible. Without their help and assistance throughout this process, this project would not have been feasible and we would not have had the wonderful opportunity to work in Dwenase.

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- The **IGSD team** at WPI provided logistical support for the creation of the project center and helped make this IQP site a reality.
- The **Chief of Dwenase, Nana Osabarima,** worked tirelessly alongside Dr. Krueger to prepare for our arrival and provided constant support during the project.
- **Nana Kwesi, Kwame, Kofi, Leticia, and Dominic** worked with us throughout the co-design and construction of both bridges offering their hard work, problem solving skills, and expertise.
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- And last, but certainly not least, we would like to thank the **community of Dwenase** and all of its residents for welcoming us with open arms, contributing to the project, making us feel at home in Dwenase, and without whom this project would never have been possible.

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