Design *With* the Majority:
The Collaborative Design of a Cargo Bicycle for Uganda
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Introduction

This paper describes the exciting and rewarding process of designing a bicycle in collaboration with Ugandan bicycle couriers. The design was developed over a period of two years through a team of Ugandan advisors with an American designer (the author). A prototype was created and brought to Uganda for three weeks. He met daily with the Ugandan couriers, tested the bicycle, and discussed revisions and improvements. The project's subject was the bicycle design, but the research objective was to learn what it means to design for the people of a very different culture and economic environment. Valuable lessons were learned regarding the design of products for people of developing nations.

The Problem

In Hoima, a small community in Uganda, Africa, many residents use bicycles for transportation. Only the very prosperous can afford to buy and own a car or truck. Whether it's to deliver some goods to the market, or to carry water from the well to their home, they rely on a traditional bicycle for their transportation needs. However, the bicycles that are available to them are unreliable, inefficient, heavy, incapable of carrying cargo, and of very poor quality.

Figures 1. A boda-boda cyclist pushing a loaded Hero bicycle in Kampala (left) and giving a passenger a ride (right) in Hoima, Uganda.

In North America and Europe a bicycle is used primarily for recreation and exercise, but in the rest of the world, it's a critical form of sustainable transportation. However, bicycle manufacturers don't design bicycles for the developing world; they design them for the richest 10 percent of the population.

The Objectives

The outward objective of this project is to design and develop a low cost utility bicycle with rural Ugandans as the target user. The solution could be appropriate throughout East Africa and other parts of the world with similar conditions. The eventual goal is to convince a manufacturer to

produce and distribute this bicycle design to developing countries. In order to generate interest and gain credibility, the design must be practical, manufacturable, unique and feasible. The bicycle must be able to carry loads up to 300 lbs in addition to the rider. It must withstand the rugged roads and conditions of the environment. It must be strong and durable, with minimal maintenance. And the most difficult constraint to meet is a retail target cost less than $80 USD.

The underlying research objective of the project is to learn about what it means to design for people of a developing country and of a different culture. How can a Westerner design an appropriate and successful product for an African? What are the challenges and obstacles? Are people the same all over the world in relation to the products they use? What design process works? In order to answer these questions, intensive research was done in multiple areas; hard facts about the country, the environment and conditions present, the intended user, the existing bicycles in use, the infrastructure of repair and maintenance, and the culture of the user.

RESEARCH

The chart below highlights some contrasts between the US and Uganda.

Statistical Contrasts	**USA**	**Uganda**
GDP per capita	$46,000	$1100
Fertility Rate	2.1	6.8
Infant mortality rate	.006%	.07% (11x)
Population HIV/AID	0.6%	4%
Population under 15 years old	20%	50%
Life Expectancy	78 years	52 years
Population	303 million	31 million
Geography Size	9.8 million sq km	.24 million sq km (size of Oregon)
Agricultural Labor Force	0.6% of population	82%
Internet Users	69% of population	2.4%

Source: CIA World Factbook

Most Ugandans are subsistence farmers. Health care is inadequate so major infectious diseases are a very high risk and include hepatitis A, typhoid fever, malaria, plague, African sleeping sickness, and schistosomiasis. A paved road is a rare treasure to find in Uganda, for only 22% of the roads are paved and the majority of those are in its capital Kampala. Most are rough red dirt and clay which get extremely slippery when wet. When dry the fine clay dust fills the air, making visibility difficult.

The User: the Boda-Boda

A Boda-Boda is a person who gives passengers rides, or delivers goods on his bicycle or motorbike. He is essentially a two wheeled taxi driver. The name may come from the word “border,” as they may take your across a border. Or it may come from the puttering sound of a motorbike. Either way, the Boda-Bodas are a prominent form of public transportation in East Africa. They are everywhere, hanging out on street corners, under the shade of trees, sitting on their most valuable possession and their primary source of income, their bicycle.

Boda-Bodas start out with a bicycle and deliver passengers or goods for a small fee. A short in-town ride might be 200 to 300 Ugandan shillings (15 cents US). They carry passengers more frequently in the rural areas and small towns. They attach a vinyl-padded cushion on the rear rack and bring children to school or business people to their office. In Kampala, the bicycles are more

likely to be beasts of burden, acting more like a two-wheeled wheelbarrow for loads of goods. Fruit, firewood, 50 kg sacks rice, full-size steel bed frames, 5 gallon jerry cans of water, and whatever else one can imagine. In Kampala one bike was seen being pushed through traffic with six 50kg sacks of sugar (totaling 300kg/660 lbs) loaded on the back.

The Hero Bicycle

The most common vehicle throughout the country is the black Hero bicycle. This design was originally built in 1913 for the British military, and it has not changed since. The Hero is made in India and shipped completely broken down. The bike can be assembled anywhere with a minimum of standard tools. It is sold at retail for about 110,000 UGX ($65 USD) assembled. The quality of the bike is extremely poor, worse than the American equivalent to a department store bike. The bike is a roadster style with 28 inch wheels, a single-speed freewheel, steel rims, a heavy gauge steel tubing, and levered rod brake system. It weighs about 45 lbs with a rear rack. It's gearing is much too high for even the slightest uphill grade. The parts are made with such low tolerances that there is no hex nut that is quite the same, and none seem to fit a standard wrench size, English or metric. The steel is a low-carbon soft steel that easily bends or distorts. The steel rimmed wheels are out of true even when new. The geometry of the "cockpit" is constrained and awkward, but that is partly due to personal convention. There is only one size available for the Hero, and it is too large for the majority of East Africans (who tend to be a couple inches shorter than the average American). The primary asset for the Hero is its ubiquity. One can find the exact same model and its parts throughout Africa. Considering that they seem to be constantly breaking, this becomes an extremely important factor.

Bicycle Shops and Parts Availability

The bicycle shops in Uganda are about the size of a large closet or shed. Open in front with a counter and walls filled with shelves and spare parts for the Hero bicycle. Only one tool was found, that is a flat steel multi-purpose wrench with the intention to fit all of the nuts on a Hero bicycle. One can find tires (28 and 26 inch), chains, air pumps, patch kits, ball bearings, inner tubes, bells, bearing cups, brake parts, forks and most parts of a Hero. Low quality mechanical tools such as adjustable wrenches, screw drivers, and crescent wrenches could be found at automotive/hardware shops. The availability of such tools and parts were important to consider in the design of the bicycle.

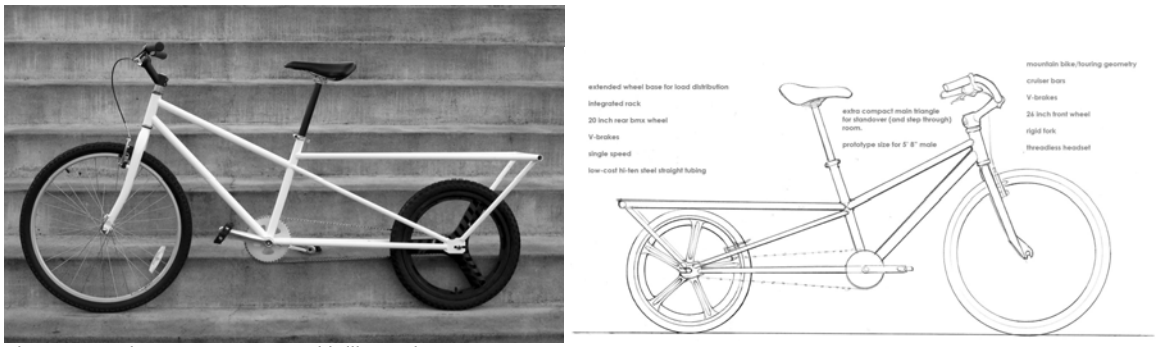
Figure 2. A bicycle shop keeper in her store (left). A man lacing and building a wheel (right). Kampala, Uganda.

THE DESIGN PROCESS

The design process started with a connection to an American resident of Uganda, Reverend Shirley Morris of the Anglican Church. Through this relationship with Rev. Shirley, an important conduit of information and research was available to inform the initial stages of the design. Rev. Shirley was a regular passenger with the Boda-Bodas for personal travel and had developed friendships with them. A need for a better bicycle was noticed by several in the community as well as by Americans who had visited Uganda.
Rev. Shirley became a mediator between the American designer and the Ugandan users. She formed a "design team" of Ugandan couriers who gathered regularly for lunch to discuss the ideas the American designer had for a new bike design. Drawings were emailed to Rev. Shirley and printed in Uganda, reviewed and critiqued by the Boda-Bodas who then sent their comments back to the US. For almost two years, designs were proposed, revised, refined and changed through these lunch time meetings. After several iterations a design was finalized and a prototype was made in the US. The designer then traveled to Uganda to meet the couriers and to have the bike tested and critiqued.

Prototype 1.0

The first prototype design is essentially an elongated mountain bike with an integrated rack. The front geometry has comfortable mountain bike geometry with a low stand-over height, rigid fork, and 26 inch front wheel. The 20 inch rear wheel has been moved back, increasing its wheelbase 10 inches which allows for a more distributed load between the two wheels and provides more area for loads and passengers. A rear rack is designed to be integrated into the welded frame and is in the form of a tetrahedron. This is a very structurally rigid and lightweight form.



Figures 3 and 4. Prototype 1.0. with illustration.

All extraneous parts and accessories were omitted. The rear wheel uses a coaster brake hub to eliminate rear cables, brake pads, and reduce maintenance. The drive train is a simple roller chain, single-speed freewheel and is geared low to roll at 12 mph at 90 rpm. (3.7 m (145 inches) per revolution development). A small rear wheel allows for a lower platform and center of gravity for carrying cargo. This would be advantageous for some types of low density cargo, such as firewood or charcoal and is stacked high on the bike. A small 20 inch wheel is structurally stronger but has higher rolling resistance than a 26 inch or larger wheel.

Relationships

The designer spent a majority of the time in Uganda building relationships with a group of Boda-Bodas. This group of ten young Ugandans had formed an organization, the Hoima United Riders Association, which was a community of colleagues that supported each other in their professions and their families. These men were open, friendly and adopted the designer into their community.

They invited the designer to visit their homes and meet their families. Their small homes are typically made with wood framework and mud or homemade brick, a corrugated steel roof, with no glass windows, no plumbing, no electricity and four small rooms. The designer was honored to visit all ten families at their homes, eat with them, meet their numerous children and was given generous gifts, such as sugar cane stalks, pineapples, avocados, and live chickens. The designer spent nearly everyday with these men over the course of three weeks. This contact allowed him to learn about them, their concerns, and their culture. This experience was invaluable in affecting the bicycle design.


Figures 5 and 6. The designer with Patrick, his two wives, and twelve children in front of their home in Hoima. (left) Discussing the difficulties of brake adjustment. (right)

Reactions and Revisions


Figure 7 and 8. First bicycle prototype test with 3 passengers. Debate and critique of the design, Hoima, Uganda.

Several meetings were held with many different Ugandans in Hoima to test ride the bicycle and discuss ways that it could be improved and features that they liked. Positive comments were received on its light weight, lower gear ratio, performance of linear brakes, riding comfort, color and its ability to carry loads. Negative reactions were regarding its different sized wheels, the lack of a chain guard, the rear platform low height, its need for foot pegs, and its lack of compatible parts availability. Everyone was open to new technologies, such as linear pull brakes and quick release skewers, as long as there were compatible parts available. “How much will it cost?” and “Can I get spare parts” were the most commonly asked questions. The bike performed well through many rides on the rough roads around Hoima and was used frequently with passengers.

LESSONS ABOUT DESIGNING FOR EAST AFRICANS

Cultural Contrasts

A number of important lessons were learned from this experience, the first of which was the realization of the difference of cultures and how it affects product design. Designing for another culture requires an understanding of the culture and how the people think differently. East Africans are culturally different from Americans is some obvious ways and some puzzling ways.

In Uganda, the communities needs come before the individuals. Friendships and family come before career. Saving money is considered hoarding and selfish, because someone in your community could need it now. A Ugandan invests in their friends and family, because when all else is lost, those are the people that you can rely upon. This mindset seems to come from a long history of poverty and disasters. (Maranz, 2001 and personal observations)

It seems that nothing is reliable in a Ugandans world. Politicians are corrupt and expected to be. Being bit by the wrong mosquito could means contracting malaria and dying a week later. Drinking the wrong water could mean a life threatening disease. A job may be here today and gone tomorrow. That employer may pay you, or may not and disappear. The rainy season may come early or late, or you may have a drought and your family will starve. Electricity for an entire town is turned on and off at random times by the power company. If you are injured and go to a hospital, the doctor may be there, or they may not, and no one knows when or if they will show up to work that day. All of these are accepted facts of life for a Ugandan, but are maddeningly frustrating for an American.

This unreliability leads to awareness that life is very short, random and unpredictable. This awareness affects decision-making in regards to long or short term benefits. The immediate need is addressed over the long term need. The subconscious thought might be: “Why would I choose a more expensive, well designed product that lasts many years, when I could die of malaria next month, or rebels could invade my town again and steal it?” These are real concerns and real possibilities for an African.

However, Americans tend to think and live as if they are going to live a long life in peace, continue earning money, never get sick, always have food to eat, enjoy continuous electrical power and internet access. Such are the luxuries that are taken for granted.

In regards to products, the story is the same. Shops are filled with a limited selection of the lowest quality, barely functioning products imaginable. These are all made in China or India with the lowest standards in order to meet the lowest price possible. The only equivalency that one might find in America is the products in a discount “dollar store,” but even those are higher quality products. Of course there is a high-end mall in Kampala with quality products, but only the very wealthy can shop there. This low standard for quality affects how a product may be designed. One of their first questions concerning the bicycle design, was “where can I get spare parts?” This reveals the implicit expectation of broken parts. A great limitation to design decisions is the lack of available replacement parts and tools for maintenance and repair. Many well-intentioned “designs-for-the-majority” are abandoned once they cease functioning because of this limitation.

Ugandans are extremely cost and value sensitive. Most are subsistence farmers and don’t have much, if any, extra money to spend on products. The education of their children is a priority, so school fees take precedence over any other product beyond food, clothing and shelter. Because of this, careful consideration is taken when comparing a lower cost product with a higher cost one. Unless the advantages of the higher cost option are abundantly clear, and others in their community confirm it, the lowest cost item will be chosen. (Aguiar 2007) This is congruent with

their attitude about meeting immediate needs first. Products are also commonly shared, such as bicycles and cell phones, and consequently experience heavy use.

Respect for the Community

Designing for another culture requires respect and meaningful egalitarian relationships with the people of that culture. The design process should include the people who are the target users. The effect of including Africans into the design process not only enriched the design but also encouraged the community of their importance. The Ugandans took great pride in their role as advisors during the design process. They told everyone in their community and even announced it on the radio. They waited with great anticipation for the arrival of "their" bike. The day it was taken out of the box they rode it into the center of town and proudly waved to all of their friends. This collaboration lifted the social status of this group of bicycle couriers, and it gave them a stake of ownership in the project.

Leapfrog or Stay Compatible with Technology

A designer must decide whether their new design is going to specify the newest or old, existing technologies. A new technology would perform better but would be incompatible with the existing infrastructure, leading to a very short product lifetime. An old technology may not work as well, but it would be understood, acceptable and would have compatibility with available parts and tools and therefore repaired and used for a longer time.

A successful example of technological leapfrogging is the cellular mobile phone. Uganda has a limited wired land phone line. Only the wealthy and businesses can afford to install and pay for a land line. However cellular phones don't need a line to be installed to every house and hut, so it made sense to install cell towers and sell mobile phones. This has proved to be very successful in Africa and many residents now own or share cell phones.

Figure 9. Repairing a cottered crank arm on a Hero bicycle. Hoima.

With bicycles the situation is different. For the past 30 years or more, the exact same Hero brand bicycle has been shipped to and sold extensively in Uganda. Although its component parts are peculiar, poorly functioning and outmoded, they are available everywhere, even in small towns. The brakes, for instance, are barely functioning, use dozens of parts, are hard to adjust, and must be disassembled to remove the wheel. But, in streets of Kampala you can see people cutting apart old auto tires into little chunks, inserting a screw through the center and selling replacement pads. So the question becomes, do you chose the superior modern linear pull brakes, which are easy to use, simple and effective, over their antiquated rod brakes? And if so, where will people find spare brake pads if no shops carry them? Conversely, how can you convince bicycle shops all over Africa to carry these new brake pads when there are no bicycles that use them yet?

It seems that there are three options. One option is to stay compatible with old technology, which would lead to greater acceptance, but may not offer significant improvement. Second is to use the latest superior technology, which would require substantial investment to flood the market with compatible parts, tools, and support services. Third is to cleverly improve the performance and design, yet use existing parts, tools and technologies. This is a significant design issue when designing for a developing country. To buy a newly designed product has much more serious ramifications than one would expect.

Conclusion

Designing products for people of developing countries can be done appropriately with intensive research, cultural understanding, meaningful relationships, collaboration and respect. If the users can be involved in the design process, it leads to shared ownership and increased credibility within the culture. With some revisions and manufacturing support, this bicycle design has the potential to be very successful in the African marketplace.

Reflections: Teaching Design in Africa

Why is an American designing for a Ugandan problem? Wouldn't it be ideal for a Ugandan to be designing for Ugandan needs? Should they be given a design, or taught how to design? How can the skills and thinking of the modern design process be taught to Africans? These are questions that arose while visiting with the students and faculty of Kyambogo University. Given the tools, Ugandan designers could be solving Ugandan problems with much greater success and without the cultural hurdles. Design consultants could be established in Uganda who are local and have the design talent, and design for the East African market.

An exciting birth of design education is happening in Africa. In Uganda there are the seeds of industrial design programs at Makere University and Kyambogo University. But, there is a need for faculty training and education, because of the limited number of product designers in East Africa. Entrepreneurship needs to be encouraged to create small businesses that address the design problems unique to East Africa.

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