The Test Strippers
Group 8

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The Cotton Catch

Problem Statement

Our Design for Emerging Markets (DEM) project was to maximize the utilization of UTI test strips in third world Africa. The goal was to design a simple, inexpensive, low-waste, and durable system that allows urine to be tested for UTIs on a test strip. This prototype must be able to be manufactured in the country with locally available materials.

Another idea we had to keep in mind while designing the product was the concept of a Cradle-to-Cradle design, which is a biomimetic approach to the design of products and systems. It is a holistic economic, industrial, and social framework that seeks to create systems that are efficient and essentially waste free.

At first, the goal was vague. We found it challenging coming up with ideas, especially since there wasn't a definite solution. A lot of our time spent on the project early on was put towards thinking of a creative solution.

Concept Development Summary

For this project, we chose Tanzania as the place in which our design could be used. Tanzania is a large country located in East Africa. One thing we really wanted to look into was the resources available in Tanzania. Through our research, we found Tanzania has a wide variety of available materials. We also wanted to research the economic situation of Tanzania. Tanzania has a large population of low-income families so access to health care is sparse. The government, however, has made a strong commitment to improving the health care system. Though their progress is slow, the country's main source of financial assistance for health systems is donor's money. The average annual income in Tanzania is $630 US dollars, and an astounding 28.2% of the population lives in poverty. We looked into Tanzania's UTI situation, as well. There was not that much information available regarding whether or not Tanzania has products to test for urinary tract infections (UTI). However, studies show that UTI is a problem in this country. A study of 247 pregnant women attending the Bugando Medical Center in Mwanza, Tanzania showed that 78 (31.5%) of the women were symptomatic of UTI. Tanzania seemed like a good market for the UTI test strip.

For prototype one, our biggest concerns were cost and environmentally friendliness. Since the poverty rate in Tanzania is so high, we wanted our design to be very cheap. We researched biodegradable dixie cups and biodegradable sandwich bags to see if we could implement them into our design. Durability and packaging were of lesser importance. Our mindset was that if we

came up with a “green” design, the other requirements would fall into place on their own. Up there in importance with cost and environmentally friendly was sanitation. Obviously, urinating onto a test strip or into a cup held in your hands will raise eyebrows when considering cleanliness. We also wanted our design to be user friendly. Our design would be useless if nobody knew how to use it.

Testing Prototype #1
Team Number 8 - The Test Strippers
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09/22/2014, 12:20-02:15 PM, Hammond Building, Penn State University

DEM project (UTI Test Strip) - Prototype 1 - Test Plan and Report

1. **Test Results Summary**

Test Descriptions

User Need / Feature	Describe Test	What is “pass”?	Materials / tools needed to run the test
1.) Cost	Calculate unit price of everything used	Less than $0.25 without being marked up	calculator, prices, internet
2.) Environmentally friendly/Reusable	Search if the design components are biodegradable and/or reusable	It has environmentally friendly features	internet, facts
3.) Education/user friendly	Test to see if other people can follow picture directions	Users can use the prototype easily with no problems	user, directions
4.) Sanitation	Test if there is a splash or if hands get wet - using water bottle with a hole in the top Test if it is easy to dispose the bag	No splashing on body and hands. Bag is disposed without spilling urine.	urine stream or a water bottle

5.) Packageable, portable	Test if it can be stacked or compressible	Bags and cups are easily stacked.	box, more than one prototype
6.) Durabililty	Test if cup can hold full sample, doesn't easily tear	Everything holds together	couple prototypes, stress tests, water, scissors.

Table 1: Testing plan for prototype 1

All of the desired features and ways to test them are listed in the above table. Tests were conducted, and the results are shown below.

Test 1

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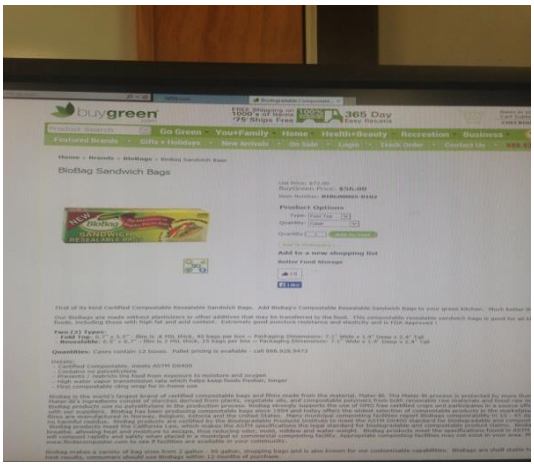
As a group, we decided that the most important aspect of our prototype is the cost. People in Tanzania do not make much money, so our prototype needs to be very cost efficient. Through our research, we found that the minimum wage for jobs in Tanzania was about $0.25/hour, so thats what we want our prototype to cost without being marked up. We researched all of the materials in our design, and their prices are listed in the table below.

Item	Cost Per Unit
Biodegradable Cup	$0.08
Biodegradable "Fold Top" Bag	$0.12
Popsicle Stick	$0.01
UTI Test Strip	$0.02

Total Cost of Prototype	$0.23

Table 2: Prices of the items used in the prototype

The total cost of our prototype is $0.23, which passes the test because it is lower than $0.25.



Picture 1: Price research

Test 2

Our group decided that the second most important aspect of the prototype is whether or not it is reusable or environmentally friendly. One of the main goals of this project was to eliminate waste, and that goal can be accomplished if our prototype is reusable/environmentally friendly. We researched each of the products used in our prototype to determine if they could help eliminate waste. The findings of our research is shown in the table below.

Item	Facts
Cup	biodegradable, reusable
Bag	biodegradable
Popsicle Stick	biodegradable

Table 3: Environmental facts about items used

Through our research, we determined that all of the products used in our prototype are environmentally friendly.

Test 3

The third most important aspect as determined by the group is whether or not the prototype is user friendly. People in Tanzania who do not speak the same language as us and they need to be able to understand how to use our prototype. Our prototype failed this test because there were no instructions on how to use it. While someone in our culture would know

what to do with it, a person from Tanzania probably would not understand. An instruction manual of pictures needs to be made in order to make our prototype user friendly.

Test 4

Sanitation was the fourth aspect that we wanted to test about the prototype, and it is an important aspect because it relates to the health of the users. The objective of test four was to test the sanitation of the prototype. In order to simulate someone urinating into the cup, we poked a small hole in the top of a water bottle and squeezed the bottle. We used this strong flowing stream to see if there is any splashing. The table below shows the distances and the results.

Distance	Result
2 inches	Very little to no splash
5 inches	Very little to no splash
10 inches	No splash

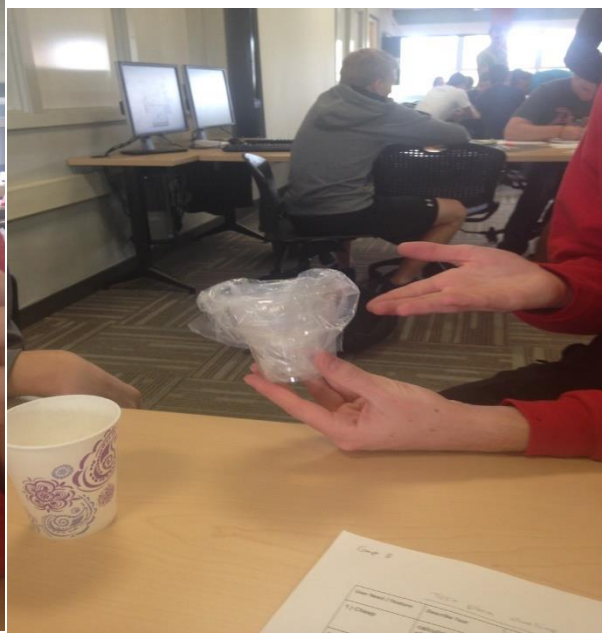
Table 4: Distance between the stream and the cup with the results

The results show that the prototype is sanitary and clean. We also tested if its easy to dispose the urine and nothing got on our hands when we disposed it. Our sanitation test is shown in the picture below.

Picture 2: Sanitation test

Test 5

The objective of the fifth test was to see if our prototype is packageable and portable. What our group had to do was figure out the best possible way to package our cup, bag, stick, and test strip. The idea that we came up with was to put one bag neatly folded inside of the cup and then put a bag in it that was ready to go. The stick was then put in the cup with the bag and we were able to easily stack our cups. This test was important for the shipping of our cups to clinics in Tanzania. The cups would need to be easily distributed to the people in need of them and shipped as efficiently as possible. This test was successful in that we were able to efficiently stack the cups with all of the other components of the test into a small and packageable unit. Our tests showing how packageable our prototype are shown below.



Pictures 3, 4, and 5: Stacking capabilities

Test 6

The objective of test six was to test the durability of the cup and the bag. This is important for the success of the product because people will not buy it if it doesn't do what it is designed to do which is to hold the urine and create a better way to test for a UTI. We needed the cup and the bag to be able to hold a full sample of urine without tearing or overflowing. To test this we blasted the cup and bag with a steady flow of water at a high amount of pressure. The prototype did not overflow after a decent amount or tear. This showed us that the unit could definitely do what it was intended to do. We then just filled the bag full of water and held it up and it was able to handle the weight of the water without it tearing. This was a very successful test and the first prototype was able to pass it with flying colors. The following picture shows how we tested our prorotypes durability.

Picture 6: Durability test

2. Observation Summary:

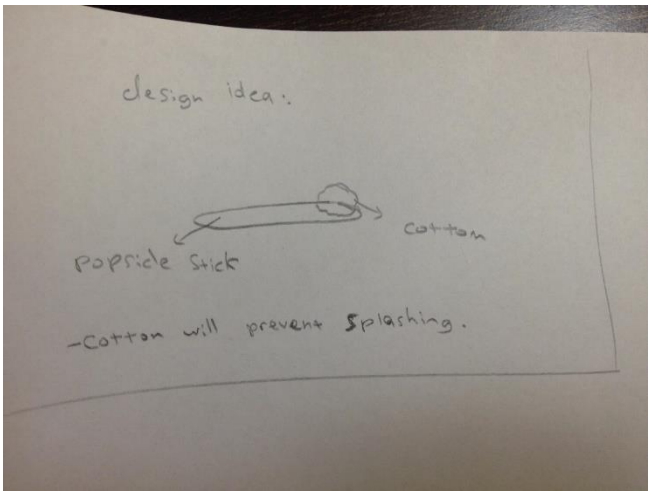
The design we came up with proved to be quite effective. Our design is rather straightforward so the biggest concern has come down to cost. Minimum wage in Tanzania is roughly $0.25/hour so cost has to be as low as we can get it. As for being environmentally friendly, the cups and bags are both biodegradable so that's a check. The idea of urinating in a cup is self explanatory, but we need an instruction manual since the system has to be assembled. The no splashing was a great relief and made the sanitation test a check. It was the first time we tried to package the cups and they fit together well. For the sturdiness test, the cup met our expectations when it was stepped on but still kept its general shape. From the tests, we learned what aspects of our prototype were good and what aspects need some work. The prototype is good for the most part, but it definitely needs an instruction manual. The biggest surprise in the testing was the minimal amount of splashing that occurred when the cup was held at close distances. Other than that, everything was pretty straight forward.

3. Re-design Ideas/ Thoughts for Prototype #2:

This prototype was a successful one but we need to improve a few things about it. First, we need to work on finding cheaper materials for the prototype so it would cost less than what it does now. We might get rid of the bag and just use a biodegradable cup with the test strip directly attached to it, so that would lower the cost. Also, we need to include pictured instructions with our prototype so that anyone can use it easily. We might need to add a test where we give our prototype to someone who is not on the team and ask him/her to use it. Moreover, this test did not reveal if the prototype would be friendly with the female users. In our next test, we should test how the cup and bag works when being used in a squatting position.

Concept Refinement Summary:

Following our testing of prototype 1, we thought we had a winner. We liked every aspect of the design, from the cost to its physical features. However, the Design Thinking Workshop really opened us up to some better ideas. The goal of the Design Thinking Workshop was to forget about our first design ideas and the "normal, everyday" ideas in order to really be creative. We were given time to draw out new designs, and we were told to draw everything that came to mind, no matter how stupid it might seem. Then, we got together as a group, rated each design, and discussed our opinions. While we threw out most of the designs, one design really caught our eye. It was a cotton ball on a popsicle stick. We researched the design to see how cost efficient it would be, and we ran some preliminary tests to see how well it would work. The new design passed all of our preliminary research, and we decided to use it as our second prototype. The Design Thinking Workshop was essential for the development of our second design. Our design for prototype 2 was completely different than our design for prototype 1. We did not change any of the desired features because they successfully outlined every requirement that our prototype needed. Here is a picture of our first sketch of prototype 2.



Picture 7: First sketch of prototype 2

Testing Prototype #2
Team Number 8 - The Test Strippers
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10/06/2014, 12:20-02:15 PM, Hammond Building, Penn State University

DEM project (UTI Test Strip) - Prototype 2 - Test Plan and Report

Test Descriptions

User Need / Feature	Describe Test	What is "pass"?	Materials / tools needed to run the test
1.) Cost	Calculate unit price of everything used	Less than $0.25 without being marked up	calculator, prices, internet
2.) Environmentally friendly/Reusable	Search if the design components are biodegradable and/or reusable	Each component is biodegradable	internet, facts
3.) Education/user friendly	Test to see if other people can follow picture directions	Ten people, including two people who are not in the class, are easily able to use prototype	user, directions
4.) Sanitation	Test if there is a splash or if hands get wet (using water bottle with a hole in the top) Test if popsicle stick can be thrown away without getting urine on hands	No splashing on body and hands. Popsicle stick can be thrown away without spilling any urine	urine stream or a water bottle

5.) Packageable, portable	Test if it can be condensed to be easily packaged	Two prototypes stacked on top of each other are less than 10 cubic inches (standard shipping box size is 12”x20”x20” which is 4800 cubic inches and we want to be able to fit more than 500 prototypes in a box)	box, more than one prototype, internet, ruler
6.) Durability	Test if cotton ball and popsicle stick can handle stream	Everything holds together	couple prototypes, stress tests, water, scissors

Table 5: Testing plan for prototype 2

All of the desired features and ways to test them are listed in the above table. Tests were conducted, and the results are shown below.

Test 1

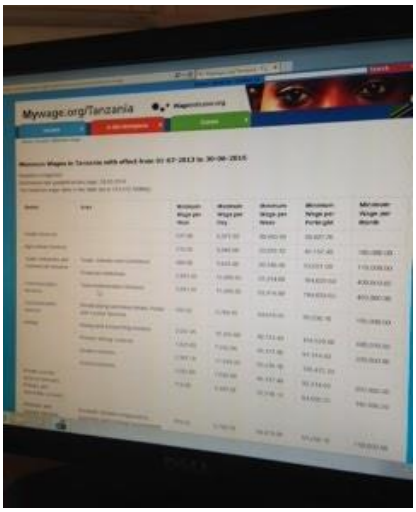
After doing more research and discussing the cost of the product we decided that this prototype should be cheaper than the first prototype. Since the average minimum wage in Tanzania is about $0.25/hour, we decided that the product should cost less than than that. We researched all of the materials in our second prototype, and their prices are listed in the table below.

Item	Cost per Unit
Popsicle Stick	$0.02
Cotton Ball	$0.01
UTI Strip	$0.02
Rubber Band	$0.01

Total Cost per Prototype	$0.08

Table 6: Prices of the items used in the prototype 2

The total cost of the second prototype is $0.08 without being marked up, which is much lower than $0.23 which was the cost of the first prototype. The Cotton Catch passed this test.



Picture 8: Searching the minimum wage in Tanzania

Test 2

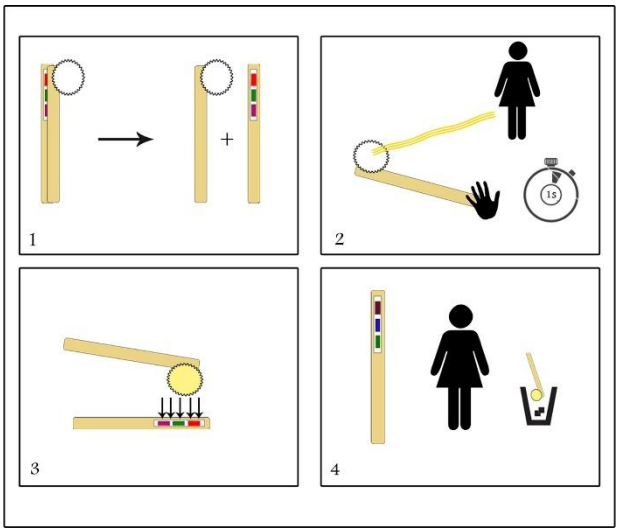
The second most important aspect of our design was that it had to be environmentally friendly. We researched the new items that we used for the Cotton Catch and it passed the test because we have found that both the popsicle stick and the cotton ball are biodegradable.

Item	Facts
Popsicle Stick	biodegradable
Cotton Ball	biodegradable

Table 7: Environmental facts about items used in prototype 2

Test 3

The third most important aspect as determined by the group was whether or not the prototype is user friendly. Our first prototype failed this test because there were no instructions on how to use it. We decided that we should include instructions with the Cotton Catch, and since Tanzanians might not understand the language of written instructions, we decided to have a picture instructions. We then tested to see if people in our class and others out of the class could use our prototype easily with the directions given. They were all able to use the prototype and they said the directions were very clear. So the prototype passed the test. Our directions for prototype 2 are shown below.



Picture 9: Picture instructions for prototype 2

Test 4

For the fourth test, we had to make sure that it was sanitary. It was very important to us that the product would get the job done without someone getting soaked by their own urine. For this test a hole was slit in the top of a water bottle to simulate a urine stream and water was squirted with full force onto the cotton that was just four inches away. We put our hands right around the cotton while it was being blasted by the water to test for splashing. Our results were outstanding. There was little to no splashing because the cotton was able to absorb the water. The fact that the Cotton Catch passed this test with flying colors told us that we truly had a great product on our hands. However, when disposing the prototype, it dripped on the ground. This can be easily avoidable by making sure there is a garbage can very close to the toilet. The following picture shows how we tested the sanitation of prototype 2.

Picture 10: Sanitation test

Test 5

The fifth test for the Cotton Catch was to test if it was able to be packaged and easily portable. This was yet another important aspect of the project. The product needed to be packaged and shipped in the most efficient way possible. To test this we got the dimensions of a standard shipping box and tested how many units could fit on top of one another. We took the volume of the entire box and the volume of our prototype to figure out how many would fit in the box. The prototypes stacked on top of each other so that the dimensions were 1” x 1” x 6”. Therefore, the volume of two prototypes stacked on top of each other is 6 cubic inches. This meant that 800 prototypes could fit in a standard size shipping box (12” x 20” x 20”). The following picture shows us testing how packageable prototype 2 is.

Picture 11: Packaging capabilities

Test 6

We decided that our product would have to be very sturdy in order for it to be effective. To test this we had to really blast the prototype with a steady stream of water to simulate the urine that it would have to endure in order to be a useful and effective product. The cotton ball and the stick were blasted with the water and actually held up extremely well. The hot glue held the soaked cotton ball perfectly. This was yet another test passed by the Cotton Catch. The following picture shows how we tested the durability of prototype 2.

Picture 12: Durability test

Cost Analysis

The Cotton Catch was a huge improvement compared to prototype 1 in terms of cost effectiveness. We went from a $0.20 product to a $0.08 one. The test strip is worth $0.02, but marked up, it's $0.20, a %1000 markup. So, if the cotton catch had a unit price of $0.08, we can assume it gets marked up to $0.80. Here is a breakdown of our costs:

Item	Cost per Unit*
Popsicle Stick (x2)	$0.02
Cotton Ball	$0.01
UTI Strip	$0.02

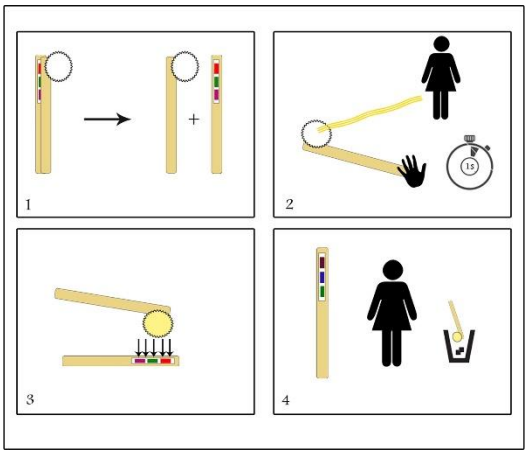
Rubber Band	$0.01

Total Cost per Prototype	$0.08

Table 8: Prices of the items used in the prototype #2
With a marked up price of $0.80, we believe that The Cotton Catch is set at a reasonable price, only being a few hours worth of minimum wage.

User Guides

We have provided picture instructions with the Cotton Catch that are really easy to understand. The instructions show how to use the product step by step.



Picture 13: The picture instructions

Redesign Ideas/Thoughts

Our second prototype was a different design than the first prototype. The HESE students appeared to be very impressed with our product. They asked us a lot of questions concerning the cost of production and the availability of the products used to make the prototype in Tanzania. From all of our research and our great understanding of the product, we were able to quickly answer their questions, and they were very impressed. Overall, the judges were very impressed with our design, and we were awarded second place. There are a couple suggestions that we would have for the next prototype of the Cotton Catch. One thing that we talked about would be a larger handle built into the handle of the original popsicle stick. This would provide a much easier way for the user to test, and it would be more sanitary than the existing product. The

only thing that this would effect would be the packaging of the product. Overall, we feel like our product has tremendous upside, and we are thrilled with how it turned out. It would be an honor if our product was actually used by the HESE students as a solution to the problem of UTIs in Tanzania.

References

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Prevalence of urinary tract infection among pregnant women at Bugando Medical Centre, Mwanza, Tanzania. (n.d.). Retrieved September 8, 2014, from http://www.bioline.org.br/request?th09027

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Tanzania. (n.d.). *Health Systems Strengthening: Where We Work:*. Retrieved Septemper 08, 2014, from http://www.healthsystems2020.org/section/

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* Sample pricing came from:
-http://www.amazon.com/Popsicle-Sticks-Box-of-1000/dp/B003UCFPJ6
-http://www.amazon.com/Rubber-Bands-Size-1900-Pack/dp/B0007893PS/ref=sr_1_2?s=office-products&ie=UTF8&qid=1413770626&sr=1-2

-http://www.blowoutmedical.com/curity-cotton-ball.html?utm_source=google&utm_medium=base&utm_campaign=products&feed_special=google

ADVICE FOR STUDENTS DEVELOPING NEXT PROTOTYPE:

I highly recommend all students to think abstractly when brainstorming ideas. Don't think of something and immediately disregard it because of one flaw. Consider all possibilities carefully and think of what your customers need. Reinvent the wheel. Come up with something better.